

# Specification for Wellhead and Christmas Tree Equipment

ANSI/API SPECIFICATION 6A  
TWENTIETH EDITION, OCTOBER 2010

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ADDENDUM 1, NOVEMBER 2011  
ADDENDUM 2, NOVEMBER 2012  
ADDENDUM 3, MARCH 2013  
ADDENDUM 4, JUNE 2016

CONTAINS API MONOGRAM ANNEX AS PART OF U.S. NATIONAL ADOPTION

**ISO 10423:2009 (Modified), Petroleum and natural gas industries—Drilling and production equipment—Wellhead and christmas tree equipment**



AMERICAN PETROLEUM INSTITUTE





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## Upstream Segment

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, [standards@api.org](mailto:standards@api.org).



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10423 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

This fourth edition cancels and replaces the third edition (ISO 10423:2003), which has been technically revised.

## Introduction

This International Standard, which has been technically revised, is based on API Spec 6A, nineteenth edition, July 2004 and its addendums and errata, and API Spec 6AV1, first edition, February 1996 and its errata, with the intent that the twentieth edition of API Spec 6A will be identical to this International Standard.

The International System of units (SI) is used in this International Standard. However, nominal sizes are shown as fractions in the inch system.

The fractions and their decimal equivalents are equal and interchangeable. Metric conversions and inch dimensions in this International Standard are based on the original fractional inch designs. Functional dimensions have been converted into the metric system to ensure interchangeability of products manufactured in metric or inch systems; see also Annex B.

Tables referenced in the main body of this International Standard that are marked with an asterisk (\*) are repeated in Annex B in US Customary (USC) units with the same table number as in the main body but with the prefix B. In figures where dimensions are given only in inches, the values of surface roughness have been indicated in accordance with US draughting conventions.

It is necessary that users of this International Standard be aware that further or differing requirements can be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this International Standard and provide details.

# **Petroleum and natural gas industries — Drilling and production equipment — Wellhead and christmas tree equipment**

## **1 Scope**

### **1.1 Purpose**

This International Standard specifies requirements and gives recommendations for the performance, dimensional and functional interchangeability, design, materials, testing, inspection, welding, marking, handling, storing, shipment, purchasing, repair and remanufacture of wellhead and christmas tree equipment for use in the petroleum and natural gas industries.

This International Standard does not apply to field use, field testing or field repair of wellhead and christmas tree equipment.

### **1.2 Applicability**

This International Standard is applicable to the following specific equipment:

- a) wellhead equipment:
  - casing-head housings,
  - casing-head spools,
  - tubing-head spools,
  - cross-over spools,
  - multi-stage head housings and spools;
- b) connectors and fittings:
  - cross-over connectors,
  - tubing-head adapters,
  - top connectors,
  - tees and crosses,
  - fluid-sampling devices,
  - adapter and spacer spools;
- c) casing and tubing hangers:
  - mandrel hangers,

- slip hangers;
- d) valves and chokes:
  - single valves,
  - multiple valves,
  - actuated valves,
  - valves prepared for actuators,
  - check valves,
  - chokes,
  - surface and underwater safety valves and actuators,
  - back-pressure valves;
- e) loose connectors [flanged, threaded, other end connectors (OEC), and welded]:
  - weld neck connectors,
  - blind connectors,
  - threaded connectors,
  - adapter and spacer connectors,
  - bullplugs,
  - valve-removal plugs;
- f) other equipment:
  - actuators,
  - clamp hubs,
  - pressure boundary penetrations,
  - ring gaskets,
  - running and testing tools (see Annex H),
  - wear bushings (see Annex H).

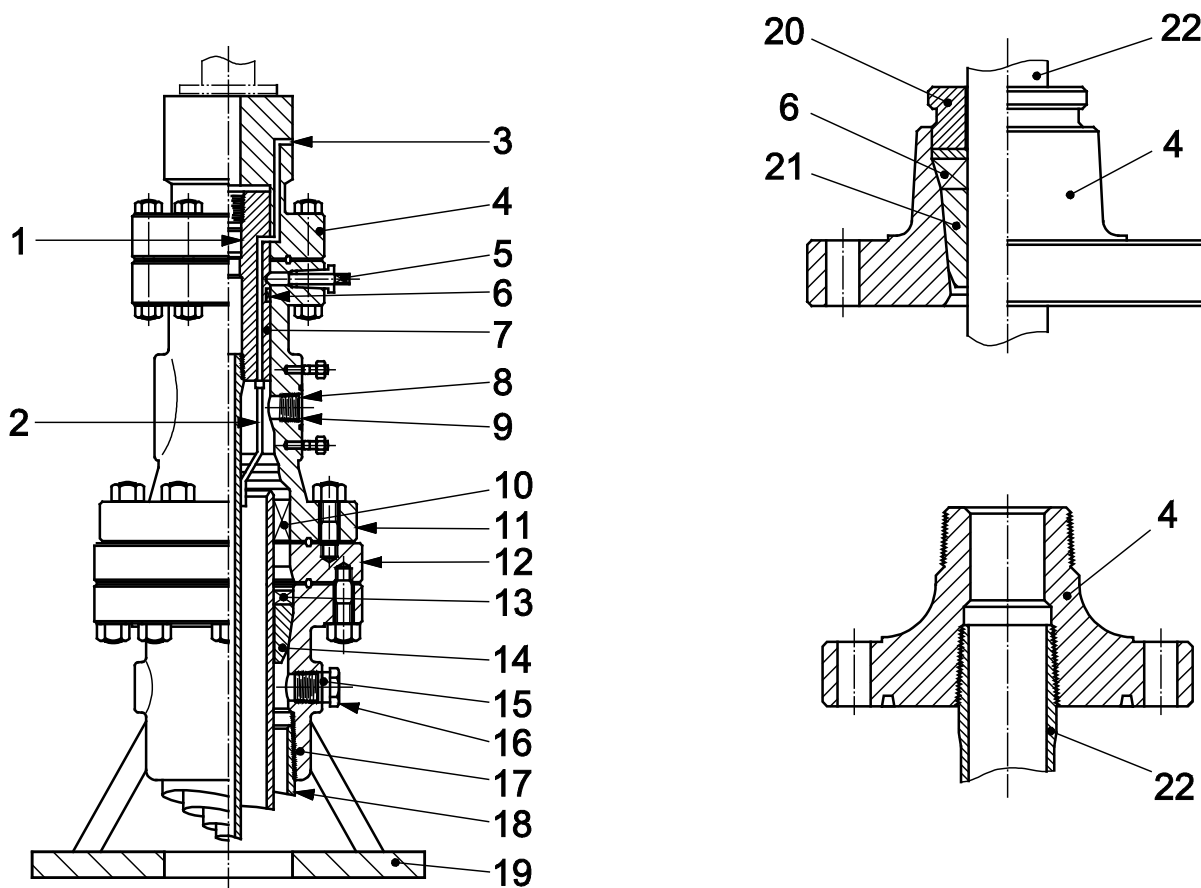
The nomenclature used in this International Standard for typical equipment is shown in Figures 1 and 2. All parts whose physical dimensions conform to the metric tables incorporated into the body of this International Standard or to the tables in USC units in Annex B are acceptable; see Introduction.

### 1.3 Service conditions

This International Standard defines service conditions, in terms of pressure, temperature and material class for the well-bore constituents, and operating conditions.

## 1.4 Product specification levels

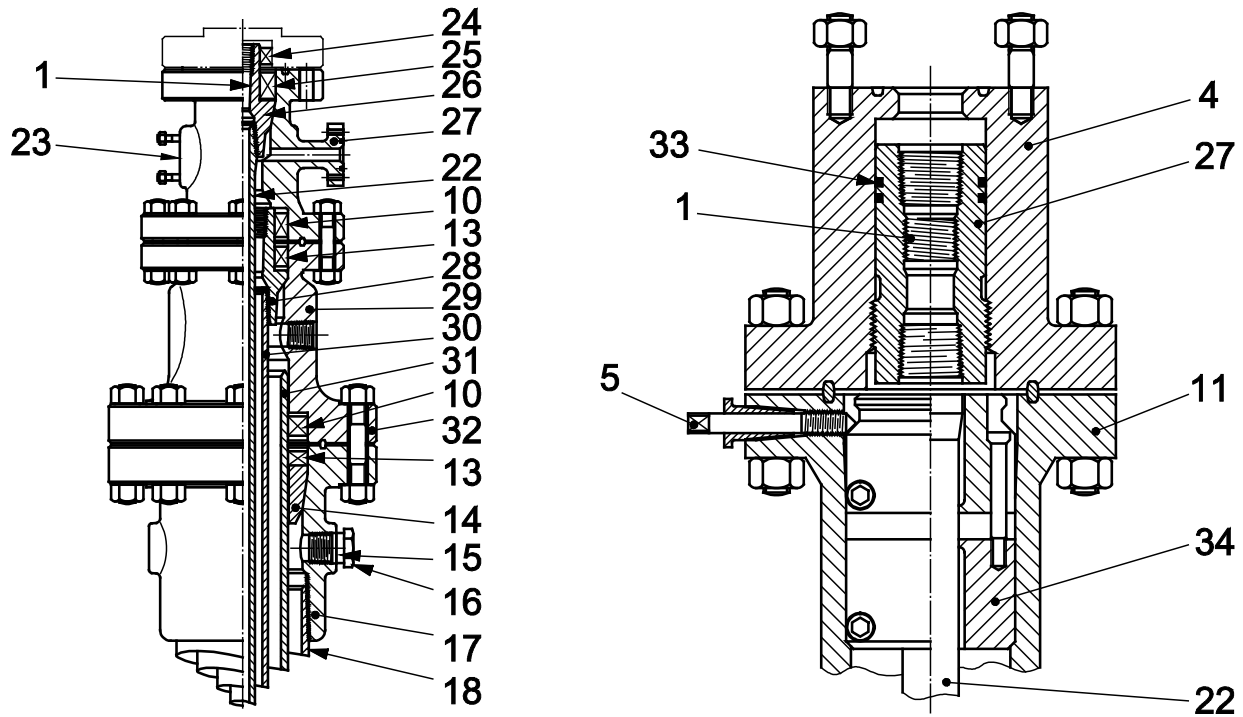
This International Standard establishes requirements for five product specification levels (PSLs): PSL 1, 2, 3, 3G and 4. These five PSL designations define different levels of technical quality requirements. Annex A provides guidelines (not requirements) for selecting an acceptable PSL.



### Key

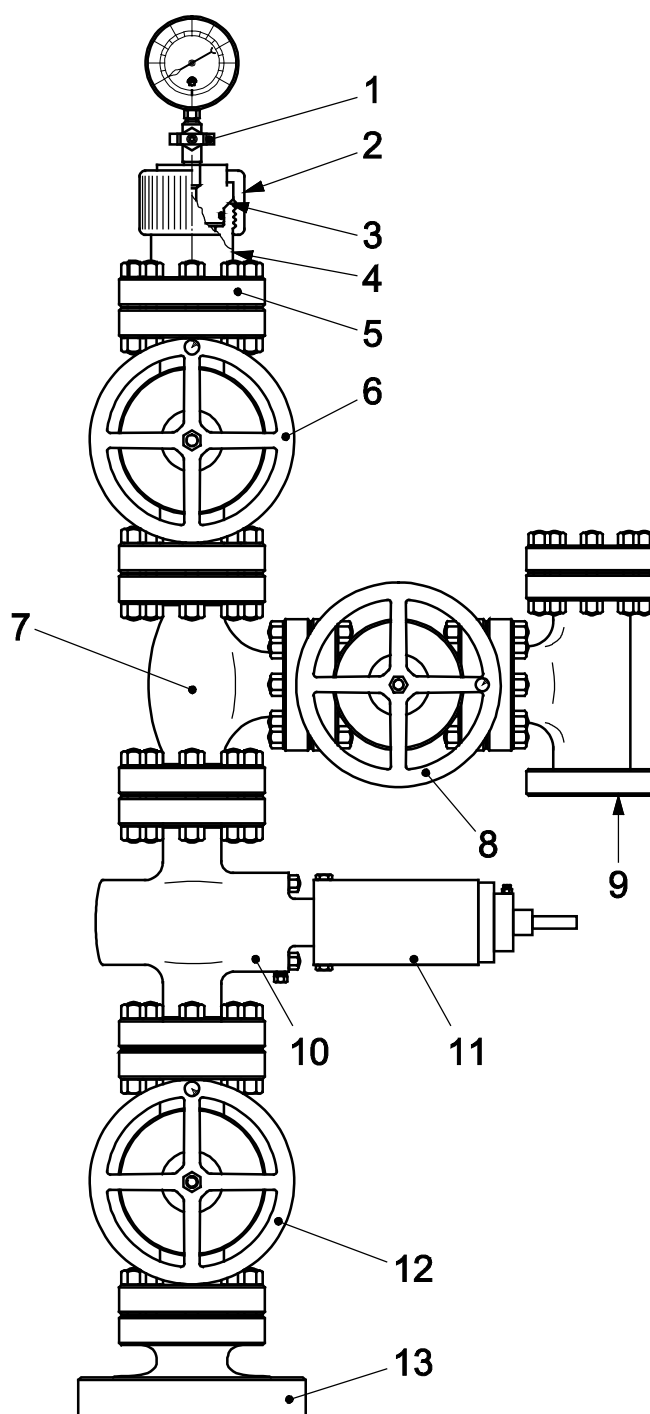
- |   |                               |
|---|-------------------------------|
| 1 back-pressure valve preparation                                       | 12 double-studded adapter     |
| 2 subsurface safety valve control line                                  | 13 annular casing pack-off    |
| 3 subsurface safety valve control line outlet                           | 14 casing hanger (slip style) |
| 4 tubing-head adapter   | 15 threaded outlet connection |
| 5 lock screw  | 16 bullplug                   |
| 6 tubing hanger pack-off  | 17 casing-head housing        |
| 7 extended neck tubing hanger with subsurface safety valve control line | 18 surface casing             |
| 8 studded side outlet   | 19 wellhead support plate     |
| 9 valve-removal preparation   | 20 tubing pack-off retainer   |
| 10 bottom casing pack-off   | 21 tubing hanger (slip style) |
| 11 tubing-head spool  | 22 tubing                     |

**Figure 1 — Typical wellhead assembly nomenclature**

**Key**

- |                                     |                                |
|-------------------------------------|--------------------------------|
| 23 studded side-outlet connection   | 29 casing-head spool           |
| 24 extended neck tubing hanger seal | 30 inner casing                |
| 25 annular tubing hanger seal       | 31 intermediate casing         |
| 26 tubing hanger mandrel            | 32 flanged end connection      |
| 27 flanged outlet connection        | 33 tubing hanger mandrel seals |
| 28 casing hanger mandrel            | 34 wrap-around hanger pack-off |

**Figure 1 — Typical wellhead assembly nomenclature** (*continued*)

**Key**

- |                       |                                   |
|-----------------------|-----------------------------------|
| 1 gauge valve         | 8 wing valve (manual or actuated) |
| 2 bonnet nut          | 9 choke                           |
| 3 blanking plug       | 10 surface safety valve           |
| 4 body                | 11 actuator                       |
| 5 top connector       | 12 master valve                   |
| 6 swab or crown valve | 13 tubing-head adapter            |
| 7 tee                 |                                   |

**Figure 2 — Typical christmas tree nomenclature**

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 31-0, *Quantities and units — Part 0: General principles*

ISO 148 (all parts), *Metallic materials — Charpy pendulum impact test*

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 6506 (all parts), *Metallic materials — Brinell hardness test*

ISO 6507 (all parts), *Metallic materials — Vickers hardness test*

ISO 6508 (all parts), *Metallic materials — Rockwell hardness test*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 9712, *Non-destructive testing — Qualification and certification of personnel*

ISO 10414-1, *Petroleum and natural gas industries — Field testing of drilling fluids — Part 1: Water-based fluids*

ISO 10424-1:2004, *Petroleum and natural gas industries — Rotary drilling equipment — Part 1: Rotary drill stem elements*

ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

ISO 13533, *Petroleum and natural gas industries — Drilling and production equipment — Drill-through equipment*

ISO 13628-4, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 4: Subsea wellhead and tree equipment*

ISO 13678, *Petroleum and natural gas industries — Evaluation and testing of thread compounds for use with casing, tubing, line pipe and drill stem elements*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H<sub>2</sub>S-containing environments in oil and gas production*

NOTE In this International Standard, ISO 15156 (all parts) and NACE MR0175 provide the same technical result for a particular provision. In the running text the provision is written in the form "ISO 15156 (NACE MR0175; see Clause 2)".

ISO 18265, *Metallic materials — Conversion of hardness values*

API<sup>1)</sup> Spec 5B, *Specification for Threading, Gauging and Thread Inspection of Casing, Tubing, and Line Pipe Threads*

API Spec 6AV1, *Specification for Verification Test of Wellhead Surface Safety Valves and Underwater Safety Valves for Offshore Service*

API Spec 7:2001, *Specification for Rotary Drill Stem Elements*

API RP 14F, *Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class 1, Division 1 and Division 2 Locations*

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1) American Petroleum Institute, 1220 L Street North West, Washington, DC 20005, USA.

ASME<sup>2)</sup> B1.1, *Unified Inch Screw Threads (UN and UNR Thread Form)*

ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads*

ASME B1.3, *Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)*

ASME B1.5, *ACME Screw Threads*

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASME Boiler and Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section V, *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section VIII, Division 1, *Rules for Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section VIII, Division 2, *Alternative Rules*

ASME Boiler and Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section IX, *Welding and Brazing Qualifications*

ASNT<sup>3)</sup> SNT-TC-1A, *Non-Destructive Testing*

ASTM<sup>4)</sup> A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A194/A194M, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A388/A388M, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings*

ASTM A453/A453M, *Standard Specification for High-Temperature Bolting Materials, with Expansion Coefficients Comparable to Austenitic Stainless Steels*

ASTM A703/A703M-08a, *Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts*

ASTM D395, *Standard Test Methods for Rubber Property — Compression Set*

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*

ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*

ASTM D1414, *Standard Test Methods for Rubber O-Rings*

ASTM D1415, *Standard Test Method for Rubber Property — International Hardness*

ASTM D1418, *Standard Practice for Rubber and Rubber Latexes — Nomenclature*

---

2) ASME International, 345 East 47<sup>th</sup> Street, New York, NY 10017-2392, USA.

3) American Society for Nondestructive Testing, 4153 Arlingate Plaza, Columbus, OH 43228-0518, USA.

4) American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

ASTM D2240, *Standard Test Method for Rubber Property — Durometer Hardness*

ASTM E10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

ASTM E92, *Standard Test Method for Vickers Hardness of Metallic Materials*

ASTM E94, *Standard Guide for Radiographic Examination*

ASTM E140, *Standard Hardness Conversion Tables for Metals — Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness and Scleroscope Hardness*

ASTM E165, *Standard Practice for Liquid Penetrant Examination for General Industry*

ASTM E428, *Standard Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*

EN<sup>5)</sup> 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

MSS<sup>6)</sup> SP-55, *Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components — Visual Method for Evaluation of Surface Irregularities*

SAE<sup>7)</sup> AMS-H-6875, *Heat treatment of steel raw materials*

SAE AS 568A:1974, *Aerospace size standard for O-rings*

### **3 Terms, definitions and abbreviated terms**

#### **3.1 Terms and definitions**

For the purposes of this document, the following terms and definitions apply.

##### **3.1.1**

##### **acceptance criteria**

defined limits placed on characteristics of materials, products or services

##### **3.1.2**

##### **accessible wetted surface**

wetted surface for purposes of non-destructive examination that can be viewed by direct line of sight

NOTE This excludes test ports, control line ports, lockdown screw holes and other penetrations of these types.

##### **3.1.3**

##### **actuator**

mechanism for the remote or automatic operation of a valve or choke

---

5) European Committee for Standardization, rue de Stassart 36, Brussels B-1050, Belgium.

6) Manufacturers Standardization Society of the Valve & Fittings Industry, 127 Park Street, N.E., Vienna, VA 22180, USA.

7) SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA.

**3.1.4****adapter**

pressure-containing piece of equipment having end connections of different nominal sizes and/or pressure ratings, used to connect other pieces of equipment of different nominal sizes and/or pressure ratings

**3.1.5****annular pack-off**

mechanism that seals off annular pressure between the outside diameter of a suspended tubular member or hanger and the inside diameter of the head or spool through which the tubular member passes or hanger is suspended

**3.1.6****as-shipped condition**

condition of the product or equipment when it is ready for shipment

**3.1.7****back-pressure valve**

unidirectional or bidirectional check valve that is installed through the christmas tree, into the tubing hanger, and prevents well fluids from flowing out of the well

**3.1.8****blind flange**

flange with no centre bore, used to close off completely a flanged end or outlet connection

**3.1.9****body**

any portion of wellhead and christmas tree equipment between end connections, with or without internal parts, which contains well-bore pressure

**3.1.10****bonnet**

pressure-containing closure for a body, other than an end or outlet connection

**3.1.11****bottom casing pack-off**

mechanism that seals off annular pressure between the outside diameter of a suspended tubular member or hanger and the inside diameter of the spool or tubing-head adapter placed over the suspended tubular or hanger

**3.1.12****bullplug**

pressure-containing closure for a female-threaded end or outlet connection, which may have an internal counter-bore and/or test port

**3.1.13****calibration**

comparison and adjustment to a standard of known accuracy

**3.1.14****carbon steel**

alloy of carbon and iron containing a maximum of 2 % mass fraction carbon, 1,65 % mass fraction manganese, and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminium)

**3.1.15****casing**

pipe run from the surface and intended to line the walls of a drilled hole

**3.1.16****casing hanger mandrel**

mechanism used to support a casing string in a casing head by means of a male or female thread attached to the casing

**3.1.17****casing-head housing**

equipment attached to the uppermost end of the surface casing, which serves to suspend and seal a casing string

**3.1.18****casing-head spool**

equipment attached to another casing head, which serves to suspend and seal a secondary casing string

**3.1.19****casting**, noun

object at or near finished shape obtained by solidification of a fluid substance in a mould

NOTE      HIP components are not considered to be a casting.

**3.1.20****certificate of compliance**

document containing the statement by the manufacturer, or repairer/remanufacturer certifying that the equipment, repair, rework or remanufacture meets the requirements of this International Standard

**3.1.21****certificate of conformance**

document certifying that the repaired/remanufactured equipment and all of its component parts meet the requirements of the original product definition

**3.1.22****check valve**

valve that permits fluid to flow freely in one direction and contains a mechanism to automatically prevent flow in the other direction

**3.1.23****chemical analysis**

determination of the chemical composition of material

**3.1.24****choke**

equipment used to restrict and control the flow of fluids

**3.1.25****choke bean**

flow bean

replaceable orifice part used in positive chokes to control flow rate

**3.1.26****choke trim**

pressure-controlling choke component, including choke beans, used to control or regulate the flow of fluids

**3.1.27****christmas tree**

assembly of equipment, including tubing-head adapters, valves, tees, crosses, top connectors and chokes attached to the uppermost connection of the tubing head, used to control well production

**3.1.28****clamp hub**

protruding rim with an external angled shoulder and a sealing mechanism used to join pressure-containing equipment

**3.1.29****closure bolting**

threaded fastener used to assemble well-bore pressure-containing parts or join end or outlet connections

EXAMPLES      Studs, nuts, bolts and capscrews.

**3.1.30****conformance**

compliance with specified requirements

**3.1.31****corrosion-resistant alloy****CRA**

nonferrous-based alloy in which any one or the sum of the specified amount of the elements titanium, nickel, cobalt, chromium, and molybdenum exceeds 50 % mass fraction

NOTE      This definition is different from that in ISO 15156 (NACE MR0175; see Clause 2).

**3.1.32****corrosion-resistant ring groove**

ring groove lined with a CRA or an austenitic stainless steel to resist metal-loss corrosion

**3.1.33****cross**

pressure-containing fitting with a minimum of four openings

**3.1.34****cross-over connector**

adapter with a restricted-area sealing means and with a top-connection pressure rating above that of the lower connection

**3.1.35****cross-over flange**

double- or single-studded adapter flange with a restricted-area sealing means and with a top-connection pressure rating above that of the lower connection

**3.1.36****cross-over spool**

flanged or other connected equipment with a restricted-area sealing means, at or near the face of its lower flange

NOTE      Cross-over spools are also provided with suitable means to suspend and seal around an inner string of casing or tubing. A cross-over spool has a top connection with a pressure rating above that of the lower connection.

**3.1.37****date of manufacture**

date of manufacturer's final acceptance of finished equipment

**3.1.38****date of repair/remanufacture**

date of repairer/remanufacturer's final acceptance of finished equipment

**3.1.39****end connection**

outlet connection

integral male or female thread; clamp hub end connector and flange, studded or through-bolted, or any other means used to join together equipment that contains or controls pressure

**3.1.40****equipment**

any item or assembled equipment to which this International Standard is applicable

**3.1.41****equivalent round  
ER**

standard for comparing various shaped sections to round bars, in determining the response to hardening characteristics when heat-treating low-alloy and martensitic corrosion-resistant steel

**3.1.42****exposed bolting**

bolting that is exposed directly to the sour environment or that is buried, insulated, equipped with flange protectors, or otherwise denied direct atmospheric exposure

**3.1.43****fabrication weld**

weld joining two or more parts

**3.1.44****fit**

geometric relationship between parts

**3.1.45****flange**

protruding rim with holes to accept bolts and having a sealing mechanism used to join pressure-containing equipment, with dimensions specified in this International Standard

**3.1.46****forge**, verb

deform metal plastically into desired shapes with compressive force

NOTE Forging is usually a hot process. The use of dies is optional.

**3.1.47****forging**, noun

shaped metal part formed by the forging method

**3.1.48****form**

essential shape of a product including all its component parts

**3.1.49****full-bore valve**

valve whose closure mechanism has a bore dimension the same as or larger than the valve body

**3.1.50****function**

operation of a product during service

**3.1.51****gate valve**

valve assembly with a gate operating within the body, 90° to the conduit, to effect a closure

**3.1.52****hanger mandrel**

portion of a casing or tubing hanger that is attached by a threaded connection to the tubular string and forms the upper end of that tubular string

**3.1.53****heat**

material originating from a final melt, or for remelted alloys, the raw material originating from a single remelted ingot

**3.1.54****heat-treat lot**

〈batch furnaces〉 material placed on loading or carry devices and moved as a batch through one heat treat cycle

**3.1.55****heat-treat lot**

〈continuous furnaces〉 group of pieces of material with the same nominal size that is moved sequentially through the heat treatment process using the same process parameters

**3.1.56****heat treatment**

heat treating

specified, timed sequence of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties

**3.1.57****heat-affected zone****HAZ**

portion of the base metal that has not been melted, but whose mechanical properties or microstructure has been altered by the heat of welding or cutting

**3.1.58****heat-sensitive lock-open device**

device installed on a surface safety valve (SSV) actuator to maintain the SSV valve in a full open position until exposed to sufficient heat to cause the device to release and allow the SSV valve to close

**3.1.59****hold period**

period of time that the product is subjected to pressure and isolated from the pressure source

**3.1.60****hot isostatic pressing****HIP**

special forming process used to compact and metallurgically bond metal powder

NOTE This process takes place within a flexible, metal container whose contents are formed into the desired shape by subjecting the container to high temperature and pressure in an autoclave. It produces a fully wrought structure.

**3.1.61****hot-work**

deform metal plastically at a temperature above the recrystallization temperature

**3.1.62****job-lot traceability**

ability to trace parts as originating from a job lot that identifies the included heat(s)

**3.1.63****linear indication**

surface NDE indication whose length is equal to or greater than three times its width

**3.1.64****lock screw**

tie-down screw

threaded pin extending through the wall of a casing-head or tubing-head connection used to lock down hangers or energize seals

**3.1.65****loose connector**

connector, as-manufactured, that is not intended to be made integral with another piece of wellhead and christmas tree equipment

EXAMPLES There are blind, threaded, spacer, welding neck, flanged, studded, or other loose connectors.

### **3.1.66**

#### **loose flange**

flange, as-manufactured, that is not intended to be made integral with equipment compliant to this International Standard

EXAMPLES Types of flanges include blind, threaded, spacer, welding neck, studded or other connected adapter flanges.

### **3.1.67**

#### **low-alloy steel**

steel containing less than 5 % mass fraction total alloying elements, or steels with less than 11 % mass fraction chromium, but more than that specified for carbon steel

### **3.1.68**

#### **make-and-break, verb**

connect and disconnect a connection

### **3.1.69**

#### **manufacturing operation**

activity involving, but not limited to, the machining, welding, heat treating or other processes utilized to produce a finished product

### **3.1.70**

#### **master valve**

lowermost valve on the vertical bore of the christmas tree

NOTE Upper master valves and lower master valves are in general use. Upper master valves are sometimes called surface safety valves.

### **3.1.71**

#### **material performance**

capabilities that it is necessary to demonstrate, as a minimum, for material to satisfy the criteria of this International Standard

### **3.1.72**

#### **multistage cross-over spool**

flanged or other connected equipment with more than one restricted-area sealing means to provide suitable capability to suspend and seal around multiple inner strings of casing or tubing at several stages

NOTE A multistage cross-over spool may have a top connector with a pressure rating above that of the lower connector.

### **3.1.73**

#### **non-exposed bolting**

bolting that is not directly exposed to sour environments and is not intended to be buried, insulated, equipped with flange protectors, or otherwise denied direct atmospheric exposure

### **3.1.74**

#### **non-pressure-containing weld**

weld whose absence does not reduce the pressure-containing integrity of the part

### **3.1.75**

#### **objective evidence**

documented field experience, test data, publications, finite element analysis or calculations that confirm performance characteristics, as applicable

### **3.1.76**

#### **original product definition**

complete definition of the requirements for the original assembled equipment, single equipment unit, or component part, including specified limits and tolerances, health, safety and environmental requirements,

limitations of use, customer specific requirements, design acceptance criteria, materials of construction, materials processing requirements and physical properties, physical dimensions, and requirements for manufacturing process controls, inspection, assembly and testing, marking, handling, storage, maintenance, and records requirements

### **3.1.77**

#### **part**

individual piece used in the assembly of single equipment units

EXAMPLES Body, bonnet, gate, stud, handwheel, etc., are parts of a valve. A part may also be a piece not in finished form.

### **3.1.78**

#### **plug valve**

valve assembly with a plug permanently mounted across the conduit so that, when rotated 90°, it effects a closure

EXAMPLES Plugs may be straight, tapered, ball, etc.

### **3.1.79**

#### **post-weld heat treatment**

any heat treatment subsequent to welding, including stress relief

### **3.1.80**

#### **pressure integrity**

structural and leak-resistant capability of a product to contain applied pressure

### **3.1.81**

#### **pressure-boundary penetration**

device that penetrates directly into or communicates with the well-bore and is not defined elsewhere in this International Standard

EXAMPLES Grease or sealant injection fitting; check valve; control, test or gauge port plug and fitting, needle valve on test, gauge or injection port; electric and control line penetration.

### **3.1.82**

#### **pressure-containing part**

part whose failure to function as intended results in a release of retained fluid to the atmosphere

EXAMPLES Bodies, bonnets, one-piece stems, and that segment of multi-piece stems that passes through the pressure boundary, are pressure-containing parts.

### **3.1.83**

#### **pressure-containing weld**

weld whose absence reduces the pressure-containing integrity of the part

### **3.1.84**

#### **pressure-controlling part**

part intended to control or regulate the movement of pressurized fluids

EXAMPLES Valve-bore sealing mechanisms, choke trim and hangers.

### **3.1.85**

#### **primary equipment**

pieces of equipment that cannot normally be isolated from well fluid or well pressure

### **3.1.86**

#### **prolongation**

extension of a piece of raw material or an extension of a production part made integrally during forging, hot working, cold working or casting

**3.1.87****proration bean**

type of positive choke bean of fixed length used to regulate the flow of fluid from a well

NOTE Proration is a system of allocating the amount of oil or gas a well or field is allowed to produce within a given period by a regulatory agency.

**3.1.88****qualified personnel**

individual with characteristics or abilities gained through training, experience, or both, as measured against the established requirements of the manufacturer/purchaser/this International Standard

**3.1.89****rated working pressure**

maximum internal pressure that the equipment is designed to contain and/or control

**3.1.90****record**, noun

retrievable information

**3.1.91****reduced-opening valve**

valve with either a regular or Venturi-type opening, either circular or non-circular, through the closure mechanism

**3.1.92****relevant indication**

surface-rupture NDE indication with major dimensions greater than 1,6 mm ( $1/16$  in)

NOTE Inherent indications not associated with a surface rupture are considered non-relevant.

**3.1.93****remanufacture**

activity involving disassembly, reassembly and testing of wellhead and christmas tree equipment, with or without the replacement of parts other than bodies, where machining, welding, heat treating or other manufacturing operations are employed

NOTE Remanufacture does not include the replacement of bodies.

**3.1.94****repair**

activity involving disassembly, reassembly and testing of wellhead and christmas tree equipment with or without the replacement of parts other than bodies

NOTE Repair does not include machining, welding, heat treating, other manufacturing operations or the replacement of bodies.

**3.1.95****repair level**

level to which equipment will be repaired or remanufactured in compliance with this International Standard

**3.1.96****repairer/remanufacturer**

principal agent in the repair and remanufacture of wellhead and christmas tree equipment who chooses to be in compliance with this International Standard

**3.1.97****replacement part**

part used to repair/remanufacture a piece of equipment that meets the wellhead and christmas tree requirement for the applicable repair/remanufacture level

**3.1.98****restricted-area sealing means**

restricted-area pack-off

pack-off or other device used to isolate an area at higher pressure from one at lower pressure

NOTE This device serves to limit pressure-induced loads on connectors or areas of a lower pressure rating. It may also be a seal that encloses a pressure-containment area smaller than the adjacent ring gasket or connector seal.

**3.1.99****retained fluid**

actual fluid produced by a well or injected into a well

**3.1.100****room temperature**

any temperature between 4 °C and 50 °C (40 °F and 120 °F)

**3.1.101****rounded indication**

surface NDE indication that is circular or elliptical, having a length less than 3 times its width

**3.1.102****running tool**

tool used to run, retrieve, position or connect wellhead equipment remotely from the drill floor

**3.1.103****sandy service**

intended for use in wells where particulates such as sand can be expected to cause equipment failure

**3.1.104****secondary equipment**

piece of equipment that can normally be isolated from the well fluid or well pressure

**3.1.105****serialization**

assignment of a unique code to individual parts and/or pieces of equipment to maintain records

**3.1.106****slip-type casing hanger**

mechanism used to support a casing string in a casing head by gripping the pipe with wedge-type members

**3.1.107****spacer**

pressure-containing piece of equipment used to connect and provide separation between other pieces of equipment

**3.1.108****SSV actuator**

underwater safety valve actuator

USV actuator

device which causes the SSV/USV valve to open when power is supplied and to close automatically when power is lost or released

**3.1.109****SSV valve**

USV valve

portion of the SSV/USV that contains the wellstream and shuts off flow when closed

**3.1.110****stainless steel**

steel containing more than 11 % mass fraction chromium to render the steel corrosion-resistant

NOTE Other elements may be added to secure special properties.

**3.1.111**

**stress relief**

controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses after welding

**3.1.112**

**stress-corrosion cracking**

cracking that results from a combination of corrosion and stress

**3.1.113**

**studded connection**

flanged end or outlet connection in which thread-anchored studs screwed into tapped holes replace the holes for bolt studs

**3.1.114**

**substantive change**

change identified by the manufacturer that affects the performance of the product in the intended service

**3.1.115**

**sulfide stress cracking**

cracking of metallic materials due to exposure to fluid containing hydrogen sulfide

**3.1.116**

**surface safety valve**

SSV

automatic wellhead valve assembly that closes upon loss of power supply

NOTE Where used in this International Standard, the term is understood to include an SSV valve and SSV actuator.

**3.1.117**

**swab valve**

crown valve

uppermost valve on the vertical bore of the christmas tree above the flowline outlet

**3.1.118**

**tee**

pressure-containing fitting with three openings

NOTE Two openings opposite one another form the run portion of the tee, and one opening is at 90° to the line of the run. Tees may be equipped with threads, flanges, studs or other end connectors.

**3.1.119**

**test agency**

independent third party that provides a test facility and administers a testing programme that meets the class II SSV/USV valve-validation testing requirements of Annex I of this International Standard and API Spec 6AV1

**3.1.120**

**test and gauge connection**

hole drilled and tapped into wellhead and christmas tree equipment through which internal pressure can be measured or through which pressure can be applied to test the sealing mechanisms

**3.1.121**

**test tool**

tool used to run into the wellhead in order to perform a pressure test

**3.1.122**

**thread protector**

cap or insert used to protect threads and seals during handling, transportation and storage

**3.1.123****threaded flange**

flange having a sealing face on one side and a female thread on the other for the purpose of joining flanged connections to threaded connections

**3.1.124****top connector**

bottomhole test adapter

uppermost fitting of a christmas tree which allows full-bore access to the christmas tree

**3.1.125****tubing**

retrievable pipe placed within a well to conduct fluid from the well's producing formation into the christmas tree or to conduct kill or treatment fluids in a well

NOTE Tubing is distinguished from casing as being retrievable during the life of the well.

**3.1.126****tubing hanger mandrel**

mechanism used to support a tubing string in a tubing head by means of a male or female thread attached to the tubing

**3.1.127****tubing-head adapter**

equipment that adapts the uppermost connection of a tubing head to the lowermost valve of the christmas tree

**3.1.128****tubing-head spool**

piece of equipment attached to the uppermost casing head or smallest casing string which serves to suspend the tubing and to seal the annular space between the tubing and casing

**3.1.129****underwater safety valve****USV**

automatic valve assembly installed at an underwater wellhead location which closes on loss of power supply

NOTE Where used in this International Standard, the term is understood to include a USV valve and USV actuator.

**3.1.130****valve-bore sealing mechanism**

internal valve parts that close off the flow through the valve bore

EXAMPLES Gates, balls, plugs, poppets, flappers and their respective seats.

**3.1.131****valve-removal plug**

threaded plug that can be installed in the wellhead to enable gate-valve removal under pressure

**3.1.132****Venturi valve**

valve with a reduced opening, in which the transformation from the full-opening ends to the reduced-closure area is well streamlined to reduce pressure loss

**3.1.133****visual examination**

examination of parts and equipment for visible defects in material and workmanship

**3.1.134****volumetric non-destructive examination**  
**volumetric NDE**

examination for internal material defects by methods such as radiography and/or ultrasonic testing

**3.1.135****wear bushing**

retrievable cylindrical device that protects the internal surfaces of wellhead equipment and the top of the last casing suspended

**3.1.136****weld preparation**

geometry of surfaces for the purpose of welding

**3.1.137****weld**, verb

fuse materials, with or without the addition of filler materials

**3.1.138****welding neck flange**

flange with a neck on the side opposite the sealing face, prepared with a bevel to weld to corresponding pipe or transition pieces

**3.1.139****wellhead**

all permanent equipment between the uppermost portion of the surface casing and the tubing-head adapter connection

**3.1.140****wetted surface**

any surface that has contact with pressurized well fluid, either by design or because of internal seal leakage

**3.1.141****wing valve**

valve located on the christmas tree, but not in the vertical run, which can be used to shut off well flow

**3.1.142****wrought product**

product made from material having a wrought structure

**3.1.143****wrought structure**

structure that contains no cast dendritic elements

**3.1.144****yield strength**

stress level, measured at room temperature, at which material plastically deforms and does not return to its original dimensions when the load is released

NOTE All yield strengths specified in this document are the 0,2 % offset yield strength in accordance with ISO 6892-1 or ASTM A370.

**3.2 Abbreviated terms**

For the purposes of this document, the following abbreviated terms apply.

AQL	acceptable quality level
CRA	corrosion-resistant alloy
DAC	distance amplitude curve

ER	equivalent round
FEA	finite element analysis
HAZ	heat-affected zone
HBW	Brinell hardness
HIP	hot isostatic pressing
HRB	Rockwell hardness scale B
HRC	Rockwell hardness scale C
NDE	non-destructive examination
NPT	national pipe thread
OEC	other end connection
PQR	procedure qualification record
PR	performance requirement
PSL	product specification level
QTC	qualification test coupon
RMS	root mean square
RL	repair/remanufacture level
$R_m$	ultimate tensile strength
ROE	radius of exposure
SSV	surface safety valve
TC	test coupon
UNS	unified numbering system
USV	underwater safety valve
WPQ	welder performance qualification
WPS	welding procedure specification

## 4 Design and performance — General requirements

### 4.1 Performance requirements — General

Performance requirements are specific and unique to the product in the as-shipped condition. All products shall be designed to perform according to the requirements of 4.2 to 4.7 and the relevant requirements specified in Clause 10 while in the pressure and temperature ranges and used with the test fluids consistent with the material class in Table 3 for which they are rated. Other requirements specified by the purchaser may include load capability, cycles, lubrication and operating force or torque.

There are two performance requirement levels: PR1 and PR2. SSVs and USVs (see 10.20) shall be of the PR2 performance level and meet the requirements of Annex I.

### 4.2 Service conditions

#### 4.2.1 Pressure ratings

##### 4.2.1.1 General

Equipment shall be designed to operate at only the following maximum rated working pressures:

- a) 13,8 MPa (2 000 psi)
- b) 20,7 MPa (3 000 psi)

- c) 34,5 MPa (5 000 psi)
- d) 69,0 MPa (10 000 psi)
- e) 103,5 MPa (15 000 psi)
- f) 138,0 MPa (20 000 psi)

#### 4.2.1.2 Threaded equipment limitations

Equipment designed with internally threaded end and outlet connections shall be limited to the thread sizes and rated working pressures in Table 1. Ratings do not include tubing and casing hangers.

#### 4.2.1.3 Design considerations

The design shall take into account the effects of pressure containment and other pressure-induced loads. Special conditions, such as pressure rating changes in cross-over connectors and pressurizing with temporary test plugs, shall also be considered. The effects of external loads (i.e. bending moments, tensions, etc.) on the assembly of components are not explicitly addressed by this International Standard; see A.2.

**Table 1 — Pressure ratings for internal threaded end or outlet connections**

Type of thread	Nominal pipe size in	Size OD mm	Rated working pressure	
			MPa	(psi)
Line-pipe/NPT (nominal sizes)	$1\frac{1}{2}$	21,3	69,0	10 000
	$\frac{3}{4}$ to 2	26,7 to 60,3	34,5	5 000
	$2\frac{1}{2}$ to 6	73,0 to 168,3	20,7	3 000
Tubing, non-upset, and external upset round thread	1,050 to $4\frac{1}{2}$	26,7 to 114,3	34,5	5 000
Casing (8 round, buttress, and extreme line)	$4\frac{1}{2}$ to $10\frac{3}{4}$	114,3 to 273,1	34,5	5 000
	$11\frac{3}{4}$ to $13\frac{3}{8}$	298,5 to 339,7	20,7	3 000
	16 to 20	406,4 to 508,0	13,8	2 000

#### 4.2.2 Temperature ratings

##### 4.2.2.1 General

Equipment shall be designed to operate in one or more of the specified temperature ratings with minimum and maximum temperatures as shown in Table 2, or to minimum and maximum operating temperatures as agreed between the purchaser and manufacturer.

Minimum temperature is the lowest ambient temperature to which the equipment may be subjected. Maximum temperature is the highest temperature of the fluid that may directly contact the equipment.

##### 4.2.2.2 Design considerations

The design shall consider the effects of differential thermal expansion from temperature changes and temperature gradients which the equipment can experience in service. Design for high-temperature rating, e.g. classifications X and Y (see Table G.1), shall take into consideration the effects of temperature on strength levels; see Annex G for guidelines.

### 4.2.2.3 Temperature rating considerations

Choosing the temperature rating is ultimately the responsibility of the user. In making these selections, the user should consider the temperature the equipment can experience in drilling and/or production services.

**Table 2 — Temperature ratings**

Temperature classification	Operating range			
	°C		(°F)	
	min.	max.	min.	max.
K	– 60	82	– 75	180
L	– 46	82	– 50	180
N	– 46	60	– 50	140
P	– 29	82	– 20	180
S	– 18	60	0	140
T	– 18	82	0	180
U	– 18	121	0	250
V	2	121	35	250

## 4.2.3 Material class ratings

### 4.2.3.1 General

Equipment shall be designed with materials, including metallics, that meet the requirements set forth in Table 3. Table 3 does not define either the present or the future wellhead environment, but provides material classes for various levels of severity of service conditions and relative corrosivity.

Provided the mechanical properties requirements can be met, stainless steels and/or CRA materials may be used for material classes AA and BB in place of carbon and low-alloy steels. Similarly, for all material classes, corrosion-resistant alloys may be used in place of stainless steels.

### 4.2.3.2 Material classes

For material classes DD, EE, FF and HH, the manufacturer shall meet the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2) for material processing and material properties (e.g. hardness). Choosing material class and specific materials for specific conditions is ultimately the responsibility of the purchaser.

Material classes DD, EE, FF and HH shall include as part of the designation and marking the maximum allowable partial pressure of H<sub>2</sub>S in units consistent with the rated working pressure markings and prefixes consistent with ISO 15156 (all parts) (NACE MR0175; see Clause 2). The maximum allowable partial pressure shall be in accordance with ISO 15156 (all parts) (NACE MR0175; see Clause 2) at the designated temperature class (see Table 2) for the limiting component(s) in the equipment assembly. For example, “FF-10” on equipment with the rated working pressure marked in megapascals indicates material class FF rated at 10 kPa H<sub>2</sub>S maximum allowable partial pressure. Where no H<sub>2</sub>S limit is defined by ISO 15156 (all parts) (NACE MR0175; see Clause 2) for the partial pressure, “NL” shall be used for marking (i.e. “DD-NL”).

**NOTE** It is necessary that users of this International Standard recognize that resistance to cracking caused by H<sub>2</sub>S is influenced by a number of other factors, some of the limits for which are given in ISO 15156 (all parts) (NACE MR0175; see Clause 2). These include, but are not limited to

- pH;
- temperature;

- chloride concentration;
- elemental sulfur.

In making the material selections, it is the responsibility of the purchaser to also consider the various environmental factors and production variables listed in Annex A.

### 4.2.3.3 Material class ZZ

ISO 15156 (all parts) (NACE MR0175; see Clause 2) includes provisions by means of testing or documented field history for the qualification of materials for a specific sour-service application that is outside the parameters defined in ISO 15156 (all parts) (NACE MR0175; see Clause 2). This can include the use of materials in fluid conditions exceeding the limits defined in ISO 15156 (all parts) (NACE MR0175; see Clause 2), or the use of materials not addressed in ISO 15156 (all parts) (NACE MR0175; see Clause 2). For such sour-service applications, equipment may be described and marked as material class ZZ.

It is the responsibility of the purchaser to evaluate and determine the applicability of the documented data for the intended application. For material class ZZ, the manufacturer shall meet material specifications supplied or approved by the purchaser, and shall maintain traceable records to document the materials of construction, regardless of PSL.

**Table 3 — Material requirements**

Material class		Minimum material requirements	
		Body, bonnet, end and outlet connections	Pressure-controlling parts, stems and mandrel hangers
AA	General service	Carbon or low-alloy steel	Carbon or low-alloy steel
BB	General service	Carbon or low-alloy steel	Stainless steel
CC	General service	Stainless steel	Stainless steel
DD	Sour service <sup>a</sup>	Carbon or low-alloy steel <sup>b</sup>	Carbon or low-alloy steel <sup>b</sup>
EE	Sour service <sup>a</sup>	Carbon or low-alloy steel <sup>b</sup>	Stainless steel <sup>b</sup>
FF	Sour service <sup>a</sup>	Stainless steel <sup>b</sup>	Stainless steel <sup>b</sup>
HH	Sour service <sup>a</sup>	CRAs <sup>bcd</sup>	CRAs <sup>bcd</sup>
<sup>a</sup> As defined by ISO 15156 (all parts) (NACE MR0175; see Clause 2). <sup>b</sup> In accordance with ISO 15156 (all parts) (NACE MR0175; see Clause 2). <sup>c</sup> CRA required on retained fluid-wetted surfaces only; CRA cladding of low-alloy or stainless steel is permitted [see 6.5.1.2.2 a)]. <sup>d</sup> CRA as defined in Clause 3; ISO 15156 (all parts) (NACE MR0175; see Clause 2) definition of CRA does not apply.			

## 4.3 Design methods

### 4.3.1 Connections

#### 4.3.1.1 Flanges

Flanges specified in this International Standard have been designed in accordance with design criteria and methods originally developed by API.

#### 4.3.1.2 Clamp hub and outlet end connections

Design of end and outlet clamp hub connections (16B and 16BX) used on equipment specified in this International Standard shall conform to the material and dimensional requirements of ISO 13533.

### 4.3.1.3 Clamps

Clamps meeting the requirements of ISO 13533 are acceptable for installation on equipment specified in this International Standard with integral clamp hubs meeting the requirements of ISO 13533.

### 4.3.2 Casing hangers, tubing hangers, back-pressure valves, lock screws and stems

Casing hangers, tubing hangers, back-pressure valves, lock screws and stems shall be designed to satisfy the manufacturer's documented performance characteristics and service conditions in accordance with 4.2. The manufacturer shall specify methods that are consistent with accepted engineering practices for use in design.

### 4.3.3 Other end connectors, bodies and bonnets

#### 4.3.3.1 General

Other end connectors, bodies and bonnets that utilize standard materials (in designs other than those specified in this International Standard) shall be designed in accordance with one or more of the methods given in 4.3.3.2 to 4.3.3.5. Standard materials are those materials whose properties meet or exceed the requirements of Table 6.

Other end connectors, bodies and bonnets that utilize non-standard materials shall be designed in accordance with the requirements of 4.3.3.6. Non-standard materials are materials with properties that do not meet all the requirements of Table 6 for a standard material.

In the event that stress levels calculated by the methods in 4.3.3.2 to 4.3.3.6 exceed the allowable stresses, other methods identified by the manufacturer, such as ASME BPVC:2004, with 2005 and 2006 addenda, Section VIII, Division 3, shall be used to justify these stresses. Fatigue analysis and localized bearing stress values are beyond the scope of this International Standard.

#### 4.3.3.2 ASME method

The design methodology described in ASME BPVC:2004, with 2005 and 2006 addenda, Section VIII, Division 2, Appendix 4, may be used for design calculations for pressure-containing equipment. Design-allowable stresses,  $S_T$ , the maximum allowable general primary membrane stress intensity at hydrostatic test pressure, and  $S_m$ , the design stress intensity at rated working pressure, shall be limited by the criteria in Equations (1) and (2), respectively:

$$S_T = 5 \frac{S_Y}{6} \quad (1)$$

$$S_m \leq 2 \frac{S_Y}{3} \quad (2)$$

where  $S_Y$  is the material-specified minimum yield strength.

#### 4.3.3.3 Distortion energy theory

The distortion energy theory, also known as the Von Mises law, may be used for design calculations for pressure-containing equipment. Rules for the consideration of discontinuities and stress concentrations are beyond the scope of this method. However, the basic pressure-vessel wall thickness may be sized by combining triaxial stresses based on hydrostatic test pressure and limited by the following criterion:

$$S_E = S_Y \quad (3)$$

where

$S_E$  is the maximum allowable equivalent stress at the most highly stressed distance into the pressure vessel wall, computed by the distortion energy theory method;

$S_Y$  is the material-specified minimum yield strength.

#### **4.3.3.4 Experimental stress analysis**

Experimental stress analysis as described in ASME BPVC:2004 with 2005 and 2006 addenda, Section VIII, Division 2, Appendix 6, may be used as an alternative method to those described in 4.3.3.2 and 4.3.3.3.

#### **4.3.3.5 Design qualification by proof test**

##### **4.3.3.5.1 General**

As an alternative to the analytical methods above, the pressure rating of equipment may be determined by the use of a hydrostatic test at elevated pressure. A test vessel, or vessel part, is made from the equipment for which the maximum allowable working pressure is to be established. It shall not previously have been subjected to a pressure greater than 1,5 times the desired or anticipated maximum allowable working pressure.

##### **4.3.3.5.2 Determination of yield strength**

###### **4.3.3.5.2.1 Method**

The yield strength of the material in the part tested shall be determined in accordance with the method prescribed in the applicable material specification.

###### **4.3.3.5.2.2 Specimen preparation**

Yield strength so determined shall be the average from three or four specimens cut from the part tested after the test is completed. The specimens shall be cut from a location where the stress during the test has not exceeded the yield strength. The specimens shall not be flame-cut because this might affect the strength of the material.

###### **4.3.3.5.2.3 Alternative specimens**

If excess stock from the same piece of material is available and has been given the same heat treatment as the pressure part, the test specimens may be cut from this excess stock. The specimen shall not be removed by flame cutting or any other method involving sufficient heat to affect the properties of the specimen.

###### **4.3.3.5.2.4 Exemption**

If yield strength is not determined by test specimens, an alternative method is given in 4.3.3.5.3 for evaluation of proof test results to establish the maximum allowable working pressure.

##### **4.3.3.5.3 Test procedure**

###### **4.3.3.5.3.1 Instrumentation**

Measure strains in the direction of the maximum stress as close as practical to the most highly stressed locations by means of strain gauges of any type capable of indicating strains to 0,005 % (50 microstrain; 0,000 05 in/in). The manufacturer shall document the procedure used to determine the location or locations at which strain is to be measured, and the means to compensate for temperature and hydrostatic pressure imposed on the gauges.

###### **4.3.3.5.3.2 Application of pressure**

Gradually increase the hydrostatic pressure in the vessel or vessel part, until approximately one-half the anticipated working pressure is reached. Thereafter, increase the test pressure in steps of approximately one-tenth or less of the rated working pressure until the pressure required by the test procedure is reached.

#### 4.3.3.5.3.3 Observations

After each increment of pressure has been applied, take and record readings of the strain gauges and the hydrostatic pressure. Then, release the pressure and determine any permanent strain at each gauge after any pressure increment that indicates an increase in strain for this increment over the previous equal pressure increment. Only one application of each increment of pressure is required.

#### 4.3.3.5.3.4 Records

Plot two curves of strain against test pressure for each gauge line as the test progresses, one showing the strain under pressure and one showing the permanent strain when the pressure is removed. The test may be discontinued when the test pressure reaches a value,  $W$ , of the hydrostatic test pressure that, calculated from Equations (4) or (5), justifies the desired working pressure, but shall not exceed the pressure at which the plotted points for the most highly strained gauge line reach 0,2 % strain.

#### 4.3.3.5.3.5 Resulting rating

Compute the maximum allowable working pressure,  $p$ , for parts tested under 4.3.3.5 using Equation (4) if the average yield strength is determined in accordance with 4.3.3.5.2 or Equation (5) if the actual average yield strength is not determined by test specimens:

$$p = 0,5W(S_Y/S_R) \quad (4)$$

$$p = 0,4W \quad (5)$$

where

$W$  is the hydrostatic test pressure at which this test was stopped, in accordance with 4.3.3.5.3.2;

$S_Y$  is the material-specified minimum yield strength;

$S_R$  is the actual average yield strength from test specimens.

#### 4.3.3.6 Non-standard materials design requirements

The design methodology described in ASME BPVC:2004 with 2005 and 2006 addenda, Section VIII, Division 2, Appendix 4, shall be used for designs and calculations for pressure-containing equipment utilizing non-standard materials. Design-allowable stresses,  $S_T$ , the maximum allowable general primary membrane stress intensity at hydrostatic test pressure;  $S_m$ , the design stress intensity at rated working pressure; and  $S_S$ , the maximum combined primary and secondary stress intensity, shall be limited by the criteria in Equations (6), (7) and (8), respectively:

$$S_T = \min (5/6 S_Y, 2/3 R_{m, \min.}) \quad (6)$$

$$S_m = \min (2/3 S_Y, 1/2 R_{m, \min.}) \quad (7)$$

$$S_S = \min (2 S_Y, R_{m, \min.}) \quad (8)$$

where

$S_Y$  is as defined as for Equations (4) and (5)

$R_{m, \min.}$  is the material-specified minimum ultimate tensile strength.

#### 4.3.4 Closure bolting

The maximum allowable tensile stress,  $S_A$ , for closure bolting shall be determined considering initial bolt-up, rated working pressure and hydrostatic test pressure conditions. Bolting stresses, based on the root area of the thread, shall not exceed the limit given in Equation (9):

$$S_A = 0,83 S_Y \quad (9)$$

where  $S_Y$  is the bolting material-specified minimum yield strength.

Bolting stresses shall be determined considering all loading on the closure, including pressure acting over the seal area, gasket loads and any additional mechanical and thermal loads.

#### 4.3.5 Other parts

All other pressure-containing parts and all pressure-controlling parts shall be designed to satisfy the manufacturer's documented performance characteristics and the service conditions in 4.2. The manufacturer shall specify methods for use in designs that are consistent with accepted engineering practices.

#### 4.3.6 Specific equipment

Equipment-specific requirements are specified in Clause 10.

### 4.4 Miscellaneous design information

#### 4.4.1 General

End and outlet connections shall be an integral part of the body or attached by welding which meets the requirements of Clause 6. PSL 4 equipment design shall not utilize fabrication welding.

#### 4.4.2 Tolerances

Unless otherwise specified in the appropriate table or figure, the tolerances in Table 4 shall apply:

**Table 4 — Tolerances, unless otherwise stated**

SI		USC	
Dimension	Tolerance mm	Dimension	Tolerance in
x,x	± 0,5	x,xx	± 0,02
x,xx	± 0,13	x,xxx	± 0,005

#### 4.4.3 Bolting

##### 4.4.3.1 End and outlet bolting

##### 4.4.3.1.1 Hole alignment

End and outlet bolt holes for flanges shall be equally spaced and shall straddle common centrelines.

##### 4.4.3.1.2 Stud thread engagement

Stud thread-engagement length into the body for studded flanges shall be a minimum of one times the outside diameter of the stud.

#### **4.4.3.2 Other bolting**

The stud thread-anchoring means shall be designed to sustain a tensile load equivalent to the load that can be transferred to the stud through a fully engaged nut.

#### **4.4.4 Test, vent, injection and gauge connections**

##### **4.4.4.1 Sealing**

All test, vent, injection and gauge connections shall provide a leak-tight seal at the hydrostatic test pressure of the equipment in which they are installed.

##### **4.4.4.2 Test and gauge connection ports**

###### **4.4.4.2.1 69,0 MPa (10 000 psi) and below**

Test and gauge connection ports for 69,0 MPa (10 000 psi) working pressure and below shall be internally threaded in conformance with the methods specified in 10.2 and shall not be less than 12 mm ( $\frac{1}{2}$  in) nominal size. High-pressure connections as described in 4.4.4.2.2 may also be used.

###### **4.4.4.2.2 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi)**

Test and gauge connections for 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi) working pressure shall be in accordance with 10.11.

##### **4.4.4.3 Vent and injection ports**

Vent and injection ports shall meet the requirements of the manufacturer's specifications.

#### **4.5 Design documentation**

Documentation of designs shall include methods, assumptions, calculations and design requirements. Design requirements shall include, but not be limited to, those criteria for size, test and operating pressures, material, environmental and other pertinent requirements on which the design is based. Design documentation media shall be clear, legible, reproducible and retrievable. Design documentation shall be retained for five years after the last unit of that model, size and rated working pressure is manufactured.

#### **4.6 Design review**

Design documentation shall be reviewed and verified by any qualified individual other than the individual who created the original design.

#### **4.7 Design validation**

Manufacturers shall document their design validation procedures and the results of design validation of designs. The design validation procedures, including acceptance criteria for SSVs and USVs, are given in Annex I. Additional validation procedures, including acceptance criteria, are given in Annex F for use if specified by the manufacturer or purchaser.

### **5 Materials — General requirements**

#### **5.1 General**

Clause 5 describes the material performance, processing and compositional requirements for bodies, bonnets, end and outlet connections, clamp hub end connectors, hangers, wear bushings, pressure-boundary penetrations

and ring gaskets. Other pressure-containing and pressure-controlling parts shall be made of materials that satisfy 5.2 and the design requirements of Clause 4.

All material requirements in Clause 5 apply to carbon steels, low-alloy steels and martensitic stainless steels (other than precipitation-hardening types). Other alloy systems (including precipitation-hardening stainless steels) may be used, provided they satisfy the requirements of Clause 5 and the design requirements of Clause 4.

Materials for actuators are specified in 10.16.4.

## **5.2 Written specifications**

### **5.2.1 General**

All metallic and non-metallic pressure-containing or pressure-controlling parts shall require a written material specification.

### **5.2.2 Metallic requirements**

The manufacturer's written specified requirements for metallic materials for bodies, bonnets, end and outlet connections, stems, valve bore sealing mechanisms and mandrel hangers shall define the following, along with accept/reject criteria:

- a) for PSL 1:
  - mechanical property requirements,
  - material qualification,
  - heat-treatment procedure, including cycle time, quenching practice and temperatures with tolerances and cooling media,
  - material composition with tolerances,
  - non-destructive examination (NDE) requirements;
- b) for PSL 2 to PSL 4, the requirements are identical to those for PSL 1, with the addition of the following:
  - allowable melting practice(s),
  - forming practice(s), including hot-working and cold-working practices,
  - heat-treating equipment calibration.

### **5.2.3 Non-metallic requirements**

Non-metallic pressure-containing or pressure-controlling seals shall have written material specifications. The manufacturer's written specified requirement for non-metallic materials shall define the following:

- generic base polymer(s); see ASTM D1418;
- physical property requirements;
- material qualification, which shall meet the equipment class requirement;
- storage and age-control requirements.

## 5.3 Mandrel tubing hangers and casing hangers

### 5.3.1 Material

All mandrel tubing hangers and casing hangers shall be fabricated from materials that meet the applicable property requirements specified by the manufacturer.

The following apply:

- a) PSL 1 requirements:
  - tensile testing,
  - hardness testing;
- b) PSL 2 to PSL 4 requirements:
  - identical to item a) for PSL 1,
  - plus impact requirements.

### 5.3.2 Processing

#### 5.3.2.1 Casting practices

The following apply:

- a) PSL 1 requirements:

All castings used for hanger mandrels shall meet the applicable requirements of Clauses 5 and 7.
- b) PSL 2 requirements:

The requirements for PSL 2 are identical to those for PSL 1, with the additional requirement that the manufacturer shall document foundry practices that establish limits for sand control, core making, rigging, melting, heat treatment and NDE to ensure repeatability for providing castings that meet the requirements of this International Standard.
- c) PSL 3 and PSL 4:

Wrought products shall be used.

#### 5.3.2.2 Hot-working practices

The following apply:

- a) PSL 1 requirements:

All wrought materials shall be formed using a hot-working practice(s) that produce(s) a wrought structure throughout.
- b) PSL 2 to PSL 4 requirements:

The requirements for PSL 2 to PSL 4 are identical to those for PSL 1, with the addition that the manufacturer shall document hot-working practices.

#### 5.3.2.3 Melting practices

The following apply:

- a) PSL 1 to PSL 3 requirements:

The manufacturer shall specify the melting practices for all hanger mandrel materials.

b) PSL 4 requirements:

The requirements for PSL 4 are identical to those for PSL 1 to PSL 3, with the addition that the manufacturer shall document the melting practice utilized for PSL 4 material.

### **5.3.3 Heat treating**

#### **5.3.3.1 Equipment qualification**

All heat-treatment operations shall be performed utilizing equipment qualified in accordance with the requirements specified by the manufacturer. A recommended practice for heat-treating furnace calibration can be found in Annex M.

#### **5.3.3.2 Temperatures**

The following apply:

a) PSL 1 to PSL 3 requirements:

Time at temperature and thermal cycles shall comply with the manufacturer's heat-treatment specifications.

b) PSL 4 requirements:

The requirements for PSL 4 are identical to those for PSL 1 to PSL 3, with the addition that the temperature levels for PSL 4 parts shall be determined by using a heat sink.

The heat sink shall be made of the same class of material when the components are made of an alloy of the following classes: carbon steel, alloy steel, stainless steel, titanium-based alloys, nickel-copper alloys and nickel-based alloys. For components that do not meet one of the preceding classes, the heat sink shall be made from the same alloy as the component. The equivalent round (ER) section of all heat sinks shall be determined in accordance with the methods of 5.7.2. The ER of the heat sink shall be greater than or equal to the largest ER of any part in a heat treatment load.

As an alternative, a production part may serve as the heat sink, provided all the requirements of 5.3.3.2 b) are satisfied. The temperature-sensing tip of the thermocouple shall be within the part or heat sink, and be no closer than 25 mm (1 in) to any external or internal surface.

#### **5.3.3.3 Quenching — PSL 2 to PSL 4 requirements (for materials that are quenched and tempered)**

The following apply:

a) water quenching:

The temperature of the water or quench media used to approximate the cooling rate of water shall not exceed 40 °C (100 °F) at the start of the quench. For bath-type quenching, the temperature of the water or quench media shall not exceed 50 °C (120 °F) at the completion of the quench.

b) other quenching media:

The temperature range of other quenching media shall meet the manufacturer's written specification.

### **5.3.4 PSL 2 to PSL 4 chemical composition**

Hanger mandrel materials shall conform to the manufacturer's written specification.

The manufacturer shall specify the nominal chemical composition, including the composition tolerances, of the material.

Material composition shall be determined on a heat basis (or a remelt-ingot basis for remelt-grade materials) in accordance with a nationally or internationally recognized standard specified by the manufacturer.

### **5.3.5 Material qualification testing — PSL 2 to PSL 4 requirements**

#### **5.3.5.1 General**

If minimum tensile and/or impact properties are required in order to qualify a material for service, the tests shall be performed as described in 5.3.5.2 and 5.3.5.3.

A qualification test coupon (QTC) as described in 5.7 shall be used.

#### **5.3.5.2 Tensile testing**

The following apply:

a) test specimens:

Tensile test specimens shall be removed from a QTC as described in 5.7.4.1.

b) test method:

Perform tensile tests at room temperature in accordance with the procedures specified in ISO 6892-1 or ASTM A370.

Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the manufacturer's specified requirements.

c) retesting:

If the results of the tensile test(s) do not satisfy the applicable requirements, two additional tests on two additional test specimens (removed from the same QTC with no additional heat treatment) may be performed in an effort to qualify the material. The results of each of these tests shall satisfy the applicable requirements.

#### **5.3.5.3 Impact testing**

The following apply:

a) test specimens:

Impact test specimens shall be removed from a QTC as described in 5.7.4.1.

b) test method:

Perform impact tests in accordance with the procedures specified in ISO 148 (all parts) or ASTM A370 using the Charpy V-notch technique.

In order to qualify a material for a temperature rating, perform the impact tests at or below the lowest temperature of that classification range.

Test a minimum of three impact specimens to qualify a heat of material. Impact properties as determined from these tests shall satisfy the manufacturer's specified requirements.

c) retesting:

If a test fails, then a retest of three additional specimens (typically removed from the same location within the same QTC with no additional heat treatment) may be made, each of which shall exhibit an impact value equal to or exceeding the required minimum average value.

## 5.4 Bodies, bonnets and end and outlet connections

### 5.4.1 Material

The following apply:

a) tensile property requirements:

All bodies, bonnets and end and outlet connections shall be fabricated from standard or non-standard materials. Standard materials as specified in Table 5 shall meet the applicable property requirements shown in Table 6.

Non-standard materials for components shown in Table 5 shall have a design stress intensity,  $S_m$ , as defined in 4.3.3.6, at least equal to that of the lowest-strength standard material permitted for that application. Non-standard material shall conform to the manufacturer's written specification which shall include minimum requirements for

- tensile strength,
- yield strength,
- hardness,
- impact strength,
- a minimum of 15 % elongation,
- a minimum of 20 % reduction of area;

b) impact strength requirements:

Impact strength for standard and non-standard materials shall conform to the requirements of Table 7.

If sub-size specimens are used, the Charpy V-notch impact requirements shall be equal to that of the 10 mm ´ 10 mm specimens multiplied by the adjustment factor listed in Table 8. Sub-size specimens shall not be used for PSL 4.

### 5.4.2 Material qualification testing

#### 5.4.2.1 General

If minimum tensile and/or impact properties are required in order for material to be qualified for service, the required tests shall be performed on specimens from a test coupon (TC) or QTC, as applicable.

The following apply:

a) PSL 1 requirements:

An acceptable TC as described in 5.6 or a QTC as described in 5.7 shall be used to qualify material.

b) PSL 2 to PSL 4 requirements:

A QTC as described in 5.7 shall be used.

**Table 5 — Standard and non-standard material applications  
for bodies, bonnets and end and outlet connections**

Part	Material designations for pressure ratings					
	13,8 MPa (2 000 psi)	20,7 MPa (3 000 psi)	34,5 MPa (5 000 psi)	69,0 MPa (10 000 psi)	103,5 MPa (15 000 psi)	138,0 MPa (20 000 psi)
<b>Body<sup>a</sup>, bonnet</b>	36K, 45K 60K, 75K NS <sup>b</sup>	36K, 45K 60K, 75K NS	36K, 45K 60K, 75K NS	36K, 45K 60K, 75K NS	45K, 60K 75K, NS —	60K, 75K NS —
<b>Integral end connection</b>						
Flanged	60K, 75K NS	60K, 75K NS	60K, 75K NS	60K, 75K NS	75K, NS —	75K, NS —
Threaded	60K, 75K NS	60K, 75K NS	60K, 75K NS	NA —	NA —	NA —
Other <sup>c</sup>	c	c	c	c	c	c
<b>Loose connectors</b>						
Welding neck	45K —	45K —	45K —	60K, 75K NS	75K, NS —	75K, NS —
Blind	60K, 75K NS	60K, 75K NS	60K, 75K NS	60K, 75K NS	75K, NS —	75K, NS —
Threaded	60K, 75K NS	60K, 75K NS	60K, 75K NS	NA —	NA —	NA —
Other	c	c	c	c	c	c
<sup>a</sup> If end connections are of the material designation indicated, welding is in accordance with Clause 6 and design is in accordance with Clause 4. <sup>b</sup> "NS" indicates non-standard materials as defined in 4.3.3 and 5.4.1 a). <sup>c</sup> As specified by manufacturer.						

**Table 6 — Standard material property requirements  
for bodies, bonnets and end and outlet connections**

Material designation	0,2 % offset yield strength min. Mpa (psi)	Tensile strength min. Mpa (psi)	Elongation in 50 mm (2 in) min. %	Reduction in area min. %
36K	248 (36 000)	483 (70 000)	21	No requirement
45K	310 (45 000)	483 (70 000)	19	32
60K	414 (60 000)	586 (85 000)	18	35
75K	517 (75 000)	655 (95 000)	17	35

**Table 7 — Charpy V-notch impact requirements — 10 mm □10 mm**

Temperature		Minimum average impact value Transverse direction J (ft·lbf )		
Classification	Test °C (°F)	PSL 1	PSL 2	PSL 3 and PSL 4
K	−60 (−75)	20 (15)	20 (15)	20 (15)
L	−46 (−50)	20 (15)	20 (15)	20 (15)
N	−46 (−50)	20 (15)	20 (15)	20 (15)
P	−29 (−20)	—	20 (15)	20 (15)
S	−18 (0)	—	—	20 (15)
T	−18 (0)	—	—	20 (15)
U	−18 (0)	—	—	20 (15)
V	−18 (0)	—	—	20 (15)

**Table 8 — Adjustment factors for sub-size impact specimens (PSL 1 to PSL 3)**

Specimen dimension	Adjustment factor	Minimum average impact value, wrought materials	
		Transverse direction and castings J (ft·lb)	Longitudinal direction J (ft·lb)
10 mm ´ 10 mm (full size)	1 (none)	20 (15); ref.	27 (20); ref.
10 mm ´ 7,5 mm	0,833	17 (13)	23 (17)
10 mm ´ 6,7 mm	0,780	16 (12)	21 (16)
10 mm ´ 5,0 mm	0,667	13 (10)	18 (13)
10 mm ´ 3,3 mm	0,440	9 (7)	12 (9)
10 mm ´ 2,5 mm	0,333	7 (5)	9 (7)

**5.4.2.2 PSL 1 tensile testing**

The following apply:

a) test specimens:

Tensile test specimens shall be removed from a TC as described in 5.6 or 5.7, as applicable. This TC shall be used to qualify a heat and the bodies, bonnets, and end and outlet connections produced from that heat.

b) test method:

Perform tensile tests at room temperature in accordance with the procedures specified in ISO 6892-1 or ASTM A370.

Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the applicable requirements of Table 6.

c) retesting:

If the results of the tensile test(s) do not satisfy the applicable requirements, two additional tests on two additional test specimens (removed from the same TC or QTC with no additional heat treatment) may be performed in an effort to qualify the material. The results of each of these tests shall satisfy the applicable requirements.

#### 5.4.2.3 PSL 2 to PSL 4 tensile testing

The following apply:

a) test specimens:

Tensile test specimens shall be removed from a QTC as described in 5.7.4.1.

b) test method:

Perform tensile tests at room temperature in accordance with the procedures specified in ISO 6892-1 or ASTM A370.

Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the applicable requirements of Table 6.

c) retesting:

If the results of the tensile test(s) do not satisfy the applicable requirements, two additional tests on two additional test specimens (removed from the same QTC with no additional heat treatment) may be performed in an effort to qualify the material. The results of each of these tests shall satisfy the applicable requirements.

#### 5.4.2.4 PSL 1 to PSL 4 impact testing

The following apply:

a) sampling:

Impact tests shall be performed on a heat of material if a body, bonnet, or end and outlet connection produced from that heat requires testing.

b) test specimens:

Impact test specimens shall be removed from a test coupon as described in 5.6 or 5.7, as applicable. This test coupon shall be used to qualify a heat and the bodies, bonnets and end and outlet connections produced from that heat.

c) test method:

Perform impact tests in accordance with the procedures specified in ISO 148 (all parts) or ASTM A370 using the Charpy V-notch technique.

In order to qualify material for a temperature rating, perform the impact tests at or below the lowest temperature of that classification range.

Test a minimum of three impact specimens to qualify a heat of material. Impact properties as determined from these tests shall satisfy the applicable requirements of Table 7. In no case shall an individual impact value fall below two-thirds of that required as a minimum average. Similarly, no more than one of the three test results shall be below the required minimum average. Where no acceptance criteria are shown in Table 7, impact testing is not required.

d) PSL 1 to PSL 4 retest:

If a test fails, then a retest of three additional specimens removed from the same QTC, or TC for PSL 1 components, with no additional heat treatment, may be made, each of which shall exhibit an impact value equal to or exceeding the required minimum average value.

e) specimen orientation:

The values listed in Table 7 are the minimum acceptable values for wrought products tested in the transverse direction and for castings and weld qualifications. Wrought products may be tested in the longitudinal direction instead of the transverse direction and then shall exhibit a minimum average value of 27 J (20 ft-lbf).

### **5.4.3 Processing**

#### **5.4.3.1 Casting practices**

The following apply:

a) PSL 1 requirements:

All castings used for bodies, bonnets and end and outlet connections shall meet the applicable requirements of Clauses 5 and 7.

b) PSL 2 requirements:

The requirements for PSL 2 are identical to those for PSL 1, with the addition that the manufacturer shall document foundry practices that establish limits for sand control, core-making, rigging, melting and heat treatment and NDE to ensure repeatability for producing castings that meet the requirements of this International Standard.

c) PSL 3 and PSL 4 requirements:

Wrought products shall be used.

#### **5.4.3.2 Hot-working practices**

The following apply:

a) PSL 1 requirements:

All wrought material(s) shall be formed using (a) hot-working practice(s) that produces a wrought structure throughout.

b) PSL 2 to PSL 4 requirements:

The requirements for PSL 2 to PSL 4 are identical to those for PSL 1, with the addition that the manufacturer shall document hot-working practices.

#### **5.4.3.3 Melting practices**

The following apply:

a) PSL 1 to PSL 3 requirements:

The manufacturer shall specify melting practices.

b) PSL 4 requirements:

The requirements for PSL 4 are identical to those for PSL 1 to PSL 3, with the addition that the manufacturer shall document the melting practice utilized for PSL 4 material.

## **5.4.4 Heat treating**

### **5.4.4.1 Equipment qualification**

All heat-treatment operations shall be performed utilizing equipment qualified in accordance with the requirements specified by the manufacturer. A recommended practice for heat-treating furnace calibration can be found in Annex M.

### **5.4.4.2 Temperatures**

The following apply:

a) PSL 1 to PSL 3 requirements:

Time at temperature and thermal cycles shall comply with the manufacturer's heat-treatment specifications.

b) PSL 4 requirements:

The requirements of PSL 1 to PSL 3 shall apply with the addition that the temperature levels for PSL 4 parts shall be determined by using a heat sink.

The heat sink shall be made of the same class of material if the components are made of an alloy of the following classes: carbon steel, alloy steel, stainless steel, titanium-based alloy, nickel-copper alloys and nickel-based alloys. For components that do not meet one of the preceding classes, the heat sink shall be made from the same alloy as the component. The ER section of all heat sinks shall be determined in accordance with the methods of 5.7.2. The ER of the heat sink shall be greater than or equal to the largest ER of any single part in a heat treatment load.

As an alternative, a production part may serve as the heat sink, provided all the requirements of 5.4.4.2 b) are satisfied. The temperature-sensing tip of the thermocouple shall be within the part or heat sink, and be no closer than 25 mm (1 in) to any external or internal surface.

### **5.4.4.3 Quenching — PSL 2 to PSL 4 requirements (for quenched and tempered materials)**

The following apply:

a) water quenching:

The temperature of the water or quench media used to approximate the cooling rate of water shall not exceed 40 °C (100 °F) at the start of the quench. For bath-type quenching, the temperature of the water or quench media shall not exceed 50 °C (120 °F) at the completion of the quench.

b) other quenching media:

The temperature range of other quenching media shall meet the manufacturer's written specification.

## **5.4.5 Chemical composition**

### **5.4.5.1 General**

Material shall conform to the manufacturer's written specification as follows.

- a) The manufacturer shall specify the nominal chemical composition, including composition tolerances, of the material.
- b) Material composition shall be determined on a heat basis (or a remelt-ingot basis for remelt-grade materials) in accordance with a nationally or internationally recognized standard.

### 5.4.5.2 Composition limits — PSL 2 to PSL 4 requirements

Tables 9 and 10 list element limits, expressed in percentage mass fraction, for carbon, low-alloy and martensitic stainless steels (other than precipitation-hardening types) required to manufacture bodies, bonnets and end outlet connections to PSL 2 to PSL 4 requirements. If the composition is specified by reference to a recognized industry standard, it is not necessary that those elements specified as residual/trace elements be reported, provided the residual/trace element limits of the industry standard are within the limits of this International Standard. Tables 9 and 10 do not apply to other alloy systems. Composition limits of other alloy systems are purposely omitted from these tables in order to provide the manufacturer with freedom to utilize alloy systems for the multiplicity of requirements encountered.

**Table 9 — Steel composition limits (PSL 2 to PSL 4)  
for bodies, bonnets and end and outlet connections materials**

Alloying element	Composition limits % mass fraction		
	Carbon and low-alloy steels	Martensitic stainless steels	45K material for welding neck flanges <sup>a</sup>
Carbon	0,45 max.	0,15 max.	0,35 max.
Manganese	1,80 max.	1,00 max.	1,05 max.
Silicon	1,00 max.	1,50 max.	1,35 max.
Phosphorus	b	b	0,05 max.
Sulfur	b	b	0,05 max.
Chromium	2,75 max.	11,0–14,0	NA
Molybdenum	1,50 max.	1,00 max.	NA
Vanadium	0,30 max.	NA	NA
<sup>a</sup> For each reduction of 0,01 % below the specified carbon maximum (0,35 %), an increase of 0,06 % manganese above the specified maximum (1,05 %) is permitted up to a maximum of 1,35 %.			
<sup>b</sup> See Table 10.			

**Table 10 — Phosphorus and sulfur concentration limits (PSL 2 to PSL 4)**

Product specification level	Component % mass fraction	
	Phosphorus	Sulfur
PSL 2	0,040 max.	0,040 max.
PSL 3 and PSL 4	0,025 max.	0,025 max.

### 5.4.5.3 Tolerance ranges

Table 11 lists, for PSL 3 and PSL 4 only, the tolerance range requirements for elements used in the composition of materials as described by the manufacturer's specification. These tolerances only apply to the materials covered by Table 9.

If the manufacturer specifies a material for PSL 3 or 4 with chemical composition requirements by reference to a recognized industry standard, the material shall meet the tolerance ranges of the referenced industry standard. If the manufacturer specifies a material chemistry not covered by a recognized industry standard, the tolerance ranges shall meet the requirements in Table 11. These tolerances only apply to the materials covered in Table 9.

**Table 11 — Maximum tolerance range limits for alloying elements (PSL 3 and PSL 4)**

Element	Maximum tolerance range <sup>a</sup> for alloying elements % mass fraction		
	Carbon and low-alloy steel	Martensitic stainless steels	45K material for welding neck flanges
Carbon	0,08	0,08	NA
Manganese	0,40	0,40	NA
Silicon	0,30	0,35	NA
Nickel	0,50	1,00	NA
Chromium	0,50	NA	NA
Molybdenum	0,20	0,20	NA
Vanadium	0,10	0,10	NA
<sup>a</sup> These values are the total allowable variation in any one element and shall not exceed the maximum specified in Table 9.			

## 5.5 Ring gaskets

### 5.5.1 Material

Ring gasket material shall conform to the manufacturer's written specification.

### 5.5.2 Material qualification testing

The following apply:

- a) tensile testing: none specified;
- b) impact testing: none specified;
- c) hardness requirements: shall be as given in Table 12:

**Table 12 — Hardness requirements**

Material	Maximum hardness HRB
Soft iron	56
Carbon and low alloys	68
Stainless steel	83
Nickel alloy UNS N08825	92
Other CRAs	<sup>a</sup>
<sup>a</sup> Hardness shall meet manufacturer's written specification.	

### **5.5.3 Processing**

#### **5.5.3.1 Melting, casting and hot working**

The following apply:

a) melting practices:

The manufacturer shall select and specify the melting practice(s) used to fabricate ring gaskets. The melt shop shall use practices which produce homogeneous material, free from cracks, banding, piping and flakes.

b) casting practices:

Centrifugal casting shall be the only acceptable method of casting ring gaskets.

c) hot-working practices:

Wrought products shall be hot-worked throughout. Ring gaskets may be made from pierced tubing or pipe, rolled rings or rolled and welded bar or plate.

#### **5.5.3.2 Heat treating**

The following apply:

a) equipment qualification:

All heat treating of parts and QTCs shall be performed with equipment meeting the requirements specified by the manufacturer. A recommended practice for heat-treating furnace calibration can be found in Annex M.

b) method:

Heat-treatment operations shall be in accordance with the manufacturer's written specification.

Ring gaskets shall be either annealed, normalized or solution-treated as the last stage of material processing prior to the final machining.

### **5.5.4 Chemical composition**

The chemistry of ring gaskets shall be as described in the manufacturer's written specification.

## **5.6 Test coupons**

### **5.6.1 General**

The properties exhibited by the TCs shall represent the properties of the thermal response of the material comprising the production parts it qualifies.

Depending upon the hardenability of a given material, the results obtained from TCs might not always correspond with the properties of the actual components at all locations throughout their cross-section.

A single TC may be used to represent the impact and/or tensile properties of the part(s) produced from the same heat, provided it satisfies the requirements of this International Standard.

For batch heat treatment only, if the TC is a trepanned core or prolongation removed from a production part, or a sacrificial production part, the TC is permitted to qualify only production parts having the same or smaller ER. The TC shall qualify only material and parts produced from the same heat.

For material heat treated in a continuous furnace, the TC shall consist of a sacrificial production part or a prolongation removed from a production part. The sacrificial production part or prolongation TC shall qualify only production parts having identical size and shape. The TC shall qualify only material and parts produced from the same heat and heat-treat lot.

When a prolongation is used, it shall remain integrally attached during all heat-treatment operations except post-weld heat treatment, stress relief and any re-tempering or re-aging that can be required. For tubular components, bar stock, mill shapes and other raw material with a uniform cross-section, the prolongation shall have the same cross-section as that of the raw material. For a production part with a complex shape or varying cross-section, it is not necessary that the prolongation be an extension of the largest cross-section of the part. However, the extension shall meet or exceed the minimum ER required for a separate TC.

### 5.6.2 Equivalent round

The following apply:

a) selection:

The size of a TC for a part shall be determined using the ER methods given in 5.6.2 b).

b) ER methods:

Figure 3 illustrates the basic models for determining the ER of simple solid and hollow parts and more complicated parts.

The ER of a part shall be determined using the actual dimensions of the part in the “as-heat-treated” condition.

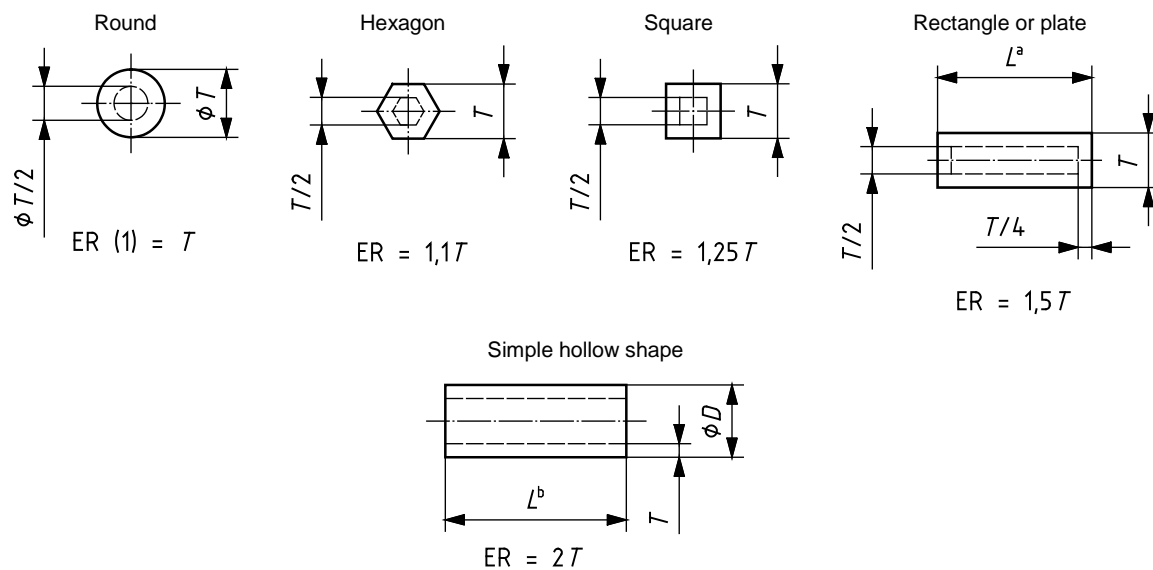
The ER of a studded type part shall be determined by using a thickness,  $T$ , equal to that of the thickest flange of that part. ER determination for these parts shall be in accordance with the methods for complexly shaped parts.

c) size requirements:

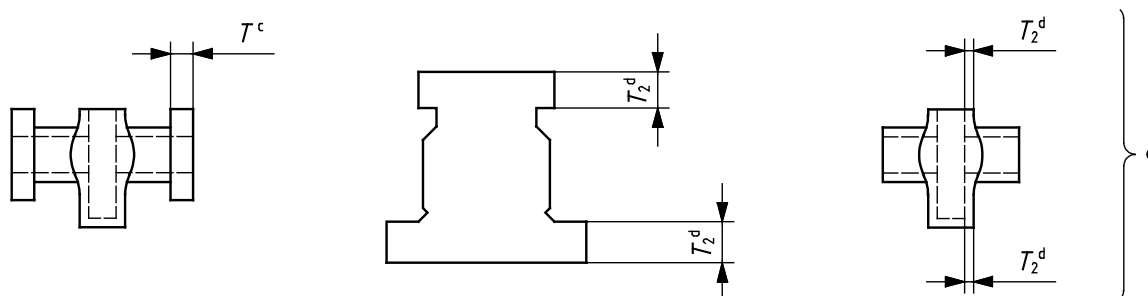
The ER of the TC shall be equal to or greater than the dimensions of the part it qualifies, except as follows:

- forging: size not required to exceed 63 mm ( $2\frac{1}{2}$  in) ER.
- casting: size not required to exceed size shown in ASTM A703/A703M-08a, Figure 1.

At the option of the manufacturer, the ER of the TC can meet ASME BPVC:2004 with 2005 and 2006 addenda, Section VIII, Division 2, AM-201 and AM-202 in place of the above requirements.

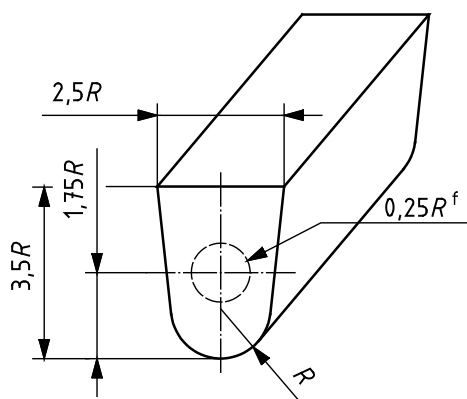


a) Simple geometric ER sections/shapes having length,  $L$



b) General flanged bodies for complex-shaped wellhead components

Figure 3 — Equivalent round models



**c) Keel block configuration, ER equals  $2,3R$**

- a When  $L$  is less than  $T$ , consider section as a plate of  $L$  thickness. Area inside dashed lines is the  $1/4T$  envelope for test specimen removal.
- b When  $L$  is less than  $D$ , consider as a plate of  $T$  thickness.
- c On multi-flanged components,  $T$  shall be the thickness of the thickest flange.
- d Where  $T$  is the thickness when the component is heat treated as in  $T_2$ , use the larger of the two indicated dimensions.
- e Bodies with screwed and open ends.
- f Envelope for test specimen removal.

NOTE When all internal and external surfaces during heat treatment are within 13 mm (1/2 in) of the final surfaces,  $ER = 1 \frac{1}{4}T$ . When all internal and external surfaces during heat treatment are not within 13 mm (1/2 in) of the final surfaces, then  $ER = 2T$ .

**Figure 3 — Equivalent round models (continued)**

### 5.6.3 Processing

#### 5.6.3.1 Melting, casting and hot working

The following apply:

a) melting practices:

In no case shall the TC be processed using a melting practice(s) cleaner than that of the material it qualifies [e.g. a TC made from a remelt grade or vacuum-degassed material shall not qualify material from the same primary melt that has not experienced the identical melting practice(s)]. Remelt-grade material removed from a single remelt ingot may be used to qualify other remelt-grade material that is from the same primary melt; no additional alloying shall be performed on these individual remelt ingots.

b) casting practices:

The manufacturer shall use the same foundry practice(s) for the TC as those used for the parts it qualifies, to assure accurate representation.

c) hot-working practices:

The manufacturer shall use on the TC hot-working ratios that are equal to or less than those used in processing the production part(s) it qualifies. The total hot-work ratio for the TC shall not exceed the total hot-work ratio of the part(s) it qualifies.

### 5.6.3.2 Welding

Welding on the TC is not allowed, except for attachment-type welds.

### 5.6.3.3 Heat treating

The following apply:

a) equipment qualification:

All heat-treatment operations shall be performed utilizing equipment qualified in accordance with 5.8.

b) method for batch heat treatment:

The TC shall experience the same specified heat treatment processing as the part(s) it qualifies. The TC shall be heat treated using the manufacturer's specified heat-treating procedure(s).

c) method for continuous furnace:

For material heat treated in a continuous furnace, the TC shall be from the same heat and heat-treat lot as the material it qualifies.

### 5.6.4 Material qualification

#### 5.6.4.1 Tensile and impact test specimens

If tensile and/or impact test specimens are required, they shall be removed from a TC after the final TC heat-treatment cycle. Multiple TCs may be used, provided that all applicable TC requirements of this International Standard are met and that the TCs are processed through heat treatment using the same furnace set points and times.

Test specimens shall be removed from the TC such that their longitudinal centreline axis is wholly within the centre core  $\frac{1}{4}T$  envelope for a solid TC or within 3 mm ( $\frac{1}{8}$  in) of the mid-thickness of the thickest section of a hollow TC (see Figure 3). For TCs larger than the size specified in 5.6.2 c), it is not necessary that the test specimens be removed from a location farther from the TC surface than would be required if the specified TC size were used.

Test specimens shall be removed from the TC such that the tensile specimen gauge length and Charpy V-notch root are at least  $\frac{1}{4}T$  from the ends of the TC.

If a sacrificial production part is used as a TC, the test specimens shall be removed from a section of the part meeting the size requirements for a TC for that production part as defined in 5.6.2.

Standard-sized, 12,7 mm (0,500 in) diameter tensile specimens shall be used to qualify carbon, low-alloy and stainless steels, unless the physical configuration of the TC prevents their use. In this case, the standard sub-size specimens referenced in ASTM A370 may be used. Either standard 12,7 mm (0,500 in) or standard sub-size specimens (see ASTM A370) may be used to qualify CRA materials.

Standard-sized impact specimens, 10 mm  $\times$  10 mm in cross-section, shall be used, except where there is insufficient material, in which case the next smaller standard size specimen obtainable shall be used. Impact specimens shall be removed such that the notch is within the  $\frac{1}{4}T$  envelope.

#### 5.6.4.2 Hardness testing

At least one Rockwell or Brinell hardness test shall be performed on the TC after the final heat-treatment cycle.

The TC heat-treatment cycles prior to hardness testing shall be the very same heat-treatment cycles experienced by the tensile and impact test specimens.

Hardness testing shall be performed in accordance with procedures specified in ISO 6506 (all parts) or ISO 6508 (all parts), or ASTM E10 or ASTM E18.

## 5.7 Qualification test coupons

### 5.7.1 General

The properties exhibited by the QTCs shall represent the properties of the thermal response of the material comprising the production parts it qualifies.

Depending upon the hardenability of a given material, the QTC results might not always correspond to the properties of the actual components at all locations throughout their cross-section.

A single QTC may be used to represent the impact and/or tensile properties of the part(s) produced from the same heat, provided it satisfies the requirements of this International Standard.

For batch heat-treatment only, if the QTC is a trepanned core or prolongation removed from a production part, the QTC may qualify only production parts having the same or smaller ER. The QTC shall qualify only material and parts produced from the same heat.

For material heat-treated in a continuous furnace, the QTC shall consist of a sacrificial production part or a prolongation removed from a production part. The sacrificial production part or prolongation QTC shall qualify only production parts having an identical size and shape. The QTC shall qualify only material and parts produced from the same heat and heat-treat lot.

When a prolongation is used, it shall remain integrally attached during all heat treatment operations, except post-weld heat treatment, stress relief, and any re-tempering or re-aging that can be required. For tubular components, bar stock, mill shapes and other raw material with a uniform cross-section, the prolongation shall have the same cross-section as that of the raw material. For a production part with a complex shape or varying cross-section, it is not necessary that the prolongation be an extension of the largest cross-section of the part. However, the extension shall meet or exceed the minimum ER required for a separate QTC.

### 5.7.2 Equivalent round

#### 5.7.2.1 Selection

The size of a QTC for a part shall be determined using the ER methods given in 5.7.2.2.

#### 5.7.2.2 ER methods

Figure 3 illustrates the basic models for determining the ER of simple solid and hollow parts and more complicated parts.

The ER of a part shall be determined using the actual dimensions of the part in the “as-heat-treated” condition.

The ER of a studded type part shall be determined by using a thickness,  $T$ , equal to that of the thickest flange of that part. An ER determination for these parts shall be in accordance with the methods for complex-shaped parts.

#### 5.7.2.3 Size requirements

The ER of the QTC shall be equal to or greater than the dimensions of the part it qualifies, except as follows:

a) for PSL 2:

- 1) forging: size not required to exceed 63 mm ( $2\frac{1}{2}$  in) ER,
- 2) casting: size not required to exceed size shown in ASTM A703/A703M;

- b) for PSL 3 and PSL 4: size not required to exceed 125 mm (5 in) ER.

At the option of the manufacturer, the ER of the QTC can meet ASME BPVC:2004 with 2005 and 2006 addenda, Section VIII, Division 2, AM-201 and AM-202, in place of the above requirements.

### **5.7.3 Processing**

#### **5.7.3.1 Melting, casting and hot working**

The following apply:

- a) melting practices:

In no case shall the QTC be processed using a melting practice(s) cleaner than that of the material it qualifies [e.g. a QTC made from a remelt-grade or vacuum-degassed material shall not qualify material from the same primary melt that has not experienced the identical melting practice(s)]. Remelt-grade material removed from a single remelt ingot may be used to qualify other remelt-grade material that is from the same primary melt; no additional alloying shall be performed on these individual remelt ingots. However, remelt-grade (consumable electrode process) material used to fabricate parts having a PSL 4 shall be qualified on a remelt-ingot basis.

- b) casting practices:

The manufacturer shall use the same foundry practice(s) for the QTC as those used for the parts it qualifies to assure accurate representation.

- c) hot-working practices:

The manufacturer shall use on the QTC hot-working ratios that are equal to or less than those used in processing the production part(s) it qualifies. The total hot-work ratio for the QTC shall not exceed the total hot-work ratio of the part(s) it qualifies.

#### **5.7.3.2 Welding**

Welding on the QTC is not allowed, except for attachment-type welds.

#### **5.7.3.3 Heat treating**

The following apply:

- a) equipment qualification:

All heat-treatment operations shall be performed utilizing equipment qualified in accordance with 5.8.

- b) method for batch heat-treatment:

The QTC shall experience the same specified heat-treatment processing as the part(s) it qualifies. The QTC shall be heat-treated using the materials manufacturer's specified heat-treating procedure(s).

If the QTC is not heat-treated as part of the same heat-treatment load as the part(s) it qualifies, the austenitizing, solution-treating or age-hardening (as applicable) temperatures for the QTC shall be within 14 °C (25 °F) of those for the part(s). The tempering temperature for the part(s) shall not be lower than 14 °C (25 °F) below that of the QTC. The upper limit shall not be higher than that permitted by the heat-treat procedure for that material. The cycle time at each temperature shall not exceed that for the part(s).

- c) method for continuous furnace:

For material heat-treated in a continuous furnace, the QTC shall be from the same heat and heat-treat lot as the material it qualifies.

## 5.7.4 Material qualification

### 5.7.4.1 Tensile and impact test specimens

If tensile and/or impact test specimens are required, they shall be removed from a QTC after the final QTC heat-treatment cycle. Multiple QTCs may be used, provided that all the applicable QTC requirements of this International Standard are met and the QTCs are processed through heat treatment using the same furnace set points and times.

Test specimens shall be removed from the QTC such that their longitudinal centreline axis is wholly within the centre core  $1/4T$  envelope for a solid QTC or within 3 mm ( $1/8$  in) of the mid-thickness of the thickest section of a hollow QTC (see Figure 3).

For QTCs larger than the size specified in 5.7.2.3, it is not necessary that the test specimens be removed from a location farther from the QTC surface than would be required if the specified QTC size were used.

Test specimens shall be removed from the QTC such that the tensile specimen gauge length and Charpy V-notch root are at least  $1/4T$  from the ends of the QTC.

If a sacrificial production part is used as a QTC, the test specimens shall be removed from a section of the part meeting the size requirements for a QTC for that production part as defined in 5.7.2.

Standard-sized, 12,7 mm (0,500 in) diameter tensile specimens shall be used, unless the physical configuration of the QTC prevents their use. In this case, the standard sub-size specimens referenced in ASTM A370 may be used.

Standard-sized impact specimens, 10 mm  $\times$  10 mm in cross-section, shall be used, except where there is insufficient material, in which case the next smaller standard-size specimen obtainable shall be used. Impact specimens shall be removed such that the notch is within the  $1/4T$  envelope.

### 5.7.4.2 Hardness testing

At least one Rockwell or Brinell hardness test shall be performed on the QTC(s) after the final heat-treatment cycle.

The QTC heat-treatment cycles prior to hardness testing shall be the very same heat-treatment cycles experienced by the tensile and impact test specimens. Hardness testing shall be performed in accordance with the procedures in ISO 6506 (all parts) or ISO 6508 (all parts), or ASTM E10 or ASTM E18.

## 5.8 Heat-treating equipment qualification

All heat treating of parts, QTCs and TCs shall be performed with “production type” equipment meeting the requirements specified by the manufacturer. A recommended practice for heat-treating furnace calibration can be found in Annex M.

“Production type” heat-treating equipment shall be considered equipment that is routinely used to process production parts having an ER equal to or greater than the ER of the subject TC.

## 5.9 Material qualification

If reference to 5.9 is given in this International Standard, the manufacturer shall specify the methods necessary to qualify and test materials.

## 5.10 Pressure-boundary penetrations

Material requirements for pressure-boundary penetrations shall be as specified by the manufacturer. Pressure-boundary penetrations directly exposed to well-bore fluid and used in sour service (material classes DD, EE, FF, and HH) shall meet the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2).

### **5.11 Wear bushings**

Material requirements for wear bushings shall be as specified by the manufacturer. The hardness of the material shall be between 241 HBW and 321 HBW.

### **5.12 Clamp hub-end connectors**

Material requirements for clamp hubs, specified dimensionally in ISO 13533, shall be equal to the material requirements of the equipment to which the clamp hub is connected. Minimum requirements are those for PSL 2 bodies, bonnets and end and outlet connections (see 5.4).

## **6 Welding — General requirements**

### **6.1 General**

Requirements are established for the following four types of welds:

- a) non-pressure-containing weldments other than weld overlays: PSL 1 to PSL 3;
- b) pressure-containing fabrication weldments for bodies, bonnets, end and outlet connections, bullplugs, valve-removal plugs and back-pressure valves: PSL 1 to PSL 3;
- c) pressure-containing repair weldments for bodies, bonnets, end and outlet connections, bullplugs, valve-removal plugs and back-pressure valves: PSL 1 to PSL 3;
- d) Weld overlay for corrosion resistance and/or hard facing and other material surface property controls: PSL 1 to PSL 4.

### **6.2 Non-pressure-containing weldments other than weld overlays — PSL 1 to PSL 3**

The following apply:

- a) welding procedure/performance:

Welding procedures and performance qualifications shall be in accordance with ASME BPVC:2004, Section IX, Articles II and III with 2005 and 2006 addenda.

- b) application:

Welding shall be performed in accordance with qualified procedures by qualified welding personnel. Non-pressure-containing weldments shall meet the manufacturer's design requirements.

- c) quality control requirements:

Welding and completed welds shall meet the requirements of Table 18.

### **6.3 Pressure-containing fabrication weldments for bodies, bonnets, end and outlet connections, bullplugs, valve-removal plugs and back-pressure valves**

#### **6.3.1 General**

No fabrication welding is allowed on bullplugs and valve-removal plugs.

## **6.3.2 PSL 1**

### **6.3.2.1 Joint design**

Design of groove and fillet welds with tolerances shall be documented in the manufacturer's specifications. Annex E recommends weld-preparation designs.

### **6.3.2.2 Materials**

The following apply:

a) welding consumables:

Welding consumables shall conform to the American Welding Society's or manufacturer's specifications. The manufacturer shall have a written procedure for storage and control of welding consumables. Materials of low-hydrogen type shall be stored and used as recommended by the manufacturer of the welding consumable to retain their original low-hydrogen properties.

b) deposited weld metal properties:

The deposited weld metal mechanical properties, as determined by the procedure qualification record (PQR), shall meet or exceed the minimum specified mechanical properties for the base material.

### **6.3.2.3 Welding procedure qualifications**

The following apply:

a) written procedure:

Welding shall be performed in accordance with welding procedure specifications (WPS), written and qualified in accordance with ASME, BPVC:2004, Section IX, Article II. The WPS shall describe all the essential, non-essential and supplementary essential (if required; see ASME, BPVC:2004, Section IX) variables.

The PQR shall record all essential and supplementary essential (if required) variables of the weld procedure used for the qualification test(s). Both the WPS and the PQR shall be maintained as records in accordance with the requirements of 7.5.

b) base metal groupings:

The manufacturer may establish a P-number grouping for material(s) not listed in ASME, BPVC:2004, Section IX.

c) heat-treat condition:

All testing shall be done with the test weldment in the post-weld heat-treated condition. Post-weld heat treatment of the test weldment shall be in accordance with the manufacturer's written specifications.

d) hardness testing:

For material classes DD, EE, FF and HH, hardness tests across the weld and base-material heat-affected zone (HAZ) cross-section shall be performed and recorded as part of the PQR. Results shall be in accordance with ISO 15156 (all parts) (NACE MR0175; see Clause 2).

The manufacturer shall specify the hardness testing locations in order to determine maximum hardness. Testing shall be performed on the weld and base-material HAZ cross-section in accordance with ISO 6508 (all parts) or ASTM E18, Rockwell method; or ISO 6507 (all parts), using the 98 N method or ASTM E92, Vickers 10 kgf method. Results shall be converted to Rockwell C, as applicable. ISO 18265 or ASTM E140 shall be used for the conversion of hardness readings for materials within the scope of their application. Other

conversion tables also exist. Users may establish correlations for individual materials outside the scope of ISO 18265 or ASTM E140.

- e) hardness testing (optional) for minimum mechanical properties:

For the purposes of hardness inspection and qualifying production weldments, a minimum of three hardness tests in the weld metal shall be made and recorded as part of the PQR. These tests shall be made by the same methods as used to inspect production weldments. These tests may be used to qualify weld metal with a hardness less than that established in 7.4.2.1.3 c) in accordance with the methods shown in 7.4.2.1.3 b).

- f) impact testing:

If impact testing is required for the base material, the testing shall be performed in accordance with ISO 148 (all parts) or ASTM A370 using the Charpy V-notch technique. Results of testing in the weld and base-material HAZ shall meet the minimum requirements of the base material. Records of results shall become part of the PQR.

Any retests of impact testing shall be in accordance with ISO 148 (all parts) or ASTM A370.

#### **6.3.2.4 Welder performance qualification**

The following apply:

- a) testing requirements:

Welders and welding operators shall be qualified in accordance with ASME, BPVC:2004, Section IX, Article III.

- b) records:

Records of welder performance qualification (WPQ) tests shall be in accordance with ASME, BPVC:2004, Section IX.

#### **6.3.2.5 Welding requirements**

The following apply:

- a) qualifications:

Welding shall be in compliance with the qualified WPS and shall be performed by qualified welders/welding operators.

- b) use of WPS:

Welders and welding operators shall have access to, and shall comply with, the welding parameters as defined in the WPS.

- c) designed welds:

All welds that are considered part of the design of a production part shall be specified by the manufacturer to describe the requirements for the intended weld.

- d) preheating:

Preheating of assemblies or parts, if required by the WPS, shall be performed to manufacturer's written procedures.

### 6.3.2.6 Post-weld heat treatment

Post-weld heat treatment shall be in accordance with the applicable qualified WPS.

Welds may be locally post-weld heat-treated. The manufacturer shall specify procedures for the use of local post-weld heat treatment.

### 6.3.2.7 Welding controls

The following apply:

a) procedures:

The manufacturer's welding control system shall include procedures for monitoring, updating and controlling the qualification of welders/welding operators and the use of welding procedure specifications.

b) instrument calibration:

Instruments to indicate temperature, voltage and amperage shall be serviced and calibrated in accordance with the manufacturer's written specifications.

## 6.3.3 PSL 2

### 6.3.3.1 General

The requirements for PSL 1 shall apply for PSL 2 with the addition of the requirements given in 6.3.3.2 to 6.3.3.4.

### 6.3.3.2 Welding procedure qualification

The following apply:

a) base metal groupings:

Each base material that is not listed in an ASME, BPVC:2004, Section IX, P-number or S-number grouping shall be specifically qualified by the manufacturer.

b) impact testing:

If impact testing is required for the base material, two sets of three test specimens shall be removed: one set from the weld metal and one set from the base-material HAZ. At least one face of each specimen shall be within  $1/4T$  of the surface of the material, where  $T$  is the thickness of the weldment. The root of the notch shall be oriented normal to the surface of the test weldment and located as follows:

- weld metal specimens (3 each): 100 % weld metal;
- HAZ specimens (3 each): to include as much HAZ material as possible.

### 6.3.3.3 Post-weld heat treatment — Furnace heating

Furnace post-weld heat treatment shall be performed with equipment meeting the requirements specified by the manufacturer.

### 6.3.3.4 Post-weld heat treatment — Local heating

Local post-weld heat treatment 57

shall consist of heating a circumferential band around the weld at a temperature within the range specified in the qualified WPS. The minimum width of the controlled band at each side of the weld on the face of the greatest weld width shall be the thickness of the weld or 50 mm (2 in) from the weld edge, whichever is less. Heating by direct flame impingement on the material shall not be permitted.

#### **6.3.4 PSL 3**

##### **6.3.4.1 General**

The requirements for PSL 1 and PSL 2 shall apply for PSL 3 with the addition of the requirements given in 6.3.4.2 to 6.3.4.4.

##### **6.3.4.2 Welding procedure qualification**

###### **6.3.4.2.1 Heat treatment**

The post-weld heat treatment of the test weldment shall be in the same temperature range as that specified on the WPS. Allowable range for the post-weld heat treatment on the WPS shall be a nominal temperature range,  $\pm 14\text{ }^{\circ}\text{C}$  ( $\pm 25\text{ }^{\circ}\text{F}$ ).

###### **6.3.4.2.2 Chemical analysis**

Chemical analysis of the base materials and filler metal for the test weldment shall be obtained from the supplier or by testing, and shall be part of the PQR.

###### **6.3.4.2.3 Hardness testing**

If the welding procedure is being qualified for use on parts or equipment used in material classes DD, EE, FF or HH, hardness testing shall be by the Rockwell method in accordance with ISO 6508 (all parts) or ASTM E18 or the Vickers 98 N method in accordance with ISO 6507 (all parts) or the 10 kgf method in accordance with ASTM E92 as follows.

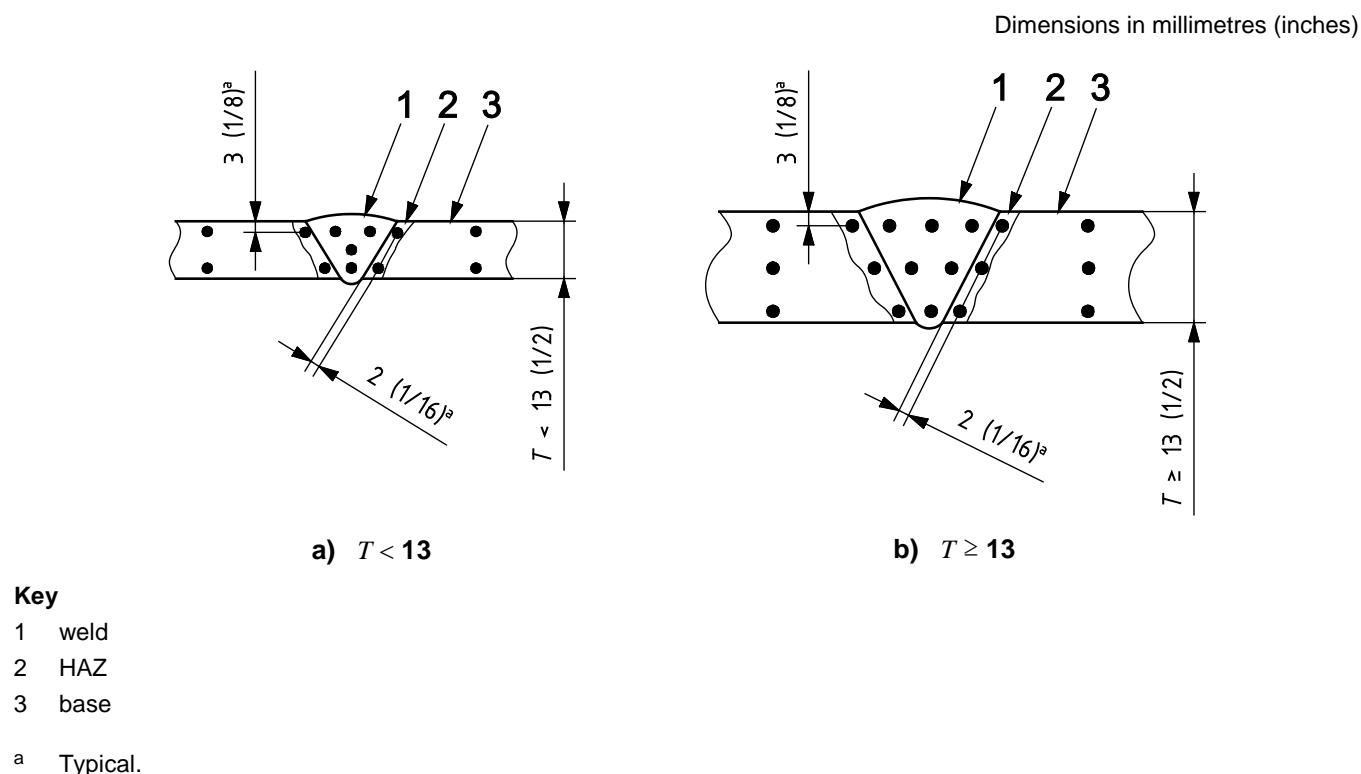
###### **a) Rockwell method:**

Test locations shall be as shown in Figure 4.

For a weld cross-section thickness less than 13 mm (1/2 in), four hardness tests shall be made in each of the base material(s), the weld and the HAZ.

For a weld cross-section thickness equal to or greater than 13 mm (1/2 in), six hardness tests shall be made in each of the base material(s), the weld and the HAZ.

For all thicknesses, HAZ hardness tests shall be performed in the base material within 2 mm (1/16 in) of the weld interface and at least one within 3 mm (1/8 in) from each of the top and the bottom of the weld.



**Figure 4 — Welding procedure qualification — Rockwell hardness test locations — PSL 3**

- b) Vickers 98 N method in accordance with ISO 6507 (all parts), or the Vickers 10 kgf method in accordance with ASTM E92:

Test locations shall be as shown in Figure 5.

For a weld cross-section thickness less than 13 mm (1/2 in), four hardness tests shall be made in each of the base material(s) and the weld.

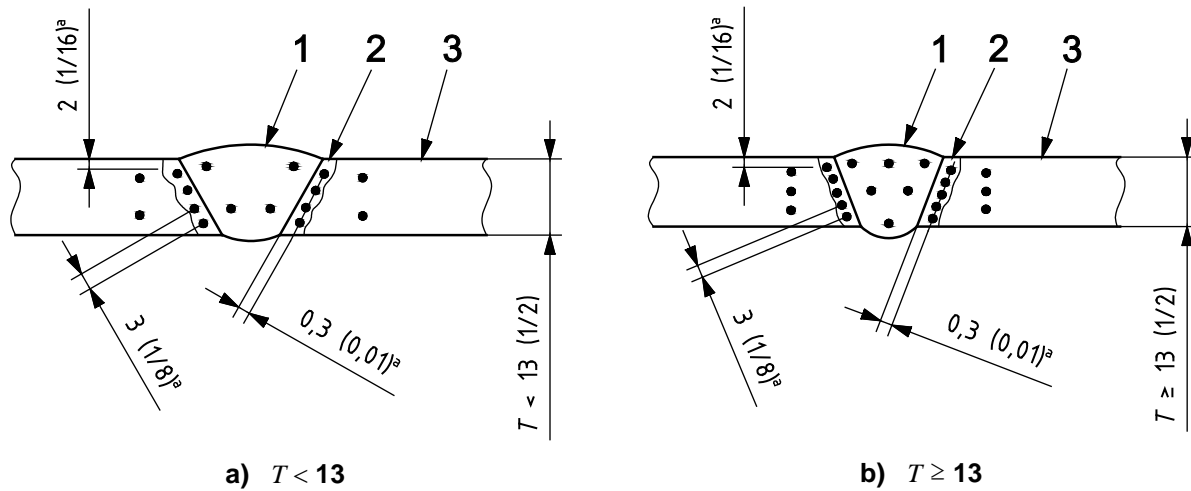
For a weld cross-section thickness equal to or greater than 13 mm (1/2 in), six hardness tests shall be made in each of the base material(s) and the weld.

For all thicknesses, multiple HAZ hardness tests equally spaced 3 mm (1/8 in) apart shall be performed in each of the base materials within 0,3 mm (0,010 in) of the weld interface with at least one within 2 mm (1/16 in) from the top and the bottom of the weld.

#### 6.3.4.3 Welding controls

Instruments, meters and gauges used to confirm welding parameters shall be serviced and calibrated to the manufacturer's written specifications by equipment traceable to a nationally or internationally recognized standard specified by the manufacturer. The calibration intervals shall be a maximum of six months until recorded calibration history can be established by the manufacturer. Intervals may be lengthened (six months maximum increment) or shall be shortened based on the recorded history. Written records shall document the calibration date, procedure used, accuracy, frequency and hardness results.

Dimensions in millimetres (inches)

**Key**

- 1 weld
- 2 HAZ
- 3 base

<sup>a</sup> Typical.

**Figure 5 — Welding procedure qualification — Vickers hardness test locations — PSL 3**

#### 6.3.4.4 Application

The post-weld heat treatment of the production weldment shall be in the same temperature range as that specified on the WPS. The stress-relieving heat-treatment time(s) at temperature of production parts shall be equal to or greater than that of the test weldment.

#### 6.3.5 PSL 4

Welding is not permitted, except for weld overlay.

#### 6.3.6 Quality control requirements

Requirements for pressure-containing welds are shown in Table 18.

### 6.4 Pressure-containing repair weldments for bodies, bonnets, end and outlet connections, bullplugs, valve-removal plugs and back-pressure valves

#### 6.4.1 PSL 1

The following apply:

##### a) general:

All repair welding procedures shall define the WPS and NDE requirements.

Welding shall be performed in accordance with the specified WPS.

b) base material:

The base-material requirements for material composition, material designation as specified in this International Standard, impact strength (if required), and heat-treatment condition shall be known prior to selecting a qualified WPS.

c) fusion:

The WPS selected and the access for repair shall be such to ensure complete fusion.

d) PQR:

The WPS selected shall be supported by a PQR as described in 6.3.2.3.

e) repair welding:

Repair welding of bullplugs, valve-removal plugs and back-pressure valves shall not be allowed.

f) access:

There shall be access to evaluate, remove and inspect the non-conforming condition; see also 7.4.2.2.13.

g) welder/welding operator qualification:

The welder/welding operator shall possess a valid qualification in accordance with 6.3.2.4.

#### 6.4.2 PSL 2 and PSL 3

The requirements for PSL 1 shall apply for PSL 2 and PSL 3 with the addition of the following requirements for bolt hole, tapped hole, and machined blind hole repair.

The following apply.

- a) The welder/welding operator shall perform an additional repair-welding performance qualification test using a mock-up hole.
- b) The repair-welding-qualification test hole shall be qualified by radiography in accordance with 7.4.2.2.14 or shall be cross-sectioned through the centreline of the hole in two places 90° apart and macro-etched to confirm complete fusion. One surface of each of the four matching segments shall be macro-etched. This evaluation shall include the total depth of the hole.
- c) The repair-weld qualification shall be restricted by the following essential variables for performance controls.
  - The hole diameter used for the performance-qualification test is the minimum diameter qualified. Any hole with a diameter greater than the diameter used for the test shall be considered qualified.
  - The depth-to-diameter ratio of the test hole shall qualify all repairs to holes with a same or smaller depth-to-diameter ratio.
  - The performance-qualification test hole shall have straight parallel walls. If any taper, counter-bore or other aid is used to enhance the hole configuration of the performance test, that configuration shall be considered an essential variable.

#### 6.4.3 PSL 4

Repair welding is not permitted.

#### 6.4.4 Quality control requirements

Weld NDE shall conform to requirements as defined by the manufacturer and by this International Standard in accordance with Table 18.

### 6.5 Weld overlay for corrosion resistance and/or hard facing and other material surface property controls

#### 6.5.1 PSL 1

##### 6.5.1.1 Ring grooves

###### 6.5.1.1.1 General

The provisions of 6.5.1.1 apply to ring grooves in loose connectors and in integral end and outlet connections.

###### 6.5.1.1.2 Welding procedure/performance qualification

Qualification shall be in accordance with ASME, BPVC:2004, Section IX, Articles II and III, for weld overlay.

The following apply:

a) chemical analysis:

Chemical analysis shall be performed on the weld metal in accordance with the requirements of ASME, BPVC:2004, Section IX, at a location 3 mm (0,125 in) or less from the original base-metal surface. The chemical composition of the deposited weld metal at that location shall be as specified by the manufacturer.

For austenitic or 300 series stainless steels, the chemical composition shall be as given in Table 13.

**Table 13 — Chemical composition of austenitic or 300 series stainless steels**

Element	Composition % mass fraction
Nickel	8,0 min.
Chromium	16,0 min.
Carbon	0,08 max.

b) Welds for use in hydrogen sulfide service shall conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2).

###### 6.5.1.1.3 Application

The following apply:

a) post-weld heat treatment:

End and outlet connections with corrosion-resistant weld-overlaid ring grooves shall be subjected to post-weld heat treatment in accordance with the WPS.

b) ring-joint grooves for welding:

Ring-joint grooves for welding shall be prepared in accordance with Table 52.

c) other weld preparations:

Other weld preparations may be used if the mechanical properties of the deposited weld metal equal or exceed those of the base metal.

### 6.5.1.2 Other corrosion-resistant overlay

#### 6.5.1.2.1 General

The provisions of 6.5.1.2 apply to use of corrosion-resistant weld overlay for bodies, bonnets, clamp hub end connectors, and end and outlet connectors for purposes other than ring grooves. These requirements do not apply to hard facing or to the weld overlay of valve-bore sealing mechanisms, choke trim or valve stems.

#### 6.5.1.2.2 Welding procedure/performance qualification

Qualification shall be in accordance with ASME, BPVC:2004, Section IX, Articles II and III, for weld overlay.

The following apply:

a) chemical analysis:

Chemical analysis of the weld metal shall be performed in accordance with the requirements of ASME, BPVC:2004, Section IX, at the minimum overlay thickness as specified by the manufacturer for the finished component.

For austenitic stainless steels, the chemical composition shall be as given in Table 14:

**Table 14 — Chemical composition of austenitic stainless steels**

Element	Composition % mass fraction
Nickel	8,0 min.
Chromium	16,0 min.
Carbon	0,08 max.

For the nickel-based alloy UNS N06625, the chemical composition shall meet one of the classes given in Table 15:

**Table 15 — Chemical composition of the nickel-based alloy UNS N06625**

Class	Element	Composition % mass fraction
Fe 5	Iron	5,0 max.
Fe 10	Iron	10,0 max.

For other compositions that are required to conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2), the chemical analysis of the overlay shall conform to the specification limits of the corresponding ISO 15156 (all parts) (NACE MR0175; see Clause 2)-approved material(s).

For all other compositions, the chemical analysis of the overlay shall conform to the specified limits of the manufacturer's written specification.

b) mechanical properties:

The manufacturer shall specify the methods to assure these mechanical properties and record the results as part of the PQR.

The base metal material shall retain the minimum mechanical property requirements after post-weld heat treatment.

If the overlay material is not considered as part of the manufacturer's or this International Standard's design criteria, a tensile test and an impact test of the overlay material are not required.

If the overlay material is considered as part of the manufacturer's or this International Standard's design criteria, mechanical testing of the overlay material is required.

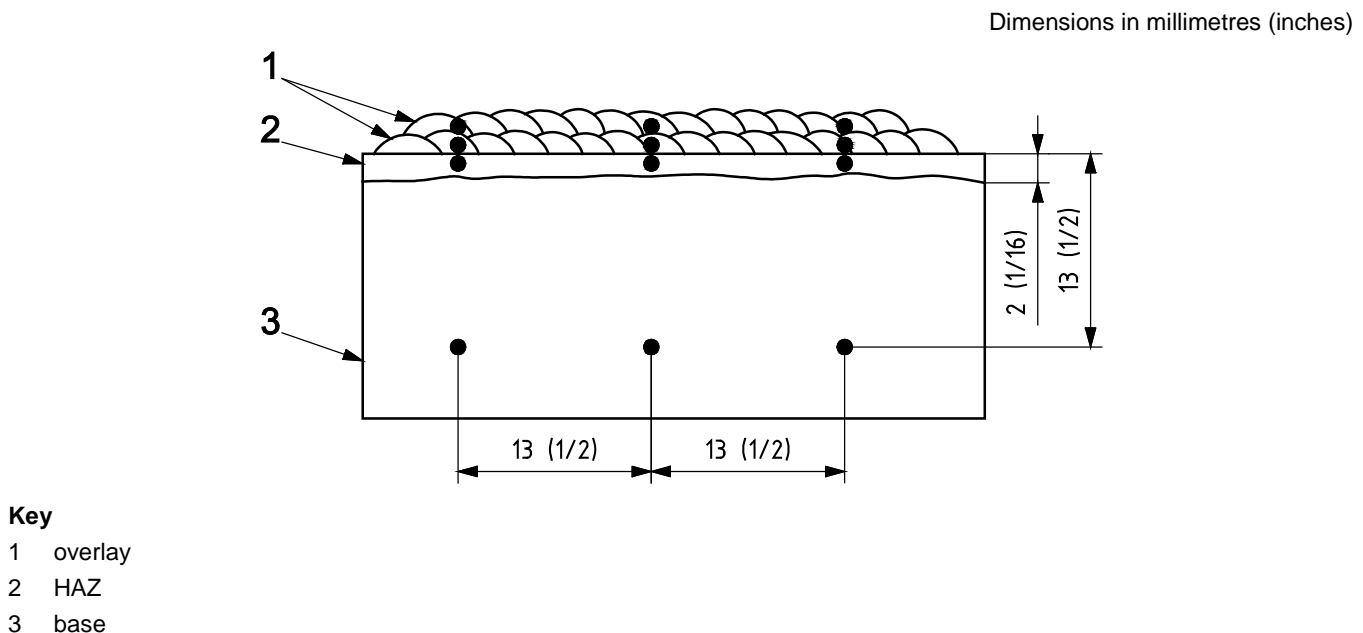
c) weld conformance to ISO 15156 (all parts) (NACE MR0175; see Clause 2):

Welds for use in hydrogen sulfide service shall conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2).

If the welding procedure is to be qualified for use on bodies, bonnets or flanges used for material classes DD, EE, FF or HH, hardness testing shall be carried out by the Rockwell method in accordance with ISO 6508 (all parts) or ASTM E18, or the Vickers 98 N method in accordance with ISO 6507 (all parts) or the Vickers 10 kgf method in accordance with ASTM E92. Hardness tests shall be performed at a minimum of three test locations in each of the base material, the heat-affected zone and in each layer of overlay up to a maximum of two layers. See Figure 6 for required hardness test locations.

d) guided-bend tests:

Guided-bend tests and acceptance criteria shall be in accordance with ASME, BPVC:2004, Section IX, to confirm weld overlay/base material bond integrity.



**Figure 6 — Hardness test locations for weld overlays**

**6.5.1.2.3 Base material conformance to ISO 15156 (all parts) (NACE MR0175; see Clause 2)**

The base material shall conform to ISO 15156 (all parts) (NACE MR0175; see Clause 2) after weld overlay and any subsequent heat treatments.

### **6.5.1.3 Other**

The use of weld overlay for purposes other than those covered by 6.5.1.1 and 6.5.1.2 does not require a welding procedure/performance qualification. The manufacturer shall use a written procedure that provides controls for consistently meeting the manufacturer-specified material surface properties in the final machined condition.

### **6.5.1.4 Repair of weld overlays**

Repairs of weld overlays, including associated base metal build-up using the overlay material, are acceptable only provided that

- a) the original applicable requirements (6.5.1.1, 6.5.1.2 or 6.5.1.3) are adhered to;
- b) if the weld overlay material and/or base metal build-up for the weld overlay are considered part of the design criteria of the manufacturer or of the design criteria of this International Standard, those properties listed in the design criteria are met;
- c) weld overlay repairs and associated base metal build-up for use in hydrogen-sulfide service conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2). Weld repairs of the base metal that are not associated with the weld overlays are not allowed for PSL 4 equipment.

## **6.5.2 PSL 2 to PSL 4**

### **6.5.2.1 General**

The requirements for PSL 2 to PSL 4 shall be identical to the requirements for PSL 1, with the addition of the requirements given in 6.5.2.2 to 6.5.2.5.

### **6.5.2.2 Welding procedure/performance qualification**

Qualification shall be in accordance with ASME, BPVC:2004, Section IX, Articles II and III, for weld overlay, hard facing or other types of overlay, as applicable.

### **6.5.2.3 Mechanical properties**

The base material shall retain the minimum mechanical property requirements after post-weld heat treatment.

The manufacturer shall specify the methods to assure these mechanical properties and record the results as part of the PQR.

### **6.5.2.4 Hardness testing for ring groove overlay**

Hardness testing shall be performed in the weld metal as part of the procedure qualification testing. Test locations shall be within 3 mm (0,125 in) of the original base material. The average of three or more test results shall be equal to or greater than 83 HRB and recorded as part of the PQR.

### **6.5.2.5 Quality control requirements**

The quality control requirements for weld metal overlays are shown in Table 18.

For the use of weld overlay for purposes other than those covered in 6.5.1.1 and 6.5.1.2, welding procedure/performance qualification requirements are not specified. The manufacturer shall use a written procedure that provides controls for consistently meeting the manufacturer-specified material surface properties in the final machined condition.

## **7 Quality control**

### **7.1 General**

Clause 7 specifies the quality control requirements and quality control record requirements for equipment and material manufactured to meet this International Standard.

### **7.2 Measuring and testing equipment**

#### **7.2.1 General**

Equipment used to inspect, test or examine material or other equipment shall be identified, controlled, calibrated and adjusted at specified intervals in accordance with documented manufacturer instructions, and consistent with nationally or internationally recognized standards specified by the manufacturer, to maintain the accuracy required by this International Standard.

#### **7.2.2 Pressure-measuring devices**

##### **7.2.2.1 Type and accuracy**

Test pressure-measuring devices shall be accurate to at least  $\pm 2\%$  of full-scale range. If pressure gauges are used in lieu of pressure transducers, they shall be selected such that the test pressure is indicated within 20 % and 80 % of the full-scale value.

Pressure recording devices (see 7.4.9.5.3) are outside the scope of 7.2.2 unless used for both measurement and recording.

##### **7.2.2.2 Calibration procedure**

Pressure-measuring devices shall be periodically calibrated with a master pressure-measuring device or a dead-weight tester to at least three equidistant points of full scale (excluding zero and full scale as required points of calibration).

##### **7.2.2.3 Calibration intervals**

Calibration intervals shall be established for calibrations based on repeatability and degree of usage. Intervals may be lengthened and shall be shortened based on recorded calibration history.

Calibration intervals shall be a maximum of three months until recorded calibration history can be established by the manufacturer and new longer intervals (three months maximum increment) established.

## **7.3 Quality-control personnel qualifications**

### **7.3.1 Non-destructive examination personnel**

Personnel performing NDE shall be qualified in accordance with the manufacturer's documented training programme that is based on the requirements specified in ISO 9712, EN 473 or ASNT SNT-TC-1A.

### **7.3.2 Visual examination personnel**

Personnel performing visual inspection for acceptance shall take and pass an annual vision examination in accordance with the manufacturer's documented procedures that meet the applicable requirements of ISO 9712, EN 473, or ASNT SNT-TC-1A.

### 7.3.3 Welding inspectors

Personnel performing visual inspections of welding operations and completed welds shall be qualified and certified as

- AWS-certified welding inspector, or
- AWS-senior certified welding inspector, or
- AWS-certified associate welding inspector, or
- welding inspector certified by the manufacturer's documented training programme.

### 7.3.4 Other personnel

All other personnel performing measurements, inspections or tests for acceptance shall be qualified in accordance with the manufacturer's documented procedures and requirements.

## 7.4 Quality control requirements

### 7.4.1 General

#### 7.4.1.1 Quality control tables

Tables 32 to 36 provide a matrix of quality control requirements for specific parts and equipment.

#### 7.4.1.2 Materials

Clause 5 provides detailed qualification requirements for mandrel tubing hangers and casing hangers; bodies, bonnets, end and outlet connections; ring gaskets; bullplugs and valve-removal plugs; back-pressure valves; pressure-boundary penetrations; wear bushings; clamp hub end connectors and qualification test coupons.

#### 7.4.1.3 Quality control instructions

All quality control work shall be controlled by the manufacturer's documented instructions, which include appropriate methodology and quantitative or qualitative acceptance criteria.

NDE instructions shall be detailed regarding the requirements of this International Standard and those of all applicable nationally or internationally recognized standards specified by the manufacturer. All NDE instructions shall be approved by a level III examiner.

#### 7.4.1.4 Acceptance status

The acceptance status of all equipment, parts and materials shall be indicated either on the equipment, parts or materials or in records traceable to the equipment, parts or materials.

#### 7.4.1.5 Material classes DD, EE, FF and HH

Each pressure-containing or pressure-controlling part for use in H<sub>2</sub>S service shall be hardness-tested individually to confirm that the ISO 15156 (all parts) (NACE MR0175; see Clause 2) hardness values have been satisfied (except for ring gaskets, which may be sampled in accordance with 7.4.6.3). If the other requirements of 7.4.1 satisfy this requirement, additional testing or examination is not required.

### 7.4.2 Bodies, bonnets, end and outlet connections and clamp hub end connectors

NOTE See Table 17.

### 7.4.2.1 PSL 1

#### 7.4.2.1.1 Tensile testing

Tensile testing shall be in accordance with 5.4.2.2.

#### 7.4.2.1.2 Impact testing

Impact testing shall be in accordance with 5.4.2.4.

#### 7.4.2.1.3 Hardness testing

The following apply:

##### a) sampling:

Loose connectors do not require hardness testing.

For bodies, bonnets, end and outlet connections and clamp hub end connectors with 13,8 MPa, 20,7 MPa and 34,5 MPa (2 000 psi, 3 000 psi and 5 000 psi) working pressure, sampling shall be in accordance with ISO 2859-1:1999, level II, 4,0 AQL.

For bodies, bonnets, end and outlet connections and clamp hub end connectors with 69,0 MPa, 103,5 MPa and 138,0 MPa (10 000 psi, 15 000 psi and 20 000 psi) working pressure, each part shall be hardness-tested.

##### b) test method:

Hardness testing shall be performed in accordance with procedures specified in ISO 6506, parts 1 through 4 or ASTM E10 (Brinell), or ISO 6508, parts 1 through 3 or ASTM E18 (Rockwell).

Portable hardness testers meeting the requirements of ASTM E110 and ISO 6506 (all parts) or ASTM E10, or ISO 6508 (all parts) or ASTM E18, as applicable, may be used for hardness testing.

ISO 18265 or ASTM E140 shall be used for the conversion of hardness readings for materials within the scope of their application. Other conversion tables also exist. Users may establish correlations for individual materials outside the scope of ISO 18265 or ASTM E140.

Tests shall be performed at a location determined by the manufacturer's specifications and following the last heat-treatment cycle (including all stress-relieving heat-treatment cycles) and all exterior machining at the test location.

If bodies, end and outlet connections and clamp hub ends have different material designations, each part shall be tested.

##### c) acceptance criteria:

Parts shall exhibit the minimum values given in Table 16:

**Table 16 — Minimum hardness values**

Material designation	Minimum Brinell hardness
36K	HBW 140
45K	HBW 140
60K	HBW 174
75K	HBW 197

Parts manufactured from non-standard, high-strength materials shall meet the minimum hardness requirements of the manufacturer's written specification.

Parts not complying with these minimum hardness levels are acceptable if the measured value satisfies the following requirement that the average tensile strength, as determined from the tensile tests results, shall be used with the QTC hardness measurements in order to determine the minimum acceptable hardness value for production parts fabricated from the same heat. The minimum acceptable Brinell hardness value for any part shall be determined by Equation (10):

$$H_{BWc, \min.} = \frac{R_{m, \min.}}{\bar{R}_{m, QTC}} (\bar{H}_{BW, QTC}) \quad (10)$$

where

- $H_{BWc, \min.}$  is the minimum acceptable Brinell hardness according to the HBW method for the part after the final heat-treatment cycle (including stress-relieving cycles);
- $R_{m, \min.}$  is the minimum acceptable ultimate tensile strength for the applicable material designation;
- $\bar{R}_{m, QTC}$  is the average ultimate tensile strength determined from the QTC tensile tests;
- $\bar{H}_{BW, QTC}$  is the average of the Brinell hardness values according to the HBW method observed among all tests performed on the QTC.

#### 7.4.2.1.4 Dimensional inspection

Dimensional inspection shall be performed on components manufactured to this PSL. The manufacturer shall specify critical dimensions.

The following apply:

a) sampling:

Sampling shall be in accordance with ISO 2859-1:1999, level II, 1,5 AQL. End and outlet connection threads on all components shall be gauged. Critical dimensions on all components shall be verified.

b) test method:

Threaded end and outlet connections shall be gauged for stand-off at hand-tight assembly by use of the gauges and gauging practices illustrated in Figures 10, 11 and 12.

c) acceptance criteria:

The end and outlet connection threads shall be in accordance with Tables 48 and B.48, API Spec 5B or ASME B1.1, ASME B1.2, and ASME B1.3, as applicable.

Acceptance criteria for critical dimensions shall be as required by the manufacturer's written specification.

#### 7.4.2.1.5 Visual examination

The following apply:

a) sampling:

Each part shall be visually examined.

b) test method:

Visual examinations of castings shall be performed in accordance with procedures specified in MSS SP-55.

Visual examination of forgings shall be performed in accordance with manufacturer's written specifications.

c) acceptance criteria:

1) for castings: in accordance with MSS SP-55:

- type 1: none acceptable,
- types 2 through 12: A and B;

2) for forgings: in accordance with manufacturer's written specifications.

#### **7.4.2.1.6 Weld NDE — General**

If examination is required (see Table 18), for all weld types, the essential welding variables and equipment shall be monitored; welding activities shall be audited; and completed weldments [a minimum of 13 mm ( $\frac{1}{2}$  in) of surrounding base metal and the entire accessible weld] shall be examined in accordance with the methods and acceptance criteria of Table 18.

Requirements and acceptance criteria for corrosion-resistant weld overlay of bodies, bonnets and flanges can be different from those for other weld types and shall meet the manufacturer's written specifications. The manufacturer's written specification for corrosion-resistant weld overlay shall include a technique for measuring the specified overlay thickness.

#### **7.4.2.2 PSL 2**

##### **7.4.2.2.1 Tensile testing**

Tensile testing requirements for PSL 2 shall be in accordance with 5.4.2.3.

##### **7.4.2.2.2 Impact testing**

Impact testing requirements for PSL 2 shall be in accordance with 5.4.2.4.

**Table 17 — Quality control requirements for bodies, bonnets, end and outlet connections and clamp hub end connectors**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3/3G	PSL 4
Tensile testing	7.4.2.1.1	7.4.2.2.1	7.4.2.2.1	7.4.2.2.1
Impact testing	7.4.2.1.2	7.4.2.2.2	7.4.2.3.2	7.4.2.4.2
Hardness testing	7.4.2.1.3	7.4.2.2.3	7.4.2.3.3	7.4.2.3.3
ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional inspection	7.4.2.1.4	7.4.2.1.4	7.4.2.3.4	7.4.2.3.4
Traceability	—	7.4.2.2.5	7.4.2.3.5	7.4.2.3.5
Chemical analysis	—	7.4.2.2.6	7.4.2.2.6	7.4.2.2.6
Visual examination	7.4.2.1.5	7.4.2.1.5 7.4.2.2.7	—	—
Surface NDE	—	7.4.2.2.8 7.4.2.2.9	7.4.2.3.8	7.4.2.3.8
Weld NDE				No welding permitted except for weld overlays (see 7.4.2.4.9)
General	7.4.2.1.6	7.4.2.1.6	7.4.2.1.6	
Examination visual	—	7.4.2.2.11	7.4.2.2.11	
NDE surface	—	7.4.2.2.12	7.4.2.2.12 7.4.2.3.11	
Repair welds	—	7.4.2.2.13	7.4.2.2.13	
NDE volumetric	—	7.4.2.2.14	7.4.2.3.12	
Hardness testing	—	—	7.4.2.3.13	
Serialization	—	—	7.4.2.3.14	7.4.2.3.14
Volumetric NDE	—	—	7.4.2.3.15	7.4.2.4.11

**7.4.2.2.3 Hardness testing**

Hardness testing requirements for PSL 2 shall be identical to the requirements for PSL 1, except that all parts shall be tested.

**7.4.2.2.4 Dimensional inspection**

Dimensional inspection requirements for PSL 2 shall be identical to the requirements for PSL 1.

**7.4.2.2.5 Traceability**

Job-lot traceability is required.

Identification shall be maintained on materials and parts to facilitate traceability, as required by documented manufacturer requirements.

Manufacturer-documented traceability requirements shall include provisions for maintenance or replacement of identification marks and identification control records.

#### 7.4.2.2.6 Chemical analysis

The following apply:

a) sampling:

Chemical analysis shall be performed on a heat basis.

b) test method:

Chemical analysis shall be performed in accordance with nationally or internationally recognized standards specified by the manufacturer.

c) acceptance criteria:

The chemical composition shall meet the requirements of 5.4.5 and the manufacturer's written specification.

#### 7.4.2.2.7 Visual examination

Visual examination requirements for non-wetted and non-sealing surfaces shall be identical to the requirements for PSL 1. Wetted and sealing surfaces shall be examined by surface NDE methods described in 7.4.2.2.8 and 7.4.2.2.9, as applicable.

#### 7.4.2.2.8 Surface NDE — Ferromagnetic materials

The following apply:

a) sampling:

All accessible wetted surfaces and all accessible sealing surfaces of each finished part shall be examined by liquid-penetrant or magnetic-particle methods after final heat treatment and final machining operations.

b) test method:

All ferromagnetic materials shall be examined in accordance with procedures specified in ASTM E709 (MT) or ASTM E165 (PT). Prods are not permitted on well-fluid surfaces or sealing surfaces.

If any indications are believed to be non-relevant on the basis that they are not associated with a surface rupture (i.e. magnetic permeability variations, non-metallic stringers), they shall be examined by liquid-penetrant surface NDE methods, or removed and re-inspected, to confirm their non-relevancy.

c) acceptance criteria:

The following acceptance criteria apply:

- no relevant indication with a major dimension equal to or greater than 5 mm ( $3/16$  in);
- no more than ten relevant indications in any continuous 40 cm<sup>2</sup> (6 in<sup>2</sup>) area;
- four or more relevant indications in a line separated by less than 1,6 mm ( $1/16$  in) (edge to edge) are unacceptable;
- no relevant indications in pressure contact sealing surfaces.

#### 7.4.2.2.9 Surface NDE — Non-ferromagnetic materials

The following apply:

a) sampling:

All accessible wetted surfaces and all accessible sealing surfaces of each finished part shall be liquid-penetrant inspected after final heat treatment and final machining operations.

b) test method:

All non-ferromagnetic materials shall be examined in accordance with procedures specified in ASTM E165.

c) acceptance criteria:

The following acceptance criteria apply:

- no relevant linear indication;
- no relevant rounded indication with a major dimension equal to or greater than 5 mm ( $3/16$  in);
- four or more relevant rounded indications in a line separated by less than 1,6 mm ( $1/16$  in) (edge to edge) are unacceptable;
- no relevant indication in pressure-contact sealing surfaces.

#### 7.4.2.2.10 Weld NDE — General

General requirements for PSL 2 shall be identical to the requirements for PSL 1.

#### 7.4.2.2.11 Weld examination — Visual

The following apply:

a) sampling:

100 % of all welds shall be visually examined after post-weld heat treatment and machining operations.

b) test method:

Examinations shall include a minimum of 13 mm ( $1/2$  in) of adjacent base metal on both sides of the weld.

c) acceptance criteria:

The following acceptance criteria apply.

- All pressure-containing welds shall have complete joint penetration.
- Undercut shall not reduce the thickness in the area (considering both sides) to below the minimum thickness.
- Surface porosity and exposed slag are not permitted on or within 3 mm ( $1/8$  in) of sealing surfaces.

#### 7.4.2.2.12 Weld NDE — Surface

The following apply:

a) sampling:

100 % of all pressure-containing fabrication welds and weld overlay shall be examined by either magnetic-particle (in the case of ferromagnetic materials) or liquid-penetrant (in the case of ferromagnetic or non-ferromagnetic materials) methods after all welding, post-weld heat treatment and machining operations.

## b) test method/acceptance: magnetic-particle examination:

Examinations shall include a minimum of 13 mm (1/2 in) of adjacent base metal on both sides of the weld.

Magnetic-particle examination shall be performed as described in 7.4.2.2.8 with additional acceptance criteria as follows:

- no relevant linear indication;
- no rounded indication greater than 3 mm ( $1/8$  in) for welds whose depth is 16 mm ( $5/8$  in) or less; or 5 mm ( $3/16$  in) for welds whose depth is greater than 16 mm ( $5/8$  in).

## c) test method/acceptance: liquid-penetrant examination:

Liquid-penetrant examination shall be performed as described in 7.4.2.2.9 with additional acceptance criterion of no rounded indications greater than 3 mm ( $1/8$  in) for welds whose depth is 16 mm ( $5/8$  in) or less, or 5 mm ( $3/16$  in) for welds whose depth is greater than 16 mm ( $5/8$  in).

**Table 18 — Quality control requirements for welding**

Weld type	Stages	PSL 1	PSL 2	PSL 3/PSL 3G	PSL 4
Pressure-containing	Preparation	—	—	a	No welding permitted
	Completion	—	ab and (c or d)	ab (c or d) and e	
Non-pressure-containing	Preparation	—	—	a	No welding permitted
	Completion	—	a	a and e	
Repair	Preparation	—	h	h	No welding permitted
	Completion	—	ab and (f or g)	abe and (f or g)	
Weld metal overlay (ring grooves, stems, valve-bore sealing mechanisms and choke trim)	Preparation	—	—	b	b
	Completion	—	b	b	b
Weld metal corrosion-resistant alloy overlay (bodies, bonnets and end and outlet connections)	Preparation	a	a	a	a
	Completion	ab	ab	abi	abi
<p>a Visual examination.</p> <p>b Liquid-penetrant testing inspection for non-ferromagnetic materials and magnetic-particle testing or liquid-penetrant testing for ferromagnetic material.</p> <p>c Radiation (radiography or imaging) examination.</p> <p>d Ultrasonic examination.</p> <p>e Hardness test (weld).</p> <p>f Ultrasonic examination only if weld thickness is greater than 25 % of wall thickness, or 25 mm (1 in), whichever is less.</p> <p>g Radiation (radiography or imaging) examination only if weld thickness is greater than 25 % of wall thickness for PSL 2, or 20 % of wall thickness for PSL 3, or 25 mm (1 in), whichever is less.</p> <p>h Liquid-penetrant or magnetic-particle as applicable for material defects only.</p> <p>i Measurement of overlay thickness, testing of bond integrity and volumetric examination shall be according to the manufacturer's specifications. If the overlay is considered part of the manufacturer's design criteria or of the design criteria of this International Standard, volumetric examinations shall be in accordance with the methods and acceptance criteria of 7.4.2.3.15.</p>					
<p>NOTE "Preparation" refers to surface preparation, joint preparation, fit-up and preheat.</p> <p>"Completion" refers to after all welding, post-weld heat treat and machining.</p>					

#### 7.4.2.2.13 Repair welds

All repair welds shall be examined using the same methods and acceptance criteria as used for examining the base metal or weld metal.

Examinations shall include 13 mm ( $1/2$  in) of adjacent base metal on all sides of the weld.

Surfaces prepared for welding shall be examined prior to welding to ensure defect removal to acceptable levels. Methods and acceptance criteria shall be as in 7.4.2.2.12.

#### 7.4.2.2.14 Weld NDE — Volumetric

The following apply:

a) sampling:

100 % of all pressure-containing welds shall be examined by either radiography or ultrasonic methods after all welding, post-weld heat treatment and machining operations but prior to machining operations that limit effective interpretation of the results of the examination. All repair welds where the repair is greater than 25 % of the original wall thickness or 25 mm (1 in), whichever is less, shall be examined by either radiography or ultrasonic methods after all welding and post-weld heat treatment. Examinations shall include at least 13 mm ( $1/2$  in) of adjacent base metal on all sides of the weld.

b) test method: radiographic examination:

Radiographic examinations shall be performed in accordance with procedures specified in ASTM E94, to a minimum equivalent sensitivity of 2 % and a 2-2T quality level.

Both X-ray and gamma-ray radiation sources are acceptable within the inherent thickness range limitation of each. Real-time imaging and recording/enhancement methods may be used if the manufacturer has documented proof that these methods result in a minimum equivalent sensitivity of 2 % and a 2-2T quality level. Wire-type image quality indicators are acceptable for use in accordance with ASTM E747.

NOTE The first number of the quality level designation refers to the image quality indicator or penetrameter thickness expressed as a percentage of the specimen thickness; the second number refers to the diameter of the image quality indicator hole that it is necessary to be able to see on the radiograph, expressed as a multiple of penetrameter thickness,  $T$ .

c) acceptance criteria for radiographic examination:

The following acceptance criteria apply:

- no type of crack, zone of incomplete fusion or penetration;
- no elongated slag inclusion that has a length equal to or greater than that given in Table 19:

**Table 19 — Maximum length of elongated slag inclusions**

Weld thickness $T$		Inclusion length	
mm	(in)	mm	(in)
< 19,0	(0,75)	6,4	(0,25)
19,0 to 57,0	(0,75 to 2,25)	$0,33T$	(0,33T)
> 57,0	(2,25)	19,0	(0,75)

- no group of slag inclusions in a line having an aggregated length greater than the weld thickness,  $T$ , in any total weld length of  $12T$ , except where the distance between successive inclusions exceeds six times the length of the longest inclusion;
- no rounded indication in excess of that specified in ASME BPVC:2004 with 2005 and 2006 addenda, Section VIII, Division 1, Appendix 4.

d) test method for ultrasonic examination:

Ultrasonic examinations shall be performed in accordance with procedures specified in ASME, BPVC:2004, Section V, Subsection A, Article 4.

e) acceptance criteria for ultrasonic examination:

The following acceptance criteria apply:

- no indication whose signal amplitude exceeds that of the reference level;
- no linear indication interpreted as cracks, incomplete joint penetration or incomplete fusion;
- no slag indication with amplitudes exceeding the reference level whose length exceeds those given in Table 20:

**Table 20 — Maximum amplitude of slag indications**

Weld thickness $T^a$		Inclusion length	
mm	(in)	mm	(in)
< 19,0	(0,75)	6,4	(0,25)
19,0 to 57,0	(0,75 to 2,25)	$0,33T$	$(0,33T)$
> 57,0	(2,25)	19,0	(0,75)
<sup>a</sup> $T$ is the thickness of the weld being examined. If a weld joins two members having different thicknesses at the weld, $T$ is the thinner of the two thicknesses.			

### 7.4.2.3 PSL 3/3G

#### 7.4.2.3.1 Tensile testing

Tensile testing requirements for PSL 3 shall be identical to the requirements for PSL 2.

#### 7.4.2.3.2 Impact testing

Impact testing requirements for PSL 3 shall be in accordance with 5.4.2.4.

#### 7.4.2.3.3 Hardness testing

Hardness testing requirements for PSL 3 shall be identical to the requirements for PSL 2, except that one hardness test shall be performed on each finished part (body, bonnet, and end connections) with additional tests on each end connection face at locations specified in the manufacturer's design documents.

#### 7.4.2.3.4 Dimensional inspection

Dimensional inspection requirements for PSL 3 shall be identical to the requirements for PSL 1. Additionally, inspection shall be performed on all parts.

**7.4.2.3.5 Traceability**

Parts manufactured to PSL 3 shall be traceable to a specific heat and heat-treat lot.

**7.4.2.3.6 Chemical analysis**

Chemical analysis requirements for PSL 3 shall be identical to the requirements for PSL 2.

**7.4.2.3.7 Visual examination**

None required.

**7.4.2.3.8 Surface NDE**

Surface NDE requirements for PSL 3 shall be identical to the requirements for PSL 2 (see 7.4.2.2.8 and 7.4.2.2.9). Additionally,

- all accessible surfaces of each finished part shall be inspected;
- all magnetic particle examinations shall use the wet fluorescent method;
- surface NDE shall be performed on all surfaces prepared for “weld metal overlay” (see Table 18).

**7.4.2.3.9 Weld NDE — General**

General weld NDE requirements for PSL 3 shall be identical to the requirements for PSL 1.

Repair weld requirements for PSL 3 shall be identical to the requirements for PSL 2.

**7.4.2.3.10 Weld examination — Visual**

Visual requirements for PSL 3 shall be identical to the requirements for PSL 2.

**7.4.2.3.11 Weld NDE — Surface**

Surface requirements for PSL 3 shall be identical to the requirements for PSL 2. Additionally, magnetic-particle examination shall be performed by the wet fluorescent method.

**7.4.2.3.12 Weld NDE — Volumetric**

Volumetric requirements for PSL 3 shall be identical to the requirements for PSL 2, with the addition that all repair welds, if the repair exceeds 20 % of the original wall thickness or 25 mm (1 in), whichever is the smaller, or if the extent of the cavity exceeds approximately 65 cm<sup>2</sup> (10 in<sup>2</sup>), shall be examined by either radiography or ultrasonic methods after all welding and post-weld heat treatment.

**7.4.2.3.13 Weld NDE — Hardness testing**

The following apply:

a) sampling:

100 % of all accessible pressure-containing, non-pressure-containing and repair welds.

b) test method:

Hardness testing shall be performed in accordance with ISO 6506 (all parts) or ISO 6508 (all parts), or ASTM E10 or ASTM E18.

At least one hardness test shall be performed in both the weld and in the adjacent unaffected base metals after all heat treatment and machining operations.

c) acceptance criteria:

Hardness values shall meet the base material requirements of 7.4.2.1.3.

The hardness recorded in the PQR shall be the basis for acceptance if the weld is not accessible for hardness testing.

#### **7.4.2.3.14 Serialization**

Each individual part and/or piece of equipment shall be assigned and marked with a unique code to maintain traceability and associated records.

#### **7.4.2.3.15 Volumetric NDE**

The following apply:

a) sampling:

As far as practical, the entire volume of each part shall be volumetrically inspected (radiography or ultrasonic) after heat treatment for mechanical properties and prior to machining operations that limit effective interpretation of the results of the examination.

For quench-and-tempered products, the volumetric inspection shall be performed after heat treatment for mechanical properties exclusive of stress-relief treatments or retempering to reduce hardness.

b) ultrasonic examination:

1) The following test methods apply:

- hot-worked parts: Ultrasonic examination of hot-worked parts shall be performed in accordance with the flat-bottom-hole procedures specified in ASTM A388/388M, except that the immersion method may be used, and ASTM E428.
- calibration: The distance amplitude curve (DAC) shall be based on 1,6 mm ( $1/16$  in) flat-bottom hole for metal thicknesses through 38 mm ( $1\frac{1}{2}$  in), on 3,2 mm ( $1/8$  in) flat-bottom hole for metal thicknesses from 38 mm ( $1\frac{1}{2}$  in) through 150 mm (6 in), and on 6,4 mm ( $1/4$  in) flat-bottom hole for metal thicknesses exceeding 150 mm (6 in).

2) The following acceptance criteria apply:

- no single indication exceeding reference distance amplitude curve;
- no multiple indications exceeding 50 % of reference distance amplitude curve. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm ( $1/2$  in) of each other in any direction.

## c) radiographic examination:

## 1) test method:

Radiographic examination of hot-worked parts shall be performed in accordance with methods specified in 7.4.2.2.14.

## 2) acceptance criteria:

The following acceptance criteria apply to hot-worked parts:

- no cracks, laps, or bursts;
- no elongated indication with a length greater than that given in Table 21:
- no group of indications in a line that have an aggregate length greater than  $T$  in a length of  $12T$ .

**Table 21 — Maximum length of elongated indication**

Thickness $T$		Inclusion length	
mm	(in)	mm	(in)
< 19,0	(0,75)	6,4	(0,25)
19,0 to 57,0	(0,75 to 2,25)	$0,33T$	(0,33 $T$ )
> 57,0	(2,25)	19,0	(0,75)

#### 7.4.2.4 PSL 4

##### 7.4.2.4.1 Tensile testing

Tensile testing requirements for PSL 4 shall be identical to the requirements for PSL 2.

##### 7.4.2.4.2 Impact testing

Impact testing requirements for PSL 4 shall be in accordance with 5.4.2.4.

##### 7.4.2.4.3 Hardness testing

Hardness testing requirements for PSL 4 shall be identical to the requirements for PSL 3.

##### 7.4.2.4.4 Dimensional inspection

Dimensional inspection requirements for PSL 4 shall be identical to the requirements for PSL 3.

##### 7.4.2.4.5 Traceability

Traceability requirements for PSL 4 shall be identical to the requirements for PSL 3.

##### 7.4.2.4.6 Chemical analysis

Chemical analysis requirements for PSL 4 shall be identical to the requirements for PSL 2.

**7.4.2.4.7 Visual examination**

None required.

**7.4.2.4.8 Surface NDE**

Surface NDE requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.2.4.9 Weld NDE**

No welding except overlay is permitted on PSL 4 parts or equipment. Weld NDE requirements for overlay in PSL 4 shall be identical to the requirements for PSL 3.

**7.4.2.4.10 Serialization**

Serialization requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.2.4.11 Volumetric NDE**

Volumetric NDE requirements for PSL 4 shall be identical to the requirements for PSL 3, with the addition of the following:

a) acceptance criteria for ultrasonic examination:

Same acceptance criteria as for PSL 3 with the addition that no continuous cluster of indications on the same plane, regardless of amplitude, shall be found over an area twice the diameter of the search unit.

b) acceptance criteria for radiographic examination of hot-worked parts:

- no type of crack, lap or burst;
- no elongated indication exceeding 6,4 mm ( $1/4$  in);
- no more than two indications separated by less than 13 mm ( $1/2$  in).

**7.4.3 Stems (PSL 1 to PSL 4)****7.4.3.1 Quality control requirements, methods and acceptance criteria**

Table 22 lists the quality control requirements for stems. The requirements shown for stems are the same as for bodies and bonnets, except that material properties shall conform to the requirements of 5.1 and 5.2. Impact testing requirements and acceptance criteria for stems shall be the same as for bodies, bonnets, and end and outlet connections.

**7.4.3.2 Volumetric NDE examination (PSL 3 and PSL 4)**

The following apply:

a) sampling:

Each stem, or bar from which stems are machined, shall be volumetrically inspected using ultrasonic or radiographic techniques. The inspection shall be conducted after final heat treatment (exclusive of stress-relief treatments) and prior to machining operations that limit effective interpretation of the results of the examination.

## b) test method:

Inspection shall be performed in accordance with the methods of 7.4.2.3.15 for wrought products. If ultrasonic inspection is performed, each stem (or bar from which stems are machined) shall be ultrasonically inspected from the outer diameter and ends by the straight-beam technique. Stems that cannot be examined axially using the straight-beam technique shall be examined using the angle-beam technique.

## c) calibration:

DAC based on 3,2 mm (1/8 in) flat-bottom hole (straight-beam technique) and 1,6 mm (1/16 in) side-drilled hole, 25 mm (1 in) deep (angle-beam technique).

## d) acceptance criteria:

Acceptance criteria shall be in accordance with 7.4.2.3.15.

**Table 22 — Quality control requirements for stems**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Tensile testing	5.6	5.7	5.7	5.7
Impact testing	5.9	7.4.2.1.2	7.4.2.1.2	7.4.2.1.2
Hardness testing	7.4.2.1.3	7.4.2.2.3	7.4.2.3.3	7.4.2.3.3
ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional inspection	7.4.2.1.4	7.4.2.1.4	7.4.2.3.4	7.4.2.3.4
Traceability	—	7.4.2.2.5	7.4.2.3.5	7.4.2.3.5
Chemical analysis	—	7.4.2.2.6	7.4.2.2.6	7.4.2.2.6
Visual examination	7.4.2.1.5	7.4.2.2.7	—	—
Surface NDE	—	7.4.2.2.8 7.4.2.2.9	7.4.2.3.8	7.4.2.3.8
Weld NDE				No welding permitted except for weld overlays (see 7.4.2.4.9)
General	7.4.2.1.6	7.4.2.1.6	7.4.2.1.6	
Visual examination	—	7.4.2.2.11	7.4.2.2.11	
NDE surface	—	7.4.2.2.12	7.4.2.3.11	
Repair welds	—	7.4.2.2.13	7.4.2.2.13	
NDE volumetric	—	7.4.2.2.14	7.4.2.3.12	
NDE hardness testing	—	—	7.4.2.3.13	
Serialization	—	—	7.4.2.3.14	7.4.2.3.14
Volumetric NDE	—	—	7.4.3.2	7.4.3.2

#### 7.4.4 Other pressure-boundary penetrations (PSL 1 to PSL 4)

The quality control requirements for other pressure-boundary penetrations shall be controlled in accordance with the manufacturer's written specifications. The material properties shall conform to the requirements of 5.1 and 5.2.

### 7.4.5 Valve-bore sealing mechanisms and choke trim (PSL 1 to PSL 4)

Table 23 lists the quality control requirements for valve-bore sealing mechanisms and choke trim. For choke trim, only the surface NDE and serialization shall apply. Surface NDE is not required on brazed, press-fit or shrink-fit joints. Indications that are restricted to a brazed, press-fit or shrink-fit joint are not relevant.

The requirements shown for valve-bore sealing mechanisms are the same as for bodies and bonnets, except that material properties shall conform to the requirements of 5.1 and 5.2 and volumetric NDE is not required.

**Table 23 — Quality control requirements for valve-bore sealing mechanisms and choke trim**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Tensile testing	—	—	5.7	5.7
Hardness testing ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.2.3.3 7.4.1.5	7.4.2.3.3 7.4.1.5
Dimensional inspection	—	—	7.4.2.1.4 7.4.2.3.4	7.4.2.1.4 7.4.2.3.4
Traceability	—	—	7.4.2.3.5	7.4.2.3.5
Chemical analysis	—	—	7.4.2.2.6	7.4.2.2.6
Surface NDE	—	—	7.4.2.3.8	7.4.2.3.8
Weld NDE				
General	—	7.4.2.1.6	7.4.2.1.6	No welding permitted except for weld overlays (see 7.4.2.4.9)
Visual examination	—	7.4.2.2.11	7.4.2.2.11	
NDE surface	—	7.4.2.2.12	7.4.2.3.11	
Repair welds	—	7.4.2.2.13	7.4.2.2.13	
Hardness testing	—	—	7.4.2.3.13	
Serialization	—	—	7.4.2.3.14	7.4.2.3.14
NOTE Only the surface NDE and serialization are required for choke trim (see 7.4.5).				

### 7.4.6 Ring gaskets

NOTE See Table 24.

#### 7.4.6.1 Quality control requirements

Product specification levels are not applicable to ring gaskets. The quality control requirements shall be in accordance with Table 24.

**Table 24 — Quality control requirements for ring joint gaskets**

Parameter	Subclause reference
Dimensional inspection	7.4.6.2
Hardness testing ISO 15156 (NACE MR 0175; see Clause 2)	7.4.6.3 7.4.1.5
Surface finish	7.4.6.4

### 7.4.6.2 Dimensional inspection

Dimensional inspection shall be performed on ring gaskets manufactured according to this International Standard.

The following apply:

a) sampling:

Sampling shall be in accordance with the manufacturer's documented requirements.

b) test method:

The manufacturer's documented procedures shall be followed.

c) acceptance criteria:

Acceptance criteria shall be in accordance with 10.4.2.1.

### 7.4.6.3 Hardness testing

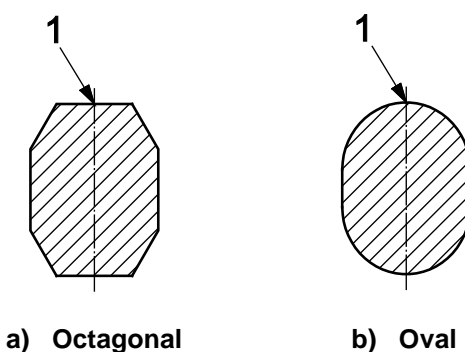
The following apply:

a) sampling:

As a minimum, sampling shall be performed on completed gaskets in accordance with ISO 2859-1:1999, level II, 1,5 AQL.

b) test method:

A minimum of one hardness test shall be performed in accordance with procedures specified in ISO 6508 (all parts) or ASTM E18. The location of the hardness test shall be in accordance with Figure 7.



**Key**

1 hardness test location

**Figure 7 — Ring gasket hardness test location**

## c) acceptance criteria:

The acceptance criteria shall be as given in Table 25:

**Table 25 — Maximum hardness**

Material	Maximum hardness
Soft iron	56 HRB
Carbon and low alloys	68 HRB
Stainless steel	83 HRB
Nickel alloy UNS N08825	92 HRB
Other CRAs	Hardness shall meet manufacturer's written specification.

#### 7.4.6.4 Surface finish

The following apply:

## a) sampling:

Sampling shall be in accordance with the manufacturer's documented requirements.

## b) test method:

The manufacturer's documented procedures shall be followed.

## c) acceptance criteria:

Acceptance criteria are as given in Table 26:

**Table 26 — Acceptance criteria for the gasket surface finish**

Gasket type	<i>Ra</i> μm	RMS (μin)
R	1,6	(63)
RX	1,6	(63)
BX	0,8	(32)

#### 7.4.7 Studs and nuts

NOTE See Table 27.

##### 7.4.7.1 Quality control requirements

The requirements for studs and nuts apply only to those used to connect end and outlet flanges and studded connections specified in 10.1.

Product specification levels are not applicable to studs and nuts. The quality control requirements shall be in accordance with Table 27. (Other studs and nuts shall meet the design requirements of 4.3.4 and the manufacturer's specifications.)

### 7.4.7.2 Tensile testing

Tensile testing requirements shall be performed in accordance with procedures specified in ASTM A193/A193M, ASTM A194/A194M, ASTM A320/A320M or ASTM A453/A453M, as appropriate, except that yield strength shall meet or exceed the minimum values shown in Table 62.

**Table 27 — Quality control requirements for studs and nuts**

Parameter	Subclause reference
Tensile testing	7.4.7.2
Impact testing	7.4.7.3
Dimensional inspection	7.4.7.4
Hardness testing	7.4.7.5
ISO 15156 (NACE MR 0175; see Clause 2)	7.4.7.5
Chemical analysis	7.4.7.6

### 7.4.7.3 Impact testing

Impact testing shall be performed on studs and nuts as required by Table 62.

### 7.4.7.4 Dimensional inspection

Dimensional inspection shall be performed on studs and nuts manufactured in accordance with this International Standard. The following apply:

a) sampling:

Sampling shall be in accordance with the applicable ASTM specification, or the manufacturer's written specification for CRAs not covered by ASTM.

b) test method:

The method shall be in accordance with the applicable ASTM specification, or the manufacturer's written specification for CRAs not covered by ASTM.

c) acceptance criteria:

The acceptance criteria shall be in accordance with the applicable ASTM specification, or the manufacturer's written specification for CRAs not covered by ASTM.

### 7.4.7.5 Hardness testing

The following apply:

a) specimens:

Specimens shall be in accordance with the applicable ISO or ASTM specification.

b) sampling:

Sampling shall be in accordance with the applicable ISO or ASTM specification with the addition that ASTM A453/A453M, grade 660 bolting and other CRA bolting material shall be individually hardness-tested.

c) test method:

Hardness testing shall be performed in accordance with ISO 6508 (all parts) or ASTM E18.

## d) acceptance criteria:

The acceptance criteria for exposed bolting shall be in accordance with ISO 15156 (all parts) (NACE MR0175; see Clause 2). Hardness testing is not required on ISO 15156 (all parts) (NACE MR0175; see Clause 2), non-exposed bolting.

All other bolting shall be in accordance with the applicable ASTM specification, or the manufacturer's written specification for CRAs not covered by ASTM.

**7.4.7.6 Chemical analysis**

Chemical analysis shall be performed in accordance with procedures specified in the applicable ASTM specification, or the manufacturer's written specification for CRAs not covered by ASTM.

**7.4.8 Non-metallic seals (PSL 1 to PSL 4)**

NOTE See Table 28.

**7.4.8.1 PSL 1****7.4.8.1.1 Dimensional inspection**

Dimensional inspection shall be performed on non-metallic seals manufactured in accordance with this International Standard.

The following apply:

## a) sampling:

Sampling shall be performed on non-metallic seals in accordance with ISO 2859-1:1999, level II, 2,5 AQL for O-rings and 1,5 AQL for other seals.

## b) test method:

Each piece of the sample shall be dimensionally inspected for compliance to specific tolerances.

## c) acceptance criteria:

If inspection methods produce fewer rejections than allowed in sampling, the batch shall be accepted.

**Table 28 — Quality control requirements for non-metallic seals**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Dimensional inspection	7.4.8.1.1	7.4.8.1.1	7.4.8.1.1	7.4.8.1.1
Visual examination	7.4.8.1.2	7.4.8.1.2	7.4.8.1.2	7.4.8.1.2
Hardness	7.4.8.1.3	7.4.8.1.3	7.4.8.1.3	7.4.8.1.3
Documentation	—	7.4.8.2.4	7.4.8.3.4	7.4.8.4.4
Batch traceability	—	—	7.4.8.3.4 a)	7.4.8.3.4 a)
Cure date certification	—	—	7.4.8.3.4 b)	7.4.8.3.4 b)
Shelf-life expiration date certification	—	—	7.4.8.3.4 c)	7.4.8.3.4 c)
Physical property data	—	—	—	7.4.8.4.4
Storage and age control	9.6 a)	9.6 a)	9.6 b)	9.6 b)

#### **7.4.8.1.2 Visual examination**

The following apply:

a) sampling:

Sampling shall be performed in accordance with ISO 2859-1:1999, level II, 2,5 AQL for O-rings and 1,5 AQL for other seals.

b) test method:

Each piece of the sample shall be visually inspected according to manufacturer's written requirements.

c) acceptance criteria:

If inspection methods produce rejections less than allowed in sampling, the batch shall be accepted.

#### **7.4.8.1.3 Hardness testing**

The following apply:

a) sampling:

Sampling shall be performed in accordance with ISO 2859-1:1999, level II, 2,5 AQL for O-rings and 1,5 AQL for other seals.

b) test method:

Hardness testing shall be performed in accordance with procedures specified in ASTM D2240 or ASTM D1415.

c) acceptance criteria:

The hardness shall be controlled in accordance with the manufacturer's written specification.

#### **7.4.8.2 PSL 2**

##### **7.4.8.2.1 Dimensional inspection**

Dimensional inspection requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.8.2.2 Visual examination**

Visual examination requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.8.2.3 Hardness testing**

Hardness testing requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.8.2.4 Documentation**

The supplier/manufacturer shall certify that materials and end products meet manufacturer's specifications. Certification shall include manufacturer's part number, specification number and compound number.

### **7.4.8.3 PSL 3**

#### **7.4.8.3.1 Dimensional inspection**

Dimensional inspection requirements for PSL 3 shall be identical to the requirements for PSL 1.

#### **7.4.8.3.2 Visual examination**

Visual examination requirements for PSL 3 shall be identical to the requirements for PSL 1.

#### **7.4.8.3.3 Hardness testing**

Hardness testing requirements for PSL 3 shall be identical to the requirements for PSL 1.

#### **7.4.8.3.4 Documentation**

Documentation requirements for PSL 3 shall be identical to the requirements for PSL 2, with the addition that the following documentation shall be included:

- a) batch number;
- b) cure/mould date;
- c) shelf-life expiration date.

#### **7.4.8.3.5 Storage and age control**

The storage of non-metallic seals shall conform to the requirements of 9.6.

### **7.4.8.4 PSL 4**

#### **7.4.8.4.1 Dimensional inspection**

Dimensional inspection requirements for PSL 4 shall be identical to the requirements for PSL 1.

#### **7.4.8.4.2 Visual examination**

Visual examination requirements for PSL 4 shall be identical to the requirements for PSL 1.

#### **7.4.8.4.3 Hardness testing**

Hardness testing requirements for PSL 4 shall be identical to the requirements for PSL 1.

#### **7.4.8.4.4 Documentation**

Documentation requirements for PSL 4 shall be identical to the requirements for PSL 3, with the addition that the following documentation shall be included.

- a) Supplier/manufacture shall supply a copy of test results of the physical properties of the compound supplied. Physical properties shall be in accordance with the manufacturer's written specification.
- b) Physical property data for qualification of homogeneous elastomers shall include the items given in Table 29:

**Table 29 — Physical property data for qualification of homogeneous elastomers**

<b>Data</b>	<b>Documentation in accordance with</b>
Hardness testing	ASTM D1414 and ASTM D2240
Tensile testing	ASTM D412 and ASTM D1414
Elongation	ASTM D412 and ASTM D1414
Compression set	ASTM D395 and ASTM D1414
Modulus	ASTM D412 and ASTM D1414
Fluid immersion	ASTM D471 and ASTM D1414

- c) Physical property data for other non-metallic seal materials shall meet the requirements of the manufacturer's written specification.

#### **7.4.8.4.5 Storage and age control**

Storage requirements for PSL 4 non-metallic seals shall be identical to the requirements for PSL 3.

### **7.4.9 Assembled equipment (PSL 1 to PSL 4)**

#### **7.4.9.1 General**

Tables 32 to 36 provide a matrix of quality control requirements and product specification levels for assembled equipment. The requirements are outlined according to product specification level.

All hydrostatic body testing and all hydrostatic valve seat testing shall be performed prior to any gas testing. The sequence of gas testing may be varied at the option of the manufacturer. The drift test shall be performed after the equipment has been assembled, operated and tested. The sequence of other tests shall be at the option of the manufacturer.

#### **7.4.9.2 Assembly serialization and traceability record**

##### **7.4.9.2.1 Assembly serialization**

- a) for PSL 1, none required;
- b) for PSL 2 to PSL 4, serialization of valves, wellhead equipment, tees, crosses, tubing-head adapters, hangers, chokes, back-pressure valves and fluid sampling devices is required.

##### **7.4.9.2.2 Traceability record**

- a) for PSL 1 and PSL 2, none required;
- b) for PSL 3 and PSL 4, report identifying the body, bonnet, stem, end and outlet connection, and valve-bore sealing mechanisms shall be listed traceable to the assembly.

#### **7.4.9.3 PSL 1 testing**

##### **7.4.9.3.1 Drift test — Full-bore valves**

The following apply:

- a) test method:

Pass a drift mandrel as described in Table 30 through the valve bore after the valve has been assembled, operated and pressure-tested.

b) acceptance criteria:

The drift mandrel shall pass completely through the valve bore.

#### **7.4.9.3.2 Drift test — Christmas trees**

NOTE See Table 30.

The following apply:

a) test method:

Pass a drift mandrel through the main bore of christmas tree assemblies.

b) acceptance criteria:

The drift mandrel shall completely pass through the main bore of the christmas tree.

#### **7.4.9.3.3 Hydrostatic body test — Single-equipment units**

The following apply:

a) test method:

Subject single equipment units to a hydrostatic body test prior to shipment from the manufacturer's facility. The hydrostatic body test shall be the first pressure test performed. Do not apply the test pressure as a differential pressure across closure mechanisms of valves. Use water or water with additives as the testing fluid. Complete tests prior to painting; however, if the bodies and other pressure-containing parts have been made of wrought material, tests may be completed after painting.

Loose connectors, bullplugs, and valve-removal plugs do not require a hydrostatic test.

The hydrostatic body test for assembled equipment shall consist of three parts:

- primary pressure-holding period;
- reduction of the pressure to zero;
- secondary pressure-holding period.

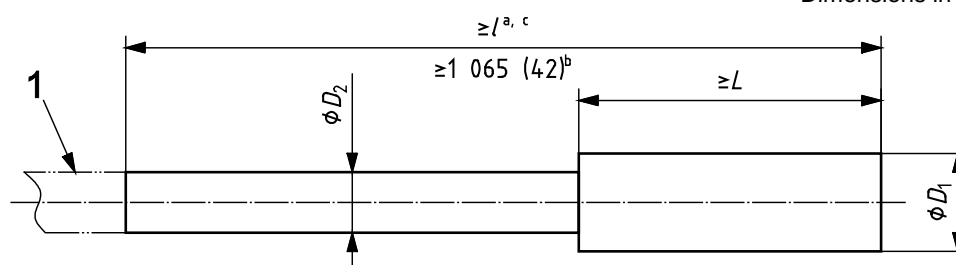
Conduct tests prior to the addition of body-filler grease. Lubrication applied during assembly is acceptable.

Both pressure-holding periods shall not be less than 3 min. Do not start the timing until the test pressure has been reached, the equipment and the pressure-monitoring gauge have been isolated from the pressure source and the external surfaces of the body members have been thoroughly dried.

The hydrostatic body test pressure requirements are based on the rated working pressure and equipment type. The minimum test pressures are given in Table 31.

**Table 30 — Drift Diameter for Individual Valves and Christmas Trees**

Dimensions in millimetres (inches)

**Key**

1 handle

<sup>a</sup> Minimum length for individual valves only.<sup>b</sup> Minimum length for christmas trees.<sup>c</sup> Valve end-to-end dimension.

Nominal flange size		Nominal bore size		$L$ min.		$D_1$ $+0,68$ $0$ mm $\left( +0,027$ $0$ in)		$D_2$ $+0,68$ $0$ mm $\left( +0,027$ $0$ in)	
mm	(in)	mm	(in)	mm	(in)	mm	(in)	mm	(in)
46	(1 <sup>13</sup> / <sub>16</sub> )	46	(1,81)	76	(3,00)	45,20	(1,78)	38,6	(1,52)
52	(2 <sup>1</sup> / <sub>16</sub> )	46	(1,81)	76	(3,00)	45,20	(1,78)	38,6	(1,52)
52	(2 <sup>1</sup> / <sub>16</sub> )	52	(2,06)	76	(3,00)	51,60	(2,03)	48,3	(1,90)
65	(2 <sup>9</sup> / <sub>16</sub> )	65	(2,56)	76	(3,00)	64,30	(2,53)	59,7	(2,35)
78	(3 <sup>1</sup> / <sub>16</sub> )	78	(3,06)	78	(3,06)	77,00	(3,03)	73,2	(2,88)
79	(3 <sup>1</sup> / <sub>8</sub> )	79	(3,12)	79	(3,12)	78,60	(3,09)	73,2	(2,88)
103	(4 <sup>1</sup> / <sub>16</sub> )	103	(4,06)	103	(4,06)	102,40	(4,03)	97,3	(3,83)
130	(5 <sup>1</sup> / <sub>8</sub> )	130	(5,12)	130	(5,12)	129,40	(5,09)	126,2	(4,97)
179	(7 <sup>1</sup> / <sub>16</sub> )	152	(6,00)	152	(6,00)	151,60	(5,97)	148,3	(5,85)
179	(7 <sup>1</sup> / <sub>16</sub> )	156	(6,12)	156	(6,12)	154,80	(6,09)	151,6	(5,97)
179	(7 <sup>1</sup> / <sub>16</sub> )	162	(6,38)	162	(6,38)	161,00	(6,34)	158,0	(6,22)
179	(7 <sup>1</sup> / <sub>16</sub> )	168	(6,62)	168	(6,62)	167,50	(6,59)	164,3	(6,47)
179	(7 <sup>1</sup> / <sub>16</sub> )	179	(7,06)	179	(7,06)	178,60	(7,03)	175,5	(6,91)
228	(9)	228	(9,00)	228	(9,00)	227,80	(8,97)	224,8	(8,85)

NOTE Due to SI unit conversion methods noted in Annex B, the drift dimensions in millimeters may have interference if used for drifting equipment manufactured to USC bore sizes, measured in inches. It is recommended that the units of measure used for the drift diameter  $D_1$  be consistent with the units used for manufacturing equipment to be drift tested.

**Table 31 — Hydrostatic body test pressure**

Working pressure rating	End and outlet connections						
	Nominal size of flange mm (in)		Line-pipe and tubing threads	Casing threads mm (in)			
	346 (13 <sup>5</sup> / <sub>8</sub> ) and smaller	425 (16 <sup>3</sup> / <sub>4</sub> ) and larger		114,3 to 273,1 (4 <sup>1</sup> / <sub>2</sub> to 10 <sup>3</sup> / <sub>4</sub> )	298,5 to 339,7 (11 <sup>3</sup> / <sub>4</sub> to 13 <sup>3</sup> / <sub>8</sub> )	406,5 to 508,0 (16 to 20)	
MPa      (psi)	MPa      (psi)	MPa      (psi)	MPa      (psi)	MPa      (psi)	MPa      (psi)	MPa      (psi)	MPa      (psi)
13,8    (2 000)	27,6    (4 000)	20,7    (3 000)	27,6    (4 000)	27,6    (4 000)	27,6    (4 000)	15,5    (2 250)	
20,7    (3 000)	41,5    (6 000)	31,0    (4 500)	41,5    (6 000)	41,4    (6 000)	31,0    (4 500)	—      —	
34,5    (5 000)	51,7    (7 500)	51,7    (7 500)	51,7    (7 500)	51,7    (7 500)	—      —	—      —	
69,0    (10 000)	103,5    (15 000)	103,5    (15 000)	103,5    (15 000)	—      —	—      —	—      —	
103,5    (15 000)	155,0    (22 500)	155,0    (22 500)	—      —	—      —	—      —	—      —	
138,0    (20 000)	207,0    (30 000)	—      —	—      —	—      —	—      —	—      —	

## b) special considerations:

For equipment with end or outlet connections having different working pressures, use the lowest working pressure rating to determine the hydrostatic body test pressure (except for cross-over connectors and chokes).

Test a cross-over connector at a test pressure based on the pressure rating for the upper connection. Apply test pressure inside and above the restricted-area pack-off of the lower connection. The lower connection shall be tested below the restricted-area pack-off to a level based on its pressure rating.

For chokes having an inlet connection with a higher pressure rating than the outlet connection, test the body hydrostatically, from the inlet connection to the body-to-bean seal point of the replaceable seat or flow bean, to the appropriate pressure for the inlet connection. Test the remainder of the body, downstream from the seal point, to the appropriate pressure for the outlet connection. Temporary seat seals may be used to facilitate testing.

Valves and chokes shall be in the partially open position during testing.

Test each bore of multiple-bore equipment individually.

## c) acceptance criteria:

The equipment shall show no visible leakage under the test pressure. Leakage by the thread during the hydrostatic testing of a threaded wellhead member when joined with a threaded test fixture is permissible above the working pressure of the thread.

**7.4.9.3.4 Hydrostatic body test — Christmas trees**

The same requirements are applicable as in 7.4.9.3.3, except that for trees assembled entirely with equipment that, other than loose connectors, has been previously hydrostatically tested, only testing to rated working pressure is necessary.

#### **7.4.9.3.5 Hydrostatic seat test — Valves**

The following apply:

a) test method:

For bidirectional valves, apply hydrostatic seat test pressure, equal to the rated working pressure, to each side of the gate or plug with the other side open to the atmosphere.

For unidirectional valves, apply pressure in the direction indicated on the body, except for check valves, which shall be tested on the downstream side.

Holding periods for tests shall be a minimum of 3 min.

Reduce the pressure to zero between all holding periods.

Test valves a minimum of two times on each side of the gate or plug.

b) acceptance criteria:

No visible leakage shall occur during each holding period.

#### **7.4.9.4 PSL 2 testing**

##### **7.4.9.4.1 Drift test — Full-bore valves**

Drift test requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.9.4.2 Drift test — Christmas trees**

Drift test requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.9.4.3 Hydrostatic body test — Single equipment units**

Hydrostatic body test requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.9.4.4 Hydrostatic body test — Christmas trees**

Hydrostatic body test requirements for PSL 2 shall be identical to the requirements for PSL 1.

##### **7.4.9.4.5 Hydrostatic seat test — Valves**

For PSL 2 and PSL 3G, the following apply:

a) test method:

Apply the hydrostatic seat test pressure, which is equal to the rated working pressure, to one side of the gate or plug of the valve with the other side open to atmosphere. Test bidirectional valves in both directions. Test unidirectional valves in the direction indicated on the body, except for check valves which shall be tested from the downstream side.

After the pressure has been applied to one side of the gate or plug, hold the pressure and monitor for a minimum of 3 min.

Then, open the valve, except for check valves, while under full differential pressure.

Repeat the above two steps.

Then, pressurize one side of the gate or plug, hold, and monitor a third time for a minimum of 3 min.

Next test bidirectional valves on the other side of the gate or plug using the same procedure outlined above. Split-gate valves may have both seats tested simultaneously.

- b) acceptance criteria for the seat test:

Valves shall show no visible leakage during each holding period.

#### **7.4.9.5 PSL 3 testing**

##### **7.4.9.5.1 Drift test — Full-bore valves**

Drift test requirements for PSL 3 shall be identical to the requirements for PSL 1.

##### **7.4.9.5.2 Drift test — Christmas trees**

Drift test requirements for PSL 3 shall be identical to the requirements for PSL 1.

##### **7.4.9.5.3 Records of pressure tests**

The following apply.

- a) A chart recorder shall be used on all hydrostatic tests. The record shall identify the recording device, shall be dated, and shall be signed.
- b) Chart recording of gas testing is not required. Records of gas testing shall document test parameters and acceptance.
- c) If the chart recorder is not qualified as a pressure-measuring device in accordance with 7.2.2, it shall be used in parallel with a calibrated pressure-measuring device, and the pressure-measuring device readings at the start and stop of each hold period shall be written on the chart as part of the record.

##### **7.4.9.5.4 Hydrostatic body test (extended) — Single equipment units**

Hydrostatic body test requirements for PSL 3 shall be identical to the requirements for PSL 1, with the addition that this hydrostatic body test requires an extension of the secondary pressure-holding period to a minimum of 15 min.

##### **7.4.9.5.5 Hydrostatic body test (extended) — Christmas trees**

Hydrostatic body test requirements for PSL 3 shall be identical to the requirements for PSL 1, with the addition that this hydrostatic body test requires the extension of the secondary pressure-holding period to a minimum of 15 min.

**Table 32 — Quality control requirements for full-bore valves**

Parameter		Subclause reference				
		PSL 1	PSL 2	PSL 3	PSL 3G	PSL 4
Drift test		7.4.9.3.1	7.4.9.3.1	7.4.9.3.1	7.4.9.3.1	7.4.9.3.1
Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	7.4.9.4.5	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
	seat	—	—	7.4.9.5.6	—	7.4.9.5.6
Gas test	body	—	—	—	7.4.9.5.7	7.4.9.6.6
	seat	—	—	—	7.4.9.5.8	7.4.9.6.7
	back seat	—	—	—	7.4.9.5.9 <sup>a</sup>	7.4.9.6.8
Traceability		—	—	7.4.9.2.2 b)	7.4.9.2.2 b)	7.4.9.2.2 b)
Serialization		—	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)
<sup>a</sup> Optional.						

**Table 33 — Quality control requirements for regular and Venturi bore valves**

Parameter		Subclause reference				
		PSL 1	PSL 2	PSL 3	PSL 3G	PSL 4
Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	—	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
	seat	—	—	7.4.9.5.6	7.4.9.5.6	7.4.9.5.6
Gas test	body	—	—	—	7.4.9.5.7	7.4.9.6.6
	seat	—	—	—	7.4.9.5.8	7.4.9.6.7
	back seat	—	—	—	7.4.9.5.9 <sup>a</sup>	7.4.9.6.8
Traceability		—	—	7.4.9.2.2 b)	7.4.9.2.2 b)	7.4.9.2.2 b)
Serialization		—	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)
<sup>a</sup> Optional.						

**Table 34 — Quality control requirements for production check valves**

Parameter		Subclause reference				
		PSL 1	PSL 2	PSL 3	PSL 3G	PSL 4
Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	7.4.9.4.5	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
	seat	—	—	7.4.9.5.6	—	7.4.9.5.6
Gas test	body	—	—	—	7.4.9.5.7	7.4.9.6.6
	seat	—	—	—	7.4.9.5.8	7.4.9.6.7
Traceability		—	—	7.4.9.2.2 b)	7.4.9.2.2 b)	7.4.9.2.2 b)
Serialization		—	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)

**Table 35 — Quality control requirements for casing and tubing heads, tubing-head adapters, chokes, tees, crosses, fluid sampling devices, cross-over connectors, adapter and spacer spools, and top connectors**

Parameter	Subclause reference				
	PSL 1	PSL 2	PSL 3	PSL 3G	PSL 4
Hydrostatic test	7.4.9.3.3	7.4.9.3.3	—	—	—
Hydrostatic test (extended)	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
Gas test	—	—	—	7.4.9.5.7	7.4.9.6.6
Traceability	—	—	7.4.9.2.2 b)	7.4.9.2.2 b)	7.4.9.2.2 b)
Serialization	—	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)	7.4.9.2.1 b)

**Table 36 — Quality control requirements for christmas trees**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3/3G	PSL 4
Drift test	7.4.9.3.2	7.4.9.3.2	7.4.9.3.2	7.4.9.3.2
Hydrostatic test	7.4.9.3.4	7.4.9.3.4	—	—
Hydrostatic test (extended)	—	—	7.4.9.5.5	7.4.9.5.5

#### **7.4.9.5.6 Hydrostatic seat test (extended) — Valves**

Hydrostatic seat test requirements for PSL 3 shall be identical to the requirements for PSL 2, with the addition that this hydrostatic seat test requires the second and third holding periods to be extended to a minimum of 15 min.

#### **7.4.9.5.7 PSL 3G gas body test — Single equipment units**

In addition to a hydrostatic body test (extended) for single equipment units (in accordance with 7.4.9.5.4), a gas body test shall be performed as follows.

##### **a) test method:**

Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

Valves and chokes shall be in the partially open position during testing.

The gas body test for assembled equipment shall consist of a single pressure-holding period of not less than 15 min; do not start the timing until the test pressure has been reached and the equipment and pressure-monitoring gauge have been isolated from the pressure source.

Test pressure shall equal the rated working pressure of the equipment.

##### **b) special considerations; see 7.4.9.3.3 b):**

The special considerations for hydrostatic body tests shall also apply, if appropriate, to gas body tests.

##### **c) acceptance criteria:**

No visible bubbles shall appear in the water bath during the holding period. A maximum reduction of the gas test pressure of 2.0 MPa (300 psi) is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

#### 7.4.9.5.8 PSL 3G gas seat test — Valves

In addition to a hydrostatic seat test for valves in accordance with 7.4.9.4.5, a gas seat test shall be performed as follows.

a) test method:

Apply gas pressure on each side of the gate or plug of bidirectional valves with the other side open to atmosphere. Test unidirectional valves in the direction indicated on the body, except for check valves, which shall be tested from the downstream side.

Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

Testing shall consist of two, monitored holding periods.

The primary-test pressure shall be the rated working pressure.

The primary-test monitored holding period shall be a minimum of 15 min.

Reduce the pressure to zero between the primary and secondary holding periods.

The secondary-test pressure shall be at 2,0 MPa (300 psi)  $\pm$  10 %.

The secondary-test monitored holding period shall be a minimum of 15 min.

The valves shall be fully opened and fully closed between tests.

Next, test bidirectional valves on the other side of the gate or plug using the same procedure outlined above. Split-gate valves may have both seats tested simultaneously.

b) acceptance criteria:

No visible bubbles shall appear in the water bath during the holding periods. A maximum reduction of the gas test pressure of 2,0 MPa (300 psi) for the primary test and 0,2 MPa (30 psi) for the secondary test is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

#### 7.4.9.5.9 PSL 3G gas back-seat test — Gate valves

A gas back-seat test may be performed on gate valves. A gas back-seat test shall be used in conjunction with the gas body test, single equipment units (see 7.4.9.5.7) and the gas seat test for valves (see 7.4.9.5.8).

The following apply:

a) test method:

Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

The area between the primary packing and the back seat, or other means for repacking the stuffing box, shall be vented during the test.

The test shall consist of one holding period.

The monitored holding period shall be at the rated working pressure.

The monitored holding period shall be a minimum of 15 min.

b) acceptance criteria:

No visible bubbles shall appear in the water bath during the holding period. A maximum reduction of the gas test pressure of 2,0 MPa (300 psi) is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

**7.4.9.6 PSL 4 testing**

**7.4.9.6.1 Drift test — Full-bore valves**

Drift test requirements for PSL 4 shall be identical to the requirements for PSL 1.

**7.4.9.6.2 Drift test — Christmas trees**

Drift test requirements for PSL 4 shall be identical to the requirements for PSL 1.

**7.4.9.6.3 Hydrostatic body test (extended) — Single equipment units**

Hydrostatic body test requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.9.6.4 Hydrostatic body test (extended) — Christmas trees**

Hydrostatic body test requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.9.6.5 Hydrostatic seat test (extended) — Valves**

Hydrostatic seat test requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.9.6.6 Gas body test — Single equipment units**

The following apply:

a) test method:

Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

Valves and chokes shall be in the partially open position during testing.

The gas body test for single equipment units shall consist of a single pressure-holding period of not less than 15 min. Do not start the timing until the test pressure has been reached and the equipment and pressure-monitoring gauge have been isolated from the pressure source.

Test pressure shall equal the rated working pressure of the equipment.

b) special considerations; see 7.4.9.3.3 b):

The special considerations for hydrostatic body tests shall also apply, if appropriate, to gas body tests.

c) acceptance criteria:

No visible bubbles shall appear in the water bath during the holding period. A reduction of the gas test pressure of maximum 2,0 MPa (300 psi) is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

#### 7.4.9.6.7 Gas seat test — Valves

The following apply:

a) test method:

Apply gas pressure on each side of the gate or plug of bidirectional valves with the other side open to the atmosphere. Test unidirectional valves in the direction indicated on the body, except for check valves, which shall be tested from the downstream side.

Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

Testing shall consist of two, monitored holding periods.

The primary-test pressure shall equal rated working pressure.

The primary-test monitored holding period shall be 60 min.

Reduce the pressure to zero between the primary and secondary holding periods.

The secondary-test pressure shall be greater than 5 % and less than 10 % of the rated working pressure.

The secondary-test monitored holding period shall be 60 min.

The valves shall be fully opened and fully closed between tests.

Next, test bidirectional valves on the other side of the gate or plug using the same procedure outlined above. Split-gate valves may have both seats tested simultaneously.

b) acceptance criteria:

No visible bubbles shall appear in the water bath during the holding periods. A maximum reduction of the gas test pressure of 2,0 MPa (300 psi) for the primary test holding period and 0,2 MPa (30 psi) for the secondary test holding period is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

#### 7.4.9.6.8 Gas back-seat test — Gate valves

The following apply:

a) test method:

Gas-test the back seat or other means provided for repacking. Conduct the test at ambient temperatures using nitrogen as the test medium. Conduct the test with the equipment completely submerged in a water bath.

During the test, vent the area between the primary packing and the back seat, or other means for repacking the stuffing box.

The test shall consist of two holding periods.

The monitored holding time for each period shall be 60 min.

The first pressure-holding period shall be at rated working pressure.

Reduce the pressure to zero between the primary and secondary holding periods and cycle.

The second pressure-holding period shall be at a pressure greater than 5 % and less than 10 % of the rated working pressure.

Disengage the back seat, or other means provided for repacking, between the high and low pressure-holding periods.

b) acceptance criteria:

No visible bubbles shall appear in the water bath during the holding period. A reduction of the gas test pressure of maximum 2,0 MPa (300 psi) is acceptable, as long as there are no visible bubbles in the water bath during the holding period.

#### **7.4.10 Casing and tubing hanger mandrels (PSL 1 to PSL 4)**

NOTE See Table 37.

##### **7.4.10.1 PSL 1**

###### **7.4.10.1.1 Tensile testing**

Tensile testing shall be in accordance with 5.4.2.2.

###### **7.4.10.1.2 Dimensional inspection**

Dimensional inspection shall be performed on casing and tubing hanger mandrels manufactured in accordance with this International Standard. The manufacturer shall specify critical dimensions.

The following apply:

a) sampling:

All suspension, lift and back-pressure valve threads or retention profiles shall be gauged. Critical dimensions on all components shall be verified.

b) test method:

Gauge the connections for stand-off at hand-tight assembly by use of the gauges and gauging practices illustrated in Figures 10, 11 and 12. Dimensionally inspect ACME and other parallel thread profiles, in accordance with the manufacturer's specifications.

c) acceptance criteria:

Acceptance criteria for critical dimensions shall be in accordance with the manufacturer's specification. The end and outlet connection threads shall be in accordance with Tables 61 and B.61, API Spec 5B or ASME B1.1, ASME B1.2 and ASME B1.3, as applicable.

**Table 37 — Quality control requirements for casing and tubing hanger mandrels**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Tensile testing <sup>a</sup>	7.4.10.1.1	7.4.10.2.1	7.4.10.2.1	7.4.10.2.1
Impact testing <sup>a</sup>	—	7.4.10.2.2	7.4.10.2.2	7.4.10.4.2
Hardness testing <sup>a</sup>	7.4.10.1.3	7.4.10.1.3	7.4.10.3.4	7.4.10.3.4
ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional inspection	7.4.10.1.2	7.4.10.1.2	7.4.10.3.3	7.4.10.3.3
Traceability	7.4.10.1.4	7.4.10.1.4	7.4.10.3.5	7.4.10.3.5
Chemical analysis <sup>a</sup>	7.4.10.1.5	7.4.10.1.5	7.4.10.1.5	7.4.10.1.5
Visual examination	7.4.10.1.6	7.4.10.1.6	—	—
Surface NDE	—	7.4.10.2.8	7.4.10.3.8	7.4.10.3.8
Weld NDE		7.4.10.2.9		No welding permitted except for weld overlays (see 7.4.10.4.9)
General	—	7.4.2.2.10	7.4.10.3.9	
Visual examination	—	7.4.2.2.11	7.4.10.3.10	
NDE surface	—	7.4.2.2.12	7.4.10.3.11	
Repair welds	—	7.4.2.2.13	7.4.10.3.12	
NDE volumetric	—	7.4.2.2.14	7.4.10.3.13	
Hardness testing	—	—	7.4.10.3.14	
Serialization	—	—	7.4.10.3.15	7.4.10.3.15
Volumetric NDE	—	—	7.4.10.3.16	7.4.10.4.11
<sup>a</sup> Acceptance criteria shall be as required by 5.1, 5.2 and 5.3, as applicable.				

**7.4.10.1.3 Hardness testing**

The following apply:

## a) sampling:

Each part shall be hardness tested.

## b) test method:

Perform hardness testing in accordance with procedures specified in ISO 6506 (all parts) or ISO 6508 (all parts), or ASTM E10 or ASTM E18. Perform test at a location determined by the manufacturer's specifications and following the last heat treatment (including all stress-relieving heat-treatment cycles) and all exterior machining.

## c) acceptance criteria:

Acceptance criteria shall be in accordance with the manufacturer's specification.

**7.4.10.1.4 Traceability**

Job-lot traceability is required.

Identification shall be maintained on materials and parts, to facilitate traceability, as required by documented manufacturer requirements.

Manufacturer-documented traceability requirements shall include provisions for maintenance or replacement of identification marks and identification control records.

#### **7.4.10.1.5 Chemical analysis**

The following apply:

a) sampling:

Chemical analysis shall be performed on a heat basis.

b) test method:

Perform chemical analysis in accordance with nationally or internationally recognized standards specified by the manufacturer.

c) acceptance criteria:

The chemical composition shall meet the requirements of the manufacturer's written specification.

#### **7.4.10.1.6 Visual examination**

The following apply:

a) sampling:

Each part shall be visually examined.

b) test method:

Perform visual examinations of castings in accordance with procedures specified in MSS SP-55.

Perform visual examination of forgings in accordance with manufacturer's written specifications.

c) acceptance criteria:

Acceptance criteria for castings shall be in accordance with MSS SP-55.

— for type 1: none acceptable;

— for types 2 through 12: A and B, acceptance criteria for forgings shall be in accordance with manufacturer's written specifications.

#### **7.4.10.2 PSL 2**

##### **7.4.10.2.1 Tensile testing**

Tensile testing shall be in accordance with 5.3.5.1 and 5.3.5.2.

##### **7.4.10.2.2 Impact testing**

Impact testing shall be in accordance with 5.3.5.1 and 5.3.5.3.

**7.4.10.2.3 Dimensional inspection**

Dimensional inspection requirements for PSL 2 shall be identical to the requirements for PSL 1.

**7.4.10.2.4 Hardness testing**

Hardness testing requirements for PSL 2 shall be identical to the requirements for PSL 1.

**7.4.10.2.5 Traceability**

Traceability requirements for PSL 2 shall be identical to the requirements for PSL 1.

**7.4.10.2.6 Chemical analysis**

Chemical analysis requirements for PSL 2 shall be identical to the requirements for PSL 1.

**7.4.10.2.7 Visual examination**

Visual examination requirements shall be identical to the requirements for PSL 1.

**7.4.10.2.8 Surface NDE**

Surface NDE requirements shall be in accordance with 7.4.2.2.8 and 7.4.2.2.9.

**7.4.10.2.9 Welding**

Quality control requirements shall be in accordance with 7.4.2.2.10 to 7.4.2.2.14. Repair welding shall be in accordance with 6.4.

**7.4.10.3 PSL 3****7.4.10.3.1 Tensile testing**

Tensile testing requirements for PSL 3 shall be identical to the requirements for PSL 2.

**7.4.10.3.2 Impact testing**

Impact testing requirements for PSL 3 shall be identical to the requirements for PSL 2.

**7.4.10.3.3 Dimensional inspection**

Dimensional inspection requirements for PSL 3 shall be identical to the requirements for PSL 1, with the addition that inspection shall be performed on all parts.

**7.4.10.3.4 Hardness testing**

Hardness testing requirements for PSL 3 shall be identical to the requirements for PSL 1, with the addition that one hardness test shall be performed on each finished part with additional tests at locations specified in the manufacturer's design documents.

**7.4.10.3.5 Traceability**

Parts manufactured to PSL 3 shall be traceable to a specific heat and heat-treat lot.

**7.4.10.3.6 Chemical analysis**

Chemical analysis requirements for PSL 3 shall be identical to the requirements for PSL 1.

**7.4.10.3.7 Visual examination**

None required.

**7.4.10.3.8 Surface NDE**

Surface NDE requirements shall be in accordance with 7.4.2.3.8.

**7.4.10.3.9 Weld NDE — General**

General weld NDE requirements shall be in accordance with 7.4.2.2.10.

**7.4.10.3.10 Weld examination — Visual**

Visual weld examination requirements shall be in accordance with 7.4.2.2.11.

**7.4.10.3.11 Weld NDE — Surface**

Surface weld NDE requirements shall be in accordance with 7.4.2.3.11.

**7.4.10.3.12 Repair welds**

Repair weld requirements shall be in accordance with 7.4.2.2.13.

**7.4.10.3.13 Weld NDE — Volumetric**

Volumetric weld NDE requirements shall be in accordance with 7.4.2.2.14.

**7.4.10.3.14 Weld NDE — Hardness testing**

The following apply:

a) sampling:

100 % of all accessible pressure-containing, non-pressure-containing and repair welds shall be tested.

b) test method:

Perform hardness testing in accordance with procedures specified in ISO 6506 (all parts) or ASTM E10 or procedures specified in ISO 6508 (all parts) or ASTM E18.

Perform at least one hardness test both in the weld and in the adjacent unaffected base metals after all heat treatment and machining operations.

c) acceptance criteria:

Acceptance criteria shall be in accordance with the manufacturer's specifications.

The hardness recorded in the PQR shall be the basis for acceptance if the weld is not accessible for hardness testing.

**7.4.10.3.15 Serialization**

Serialization requirements shall be in accordance with 7.4.2.3.14.

**7.4.10.3.16 Volumetric NDE**

Volumetric NDE requirements shall be in accordance with 7.4.2.3.15.

**7.4.10.4 PSL 4****7.4.10.4.1 Tensile testing**

Tensile testing requirements for PSL 4 shall be identical to the requirements for PSL 2.

**7.4.10.4.2 Impact testing**

Impact testing requirements for PSL 4 shall be identical to the requirements for PSL 2.

Acceptance criteria shall be in accordance with the manufacturer's specifications.

**7.4.10.4.3 Dimensional inspection**

Dimensional inspection requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.10.4.4 Hardness testing**

Hardness testing requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.10.4.5 Traceability**

Traceability requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.10.4.6 Chemical analysis**

Chemical analysis requirements for PSL 4 shall be identical to the requirements for PSL 1.

**7.4.10.4.7 Visual examination**

None required.

**7.4.10.4.8 Surface NDE**

Surface NDE requirements for PSL 4 shall be identical to the requirements for PSL 3.

**7.4.10.4.9 Weld NDE**

No welding except overlay is permitted on PSL 4 parts or equipment. Weld NDE requirements for overlay in PSL 4 shall be identical to the requirements for PSL 3.

**7.4.10.4.10 Serialization**

Serialization requirements for PSL 4 shall be identical to the requirements for PSL 3.

#### 7.4.10.4.11 Volumetric NDE

Volumetric NDE requirements for PSL 4 shall be identical to the requirement for PSL 3, with the addition of the following:

a) acceptance criteria for the ultrasonic testing:

Same acceptance criteria as PSL 3, with the addition that no continuous cluster of indications on the same plane, regardless of amplitude, shall be found over an area twice the diameter of the search unit.

b) acceptance criteria for the radiographic testing:

Acceptance criteria shall be as follows:

- no type of crack, lap or burst;
- no elongated indications exceeding 6,4 mm ( $1/4$  in);
- no more than two indications separated by less than 13 mm ( $1/2$  in).

#### 7.4.11 Bullplugs, valve-removal plugs, and back-pressure valves (see Table 38)

##### 7.4.11.1 General

Cast iron shall not be used. Weld repair is not allowed.

##### 7.4.11.2 Tensile testing

Tensile testing for bullplugs and valve-removal plugs shall be in accordance with 5.4.2.3.

Tensile testing for back-pressure valves shall be in accordance with 5.3.5.2.

##### 7.4.11.3 Impact testing

Impact testing for bullplugs and valve-removal plugs shall be in accordance with 5.4.2.4.

Impact testing for back-pressure valves shall be in accordance with 5.3.5.3.

##### 7.4.11.4 Hardness testing

Hardness testing shall be in accordance with 7.4.2.1.3.

##### 7.4.11.5 Dimensional inspection

Dimensional inspection shall be in accordance with 7.4.2.1.4. In addition, all threads or retention profiles shall be gauged.

##### 7.4.11.6 Traceability

Traceability requirements shall be in accordance with 7.4.2.2.5.

##### 7.4.11.7 Chemical analysis

Chemical analysis requirements shall be in accordance with 7.4.2.2.6.

### 7.4.11.8 Visual examination

Visual examination shall be in accordance with 7.4.2.1.5.

### 7.4.11.9 Hydrostatic test for back-pressure valves

The back-pressure valves shall be hydrostatically tested by applying a minimum of the rated working pressure across the full sealing bore of the back-pressure valve. Seals may be replaced after testing. Acceptance criteria shall be in accordance with 7.4.9.3.3 c). Pressure holding period shall be 3 minutes minimum.

**Table 38 — Quality control requirements for bullplugs, valve-removal plugs and back-pressure valves**

Test	Body (bullplugs and valve-removal plugs)	Body (back-pressure valves)	Valve sealing mechanism (back-pressure valves)	Assembly (back-pressure valves)
Tensile testing <sup>a</sup>	7.4.11.2	5.3.5.2	—	—
Impact testing <sup>b</sup>	7.4.11.3	5.3.5.3	—	—
Hardness testing <sup>c</sup>	7.4.11.4	7.4.11.4	—	—
ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.1.5	—
Dimensional inspection	7.4.11.5	7.4.11.5	—	—
Traceability	7.4.11.6	7.4.11.6	—	—
Chemical analysis <sup>d</sup>	7.4.11.7	7.4.11.7	—	—
Visual examination	7.4.11.8	7.4.11.8	—	—
Hydrostatic test	—	—	—	7.4.11.9
<sup>a</sup> Acceptance criteria in accordance with 5.4.2.3. <sup>b</sup> Acceptance criteria in accordance with 5.4.2.4. <sup>c</sup> Hardness testing is not required for those materials that have no hardness restriction specified by ISO 15156 (all parts) (NACE MR0175; see Clause 2) or are not heat treated to obtain a minimum specified strength level. <sup>d</sup> Acceptance criteria in accordance with 5.4.5.				

## 7.5 Quality control records requirements

### 7.5.1 General

#### 7.5.1.1 Purpose

The quality control records required by this International Standard are necessary to substantiate that all materials and products made to meet this International Standard do conform to the specified requirements.

#### 7.5.1.2 ISO 15156 (all parts) (NACE MR0175; see Clause 2) records requirements

Records required to substantiate conformance of material classes DD, EE, FF and HH equipment to ISO 15156 (all parts) (NACE MR0175; see Clause 2) requirements shall be in addition to those described in 7.5.2, unless the records required by this International Standard also satisfy the ISO 15156 (all parts) (NACE MR0175; see Clause 2) requirements.

### **7.5.1.3 Records control**

The following apply.

- a) Quality control records required by this International Standard shall be legible, identifiable, retrievable and protected from damage, deterioration or loss.
- b) Quality control records required by this International Standard shall be retained by the manufacturer for a minimum of five years following the date of manufacture as marked on the equipment associated with the records.
- c) All quality control records required by this International Standard shall be signed and dated.

### **7.5.2 Records that shall be maintained by manufacturer**

#### **7.5.2.1 Body, bonnet, end and outlet connections, stem, valve-bore sealing mechanism, mandrel tubing hanger and casing hanger records**

The following apply:

- a) for PSL 1:
  - 1) material test records:
    - chemical analysis,
    - tensile test,
    - impact test (if required),
    - hardness test;
  - 2) welding process records:
    - weld procedure specification,
    - weld procedure qualification record,
    - welder qualification record;
  - 3) NDE personnel qualification records;
  - 4) hardness test (if applicable);
- b) for PSL 2:
  - 1) All records required for PSL 1 are also required for PSL 2.
  - 2) NDE records:
    - surface NDE records,
    - weld volumetric NDE records,
    - repair weld NDE records;

3) heat-treatment certification of compliance;

c) for PSL 3:

1) All required records shall reference the specific part serial number.

2) All records required for PSL 2 are also required for PSL 3.

3) volumetric NDE records (except valve-bore sealing mechanisms).

4) heat-treatment record:

- actual temperature,
- actual times at temperature,
- certification of compliance is not required;

5) hardness test record:

- actual hardness;

6) welding process records:

- welder identification,
- weld procedures,
- filler material type,
- post-weld heat treatments;

7) records that dimensional inspection was performed (those activities required by 7.4.2.3.4);

d) for PSL 4:

1) All required records shall reference the specific part serial number.

2) All records required for PSL 3 are also required for PSL 4.

3) actual heat-treatment temperature charts showing times and temperatures are required for bodies, bonnets, end and outlet connections, stems, mandrel tubing and casing hangers.

4) melting practice utilized (bodies, bonnets, and end and outlet connections only).

#### **7.5.2.2 Ring gasket records**

No records are required.

#### **7.5.2.3 Studs and nuts records**

No records are required.

#### **7.5.2.4 Non-metallic sealing material records**

Non-metallic sealing material records are required and shall be in accordance with 7.4.8.

### **7.5.2.5 Bullplugs, valve-removal plugs and back-pressure valves**

The following material test records are required:

- chemical analysis;
- tensile test;
- impact test;
- hardness test.

### **7.5.2.6 Assembled equipment records**

- a) for PSL 1, no records are required;
- b) for PSL 2, the following assembled-equipment pressure test records are required:
  - actual test pressure,
  - holding period duration;
- c) for PSL 3:
  - 1) All records required for PSL 2 are also required for PSL 3.
  - 2) Additionally, the following records are required:
    - assembly traceability records,
    - hydrostatic pressure test records;
  - 3) Furthermore, the following gas-test records are required for equipment designated PSL 3G:
    - actual test pressures,
    - actual holding period durations;
- d) for PSL 4:
  - 1) All records required for PSL 3 are also required for PSL 4.
  - 2) Additionally, the following gas-test records are required:
    - actual test pressures,
    - actual holding period durations.

### **7.5.2.7 Choke trim records**

The following apply:

- a) for PSL 1 and PSL 2, no records are required;
- b) for PSL 3 and PSL 4, surface NDE records are required.

### **7.5.3 Records that shall be furnished to purchaser**

#### **7.5.3.1 General**

These records shall be provided by the manufacturer to the original purchaser of equipment made to comply with this International Standard.

These records, if applicable, shall be identical to or contain the same information as those retained by the manufacturer.

These records provided by the manufacturer shall prominently reference part serial number(s).

#### **7.5.3.2 Body, bonnet, end and outlet connections, stem, valve-bore sealing mechanism, mandrel tubing hanger and casing hanger and back-pressure valve records**

The following apply:

- a) for PSL 1 to PSL 3, no records are required;
- b) for PSL 4, the following records are required:
  - NDE records,
  - hardness test records,
  - material test records,
  - heat treatment records.

#### **7.5.3.3 Ring gasket records**

No records are required.

#### **7.5.3.4 Studs and nuts records**

No records are required.

#### **7.5.3.5 Non-metallic sealing material records**

- a) for PSL 1 to PSL 3, no records are required;
- b) for PSL 4, certification of compliance is required, stating that non-metallic seals conform to PSL 4 of this International Standard.

#### **7.5.3.6 Assembled equipment records**

- a) for PSL 1 and PSL 2, no records are required;
- b) for PSL 3, the following records are required:
  - certificate of compliance stating that equipment conforms to PSL 3 of this International Standard, and the temperature and material class,
  - assembly traceability records,
  - pressure test records;
- c) for PSL 3G and PSL 4, all records/certifications for PSL 3 are required with the addition that gas-test records shall also be furnished.

## 8 Equipment marking

### 8.1 Marking requirements

#### 8.1.1 General

Equipment shall be marked on the exterior surface as specified in Table 39. Marking shall contain the designation ISO 10423, the temperature classification, or maximum and minimum operating temperatures, material class, product specification level, performance requirement level, date of manufacture (month and year), and manufacturer's name or mark. Other marking shall be as specified in Tables 39 to 47. Marking for features that do not exist on a product is not applicable.

#### 8.1.2 Marking method

Marking using low-stress (dot, vibration or rounded V) stamps is acceptable. Conventional sharp V-stamping is acceptable in low-stress areas, such as the outside diameter of flanges. Sharp V-stamping is not permitted in high-stress areas unless subsequently stress-relieved at 590 °C (1 100 °F) minimum. The method of marking on nameplates is optional.

#### 8.1.3 Nameplates

Nameplates are not required if the information is permanently marked on the body or connector.

#### 8.1.4 Hidden marking

Marking required on a connector OD that would be covered by clamps or other parts of the connector assembly shall be stamped in a visible location near the connector.

#### 8.1.5 Thread marking

The thread type marking, in accordance with ISO 11960, shall be as follows:

- line pipe: LP;
- casing (short thread): STC;
- casing (long thread): LC;
- casing (buttress): BC;
- casing (extreme line): XC;
- tubing (non-upset): NU;
- tubing (external-upset): EU.

#### 8.1.6 Size marking

The size marking shall include the nominal size and, if applicable, the restricted or over-size bore.

#### 8.1.7 Weld metal overlay

If equipment has metal-overlaid, corrosion-resistant ring grooves, the ring gasket type and number shall be followed by "CRA" to designate a corrosion-resistant alloy, or "SST" to designate an austenitic stainless steel.

**Table 39 — Marking requirements and locations**

Marking	Location					
	Wellhead equipment	Connectors and fittings	Casing and tubing hangers	Loose connectors	Valves and chokes	Actuators
ISO 10423	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body
Temperature class or upper and lower operating temperature range rating (4.2.2)	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body (actuators containing retained fluid)
Material class (4.2.3)	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body (actuators containing retained fluid)
Product specification level (1.4)	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body (actuators containing retained fluid)
Performance requirement level <sup>a</sup> (4.1)	Nameplate and/or body	—	Nameplate and/or body	—	Nameplate and/or body	Nameplate and/or body
Nominal size (bore if required)	Nameplate or body and connector OD	Nameplate, body and/or connector OD	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body
Thread size (threaded products only)	Nameplate or body, and or near each thread	Nameplate or body, and or near each thread	Nameplate and/or near each connector	OD of connector	Nameplate or body, and or near each thread	—
End and outlet connector size	Nameplate or body, and each connector OD	Nameplate or body, and each connector OD	—	OD of connector	Nameplate and/or body	—
Rated working pressure (4.2.1)	Nameplate or body, and each connector OD	Nameplate or body, and each connector OD	—	OD of connector	Nameplate or body, and each connector OD	—
Ring gasket type and number	Near each connector	Near each connector	—	OD of connector	Near each connector	—
Date of manufacture	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body
Manufacturer's name or mark	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body
Serial number (if applicable)	Nameplate and/or body	Nameplate and/or body	Nameplate and/or body	OD of connector	Nameplate and/or body	Nameplate and/or body
Hardness test values (if applicable)	Adjacent to test location	Adjacent to test location	Adjacent to test location	Adjacent to test location	Adjacent to test location	Adjacent to test location

<sup>a</sup> For SSV/USV, in place of performance requirement level, mark class I or class II as appropriate.

### 8.1.8 Hardness tests

If hardness tests are required for bodies, bonnets or end and outlet connectors, the actual value of the hardness test shall be stamped on the part adjacent to the test location. It is permissible for hardness marking to be covered by other components after assembly.

### 8.1.9 Other end connectors

The following apply.

- a) Other end connectors shall be marked with "OEC" following the size or pressure rating.
- b) Clamp hub end connectors shall be marked "ISO 13533" following the size and pressure rating.

## 8.2 Wellhead equipment

Casing-head housings, casing-head spools, tubing-head spools, cross-over spools, multi-stage head housings, multi-stage spools, and adapter and spacer spools shall be marked as specified in Tables 39 and 40. The bore size shall be preceded by the word "Bore".

Wellhead outlets with valve removal preparations shall be marked near the outlet with "ISO 10423" followed by the nominal size and "VR" for 69,0 MPa (10 000 psi) working pressure or "HP VR" for 138,0 MPa (20 000 psi) working pressure.

## 8.3 Connectors and fittings

Cross-over connectors, tubing-head adapters, top connectors, tees, crosses, fluid sampling devices, adapters and spacers shall be marked as shown in Tables 39 and 41. Performance-requirement marking is not required for connectors and fittings.

## 8.4 Casing and tubing hangers

### 8.4.1 Marking of mandrel hangers

If mandrel hangers have different top and bottom threads, both threads shall be listed with the bottom thread first, followed by the top thread description plus the word "TOP". Any hanger that can be installed upside down shall have the word "DOWN" on the end that faces downhole when properly installed. Marking of rated working pressure and load rating is optional for mandrel hangers. Mandrel hangers shall be marked as specified in Tables 39 and 42.

### 8.4.2 Marking of slip hangers

Any hanger that can be installed upside down shall have the word "DOWN" on the end that faces downhole when properly installed. Marking of rated working pressure and load rating is optional for slip hangers. Slip hangers shall be marked as specified in Tables 39 and 42.

**Table 40 — Additional marking for wellhead equipment**

Marking	Location
Bottom preparation	Nameplate or body and bottom connector OD
Minimum vertical bore	Nameplate or body, and each connector OD

**Table 41 — Additional marking for connectors and fittings**

Marking	Location
Pack-off casing size	Nameplate or body, and bottom connector OD
Minimum vertical bore	Nameplate or body, and each connector OD

**Table 42 — Additional marking for hangers**

Marking	Location	
	Mandrel hangers	Slip hangers
Minimum bore	Nameplate and/or body	—
Back-pressure valve style or model	Nameplate and/or body (tubing hangers only)	—
Casing or tubing size	—	Nameplate and/or body
Rated working pressure (optional)	Nameplate and/or body (optional)	Nameplate and/or body (optional)
Load rating information (optional)	Nameplate and/or body (optional)	Nameplate and/or body (optional)
Minimum vertical bore	Nameplate and/or body	—
Orientation “DOWN” (if required)	Bottom of body	Bottom of body

## 8.5 Valves and chokes

Valves, multiple valves, actuated valves, valves prepared for actuators, check valves and chokes shall be marked as specified in Tables 39 and 43.

The following apply:

- a) additional marking for multiple valves:

Multiple valves shall be designated by the nominal bore sizes in decreasing sizes (e.g. 3 1/16 ´ 2 1/16, 2 9/16 ´ 2 9/16). For valves having equal bore sizes, it is also acceptable to use the nominal bore size followed by the number of bores (e.g. 2 1/16 Quad).

- b) valve handwheels:

Valve handwheels shall be marked with the direction of movement for opening the valves.

- c) nominal size and maximum orifice for chokes:

Chokes shall be marked with their nominal size and maximum orifice as specified in 10.9.3.3.

- d) choke beans:

Choke beans shall be marked as specified in Table 44, with the orifice size and the manufacturer's name or mark on its OD or end.

- e) valves prepared for actuators:

Mark the letter “V” after “ISO 10423”.

- f) surface and underwater safety valves:

Safety valves meeting the requirements of 10.20 shall be marked with the letters “SSV” or “USV” following “ISO 10423”. For SSV/USV, in place of the performance-requirement level, mark “class I” or “class II”, as appropriate.

**Table 43 — Additional marking for valves and chokes**

Marking	Location	
	Valves	Chokes
Flow direction (unidirectional valves only)	Body	Body
Direction of movement to open	Handwheel	Handwheel
Bore sizes <sup>a</sup> (multiple-bore valves only)	Connector OD (see Tables 73* and 74*)	—
<sup>a</sup> See also 10.5.4.2.2.		
NOTE The data in tables marked with an asterisk (*) are repeated in USC units in Annex B (with the same table number as in the main body of this International Standard, but with the prefix “B”).		

**Table 44 — Marking for choke beans**

Marking	Location
Manufacturer's name or mark	OD or end
Size Nominal orifice size Bean size	OD or end

## 8.6 Loose connectors [flanged, threaded, other end connectors (OEC) and welded]

Welding neck connectors, blind connectors, threaded connectors, adapter connectors and spacer connectors shall be marked as specified in Table 39. Performance-requirement level marking is not required for loose connectors.

## 8.7 Other equipment

### 8.7.1 Actuators

Actuators shall be marked as specified in Table 39. Marking of the temperature rating class or maximum and minimum operating temperature, material class and product specification level applies to retained-fluid actuators only. Bonnets attached to actuators shall be considered part of the valve for marking purposes. Marking for electric actuators may be on a separate nameplate on the actuator and shall include, but not be limited to, area classification, voltage, frequency, amperage (starting and running) and motor insulation requirements.

### 8.7.2 Assemblies of actuators and valves prepared for actuators

Valves prepared for actuators, if assembled with the actuator, shall be tagged with the information specified in Table 47.

### 8.7.3 Ring gaskets

Ring gaskets shall be identified by the marks in Table 45 and shall be marked as specified in Table 46:

**Table 45 — Identification marks for ring gaskets**

Material	Mark
Soft iron	D-4
Carbon and low-alloy steel	S-4
304 stainless steel	S304-4
316 stainless steel	S316-4
Nickel alloy UNS N08825	825-4
Other CRA materials	UNS number-4

**Table 46 — Marking for ring gaskets**

Marking	Location
Date of manufacture	OD of gasket
Manufacturer's name or mark	OD of gasket
Ring gasket type and number	OD of gasket
Material	OD of gasket

## 8.8 Studs and nuts

### 8.8.1 Stud marking

Studs shall be marked in accordance with ASTM A193/A193M, ASTM A320/A320M, or ASTM A453/A453M, as applicable. CRA material studs shall be metal-stamped with the UNS numbering or, if this is not available, the alloy trade name and yield strength shall be marked.

### 8.8.2 Nut marking

Nuts shall be marked in accordance with ASTM A194/A194M.

### 8.8.3 Impact test marking

If the impact test temperature is different from that specified by the ASTM specification, the actual test temperature, expressed in degrees Celsius (or degrees Fahrenheit), shall be metal-stamped directly under the grade as required by the ASTM specification. The impact test temperatures, expressed in degrees Celsius (or degrees Fahrenheit), for all CRA material studs shall be metal-stamped directly under the "CRA" marking.

## 8.9 Christmas trees

Assembled christmas trees shall be tagged with the information as specified in Table 47.

**Table 47 — Marking for christmas trees and assemblies of actuators and valves prepared for actuators**

Marking	Location
Date of final acceptance	Tag or nameplate
Name of assembler	Tag or nameplate
Location of assembler	Tag or nameplate

## **8.10 Valve-removal plugs**

Valve-removal plugs shall be marked with "ISO 10423" followed by the nominal size and "VR" for 69,0 MPa (10 000 psi) working pressure or "HPVR" for 138,0 MPa (20 000 psi) working pressure, material class and manufacturer's name or mark, as a minimum.

## **8.11 Bullplugs**

Bullplugs shall be marked with "ISO 10423" followed by the nominal size, material class and manufacturer's name or mark, as a minimum. Bullplugs may be marked on the exposed end or on the flat of the hex, as applicable. Bullplugs with an internal hex may be marked on the smaller, non-exposed hex.

## **8.12 Back-pressure valves**

Back-pressure valves shall be marked with "ISO 10423" followed by the nominal size, working pressure, material class and manufacturer's name or mark, as a minimum.

# **9 Storing and shipping**

## **9.1 Draining after testing**

All equipment shall be drained and lubricated after testing and prior to storage or shipment.

## **9.2 Rust prevention**

Prior to shipment, parts and equipment shall have exposed metallic surfaces protected with a rust preventative that does not become fluid and run at a temperature of less than 50 °C (125 °F).

## **9.3 Sealing-surface protection**

Exposed sealing surfaces shall be protected from mechanical damage for shipping.

## **9.4 Assembly and maintenance instructions**

The manufacturer shall furnish to the purchaser suitable drawings and instructions concerning field assembly and maintenance of wellhead and christmas tree equipment, if requested. This includes, if relevant, an operating manual for equipment specified in Annex H.

## **9.5 Ring gaskets**

Loose ring gaskets shall be boxed or wrapped during shipping and storage.

## **9.6 Age control of non-metallic materials**

The following apply:

- a) for PSL 1 and PSL 2:

Age-control procedures and the protection of non-metallic seals shall be documented by the manufacturer.

b) for PSL 3 and PSL 4:

The manufacturer's written specified requirements for non-metallic seals shall include the following minimum provisions:

- indoor storage;
- maximum temperature not to exceed 49 °C (120 °F);
- protected from direct natural light;
- stored unstressed;
- stored away from contact with liquids;
- protected from ozone and radiographic damage.

The manufacturer shall define the provisions and requirements.

## 10 Equipment-specific requirements

### 10.1 Flanged end and outlet connections

#### 10.1.1 Flange types and uses

Three types of end and outlet flanges are covered by this International Standard: Types 6B, 6BX and segmented.

Types 6B and 6BX flanges may be used as integral, blind or welding neck flanges.

Type 6B may also be used as threaded flanges. Some type 6BX blind flanges may also be used as test flanges. Segmented flanges are used on dual-completion wells and are integral with the equipment.

#### 10.1.2 Design

##### 10.1.2.1 Pressure ratings and size ranges of flange types

Type 6B, 6BX, and segmented flanges are designed for use in the combinations of nominal size ranges and rated working pressures as shown in Table 48.

**Table 48 — Rated working pressures and size ranges of flanges**

Rated working pressure MPa (psi)	Flange size range mm (in)		
	Type 6B	Type 6BX	Dual segmented
13,8 (2 000)	52 to 540 ( $2 \frac{1}{16}$ to $21 \frac{1}{4}$ )	679 to 762 ( $26 \frac{3}{4}$ to 30)	—
20,7 (3 000)	52 to 527 ( $2 \frac{1}{16}$ to $20 \frac{3}{4}$ )	679 to 762 ( $26 \frac{3}{4}$ to 30)	—
34,5 (5 000)	52 to 279 ( $2 \frac{1}{16}$ to 11)	346 to 540 ( $13 \frac{5}{8}$ to $21 \frac{1}{4}$ )	35 to 103 ' 108 ( $1 \frac{3}{8}$ to $4 \frac{1}{16}$ ' $4 \frac{1}{4}$ )
69,0 (10 000)	—	46 to 540 ( $1 \frac{13}{16}$ to $21 \frac{1}{4}$ )	—
103,5 (15 000)	—	46 to 476 ( $1 \frac{13}{16}$ to $18 \frac{3}{4}$ )	—
138,0 (20 000)	—	46 to 346 ( $1 \frac{13}{16}$ to $13 \frac{5}{8}$ )	—

### 10.1.2.2 Type 6B flanges

#### 10.1.2.2.1 General

Type 6B flanges are of the ring joint type and are not designed for face-to-face make-up. The connection make-up bolting force reacts on the metallic ring gasket. The type 6B flange shall be of the through-bolted or studded design.

#### 10.1.2.2.2 Dimensions

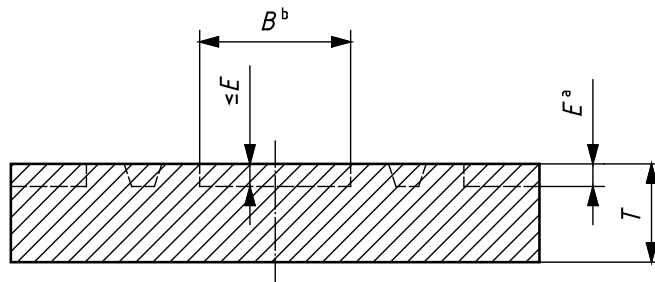
The following apply:

a) standard dimensions:

Dimensions for type 6B integral, threaded, and welding neck flanges shall be in accordance with Tables 49\*, 50\* and 51\*.

NOTE The data in tables marked with an asterisk (\*) are repeated in USC units in Annex B, with the same table number as in the main body of this International Standard, but with the prefix "B".

Dimensions for type 6B blind flanges shall conform to those referenced in Figure 8.



NOTE 1 See Tables 49\*, 50\* and 51\* for dimensions  $B$  and  $T$  and for dimensions not shown. For  $E$  dimensions, see Tables 63\* and 64\*.

NOTE 2 Raised face and/or counter-bore are optional.

<sup>a</sup> Optional.

<sup>b</sup> Counter-bore.

**Figure 8 — Type 6B blind flanges**

Dimensions for ring grooves shall conform to Table 63\* or Table 64\*.

b) integral flange exceptions:

Type 6B flanges used as end connections on casing and tubing heads may have entrance bevels, counter-bores or recesses to receive casing and tubing hangers. The dimensions of such entrance bevels, counter-bores and recesses are not covered by this International Standard and may exceed the  $B$  dimension given in Tables 49\*, 50\* and 51\*.

c) threaded flanges:

Threads shall conform to the requirements of 4.2.1.2.

d) welding neck flanges:

The following apply:

- 1) bore diameter and wall thickness: The bore diameter,  $J_L$ , shall not exceed the values shown in Tables 49\*, 50\* and 51\*. The specified bore shall not result in a weld-end wall thickness less than 87,5 % of the nominal wall thickness of the pipe to which the flange is to be attached.

- 2) weld end preparation: Dimensions for weld end preparation shall conform to Figure 9 (see Figure B.9 for USC units).
- 3) taper: If the nominal bore of the welding end is smaller than the nominal bore of the pipe by a difference of 4,8 mm (0,18 in) or more, the flange shall be taper bored from the weld end at a slope not exceeding 3 to 1. However, requirements for minimum wall thickness shall apply.

NOTE Due to smaller maximum bore dimensions, it is not intended that Type 6B welding neck flanges be welded to equipment specified in this International Standard. Their purpose is to bolt to another 6B flange and provide a transition that is welded to a pipe.

#### 10.1.2.2.3 Flange face

The flange face shall be flat or raised on the ring-joint side and shall be fully machined. The flange back face may be fully machined or spot-faced at the bolt holes. The flange back face or spot faces shall be parallel to the front face within 1° and the thickness after facing shall conform to the dimensions of Tables 49\*, 50\* and 51\*.

#### 10.1.2.2.4 Gaskets

Type 6B flanges shall use type R or type RX gaskets in accordance with 10.4.

#### 10.1.2.2.5 Corrosion-resistant ring grooves

Type 6B flanges may be manufactured with corrosion-resistant overlays in the ring grooves. Prior to application of the overlay, preparation of the ring grooves shall conform to the dimensions of Table 52\*. Other weld preparations may be employed if the strength of the overlay alloy equals or exceeds the strength of the base material.

#### 10.1.2.2.6 Ring groove surface

All 23° surfaces on ring grooves shall have a surface finish no rougher than 1,6 µm *Ra* (63 µin RMS).

### 10.1.2.3 Type 6BX flanges

#### 10.1.2.3.1 General

Type 6BX flanges are of the ring-joint type and are designed with a raised face. Depending on tolerances, the connection make-up bolting force can react on the raised face of the flange when the gasket has been properly seated. This support prevents damage to the flange or gasket from excessive bolt torque. Therefore, one of the flanges in a 6BX connection shall have a raised face. The type 6BX flange shall be of the through-bolted or studded design.

NOTE Face-to-face contact is not necessary for the proper functioning of type 6BX flanges.

#### 10.1.2.3.2 Dimensions

The following apply:

- a) standard dimensions:

Dimensions for 6BX integral flanges shall conform to Table 53\* or Table 54\*, as applicable.

Dimensions for 6BX welding neck flanges shall conform to Table 55\* or Table 56\*, as applicable.

NOTE These flanges are not available in all the same pressure ratings and sizes as the integral flanges covered by this International Standard.

Dimensions for 6BX blind and test flanges shall conform to Table 57\*, Table 58\* or Table 59\*, as applicable.

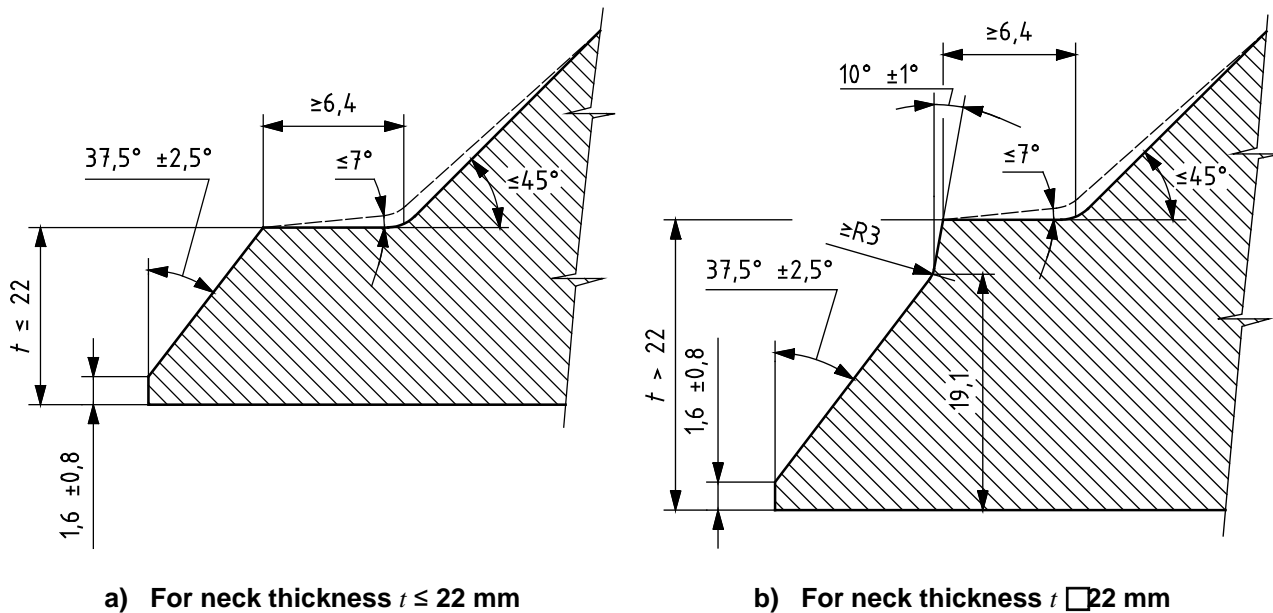
b) exceptions for integral flanges:

Type 6BX flanges used as end connections on casing and tubing heads may have entrance bevels, counterbores or recesses to receive casing and tubing hangers. The dimensions of such entrance bevels, counterbores and recesses are not covered by this International Standard and may exceed the  $B$  dimension of the tables.

c) welding neck flanges:

Dimensions for the weld end preparation shall conform to Figure 9 (see Figure B.9 for USC units).

Dimensions in millimetres unless otherwise indicated



**Figure 9 — Weld end preparation for type 6B and 6BX welding neck flanges**  
(see Annex B for USC units)

#### 10.1.2.3.3 Flange face

The flange face on the ring-joint side shall be raised, except for studed flanges, which may have flat faces. Front faces shall be fully machined. The nut-bearing surface shall be parallel to the flange gasket face within  $1^\circ$ . The back face may be fully machined or spot-faced at the bolt holes. The thickness after facing shall conform to the dimensions of Tables 53\* through 58\*, as applicable.

#### 10.1.2.3.4 Gaskets

Type 6BX flanges shall use BX gaskets in accordance with 10.4.

#### 10.1.2.3.5 Corrosion-resistant ring grooves

Type 6BX flanges may be manufactured with corrosion-resistant weld overlays in the ring grooves. Prior to the application of the overlay, preparation of the ring grooves shall conform to Table 52\*. Other weld preparations may be employed if the strength of the overlay alloy equals or exceeds the strength of the base material.

#### 10.1.2.3.6 Ring groove surface

All  $23^\circ$  surfaces on ring grooves shall have a surface finish no rougher than  $0,8 \mu\text{m } R_a$  ( $32 \mu\text{in RMS}$ ).

#### **10.1.2.4 Segmented flanges**

##### **10.1.2.4.1 General**

Segmented flanges are of the ring-joint type and are designed with a recessed face. Depending on tolerances and when the gasket has been properly seated, the connection make-up bolting force can react on the surface outside the recessed face of the flange. This support prevents damage to the flange or gasket from excessive bolt torque. The segmented flange shall be of the through-bolted or studded design.

NOTE Face-to-face contact is not necessary for the proper functioning of segmented flanges.

##### **10.1.2.4.2 Dimensions**

Segmented flange dimensions shall conform to Table 60\*. Ring groove dimensions shall conform to Table 64\*.

##### **10.1.2.4.3 Flange face**

The flange face shall be fully machined. The nut-bearing surface shall be parallel to the flange gasket face within 1°. The back face may be fully machined or spot-faced at the bolt holes. The thickness after facing shall meet the dimensions of Table 60\*.

##### **10.1.2.4.4 Gaskets**

Segmented flanges shall use RX gaskets in accordance with 10.4.

##### **10.1.2.4.5 Corrosion-resistant ring grooves**

Segmented flanges shall not be manufactured with corrosion-resistant ring grooves.

##### **10.1.2.4.6 H<sub>2</sub>S service**

These flanges shall not be used for hydrogen sulfide service for material classes DD, EE, FF and HH.

##### **10.1.2.4.7 Installation**

Segmented flanges shall be used in sets, i.e. two flanges side-by-side for dual completions. Manifolds shall be rigidly tied together to add stability to the flanges.

##### **10.1.2.4.8 Ring groove surface**

The 23° surface on ring grooves shall have a surface finish no rougher than 1,6 µm *Ra* (63 µin RMS).

#### **10.1.3 Materials**

Flange material shall conform to the requirements in Clause 5.

#### **10.1.4 Testing**

Loose flanges do not require a hydrostatic test prior to final acceptance.

#### **10.1.5 Marking**

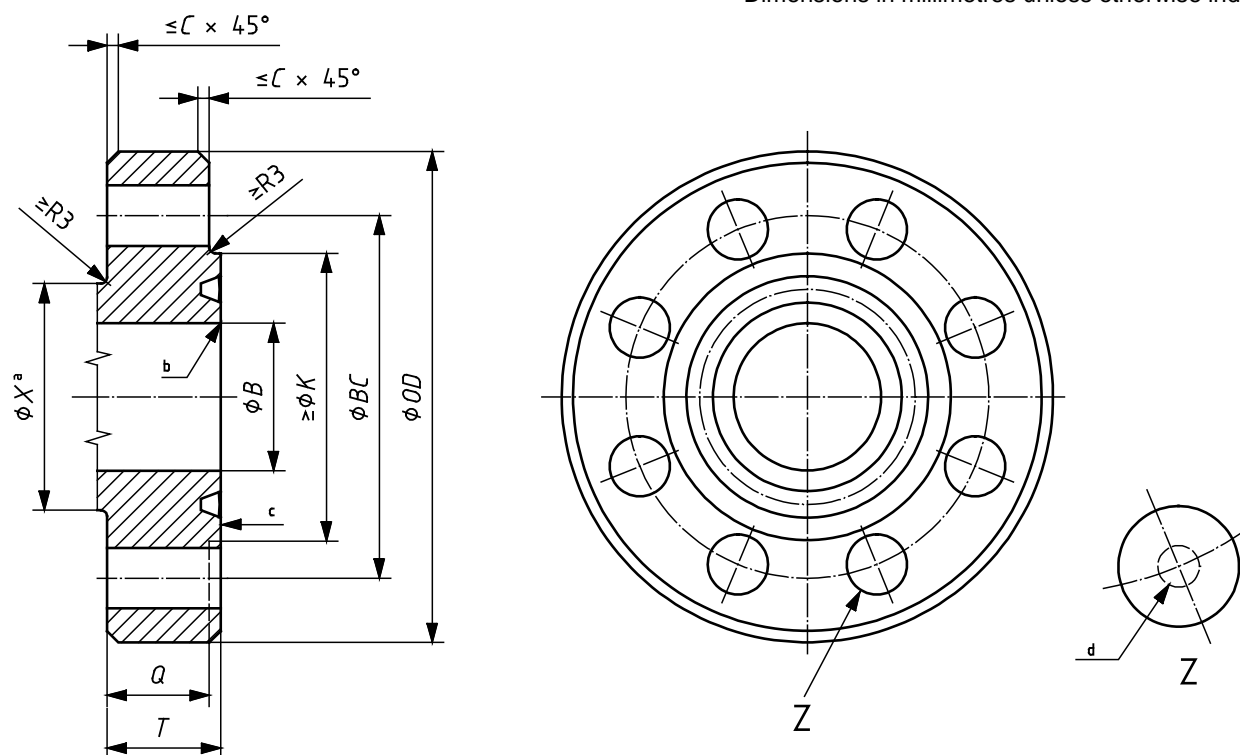
Flanges shall be marked in accordance with Clause 8.

#### **10.1.6 Storing and shipping**

All flanges shall be stored and shipped in accordance with Clause 9.

**Table 49 — Type 6B flanges for 13,8 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**a) Flange section — Integral flange**

Table 49 (continued)

Dimensions in millimetres unless otherwise indicated

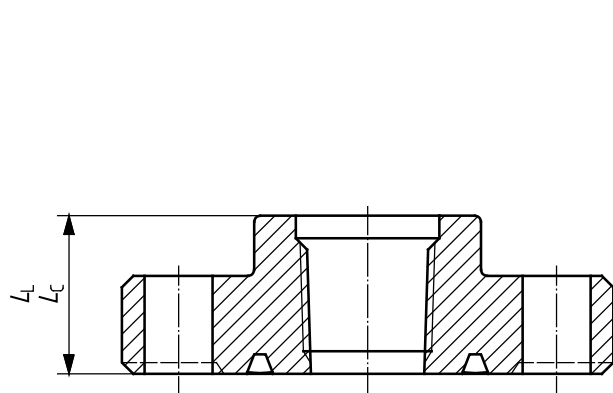
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> <sub>+3 0</sub>	<i>Q</i>	<i>X</i>
mm	(in)								
52	2 <sup>1</sup> / <sub>16</sub>	53,2	165	± 2	3	108	33,4	25,4	84
65	2 <sup>9</sup> / <sub>16</sub>	65,9	190	± 2	3	127	36,6	28,6	100
79	3 <sup>1</sup> / <sub>8</sub>	81,8	210	± 2	3	146	39,7	31,8	117
103	4 <sup>1</sup> / <sub>16</sub>	108,7	275	± 2	3	175	46,1	38,1	152
130	5 <sup>1</sup> / <sub>8</sub>	131,0	330	± 2	3	210	52,4	44,5	189
179	7 <sup>1</sup> / <sub>16</sub>	181,8	355	± 3	6	241	55,6	47,6	222
228	9	229,4	420	± 3	6	302	63,5	55,6	273
279	11	280,2	510	± 3	6	356	71,5	63,5	343
346	13 <sup>5</sup> / <sub>8</sub>	346,9	560	± 3	6	413	74,7	66,7	400
425	16 <sup>3</sup> / <sub>4</sub>	426,2	685	± 3	6	508	84,2	76,2	495
540	21 <sup>1</sup> / <sub>4</sub>	540,5	815	± 3	6	635	98,5	88,9	610

Dimensions in millimetres unless otherwise indicated

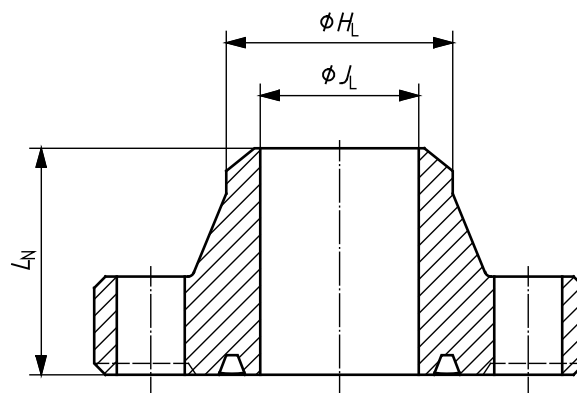
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
		<i>BC</i>		(in)	diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
mm	(in)							
52	2 <sup>1</sup> / <sub>16</sub>	127,0	8	<sup>5</sup> / <sub>8</sub>	20	+ 2	115	23
65	2 <sup>9</sup> / <sub>16</sub>	149,2	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	125	26
79	3 <sup>1</sup> / <sub>8</sub>	168,3	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	135	31
103	4 <sup>1</sup> / <sub>16</sub>	215,9	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	37
130	5 <sup>1</sup> / <sub>8</sub>	266,7	8	1	29	+ 2	170	41
179	7 <sup>1</sup> / <sub>16</sub>	292,1	12	1	29	+ 2	180	45
228	9	349,3	12	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	205	49
279	11	431,8	16	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	220	53
346	13 <sup>5</sup> / <sub>8</sub>	489,0	20	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	230	57
425	16 <sup>3</sup> / <sub>4</sub>	603,2	20	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	260	65
540	21 <sup>1</sup> / <sub>4</sub>	723,9	24	1 <sup>5</sup> / <sub>8</sub>	45	+ 2,5	300	73

<sup>e</sup> Minimum bolt hole tolerance is – 0,5 mm.

Table 49 (continued)



b) Threaded flange



c) Welding neck line-pipe flange

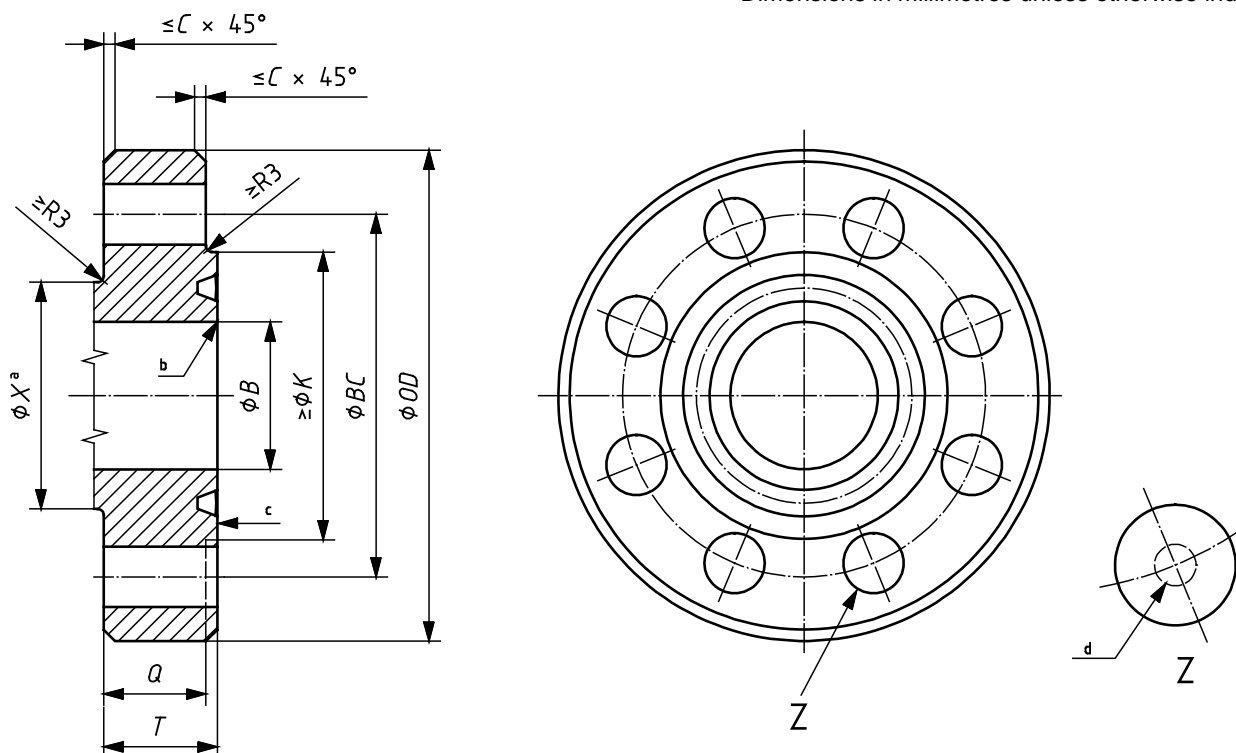
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)
Nominal size and bore of flange		Hub and bore dimensions					
		Hub length threaded line-pipe flange	Hub length threaded casing flange	Hub length welding neck line-pipe flange	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange
mm	(in)	$L_L$	$L_C$	$L_N \pm 1,5$	$H_L$	tol. <sup>f</sup>	$J_L$
52	2 <sup>1</sup> / <sub>16</sub>	45	—	81	60,3	+2,4	53,3
65	2 <sup>9</sup> / <sub>16</sub>	50	—	88	73,0	+2,4	63,5
79	3 <sup>1</sup> / <sub>8</sub>	54	—	91	88,9	+2,4	78,7
103	4 <sup>1</sup> / <sub>16</sub>	62	89	110	114,3	+2,4	103,1
130	5 <sup>1</sup> / <sub>8</sub>	69	102	122	141,3	+2,4	122,9
179	7 <sup>1</sup> / <sub>16</sub>	75	115	126	168,3	+4	147,1
228	9	85	127	141	219,1	+4	199,1
279	11	94	134	160	273,0	+4	248,4
346	13 <sup>5</sup> / <sub>8</sub>	100	100	—	—	—	—
425	16 <sup>3</sup> / <sub>4</sub>	115	115	—	—	—	—
540	21 <sup>1</sup> / <sub>4</sub>	137	137	—	—	—	—

<sup>f</sup> Minimum tolerance for this dimension is – 0,8.

**Table 50 — Type 6B flanges for 20,7 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**a) Flange section integral flange**

Table 50 (continued)

Dimensions in millimetres unless otherwise indicated

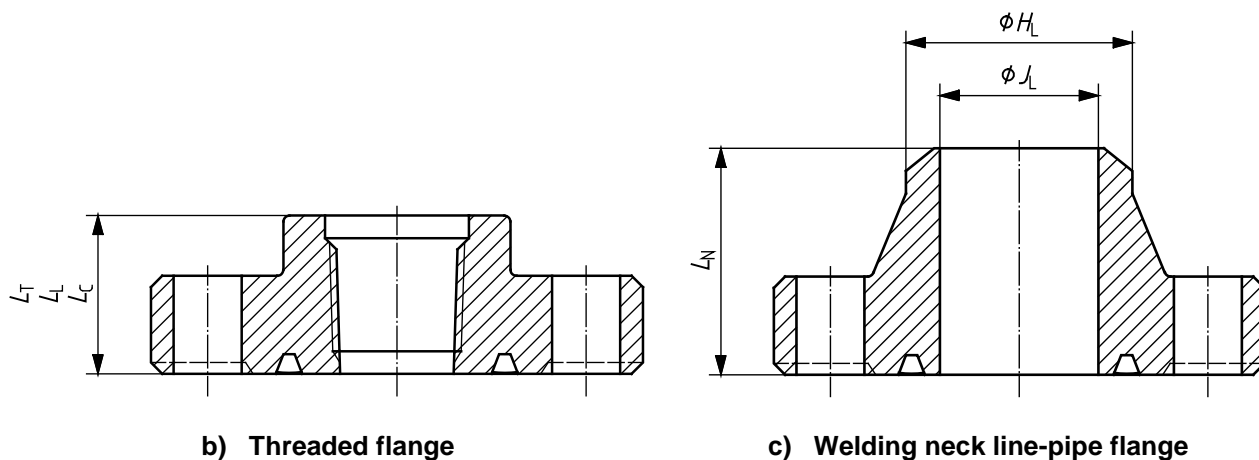
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> +3 0	<i>Q</i>	<i>X</i>
mm	(in)								
52	2 <sup>1</sup> / <sub>16</sub>	53,2	215	± 2	3	124	46,1	38,1	104,8
65	2 <sup>9</sup> / <sub>16</sub>	65,9	245	± 2	3	137	49,3	41,3	123,8
79	3 <sup>1</sup> / <sub>8</sub>	81,8	240	± 2	3	156	46,1	38,1	127,0
103	4 <sup>1</sup> / <sub>16</sub>	108,7	290	± 2	3	181	52,4	44,4	158,8
130	5 <sup>1</sup> / <sub>8</sub>	131,0	350	± 2	3	216	58,8	50,8	190,5
179	7 <sup>1</sup> / <sub>16</sub>	181,8	380	± 3	6	241	63,5	55,6	235,0
228	9	229,4	470	± 3	6	308	71,5	63,5	298,5
279	11	280,2	545	± 3	6	362	77,8	69,9	368,3
346	13 <sup>5</sup> / <sub>8</sub>	346,9	610	± 3	6	419	87,4	79,4	419,1
425	16 <sup>3</sup> / <sub>4</sub>	426,2	705	± 3	6	524	100,1	88,9	508,0
527	20 <sup>3</sup> / <sub>4</sub>	527,8	855	± 3	6	648	120,7	108,0	622,3

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
		<i>BC</i>		(in)	diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
mm	(in)							
52	2 <sup>1</sup> / <sub>16</sub>	165,1	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	24
65	2 <sup>9</sup> / <sub>16</sub>	190,5	8	1	29	+ 2	165	27
79	3 <sup>1</sup> / <sub>8</sub>	190,5	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	31
103	4 <sup>1</sup> / <sub>16</sub>	235,0	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	180	37
130	5 <sup>1</sup> / <sub>8</sub>	279,4	8	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	195	41
179	7 <sup>1</sup> / <sub>16</sub>	317,5	12	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	205	45
228	9	393,7	12	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	230	49
279	11	469,9	16	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	240	53
346	13 <sup>5</sup> / <sub>8</sub>	533,4	20	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	260	57
425	16 <sup>3</sup> / <sub>4</sub>	616,0	20	1 <sup>5</sup> / <sub>8</sub>	45	+ 2,5	300	66
527	20 <sup>3</sup> / <sub>4</sub>	749,3	20	2	54	+ 2,5	370	74

<sup>e</sup> Minimum bolt hole tolerance is – 0,5 mm.

Table 50 (continued)



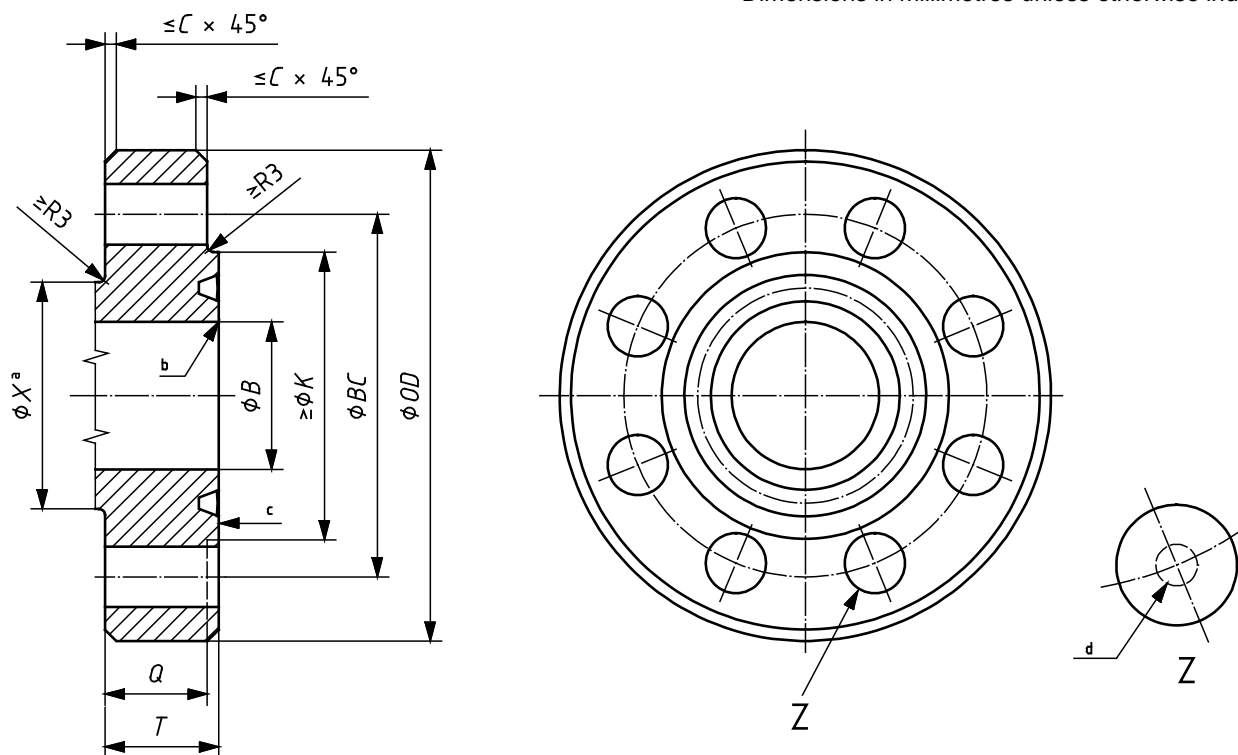
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Nominal size and bore of flange		Hub and bore dimensions						
		Hub length threaded line-pipe flange	Hub length threaded casing flange	Hub length tubing flange	Hub length welding neck line-pipe flange	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange
mm	(in)	$L_L$	$L_C$	$L_T$	$L_N \pm 1,6$	$H_L$	tol. <sup>f</sup>	$J_L$
52	2 <sup>1</sup> / <sub>16</sub>	65,1	—	65,1	109,6	60,3	+ 2,4	50,0
65	2 <sup>9</sup> / <sub>16</sub>	71,4	—	71,4	112,7	73,0	+ 2,4	59,7
79	3 <sup>1</sup> / <sub>8</sub>	61,9	—	74,7	109,5	88,9	+ 2,4	74,4
103	4 <sup>1</sup> / <sub>16</sub>	77,8	88,9	88,9	122,2	114,3	+ 2,4	98,0
130	5 <sup>1</sup> / <sub>8</sub>	87,3	101,6	—	134,9	141,3	+ 2,4	122,9
179	7 <sup>1</sup> / <sub>16</sub>	93,7	114,3	—	147,6	168,3	+ 4,1	147,1
228	9	109,5	127,0	—	169,9	219,1	+ 4,1	189,7
279	11	115,9	133,4	—	192,1	273,0	+ 4,1	237,2
346	13 <sup>5</sup> / <sub>8</sub>	125,4	125,4	—	—	—	—	—
425	16 <sup>3</sup> / <sub>4</sub>	128,6	144,6	—	—	—	—	—
527	20 <sup>3</sup> / <sub>4</sub>	171,4	171,5	—	—	—	—	—

<sup>f</sup> Minimum tolerance for this dimension is – 0,8.

**Table 51 — Type 6B flanges for 34,5 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**a) Flange section integral flange**

**Table 51** (continued)

Dimensions in millimetres unless otherwise indicated

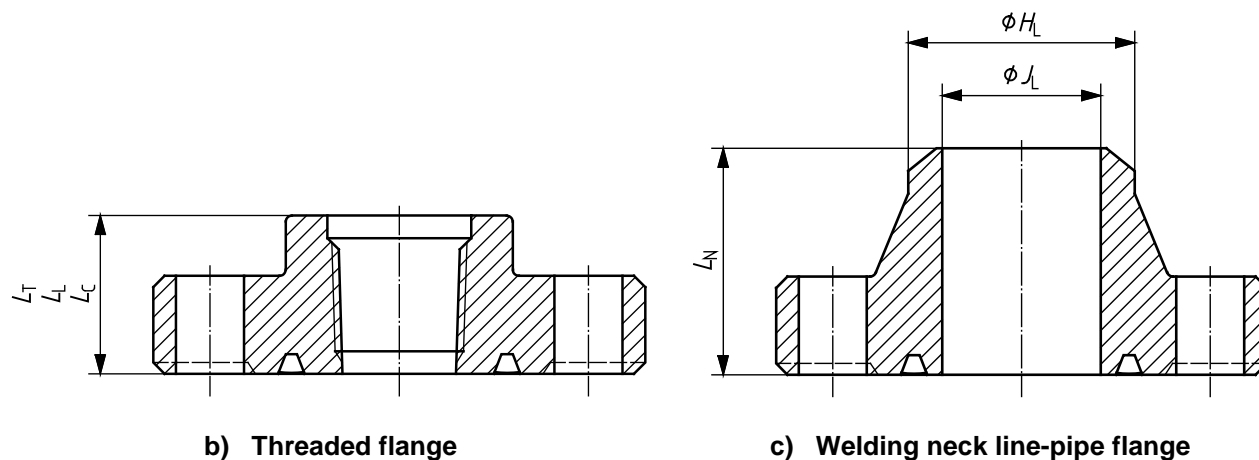
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> $\begin{smallmatrix} +3 \\ 0 \end{smallmatrix}$	<i>Q</i>	<i>X</i>
mm	(in)								
52	2 <sup>1</sup> / <sub>16</sub>	53,2	215	± 2	3	124	46,1	38,1	104,8
65	2 <sup>9</sup> / <sub>16</sub>	65,9	245	± 2	3	137	49,3	41,3	123,8
79	3 <sup>1</sup> / <sub>8</sub>	81,8	265	± 2	3	168	55,6	47,7	133,3
103	4 <sup>1</sup> / <sub>16</sub>	108,7	310	± 2	3	194	62,0	54,0	161,9
130	5 <sup>1</sup> / <sub>8</sub>	131,0	375	± 2	3	229	81,0	73,1	196,8
179	7 <sup>1</sup> / <sub>16</sub>	181,8	395	± 3	6	248	92,1	82,6	228,6
228	9	229,4	485	± 3	6	318	103,2	92,1	292,1
279	11	280,2	585	± 3	6	371	119,1	108,0	368,3

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
		<i>BC</i>		(in)	diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
mm	(in)							
52	2 <sup>1</sup> / <sub>16</sub>	165,1	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	24
65	2 <sup>9</sup> / <sub>16</sub>	190,5	8	1	29	+ 2	165	27
79	3 <sup>1</sup> / <sub>8</sub>	203,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	185	35
103	4 <sup>1</sup> / <sub>16</sub>	241,3	8	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	205	39
130	5 <sup>1</sup> / <sub>8</sub>	292,1	8	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	255	44
179	7 <sup>1</sup> / <sub>16</sub>	317,5	12	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	275	46
228	9	393,7	12	1 <sup>5</sup> / <sub>8</sub>	45	+ 2,5	305	50
279	11	482,6	12	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	350	54

<sup>e</sup> Minimum bolt hole tolerance is – 0,5 mm.

Table 51 (continued)



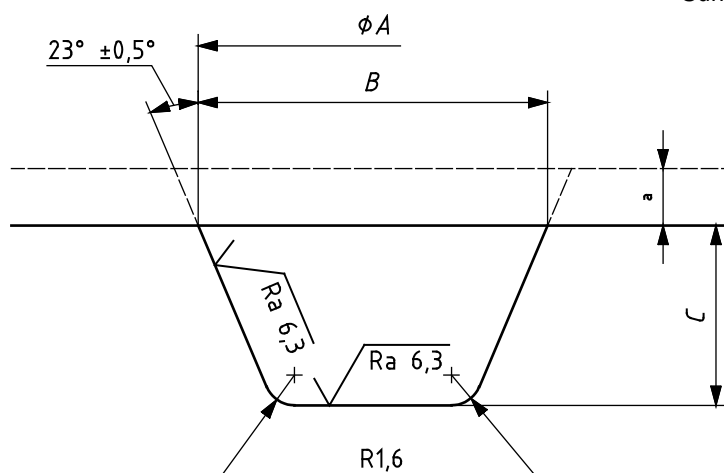
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Nominal size and bore of flange		Hub and bore dimensions						
		Hub length threaded line-pipe flange	Hub length threaded casing flange	Hub length tubing flange	Hub length welding neck line-pipe flange	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange
mm	(in)	$L_L$	$L_C$	$L_T$	$L_N \pm 1,6$	$H_L$	tol. <sup>f</sup>	$J_L$
52	2 <sup>1</sup> / <sub>16</sub>	65,1	—	65,1	109,5	60,3	+ 2,3	43,7
65	2 <sup>9</sup> / <sub>16</sub>	71,4	—	71,4	112,7	73,0	+ 2,3	54,9
79	3 <sup>1</sup> / <sub>8</sub>	81,0	—	81,0	125,4	88,9	+ 2,3	67,5
103	4 <sup>1</sup> / <sub>16</sub>	98,4	98,4	98,4	131,8	114,3	+ 2,3	88,1
130	5 <sup>1</sup> / <sub>8</sub>	112,7	112,7	—	163,5	141,3	+ 2,3	110,3
179	7 <sup>1</sup> / <sub>16</sub>	128,6	128,6	—	181,0	168,3	+ 4	132,6
228	9	154,0	154,0	—	223,8	219,1	+ 4	173,8
279	11	169,9	169,9	—	265,1	273,1	+ 4	216,7

<sup>f</sup> Minimum tolerance for this dimension is – 0,8.

**Table 52 — Rough machining detail for corrosion-resistant ring groove**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated  
Surface roughness in micrometres



- <sup>a</sup> Allow 3 mm or greater for final machining of weld overlay.

**Table 52** (continued)

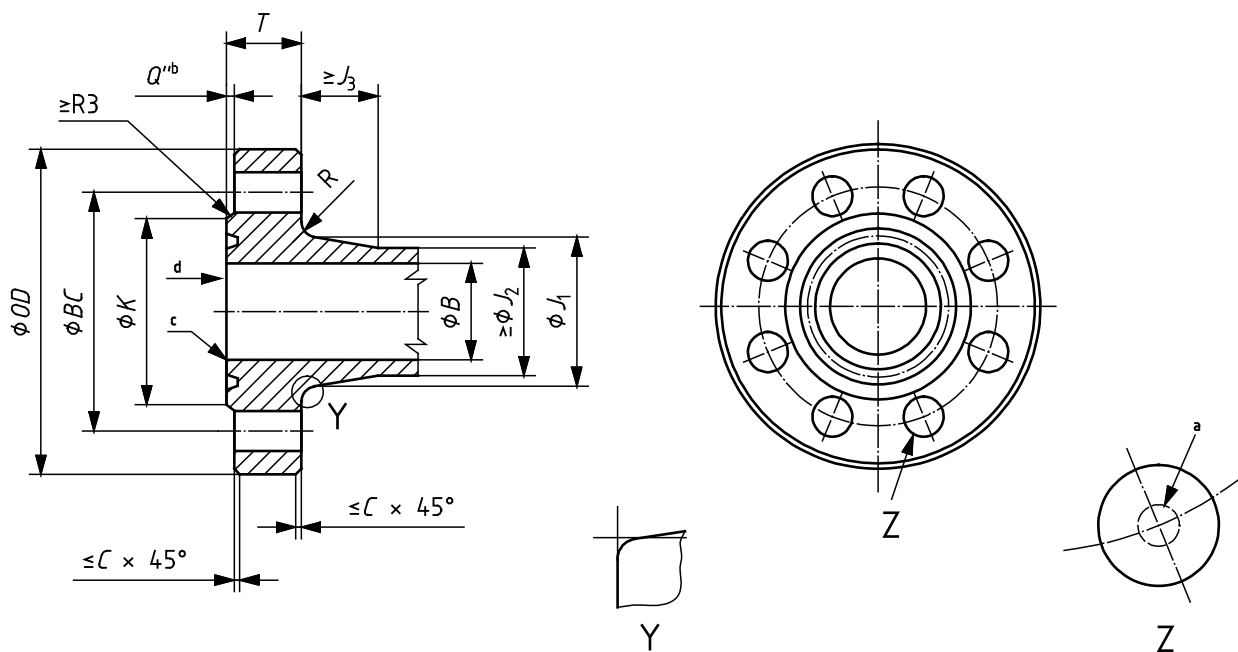
Dimensions in millimetres unless otherwise indicated

Ring number	Outside diameter of groove <i>A</i> +0,8 0	Width of groove <i>B</i> +0,8 0	Depth of groove <i>C</i> +0,8 0	Ring number	Outside diameter of groove <i>A</i> +0,8 0	Width of groove <i>B</i> +0,8 0	Depth of groove <i>C</i> +0,8 0
BX 150	81,8	18,3	9,1	R 41	201,2	19,1	11,4
BX 151	86,1	18,8	9,1	R 44	213,9	19,1	11,4
BX 152	94,5	19,6	9,7	R 45	231,4	19,1	11,4
BX 153	111,3	21,1	10,4	R 46	232,9	20,6	13,2
BX 154	127,3	22,4	11,2	R 47	256,8	26,9	16,3
BX 155	159,0	24,6	11,9	R 49	290,1	19,1	11,4
BX 156	250,2	30,5	14,7	R 50	294,9	23,9	14,7
BX 157	307,3	33,5	16,3	R 53	344,2	19,1	11,4
BX 158	365,5	36,1	17,8	R 54	349,0	23,9	14,7
BX 159	440,9	39,4	19,6	R 57	401,3	19,1	11,4
BX 160	416,3	26,9	17,8	R 63	454,4	34,0	19,6
BX 162	486,7	24,9	11,9	R 65	490,2	19,1	11,4
BX 163	571,8	32,5	21,8	R 66	495,0	23,9	14,7
BX 164	586,2	39,9	21,8	R 69	553,7	19,1	11,4
BX 165	640,8	34,3	22,6	R 70	561,6	26,9	16,3
BX 166	656,3	41,9	22,6	R 73	606,0	20,6	13,2
BX 167	776,7	30,0	24,9	R 74	612,4	26,9	16,3
BX 168	782,6	32,8	24,9	R 82	77,5	19,1	11,4
BX 169	185,2	23,9	13,2	R 84	83,8	19,1	11,4
BX 303	872,0	37,1	29,7	R 85	101,3	20,6	13,2
R 20 <sup>b</sup>	85,3	15,7	9,9	R 86	115,6	23,9	14,7
R 23	102,9	19,1	11,4	R 87	125,0	23,9	14,7
R 24	115,6	19,1	11,4	R 88	152,1	26,9	16,3
R 25 <sup>b</sup>	118,6	15,7	9,9	R 89	142,5	26,9	16,3
R 26	121,9	19,1	11,4	R 90	186,9	30,2	17,8
R 27	128,3	19,1	11,4	R 91	302,0	40,4	21,1
R 31	144,0	19,1	11,4	R 99	255,3	19,1	11,4
R 35	156,7	19,1	11,4	R 201 <sup>b</sup>	59,9	12,7	7,6
R 37	169,4	19,1	11,4	R 205 <sup>b</sup>	71,1	12,7	10,7
R 39	182,1	19,1	11,4	R 210 <sup>b</sup>	106,7	16,8	9,9
				R 215 <sup>b</sup>	150,4	19,1	11,4

<sup>b</sup> See 10.1.2.4.5.

**Table 53 — Type 6BX integral flanges for 13,8 MPa; 20,7 MPa; 34,5 MPa  
and 69,0 MPa rated working pressures**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.
- b  $Q''_{max} = E$  (Table 65).  
 $Q''_{min} = 3$  mm.  
 $Q''$  may be omitted on studded flanges.
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**Table 53** (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub
mm	(in)	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> +3 0	<i>J</i> <sub>1</sub> 0 -3	<i>J</i> <sub>2</sub>
<b>13,8 MPa</b>									
679	26 <sup>3</sup> / <sub>4</sub>	680,2	1 040	± 3	6	805	126,3	835,8	743,0
762	30	762,8	1 120	± 3	6	908	134,2	931,9	833,0
<b>20,7 MPa</b>									
679	26 <sup>3</sup> / <sub>4</sub>	680,2	1 100	± 3	6	832	161,2	870,0	776,3
762	30	762,8	1 185	± 3	6	922	167,1	970,0	871,1
<b>34,5 MPa</b>									
346	13 <sup>5</sup> / <sub>8</sub>	346,9	675	± 3	6	457	112,8	481,0	423,9
425	16 <sup>3</sup> / <sub>4</sub>	426,2	770	± 3	6	535	130,2	555,6	527,1
476	18 <sup>3</sup> / <sub>4</sub>	477,0	905	± 3	6	627	165,9	674,7	598,5
540	21 <sup>1</sup> / <sub>4</sub>	540,5	990	± 3	6	702	181,0	758,8	679,5
<b>69,0 MPa</b>									
46	1 <sup>13</sup> / <sub>16</sub>	46,8	185	± 2	3	105	42,1	88,9	65,1
52	2 <sup>1</sup> / <sub>16</sub>	53,2	200	± 2	3	111	44,1	100,0	74,7
65	2 <sup>9</sup> / <sub>16</sub>	65,9	230	± 2	3	132	51,2	120,7	92,1
78	3 <sup>1</sup> / <sub>16</sub>	78,6	270	± 2	3	152	58,4	142,1	110,2
103	4 <sup>1</sup> / <sub>16</sub>	104,0	315	± 2	3	185	70,3	182,6	146,1
130	5 <sup>1</sup> / <sub>8</sub>	131,0	360	± 2	3	221	79,4	223,8	182,6
179	7 <sup>1</sup> / <sub>16</sub>	180,2	480	± 3	6	302	103,2	301,6	254,0
228	9	229,4	550	± 3	6	359	123,9	374,7	327,1
279	11	280,2	655	± 3	6	429	141,3	450,9	400,1
346	13 <sup>5</sup> / <sub>8</sub>	346,9	770	± 3	6	518	168,3	552,5	495,3
425	16 <sup>3</sup> / <sub>4</sub>	426,2	870	± 3	6	576	168,3	655,6	601,7
476	18 <sup>3</sup> / <sub>4</sub>	477,0	1 040	± 3	6	697	223,1	752,5	674,7
540	21 <sup>1</sup> / <sub>4</sub>	540,5	1 145	± 3	6	781	241,3	847,7	762,0

Table 53 (continued)

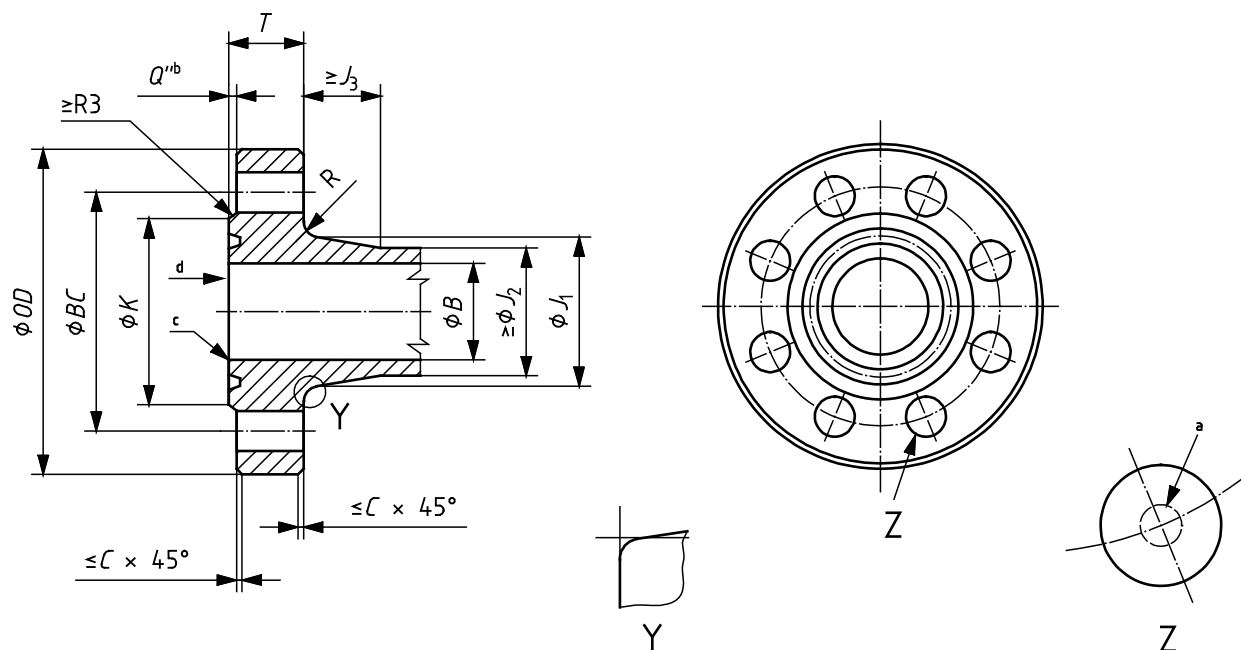
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions								
		Length of hub	Radius of hub	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
mm	(in)	$J_3$	$R$	$BC$		(in)	diameter	tol. <sup>e</sup>	$L_{ssb}$	BX
<b>13,8 MPa</b>										
679	26 <sup>3</sup> / <sub>4</sub>	185,7	16	952,5	20	1 <sup>3</sup> / <sub>4</sub>	48	+ 2,5	350	167
762	30	196,9	16	1 039,8	32	1 <sup>5</sup> / <sub>8</sub>	45	+ 2,5	360	303
<b>20,7 MPa</b>										
679	26 <sup>3</sup> / <sub>4</sub>	185,7	16	1 000,1	24	2	54	+ 2,5	430	168
762	30	196,9	16	1 090,6	32	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	450	303
<b>34,5 MPa</b>										
346	13 <sup>5</sup> / <sub>8</sub>	114,3	16	590,6	16	1 <sup>5</sup> / <sub>8</sub>	45	+ 2,5	315	160
425	16 <sup>3</sup> / <sub>4</sub>	76,2	19	676,3	16	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	370	162
476	18 <sup>3</sup> / <sub>4</sub>	152,4	16	803,3	20	2	54	+ 2,5	445	163
540	21 <sup>1</sup> / <sub>4</sub>	165,1	18	885,8	24	2	54	+ 2,5	480	165
<b>69,0 MPa</b>										
46	1 <sup>13</sup> / <sub>16</sub>	48,5	10	146,1	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	125	151
52	2 <sup>1</sup> / <sub>16</sub>	51,6	10	158,8	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	130	152
65	2 <sup>9</sup> / <sub>16</sub>	57,2	10	184,2	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	153
78	3 <sup>1</sup> / <sub>16</sub>	63,5	10	215,9	8	1	29	+ 2	170	154
103	4 <sup>1</sup> / <sub>16</sub>	73,1	10	258,8	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	205	155
130	5 <sup>1</sup> / <sub>8</sub>	81,0	10	300,0	12	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	220	169
179	7 <sup>1</sup> / <sub>16</sub>	95,3	16	403,2	12	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	285	156
228	9	93,7	16	476,3	16	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	330	157
279	11	103,2	16	565,2	16	1 <sup>3</sup> / <sub>4</sub>	48	+ 2,5	380	158
346	13 <sup>5</sup> / <sub>8</sub>	114,3	16	673,1	20	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	440	159
425	16 <sup>3</sup> / <sub>4</sub>	76,2	19	776,3	24	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	445	162
476	18 <sup>3</sup> / <sub>4</sub>	155,6	16	925,5	24	2 <sup>1</sup> / <sub>4</sub>	61	+ 2,5	570	164
540	21 <sup>1</sup> / <sub>4</sub>	165,1	21	1 022,4	24	2 <sup>1</sup> / <sub>2</sub>	67	+ 2,5	620	166

<sup>e</sup> Minimum bolt hole tolerance is – 0,5.

**Table 54 — Type 6BX integral flanges for 103,5 MPa  
and 138,0 MPa rated working pressures**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.
- b  $Q''_{max} = E$  (Table 65).  
 $Q''_{min} = 3$  mm.  
 $Q''$  may be omitted on studed flanges.
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**Table 54** (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> $\begin{smallmatrix} +3 \\ 0 \end{smallmatrix}$	<i>J</i> <sub>1</sub> $\begin{smallmatrix} 0 \\ -3 \end{smallmatrix}$	<i>J</i> <sub>2</sub>
mm	(in)								
<b>103,5 MPa</b>									
46	1 <sup>13</sup> / <sub>16</sub>	46,8	210	± 2	3	106	45,3	97,6	71,4
52	2 <sup>1</sup> / <sub>16</sub>	53,2	220	± 2	3	114	50,8	111,1	82,5
65	2 <sup>9</sup> / <sub>16</sub>	65,9	255	± 2	3	133	57,2	128,6	100,0
78	3 <sup>1</sup> / <sub>16</sub>	78,6	290	± 2	3	154	64,3	154,0	122,2
103	4 <sup>1</sup> / <sub>16</sub>	104,0	360	± 2	3	194	78,6	195,3	158,7
130	5 <sup>1</sup> / <sub>8</sub>	131,0	420	± 2	3	225	98,5	244,5	200,0
179	7 <sup>1</sup> / <sub>16</sub>	180,2	505	± 3	6	305	119,1	325,4	276,2
228	9	229,4	650	± 3	6	381	146,1	431,8	349,2
279	11	280,2	815	± 3	6	454	187,4	584,2	427,0
346	13 <sup>5</sup> / <sub>8</sub>	346,9	885	± 3	6	541	204,8	595,3	528,6
476	18 <sup>3</sup> / <sub>4</sub>	477,0	1 160	± 3	6	722	255,6	812,8	730,2
<b>138,0 MPa</b>									
46	1 <sup>13</sup> / <sub>16</sub>	46,8	255	± 2	3	117	63,5	133,4	109,5
52	2 <sup>1</sup> / <sub>16</sub>	53,2	285	± 2	3	132	71,5	154,0	127,0
65	2 <sup>9</sup> / <sub>16</sub>	65,9	325	± 2	3	151	79,4	173,0	144,5
78	3 <sup>1</sup> / <sub>16</sub>	78,6	355	± 2	3	171	85,8	192,1	160,3
103	4 <sup>1</sup> / <sub>16</sub>	104,0	445	± 2	3	219	106,4	242,9	206,4
179	7 <sup>1</sup> / <sub>16</sub>	180,2	655	± 3	6	352	165,1	385,8	338,1
228	9	229,4	805	± 3	6	441	204,8	481,0	428,6
279	11	280,2	885	± 3	6	505	223,9	566,7	508,0
346	13 <sup>5</sup> / <sub>8</sub>	346,9	1 160	± 3	6	614	292,1	693,7	628,6

**Table 54** (continued)

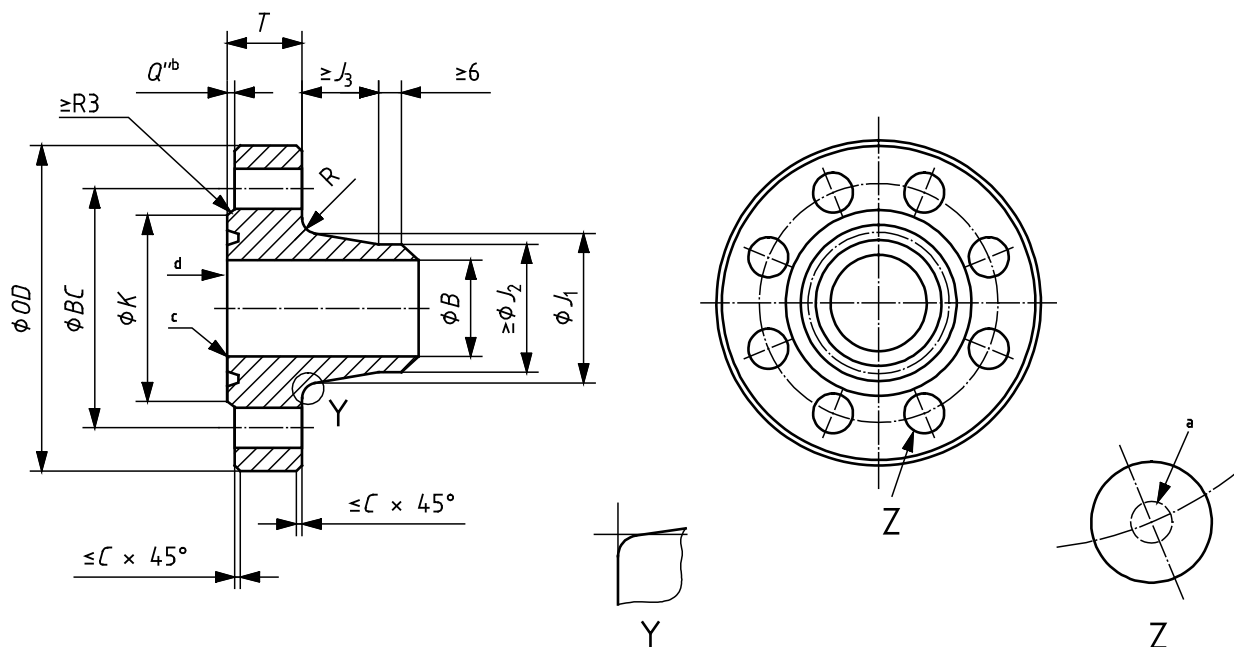
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions								
		Length of hub	Radius of hub	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
mm	(in)	$J_3$	$R$	$BC$		(in)	diameter	tol. <sup>e</sup>	$L_{ssb}$	BX
<b>103,5 MPa</b>										
46	1 <sup>13</sup> / <sub>16</sub>	47,6	10	160,3	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	140	151
52	2 <sup>1</sup> / <sub>16</sub>	54,0	10	174,6	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	152
65	2 <sup>9</sup> / <sub>16</sub>	57,1	10	200,0	8	1	29	+ 2	170	153
78	3 <sup>1</sup> / <sub>16</sub>	63,5	10	230,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	190	154
103	4 <sup>1</sup> / <sub>16</sub>	73,0	10	290,5	8	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	235	155
130	5 <sup>1</sup> / <sub>8</sub>	81,8	16	342,9	12	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	290	169
179	7 <sup>1</sup> / <sub>16</sub>	92,1	16	428,6	16	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	325	156
228	9	123,8	16	552,4	16	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	400	157
279	11	235,7	16	711,2	20	2	54	+ 2,5	490	158
346	13 <sup>5</sup> / <sub>8</sub>	114,3	25	771,5	20	2 <sup>1</sup> / <sub>4</sub>	61	+ 2,5	540	159
476	18 <sup>3</sup> / <sub>4</sub>	155,6	25	1 016,0	20	3	80	+ 3	680	164
<b>138,0 MPa</b>										
46	1 <sup>13</sup> / <sub>16</sub>	49,2	10	203,2	8	1	29	+ 2	190	151
52	2 <sup>1</sup> / <sub>16</sub>	52,4	10	230,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	210	152
65	2 <sup>9</sup> / <sub>16</sub>	58,7	10	261,9	8	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	235	153
78	3 <sup>1</sup> / <sub>16</sub>	63,5	10	287,3	8	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	255	154
103	4 <sup>1</sup> / <sub>16</sub>	73,0	10	357,2	8	1 <sup>3</sup> / <sub>4</sub>	48	+ 2,5	310	155
179	7 <sup>1</sup> / <sub>16</sub>	96,8	16	554,0	16	2	54	+ 2,5	445	156
228	9	107,9	25	685,8	16	2 <sup>1</sup> / <sub>2</sub>	67	+ 2,5	570	157
279	11	103,2	25	749,3	16	2 <sup>3</sup> / <sub>4</sub>	74	+ 2,5	605	158
346	13 <sup>5</sup> / <sub>8</sub>	133,3	25	1 016,0	20	3	80	+ 3	760	159

<sup>e</sup> Minimum bolt hole tolerance is – 0,5.

**Table 55 — Type 6BX welding neck flanges for 69,0 MPa  
and 103,5 MPa rated working pressures**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.
- b  $Q_{\max}'' = E$  (Table 65).  
 $Q_{\min}'' = 3 \text{ mm}$ .
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

**Table 55** (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal size and bore of flange		Basic flange dimensions							
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub
mm	(in)	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> <sup>+3</sup> 0	<i>J</i> <sub>1</sub> 0 −3	<i>J</i> <sub>2</sub>
69,0 MPa									
46	1 <sup>13</sup> / <sub>16</sub>	46,8	185	± 2	3	105	42,1	88,9	65,1
52	2 <sup>1</sup> / <sub>16</sub>	53,2	200	± 2	3	111	44,1	100,0	74,6
65	2 <sup>9</sup> / <sub>16</sub>	65,9	230	± 2	3	132	51,2	120,7	92,1
78	3 <sup>1</sup> / <sub>16</sub>	78,6	270	± 2	3	152	58,4	142,1	110,3
103	4 <sup>1</sup> / <sub>16</sub>	104,0	315	± 2	3	185	70,3	182,6	146,1
130	5 <sup>1</sup> / <sub>8</sub>	131,0	360	± 2	3	221	79,4	223,8	182,6
179	7 <sup>1</sup> / <sub>16</sub>	180,2	480	± 3	6	302	103,2	301,6	254,0
228	9	229,4	550	± 3	6	359	123,9	374,7	327,1
279	11	280,2	655	± 3	6	429	141,3	450,9	400,1
346	13 <sup>5</sup> / <sub>8</sub>	346,9	770	± 3	6	518	168,3	552,5	495,3
425	16 <sup>3</sup> / <sub>4</sub>	426,2	870	± 3	6	576	168,3	655,6	601,7
103,5 MPa									
46	1 <sup>13</sup> / <sub>16</sub>	46,8	210	± 2	3	106	45,3	97,6	71,4
52	2 <sup>1</sup> / <sub>16</sub>	53,2	220	± 2	3	114	50,8	111,1	82,6
65	2 <sup>9</sup> / <sub>16</sub>	65,9	255	± 2	3	133	57,2	128,6	100,0
78	3 <sup>1</sup> / <sub>16</sub>	78,6	290	± 2	3	154	64,3	154,0	122,2
103	4 <sup>1</sup> / <sub>16</sub>	104,0	360	± 2	3	194	78,6	195,3	158,8
130	5 <sup>1</sup> / <sub>8</sub>	131,0	420	± 2	3	225	98,5	244,5	200,0
179	7 <sup>1</sup> / <sub>16</sub>	180,2	505	± 3	6	305	119,1	325,4	276,2

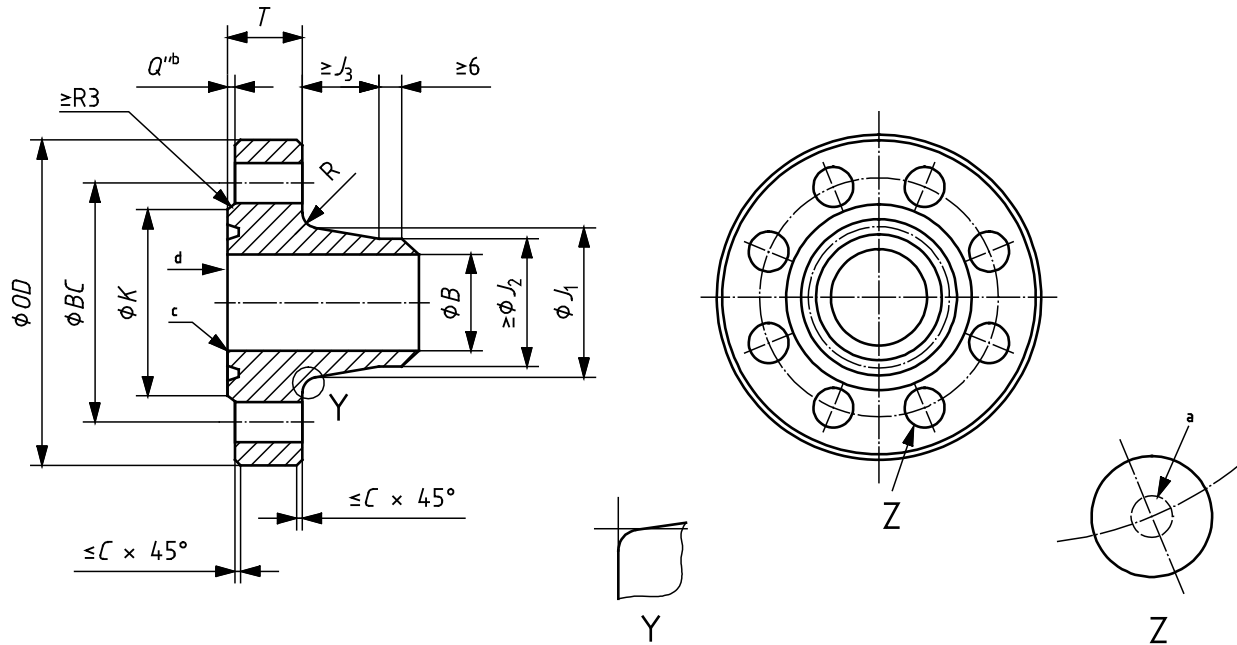
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions								
		Length of hub	Radius of hub	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
mm	(in)	$J_3$	$R$	$BC$		(in)	diameter	tol. <sup>e</sup>	$L_{ssb}$	BX
69,0 MPa										
46	1 <sup>13</sup> / <sub>16</sub>	48,4	10	146,0	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	125	151
52	2 <sup>1</sup> / <sub>16</sub>	51,6	10	158,8	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	135	152
65	2 <sup>9</sup> / <sub>16</sub>	57,2	10	184,2	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	153
78	3 <sup>1</sup> / <sub>16</sub>	63,5	10	215,9	8	1	29	+ 2	170	154
103	4 <sup>1</sup> / <sub>16</sub>	73,0	10	258,8	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	205	155
130	5 <sup>1</sup> / <sub>8</sub>	81,0	10	300,0	12	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	220	169
179	7 <sup>1</sup> / <sub>16</sub>	95,2	16	403,2	12	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	285	156
228	9	93,7	16	476,3	16	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	330	157
279	11	103,2	16	565,2	16	1 <sup>3</sup> / <sub>4</sub>	48	+ 2,5	380	158
346	13 <sup>5</sup> / <sub>8</sub>	114,3	16	673,1	20	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	440	159
425	16 <sup>3</sup> / <sub>4</sub>	76,2	19	776,3	24	1 <sup>7</sup> / <sub>8</sub>	51	+ 2,5	445	162
103,5 MPa										
46	1 <sup>13</sup> / <sub>16</sub>	47,6	10	160,3	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	140	151
52	2 <sup>1</sup> / <sub>16</sub>	54,0	10	174,6	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	152
65	2 <sup>9</sup> / <sub>16</sub>	57,2	10	200,0	8	1	29	+ 2	170	153
78	3 <sup>1</sup> / <sub>16</sub>	63,5	10	230,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	190	154
103	4 <sup>1</sup> / <sub>16</sub>	73,0	10	290,5	8	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	235	155
130	5 <sup>1</sup> / <sub>8</sub>	81,8	16	342,9	12	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	290	169
179	7 <sup>1</sup> / <sub>16</sub>	92,1	16	428,6	16	1 <sup>1</sup> / <sub>2</sub>	42	+ 2,5	325	156

<sup>e</sup> Minimum bolt hole tolerance is – 0,5.

**Table 56 — Type 6BX welding neck flanges for 138,0 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.
- b  $Q''_{\max} = E$  (Table 65).  
 $Q''_{\min} = 3 \text{ mm}$ .
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

Table 56 (continued)

Dimensions in millimetres unless otherwise indicated

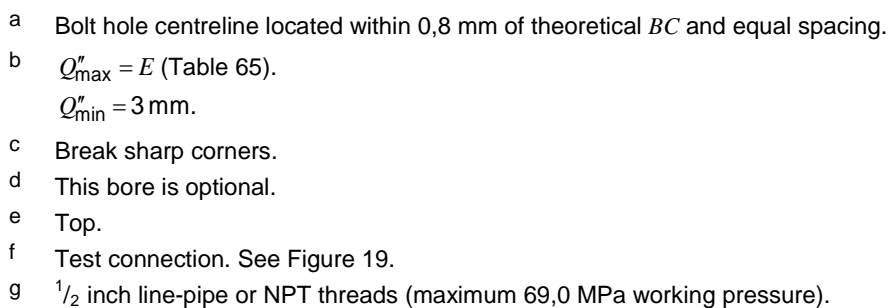
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange		Basic flange dimensions									
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> +3 0	<i>J</i> <sub>1</sub> 0 -3	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
mm	(in)										
46	1 <sup>13</sup> / <sub>16</sub>	46,8	255	± 2	3	117	63,5	133,4	109,5	49,2	10
52	2 <sup>1</sup> / <sub>16</sub>	53,2	285	± 2	3	132	71,5	154,0	127,0	52,4	10
65	2 <sup>9</sup> / <sub>16</sub>	65,9	325	± 2	3	151	79,4	173,0	144,5	58,7	10
78	3 <sup>1</sup> / <sub>16</sub>	78,6	355	± 2	3	171	85,8	192,1	160,3	63,5	10
103	4 <sup>1</sup> / <sub>16</sub>	104,0	445	± 2	3	219	106,4	242,9	206,4	73,0	10
179	7 <sup>1</sup> / <sub>16</sub>	180,2	655	± 3	6	352	165,1	385,8	338,1	96,8	16

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
		<i>BC</i>		(in)	diameter	tol. <sup>e</sup>	<i>L</i> <sub>ssb</sub>	BX
mm	(in)							
46	1 <sup>13</sup> / <sub>16</sub>	203,2	8	1	29	+ 2	190	151
52	2 <sup>1</sup> / <sub>16</sub>	230,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	210	152
65	2 <sup>9</sup> / <sub>16</sub>	261,9	8	1 <sup>1</sup> / <sub>4</sub>	35	+ 2	235	153
78	3 <sup>1</sup> / <sub>16</sub>	287,3	8	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	255	154
103	4 <sup>1</sup> / <sub>16</sub>	357,2	8	1 <sup>3</sup> / <sub>4</sub>	48	+ 2,5	310	155
179	7 <sup>1</sup> / <sub>16</sub>	554,0	16	2	54	+ 2,5	445	156

<sup>e</sup> Minimum bolt hole tolerance is – 0,5.

Dimensions in millimetres unless otherwise indicated



Ring groove shall be concentric with bore within 0,25 total indicator runout.

**Table 57** (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange		Basic flange dimensions									
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> +3 0	<i>J</i> <sub>1</sub> 0 -3	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
mm	(in)										
69,0 MPa											
46	1 <sup>13</sup> / <sub>16</sub>	46,8	185	± 2	3	105	42,1	88,9	65,1	48,4	10
52	2 <sup>1</sup> / <sub>16</sub>	53,2	200	± 2	3	111	44,1	100,0	74,6	51,6	10
65	2 <sup>9</sup> / <sub>16</sub>	65,9	230	± 2	3	132	51,3	120,6	92,1	57,1	10
78	3 <sup>1</sup> / <sub>16</sub>	78,6	270	± 2	3	152	58,4	142,1	110,3	63,5	10
103	4 <sup>1</sup> / <sub>16</sub>	104,0	315	± 2	3	185	70,3	182,6	146,0	73,0	10
130	5 <sup>1</sup> / <sub>8</sub>	131,0	360	± 2	3	221	79,4	223,8	182,6	81,0	10
103,5 MPa											
46	1 <sup>13</sup> / <sub>16</sub>	46,8	210	± 2	3	106	45,3	97,6	71,4	47,6	10
52	2 <sup>1</sup> / <sub>16</sub>	53,2	220	± 2	3	114	50,8	111,1	82,6	54,0	10
65	2 <sup>9</sup> / <sub>16</sub>	65,9	255	± 2	3	133	57,2	128,6	100,0	57,1	10
78	3 <sup>1</sup> / <sub>16</sub>	78,6	290	± 2	3	154	64,3	154,0	122,2	63,5	10
103	4 <sup>1</sup> / <sub>16</sub>	104,0	360	± 2	3	194	78,6	195,3	158,8	73,0	10

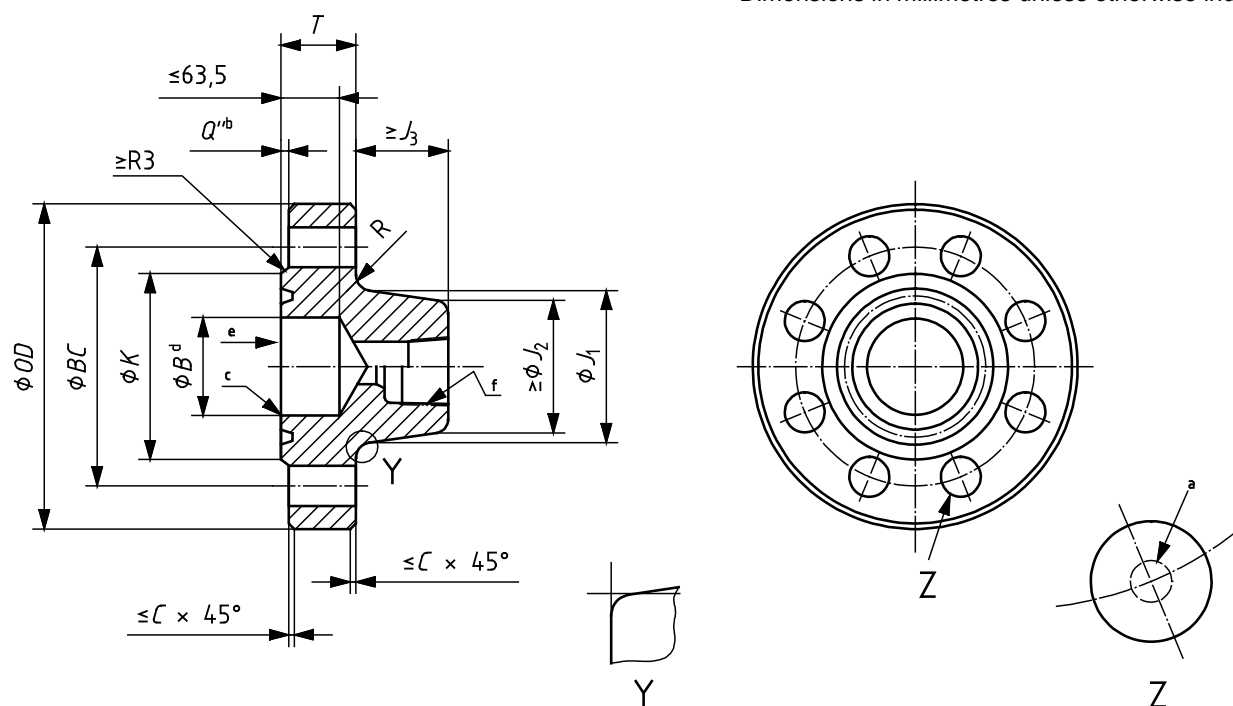
Dimensions in millimetres unless otherwise indicated

(1)	(2)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
mm	(in)	BC		(in)	diameter	tol. <sup>h</sup>	L <sub>ssb</sub>	BX
<b>69,0 MPa</b>								
46	1 <sup>13</sup> / <sub>16</sub>	146,0	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	125	151
52	2 <sup>1</sup> / <sub>16</sub>	158,8	8	<sup>3</sup> / <sub>4</sub>	23	+ 2	135	152
65	2 <sup>9</sup> / <sub>16</sub>	184,2	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	153
78	3 <sup>1</sup> / <sub>16</sub>	215,9	8	1	29	+ 2	170	154
103	4 <sup>1</sup> / <sub>16</sub>	258,8	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	205	155
130	5 <sup>1</sup> / <sub>8</sub>	300,0	12	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	220	169
<b>103,5 MPa</b>								
46	1 <sup>13</sup> / <sub>16</sub>	160,3	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	140	151
52	2 <sup>1</sup> / <sub>16</sub>	174,6	8	<sup>7</sup> / <sub>8</sub>	26	+ 2	150	152
65	2 <sup>9</sup> / <sub>16</sub>	200,0	8	1	29	+ 2	170	153
78	3 <sup>1</sup> / <sub>16</sub>	230,2	8	1 <sup>1</sup> / <sub>8</sub>	32	+ 2	190	154
103	4 <sup>1</sup> / <sub>16</sub>	290,5	8	1 <sup>3</sup> / <sub>8</sub>	39	+ 2	235	155

<sup>h</sup> Minimum bolt hole tolerance is – 0,5.

**Table 58 — Type 6BX blind and test flanges for 103,5 MPa  
and 138,0 MPa rated working pressures**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.
- b  $Q''_{\max} = E$  (Table 65).  
 $Q''_{\min} = 3 \text{ mm}$ .
- c Break sharp corners.
- d This bore is optional.
- e Top.
- f Test connection. See Figure 19.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

Table 58 (continued)

Dimensions in millimetres unless otherwise indicated

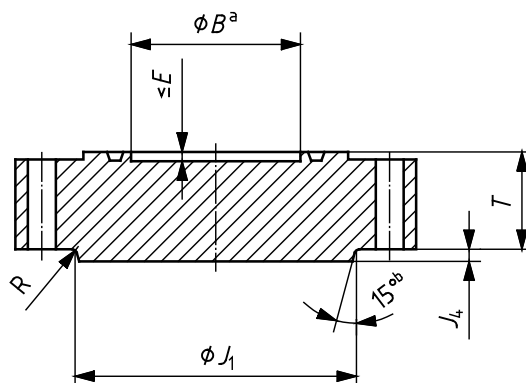
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange		Basic flange dimensions									
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
		<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 1,6	<i>T</i> +3 0	<i>J</i> <sub>1</sub> 0 -3	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
mm	(in)										
103,5 MPa											
130	5 1/8	131	420	± 2	3	225	98,5	244,5	200,0	81,8	16
138,0 MPa											
46	1 13/16	46,8	255	± 2	3	117	63,5	133,4	109,5	49,2	10
52	2 1/16	53,2	285	± 2	3	132	71,4	154,0	127,0	52,4	10
65	2 9/16	65,9	325	± 2	3	151	79,4	173,0	144,5	58,7	10
78	3 1/16	78,6	355	± 2	3	171	85,7	192,1	160,3	63,5	10
103	4 1/16	104,0	445	± 2	3	219	106,4	242,9	206,4	73,0	10

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Nominal size and bore of flange		Bolting dimensions						
		Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
		<i>BC</i>		(in)	diameter	tol. <sup>9</sup>	<i>L</i> <sub>ssb</sub>	BX
mm	(in)							
103,5 MPa								
130	5 1/8	342,9	12	1 1/2	42	+ 2,5	290	169
138,0 MPa								
46	1 13/16	203,2	8	1	29	+ 2	190	151
52	2 1/16	230,2	8	1 1/8	32	+ 2	210	152
65	2 9/16	261,9	8	1 1/4	35	+ 2	235	153
78	3 1/16	287,3	8	1 3/8	39	+ 2	255	154
103	4 1/16	357,2	8	1 3/4	48	+ 2,5	310	155

<sup>9</sup> Minimum bolt hole tolerance is – 0,5.

**Table 59 — Type 6BX blind flanges for 13,8 MPa; 20,7 MPa; 34,5 MPa;  
69,0 MPa; 103,5 MPa and 138,0 MPa rated working pressures**  
(see Annex B for USC units)



- <sup>a</sup> Counter-bore.  
<sup>b</sup> Maximum slope.

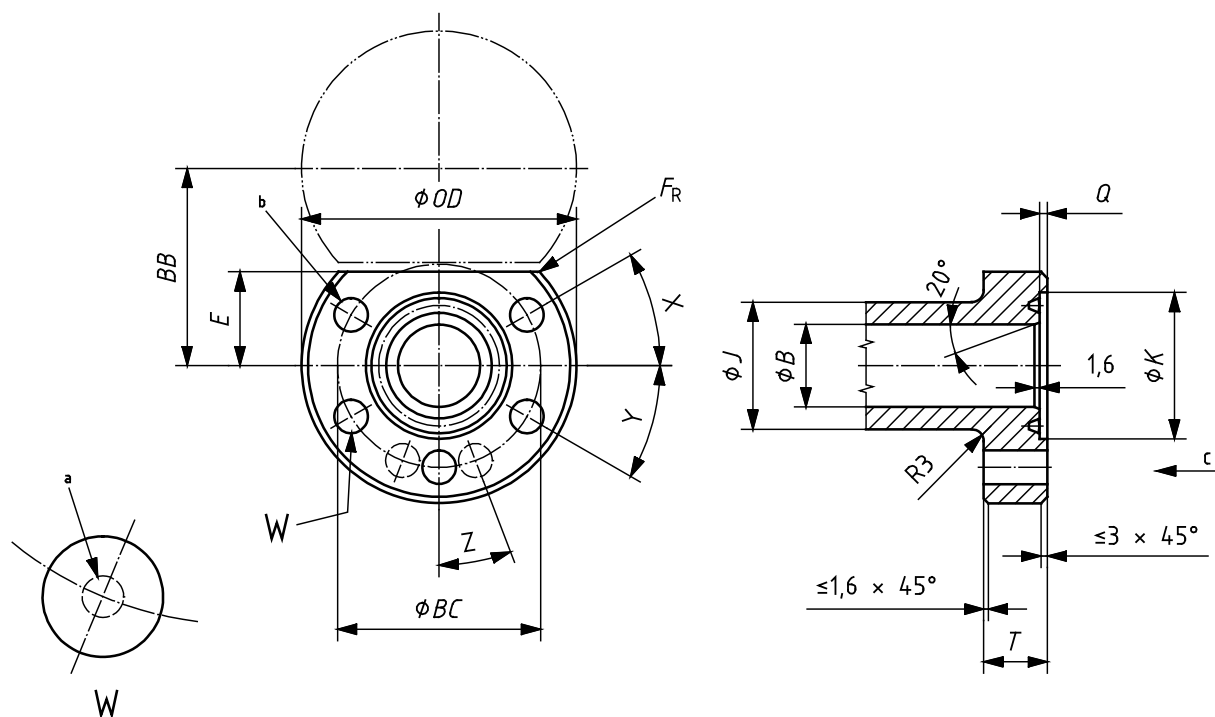
**Table 59** (continued)

Dimensions in millimetres unless otherwise indicated

Nominal size of flange		Flange thickness	Hub diameter	Counter-bore depth	Added hub thickness
$B$		$T$	$J_1$	$E$	$J_4$
mm	(in)	$+3$ 0	0 -3		min.
<b>13,8 MPa</b>					
679	26 <sup>3</sup> / <sub>4</sub>	126,3	835,8	21,4	9,7
762	30	134,2	931,9	23,0	17,5
<b>20,7 MPa</b>					
679	26 <sup>3</sup> / <sub>4</sub>	161,2	870,0	21,4	0
762	30	167,1	970,0	23,0	12,7
<b>34,5 MPa</b>					
346	13 <sup>5</sup> / <sub>8</sub>	112,8	481,1	14,3	23,9
425	16 <sup>3</sup> / <sub>4</sub>	130,2	555,8	8,3	17,5
476	18 <sup>3</sup> / <sub>4</sub>	165,9	674,7	18,3	19,1
540	21 <sup>1</sup> / <sub>4</sub>	181,0	758,8	19,1	22,4
<b>69,0 MPa</b>					
130	5 <sup>1</sup> / <sub>8</sub>	79,4	223,8	9,5	6,4
179	7 <sup>1</sup> / <sub>16</sub>	103,2	301,8	11,1	9,7
228	9	123,9	374,7	12,7	9,7
279	11	141,3	450,9	14,3	14,2
346	13 <sup>5</sup> / <sub>8</sub>	168,3	552,5	15,9	17,5
425	16 <sup>3</sup> / <sub>4</sub>	168,3	655,6	8,3	30,2
476	18 <sup>3</sup> / <sub>4</sub>	223,1	752,3	18,3	25,4
540	21 <sup>1</sup> / <sub>4</sub>	241,3	847,9	19,1	31,8
<b>103,5 MPa</b>					
130	5 <sup>1</sup> / <sub>8</sub>	98,5	244,5	9,5	6,4
179	7 <sup>1</sup> / <sub>16</sub>	119,1	325,4	11,1	7,9
228	9	146,1	431,8	12,7	14,2
279	11	187,4	584,2	14,3	12,7
346	13 <sup>5</sup> / <sub>8</sub>	204,8	595,3	15,9	17,5
476	18 <sup>3</sup> / <sub>4</sub>	255,6	812,8	18,3	35,1
<b>138,0 MPa</b>					
179	7 <sup>1</sup> / <sub>16</sub>	165,1	385,8	11,1	7,9
228	9	204,8	481,1	12,7	6,4
279	11	223,9	566,7	14,3	12,7
346	13 <sup>5</sup> / <sub>8</sub>	292,1	693,7	15,9	14,2
NOTE For dimensions not listed, see Tables 53 to 58, as applicable.					

**Table 60 — Dimensions for 34,5 MPa rated working pressure,  
segmented flanges for dual completion**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- a Bolt hole centreline located within 0,8 mm of theoretical  $BC$  and equal spacing.
- b Bolt holes:  $L$ ,  $M$ .
- c Top.

Ring groove shall be concentric with bore within 0,25 total indicator runout.

Table 60 (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Nominal size and bore of flange		Basic flange dimensions										
		Maximum bore	Outside diameter of flange		Total thickness of flange	Distance flat to centre	Minimum radius	Diameter of hub		Diameter of counter-bore	Depth of counter-bore	Ring number
mm	(in)	<i>B</i>	<i>OD</i>	tol.	<i>T</i> +3 0	<i>E</i> − 0,5	<i>F</i> <sub>R</sub>	<i>J</i>	tol.	<i>K</i>	<i>Q</i> + 0,25	RX
35	1 3⁄8	35,3	130	± 2	39,7	29,5	6	56,4	− 0,5	52,4	2,77	201
46	1 13⁄16	46,4	155	± 2	52,4	34,9	3	69,8	− 0,5	66,7	1,83	205
52	2 1⁄16	53,2	165	± 2	54,0	44,4	3	77,0	− 0,8	79,4	3,68	20
65	2 9⁄16	65,9	215	± 2	63,5	56,4	3	93,7	− 0,8	101,6	3,68	210
78	3 1⁄8	80,2	230	± 2	69,9	63,5	3	114,3	− 0,8	115,9	3,30	25
103	4 1⁄16	104,0	270	± 2	69,9	74,6	25	133,4	− 0,8	144,5	5,33	215
103 ´ 108	4 1⁄16 ´ 4 1⁄4	108,7	270	± 2	69,9	74,6	25	133,4	− 0,8	144,5	5,33	215

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Nominal size and bore of flange		Bolting dimensions										
		Diameter of bolt circle	Diameter of bolt holes		Number of bolt holes	Degrees	Degrees	Degrees	Diameter of bolt	Length of double- ended stud bolt	Length of threaded stud bolt	Bore- to-bore equal size
		mm	(in)	BC	L	tol. <sup>d</sup>	M	X	Y	Z	(in)	BB
35	1 3/8	98,4	16	+ 2	5	13	38,5	—	1/2	70	115	—
46	1 13/16	117,5	20	+ 2	5	16	37	—	5/8	90	145	70,64
52	2 1/16	130,2	23	+ 2	5	19	35,5	—	3/4	95	150	90,09
65	2 9/16	161,9	29	+ 2	5	21	34,5	—	1	120	185	114,30
78	3 1/8	179,4	29	+ 2	5	23	33,5	—	1	125	195	128,19
103	4 1/16	206,4	32	+ 2	6	28,5	19	23,5	1 1/8	135	210	—
103 ´ 108	4 1/16 ´ 4 1/4	206,4	32	+ 2	6	28,5	19	23,5	1 1/8	135	210	—

<sup>d</sup> Minimum bolt hole tolerance is − 0,5.

## 10.2 Threaded end and outlet connections

### 10.2.1 General

The requirements for integral equipment end and outlet connections, including tubing and casing hangers, apply only to those which are threaded according to API Spec 5B. Other loose threaded end and outlet connections are not covered by this International Standard.

### 10.2.2 Design

#### 10.2.2.1 General

Internal and external thread dimensions and tolerances shall conform with API Spec 5B or ASME B1.20.1 if applicable; see 10.2.2.3.

The following apply:

a) thread lengths:

The length of internal threads shall not be less than the effective thread length,  $L_2$ , of the external thread as specified in the figure belonging to Table 61\* and as stipulated in API Spec 5B.

b) internal and external NPT threads meeting the requirements of ASME B1.20.1:

Pipe threads, general-purpose (inch), may be used for line-pipe thread sizes 38 mm (1 1/2 inch) and smaller.

**NOTE** While line-pipe threads in accordance with API Spec 5B and NPT threads are basically interchangeable, the slight variation in thread form can increase wear and tendency for galling after several make-ups.

#### 10.2.2.2 Thread clearance

A clearance of minimum length,  $J$ , as illustrated in API Spec 5B, shall be provided on all internal threaded equipment.

#### 10.2.2.3 Thread counter-bores

End and outlet connections, equipped with internal threads, may be supplied with or without a thread-entrance counter-bore. Internal threads, furnished without a counter-bore, should have the outer angles of 45° to a minimum depth of  $P/2$ , as illustrated in the figure belonging to Table 61\* and Figure 10. Internal threads, furnished with a counter-bore, should conform to the counter-bore dimensions specified in Table 61\* and the bottom of the counter-bore should be chamfered at an angle of 45°. As an alternative, counter-bore dimensions may be as specified in API Spec 5B.

#### 10.2.2.4 Thread alignment

Threads shall align with the axis of the end connection within a tolerance of  $\pm 5,0$  mm/m ( $\pm 0,06$  in/ft) or 0,3° of the projected axis.

#### 10.2.2.5 End/outlet coupling diameter

The outlet coupling diameter shall be of sufficient diameter to provide for the structural integrity of the threaded part at the rated pressure. This diameter shall not be less than the tabulated joint or coupling diameter for the specified thread.

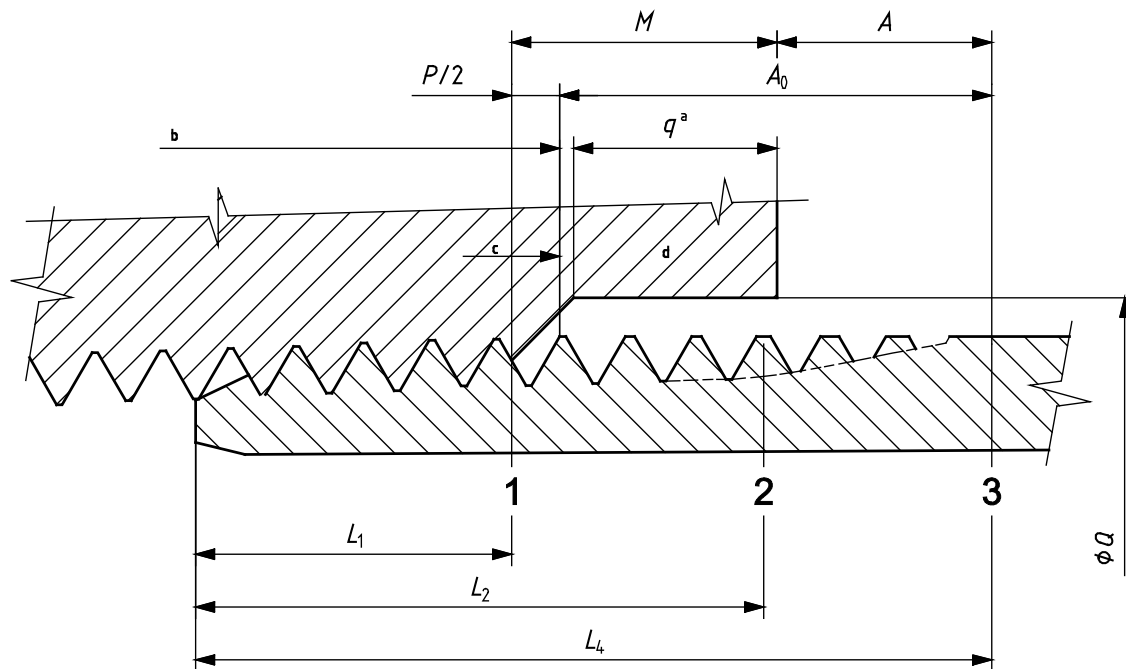
### 10.2.3 Testing (gauging)

Thread gauges shall comply with the requirements for working gauges as stipulated in API Spec 5B. Threads shall be gauged for stand-off at hand-tight assembly. For threads manufactured in accordance with this International Standard, use gauging practices as illustrated in Figures 10, 11 and 12. For threads manufactured in accordance with API Spec 5B, use gauging practices as specified in API Spec 5B.

### 10.2.4 Marking

Threaded connectors shall be marked in accordance with Clause 8.

**Table 61 — Pipe thread counter-bore and stand-off dimensions**  
(see Annex B for USC units)



#### Key

- 1 plane of hand-tight engagement
- 2 plane of effective thread length
- 3 plane of vanish point
- a See 10.2.2.3.
- b Internal thread length.
- c Without counter-bore.
- d With counter-bore.

NOTE See API Spec 5B for dimensions  $L_1$ ,  $L_2$  and  $L_4$ .

**Table 61** (continued)

Dimensions in millimetres unless otherwise indicated

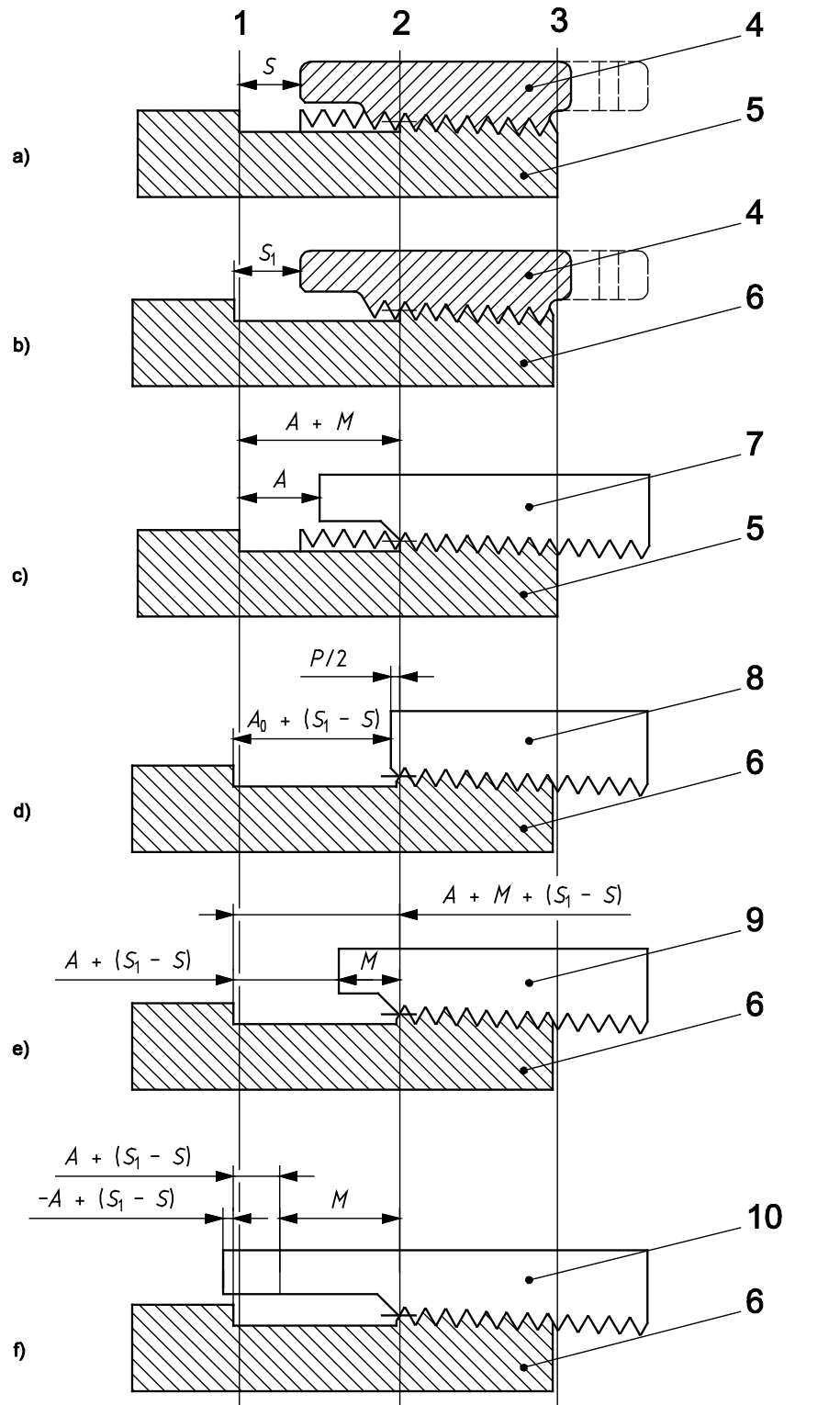
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nominal thread size	Length: plane of vanish point to hand-tight plane	Hand-tight standoff		Length: face of counter- bore to hand- tight plane	Counter-bore	
		Thread without counter-bore	Thread with shallow counter-bore		Diameter	Depth
(in)	$A + M$	$A_0$	$A$	$M$	$Q$	$q$
<b>Line-pipe threads</b>						
$\frac{1}{8}$	5,40	4,93	1,01	4,38	11,9	3,3
$\frac{1}{4}$	10,02	9,32	5,45	4,57	15,2	3,3
$\frac{3}{8}$	9,16	8,45	4,55	4,61	18,8	3,3
$\frac{1}{2}$	11,72	10,82	3,45	8,28	23,6	6,4
$\frac{3}{4}$	11,54	10,64	3,27	8,27	29,0	6,4
1	14,85	13,74	6,32	8,53	35,8	6,4
$1 \frac{1}{4}$	14,95	13,84	6,48	8,47	44,5	6,4
$1 \frac{1}{2}$	15,37	14,27	6,89	8,48	50,5	6,4
2	15,80	14,70	6,87	8,94	63,5	6,4
$2 \frac{1}{2}$	22,59	21,00	10,04	12,55	76,2	9,7
3	22,04	20,45	9,45	12,59	92,2	9,7
$3 \frac{1}{2}$	21,91	20,33	9,32	12,59	104,9	9,7
4	22,60	21,01	9,99	12,61	117,6	9,7
5	22,94	21,35	10,35	12,58	144,5	9,7
6	25,10	23,51	12,48	12,62	171,5	9,7
8	27,51	25,93	14,81	12,70	222,3	9,7
10	29,18	27,59	16,36	12,81	276,4	9,7
12	30,45	28,86	16,83	13,62	328,7	9,7
14D	28,49	26,90	14,94	13,56	360,4	9,7
16D	27,22	25,63	13,71	13,52	411,2	9,7
18D	27,53	25,94	14,00	13,53	462,0	9,7
20D	29,43	27,84	15,85	13,58	512,8	9,7

Table 61 (continued)

Dimensions in millimetres unless otherwise indicated

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nominal thread size	Length: plane of vanish point to hand- tight plane	Hand-tight standoff		Length: face of counter- bore to hand- tight plane	Counter-bore	
		Thread without counter-bore	Thread with shallow counter-bore		Diameter	Depth
(in)	$A + M$	$A_0$	$A$	$M$	$Q$	$q$
Long and short casing threads						
4 <sup>1</sup> / <sub>2</sub>	27,41	25,82	15,00	12,40	117,6	9,7
5	27,41	25,82	15,00	12,40	130,3	9,7
5 <sup>1</sup> / <sub>2</sub>	27,41	25,82	15,00	12,40	143,0	9,7
6 <sup>5</sup> / <sub>8</sub>	27,41	25,82	15,07	12,34	171,5	9,7
7	27,41	25,82	15,00	12,40	181,1	9,7
7 <sup>5</sup> / <sub>8</sub>	29,11	27,52	16,72	12,39	196,9	9,7
8 <sup>5</sup> / <sub>8</sub>	29,11	27,52	16,72	12,39	222,3	9,7
9 <sup>5</sup> / <sub>8</sub>	29,11	27,52	16,72	12,39	247,7	9,7
10 <sup>3</sup> / <sub>4</sub> <sup>e</sup>	29,11	27,52	16,65	12,46	276,4	9,7
11 <sup>3</sup> / <sub>4</sub> <sup>e</sup>	29,11	27,52	16,65	12,46	301,8	9,7
13 <sup>3</sup> / <sub>8</sub> <sup>e</sup>	29,11	27,52	15,95	13,15	344,4	9,7
16 <sup>e</sup>	29,11	27,52	15,89	13,22	411,2	9,7
20 <sup>e</sup>	29,11	27,52	15,89	13,22	512,8	9,7
Non-upset tubing threads						
1,050	16,41	15,14	8,13	8,28	29,0	6,4
1,315	16,41	15,14	8,07	8,34	35,8	6,4
1,660	16,41	15,14	8,13	8,28	44,5	6,4
1,900	16,41	15,14	8,13	8,28	50,5	6,4
2 <sup>3</sup> / <sub>8</sub>	16,41	15,14	7,69	8,72	63,5	6,4
2 <sup>7</sup> / <sub>8</sub>	16,41	15,14	4,51	11,90	76,2	9,7
3 <sup>1</sup> / <sub>2</sub>	16,41	15,14	4,45	11,96	92,2	9,7
4	19,91	18,33	7,65	12,27	104,9	9,7
4 <sup>1</sup> / <sub>2</sub>	19,91	18,33	7,65	12,27	117,6	9,7
External upset tubing threads						
1,050	16,41	15,14	8,07	8,34	35,8	6,4
1,315	16,41	15,14	7,99	8,42	39,9	6,4
1,660	16,41	15,14	8,04	8,37	48,5	6,4
1,900	16,41	15,14	8,05	8,36	55,6	6,4
2 <sup>3</sup> / <sub>8</sub>	19,91	18,33	10,87	9,04	69,1	6,4
2 <sup>7</sup> / <sub>8</sub>	19,91	18,33	7,69	12,22	81,8	9,7
3 <sup>1</sup> / <sub>2</sub>	19,91	18,33	7,65	12,27	98,6	9,7
4	19,91	18,33	7,65	12,27	111,3	9,7
4 <sup>1</sup> / <sub>2</sub>	19,91	18,33	7,65	12,27	124,0	9,7
<sup>e</sup> Short casing threads only (long casing threads not covered).						

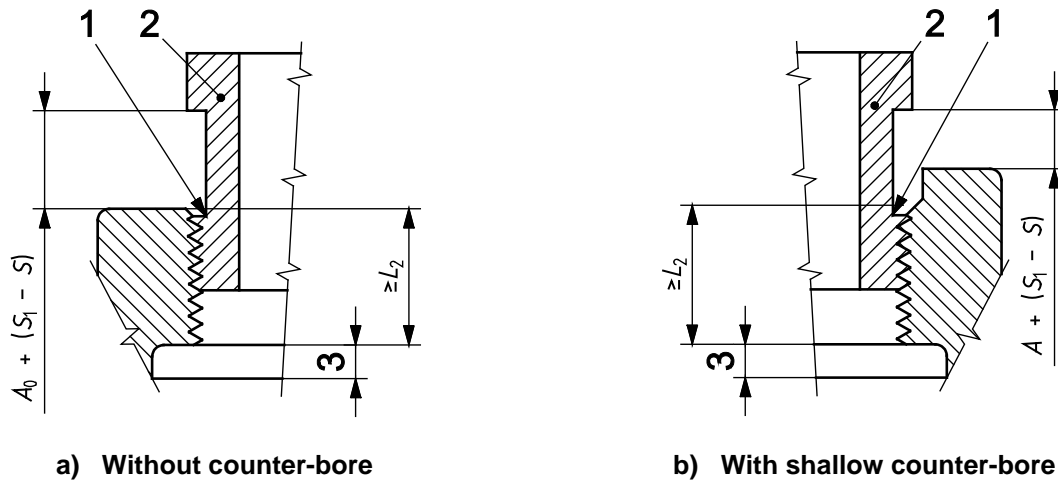
<sup>e</sup> Short casing threads only (long casing threads not covered).

**Key**

- |   |  |
|---|--|
| 1 plane of vanish point                 | 6 working plug gauge                       |
| 2 plane of hand-tight engagement        | 7 product thread                           |
| 3 plane of end of pipe                  | 8 product thread without counter-bore      |
| 4 certified reference master ring gauge | 9 product thread with shallow counter-bore |
| 5 certified reference master plug gauge | 10 product thread with deep counter-bore   |

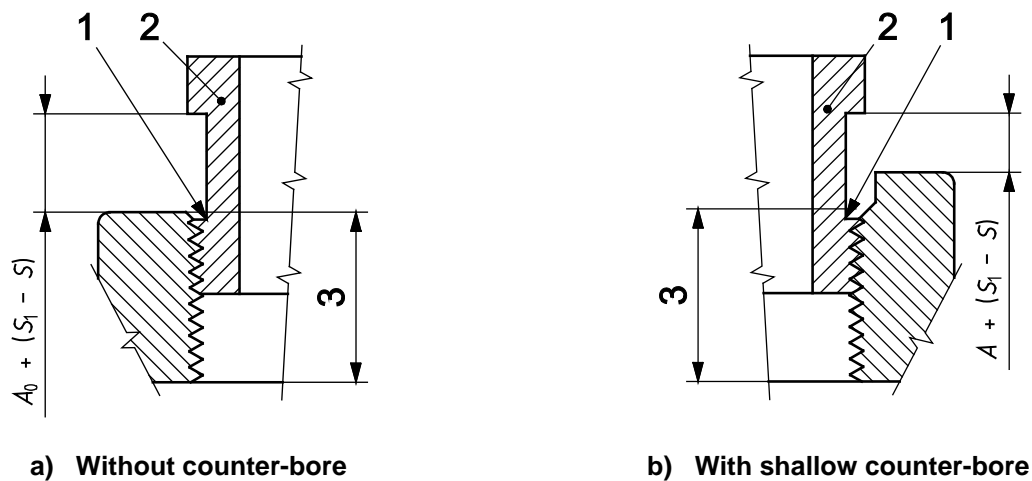
NOTE See API Spec 5B for dimensions of  $S$  and  $S_1$ .

**Figure 10 — Gauging practice for line-pipe, casing and tubing internal threads, hand-tight assembly**

**Key**

- 1 gauge notch in alignment with bottom of chamfer, within tolerance
- 2 working plug gauge
- 3 recess clearance

**Figure 11 — Application of working plug gauge to valve and fitting threads having internal recess clearance**

**Key**

- 1 gauge notch in alignment with bottom of chamfer, within tolerance
- 2 working plug gauge
- 3  $L_2$  (min.) plus thread clearance

**Figure 12 — Application of working plug gauge to valve and fitting threads having thread clearance**

## 10.3 Studs and nuts

### 10.3.1 General

The requirements for studs and nuts apply only to those used to connect end and outlet flanges and studded connections as specified in 10.1. For calculation of bolt length, see Annex C, and for flange bolt torques, see Annex D.

### 10.3.2 Design

The requirements for studs and nuts are shown in Table 62. Studs and nuts shall meet the requirements of the applicable ASTM specification, unless otherwise indicated. Dimensions and thread pitch shall be in accordance with ASTM A193/A193M for studs and ASTM A194/A194M for nuts. The mechanical properties specified in Table 62 take precedence over those required by ASTM.

### 10.3.3 Materials

#### 10.3.3.1 General

Bolting shall meet the requirements of the applicable ASTM specifications as shown in Table 62. Alternative materials may be used, provided the mechanical properties meet the requirements shown in Table 62.

The following apply:

- a) yield strength:

Yield strength shall meet or exceed the minimum requirements shown in Table 62.

- b) size limitations:

The material size limitations specified in ASTM A320/A320M for grade L7M may be exceeded if the material requirements are met.

#### 10.3.3.2 Exposed bolting

The following apply:

- a) for ASTM A453/A453M grade 660:

ASTM A453/A453M grade 660 solution-treated and age-hardened is acceptable at a hardness of HRC 35 and lower, and a minimum 0,2 % offset yield strength of 725 MPa (105 000 psi) for diameters up to 63,5 mm (2,5 in) or 655 MPa (95 000 psi) for larger sizes. Environmental and material limits specified in ISO 15156 (all parts) (NACE MR0175; see Clause 2) shall apply.

- b) for CRA materials:

CRA materials may be used, provided they satisfy the minimum mechanical requirements of ASTM A453/A453M grade 660 bolting, except that the maximum hardness shall meet ISO 15156 (all parts) (NACE MR0175; see Clause 2) requirements.

NOTE Some materials can be susceptible to environmentally assisted cracking.

Bolting used with insulated flanges in sour service shall satisfy the requirements of 10.3.3.3.

### 10.3.3.3 Exposed bolting (low-strength)

The following apply:

- a) for ASTM A193/A193M grade B7M:

ASTM A 193/A193M grade B7M is acceptable at a minimum 0,2 % offset yield strength of 550 MPa (80 000 psi) for the flanges listed in Table 62 for ISO 15156 (all parts) (NACE MR0175; see Clause 2) exposed bolting (low-strength) only.

- b) for ASTM A320/A320M grade L7M:

ASTM A320/A320M grade L7M is acceptable at a minimum 0,2 % offset yield strength of 550 MPa (80 000 psi) for the flanges listed in Table 62 for ISO 15156 (all parts) (NACE MR0175; see Clause 2) exposed bolting (low-strength) only.

### 10.3.3.4 Non-exposed bolting

The following apply:

- a) for ASTM A193/A193M Grade B7:

ASTM A193/A193M grade B7 is acceptable for non-exposed service for the flanges listed in Table 62 for ISO 15156 (all parts) (NACE MR0175; see Clause 2) non-exposed bolting only.

- b) for ASTM A 320/A320M grade L7 or L43:

ASTM A 320/A320M grade L7 or L43 is acceptable for non-exposed service for the flanges listed in Table 62 for ISO 15156 (all parts) (NACE MR0175; see Clause 2) non-exposed bolting only.

### 10.3.3.5 Exposed nuts

The following apply:

- a) for ASTM A194/A194M grade 2HM:

ASTM A194/A194M grade 2HM is acceptable for all flange sizes and rated working pressures.

- b) for ISO 15156 (all parts) (NACE MR0175; see Clause 2) exposed bolting:

ASTM A453/A453M grade 660 or CRA nuts may be used with ISO 15156 (all parts) (NACE MR0175; see Clause 2) exposed bolting only if provisions are made to prevent galling.

**Table 62 — Bolting requirements for end flanges**

Requirement	Material class						
	AA, BB or CC		DD, EE, FF and HH				
	Temperature rating						
	P, S, T or U	K, L, P, S, T or U	P, S, T or U	K, L, P, S, T or U	P, S, T or U	K, L, P, S, T or U	K, L, P, S, T or U
ISO 15156 (all parts) (NACE MR0175; see Clause 2) Size and rated working pressure	NA	NA	Non-exposed	Non-exposed	Exposed (low-strength)		Exposed
	All	All	All	All	All 13,8 and 20,7 MPa flgs. 34,5 MPa flgs. < 13 <sup>5</sup> / <sub>8</sub> 69,0 MPa flgs. < 4 <sup>1</sup> / <sub>16</sub> 103,5 MPa flgs. for 1 <sup>13</sup> / <sub>16</sub> and 5 <sup>1</sup> / <sub>8</sub> only All 138,0 MPa flgs.		All
Bolting							
ASTM spec. grades and materials	A193/A193M GR B7	A320/A320M GR L7 or L43	A193/A193M GR B7	A320/A320M GR L7 or L43	A193/A193M GR B7M	A320/A320M GR L7M	A453/A453M GR 660 (see 10.3.3.2) or CRA
0,2 % offset yield strength MPa minimum	725 (≤ 63,5 mm) 655 (> 63,5 mm)	725 (≤ 63,5 mm) 655 (> 63,5 mm)	725 (≤ 63,5 mm) 655 (> 63,5 mm)	725 (≤ 63,5 mm) 655 (> 63,5 mm)	550	550	725 (≤ 63,5 mm) 655 (> 63,5 mm)
0,2 % offset yield strength (ksi) minimum	105 (≤ 2,5 in) 95 (> 2,5 in)	105 (≤ 2,5 in) 95 (> 2,5 in)	105 (≤ 2,5 in) 95 (> 2,5 in)	105 (≤ 2,5 in) 95 (> 2,5 in)	80	80	105 (≤ 2,5 in) 95 (> 2,5 in)
Hardness as per ISO 15156 (all parts) (NACE MR0175; see Clause 2)	No	No	No	No	Yes	Yes	Yes
Charpy testing required	No	Yes	No	Yes	No	Yes	No
Nuts							
ASTM spec. and grades, heavy	A194/A194M 2H, 2HM, 4 or 7	A194/A194M 2H, 2HM, 4 or 7	A194/AA194M 2H, 2HM, 4 or 7	A194/A194M 2H, 2HM, 4 or 7	A194/A194M GR 2HM	A194/A194M GR 2HM	A194/A194M GR 2HM
Hardness as per ISO 15156 (all parts) (NACE MR0175; see Clause 2)	No	No	No	No	Yes	Yes	Yes
Charpy testing required	No	No	No	No	No	No	No

## 10.4 Ring gaskets

### 10.4.1 General

Types R or RX gaskets shall be used on 6B flanges. Only BX gaskets shall be used with 6BX flanges.

NOTE RX and BX gaskets provide a pressure-energized seal but are not interchangeable. RX gaskets provide additional clearance between the flanges.

## 10.4.2 Design

### 10.4.2.1 Dimensions

Ring gaskets shall conform to the dimensions and tolerances specified in Tables 63\*, 64\* and 65\* and shall be flat within a tolerance of 0,2 % of ring outside diameter to a maximum of 0,38 mm (0,015 in).

### 10.4.2.2 R and RX gaskets

The following apply:

- a) for the surface finish:

All 23° surfaces on R and RX gaskets shall have a surface finish no rougher than 1,6  $\mu\text{m}$  *Ra* (63  $\mu\text{in}$  RMS).

- b) for the RX pressure-passage hole:

Certain size RX gaskets shall have one pressure-passage hole drilled through their height as shown in Table 64\*.

### 10.4.2.3 BX gaskets

The following apply:

- a) for the surface finish:

All 23° surfaces on BX gaskets shall have a surface finish no rougher than 0,8  $\mu\text{m}$  *Ra* (32  $\mu\text{in}$  RMS).

- b) for the pressure-passage hole:

Each BX gasket shall have one pressure-passage hole drilled through its height as shown in Table 65\*.

### 10.4.2.4 Re-use of gaskets

Ring gaskets have a limited amount of positive interference, which assures that the gaskets are coined into a sealing relationship in the grooves. These gaskets shall not be re-used.

## 10.4.3 Materials

The following apply:

- a) for the gasket material:

Gasket material shall conform to Clause 5.

- b) for the coatings and platings:

Coatings and platings may be employed to aid the seal engagement while minimizing galling, and to extend shelf life. Coating and plating thicknesses shall be 0,013 mm (0,000 5 in) maximum.

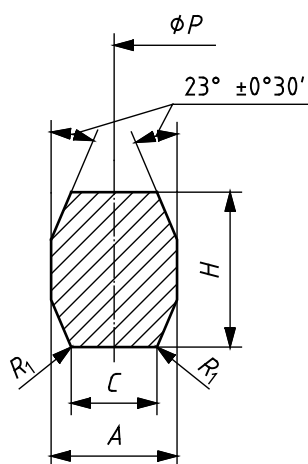
## 10.4.4 Marking

Gaskets shall be marked to conform to Clause 8.

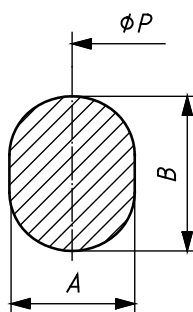
## 10.4.5 Storing and shipping

Gaskets shall be stored and shipped in accordance with Clause 9.

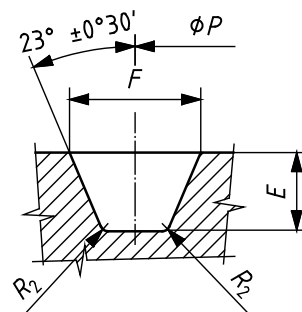
**Table 63 — Type R ring gaskets**  
(see Annex B for USC units)



**a) Octagonal**



**b) Oval**



**c) Groove**

Dimensions in millimetres

Ring number	Pitch diameter of ring (groove)	Width of ring	Height of oval ring	Height of octagonal ring	Width of flat of octagonal ring	Radius in octagonal ring	Depth of groove	Width of groove	Radius in groove	Approx. distance between made-up flanges
	$P$ $\pm 0,18$ ( $\pm 0,13$ ) <sup>a</sup>	$A$ $\pm 0,20$	$B$ $\pm 0,5$	$H$ $\pm 0,5$	$C$ $\pm 0,2$	$R_1$ $\pm 0,5$	$E$ $+0,5$ $0$	$F$ $\pm 0,20$	$R_2$ max.	$S$
R 20	68,28	7,95	14,3	12,7	5,23	1,5	6,4	8,74	0,8	4,1
R 23	82,55	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 24	95,25	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 26	101,60	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 27	107,95	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 31	123,83	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 35	136,53	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 37	149,23	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 39	161,93	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 41	180,98	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 44	193,68	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 45	211,15	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 46	211,15	12,70	19,1	17,5	8,66	1,5	9,7	13,49	1,5	4,8
R 47	228,60	19,05	25,4	23,9	12,32	1,5	12,7	19,84	1,5	4,1
R 49	269,88	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 50	269,88	15,88	22,4	20,6	10,49	1,5	11,2	16,66	1,5	4,1
R 53	323,85	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 54	323,85	15,88	22,4	20,6	10,49	1,5	11,2	16,66	1,5	4,1

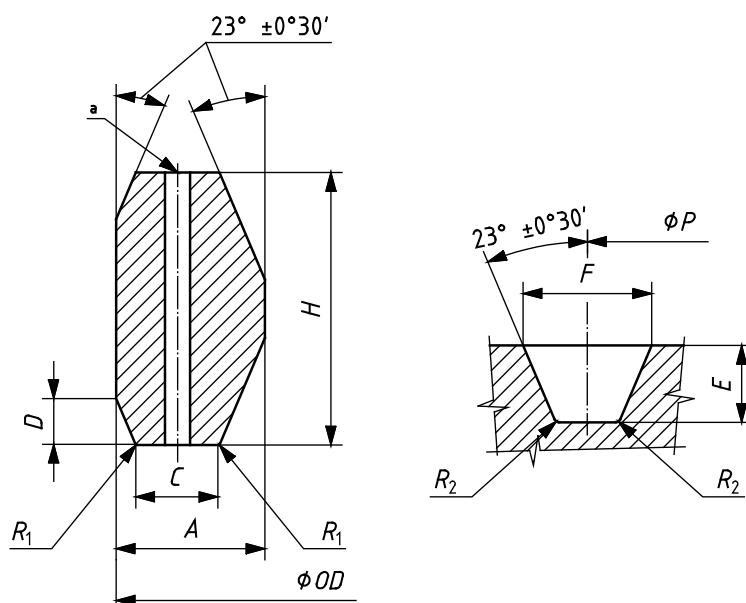
Table 63 (continued)

Dimensions in millimetres

Ring number	Pitch diameter of ring (groove)	Width of ring	Height of oval ring	Height of octagonal ring	Width of flat of octagonal ring	Radius in octagonal ring	Depth of groove	Width of groove	Radius in groove	Approx. distance between made-up flanges
	$P$ $\pm 0,18$ ( $\pm 0,13$ ) <sup>a</sup>	$A$ $\pm 0,20$	$B$ $\pm 0,5$	$H$ $\pm 0,5$	$C$ $\pm 0,2$	$R_1$ $\pm 0,5$	$E$ $+0,5$ $0$	$F$ $\pm 0,20$	$R_2$ max.	$S$
R 57	381,00	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 63	419,10	25,40	33,3	31,8	17,30	2,3	16,0	27,00	2,3	5,6
R 65	469,90	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 66	469,90	15,88	22,4	20,6	10,49	1,5	11,2	16,66	1,5	4,1
R 69	533,40	11,13	17,5	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 70	533,40	19,05	25,4	23,9	12,32	1,5	12,7	19,84	1,5	4,8
R 73	584,20	12,70	19,1	17,5	8,66	1,5	9,7	13,49	1,5	3,3
R 74	584,20	19,05	25,4	23,9	12,32	1,5	12,7	19,84	1,5	4,8
R 82	57,15	11,13	—	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 84	63,50	11,13	—	15,9	7,75	1,5	7,9	11,91	0,8	4,8
R 85	79,38	12,70	—	17,5	8,66	1,5	9,7	13,49	1,5	3,3
R 86	90,50	15,88	—	20,6	10,49	1,5	11,2	16,66	1,5	4,1
R 87	100,03	15,88	—	20,6	10,49	1,5	11,2	16,66	1,5	4,1
R 88	123,83	19,05	—	23,9	12,32	1,5	12,7	19,84	1,5	4,8
R 89	114,30	19,05	—	23,9	12,32	1,5	12,7	19,84	1,5	4,8
R 90	155,58	22,23	—	26,9	14,81	1,5	14,2	23,01	1,5	4,8
R 91	260,35	31,75	—	38,1	22,33	2,3	17,5	33,34	2,3	4,1
R 99	234,95	11,13	—	15,9	7,75	1,5	7,9	11,91	0,8	4,8

<sup>a</sup> The tolerance in brackets is the tolerance for the groove; the tolerance without the brackets is for the ring.

**Table 64 — Type RX pressure-energized ring gaskets**  
(see Annex B for USC units)



<sup>a</sup> The pressure-passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. The centreline of the hole shall be located at midpoint of dimension C. The hole diameter shall be 1,5 mm for rings RX-82 through RX-85, 2,4 mm for rings RX-86 and RX-87, and 3,0 mm for rings RX-88 through RX-91.

Dimensions in millimetres

Ring number	Pitch diameter of groove <i>P</i> ± 0,13	Outside diameter of ring <i>OD</i> +0,5 0	Width of ring <i>A</i> <sup>b</sup> +0,20 0	Width of flat <i>C</i> +0,15 0	Height of outside bevel <i>D</i> 0 -0,8	Height of ring <i>H</i> <sup>b</sup> +0,2 0	Radius in ring <i>R</i> <sub>1</sub> ± 0,5	Depth of groove <i>E</i> +0,5 0	Width of groove <i>F</i> ± 0,20	Radius in groove <i>R</i> <sub>2</sub> max.	Approx. distance between made-up flanges <i>S</i>
RX 20	68,26	76,20	8,74	4,62	3,18	19,05	1,5	6,4	8,74	0,8	9,7
RX 23	82,55	93,27	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 24	95,25	105,97	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 25	101,60	109,55	8,74	4,62	3,18	19,05	1,5	6,4	8,74	0,8	—
RX 26	101,60	111,91	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 27	107,95	118,26	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 31	123,83	134,54	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 35	136,53	147,24	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 37	149,23	159,94	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 39	161,93	172,64	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 41	180,98	191,69	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 44	193,68	204,39	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 45	211,15	221,84	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 46	211,15	222,25	13,49	6,68	4,78	28,58	1,5	9,7	13,49	1,5	11,9
RX 47	228,60	245,26	19,84	10,34	6,88	41,28	2,3	12,7	19,84	1,5	18,3
RX 49	269,88	280,59	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 50	269,88	283,36	16,66	8,51	5,28	31,75	1,5	11,2	16,66	1,5	11,9
RX 53	323,85	334,57	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 54	323,85	337,34	16,66	8,51	5,28	31,75	1,5	11,2	16,66	1,5	11,9
RX 57	381,00	391,72	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9

Table 64 (continued)

Dimensions in millimetres

Ring number	Pitch diameter of groove	Outside diameter of ring	Width of ring	Width of flat	Height of outside bevel	Height of ring	Radius in ring	Depth of groove	Width of groove	Radius in groove	Approx. distance between made-up flanges
	$P$ $\pm 0,13$	$OD$ $+0,5$ $0$	$A^b$ $+0,20$ $0$	$C$ $+0,15$ $0$	$D$ $0$ $-0,8$	$H^b$ $+0,2$ $0$	$R_1$ $\pm 0,5$	$E$ $+0,5$ $0$	$F$ $\pm 0,20$	$R_2$ max.	$S$
RX 63	419,10	441,73	27,00	14,78	8,46	50,80	2,3	16,0	27,00	2,3	21,3
RX 65	469,90	480,62	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 66	469,90	483,39	16,66	8,51	5,28	31,75	1,5	11,2	16,66	1,5	11,9
RX 69	533,40	544,12	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 70	533,40	550,06	19,84	10,34	6,88	41,28	2,3	12,7	19,84	1,5	18,3
RX 73	584,20	596,11	13,49	6,68	5,28	31,75	1,5	9,7	13,49	1,5	15,0
RX 74	584,20	600,86	19,84	10,34	6,88	41,28	2,3	12,7	19,84	1,5	18,3
RX 82	57,15	67,87	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 84	63,50	74,22	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 85	79,38	90,09	13,49	6,68	4,24	25,40	1,5	9,7	13,49	1,5	9,7
RX 86	90,50	103,58	15,09	8,51	4,78	28,58	1,5	11,2	16,66	1,5	9,7
RX 87	100,03	113,11	15,09	8,51	4,78	28,58	1,5	11,2	16,66	1,5	9,7
RX 88	123,83	139,29	17,48	10,34	5,28	31,75	1,5	12,7	19,84	1,5	9,7
RX 89	114,30	129,77	18,26	10,34	5,28	31,75	1,5	12,7	19,84	1,5	9,7
RX 90	155,58	174,63	19,84	12,17	7,42	44,45	2,3	14,2	23,02	1,5	18,3
RX 91	260,35	286,94	30,18	19,81	7,54	45,24	2,3	17,5	33,34	2,3	19,1
RX 99	234,95	245,67	11,91	6,45	4,24	25,40	1,5	7,9	11,91	0,8	11,9
RX 201	46,05	51,46	5,74	3,20	1,45 <sup>c</sup>	11,30	0,5 <sup>d</sup>	4,1	5,56	0,8	—
RX 205	57,15	62,31	5,56	3,05	1,83 <sup>c</sup>	11,10	0,5 <sup>d</sup>	4,1	5,56	0,5	—
RX 210	88,90	97,64	9,53	5,41	3,18 <sup>c</sup>	19,05	0,8 <sup>d</sup>	6,4	9,53	0,8	—
RX 215	130,18	140,89	11,91	5,33	4,24 <sup>c</sup>	25,40	1,5 <sup>d</sup>	7,9	11,91	0,8	—

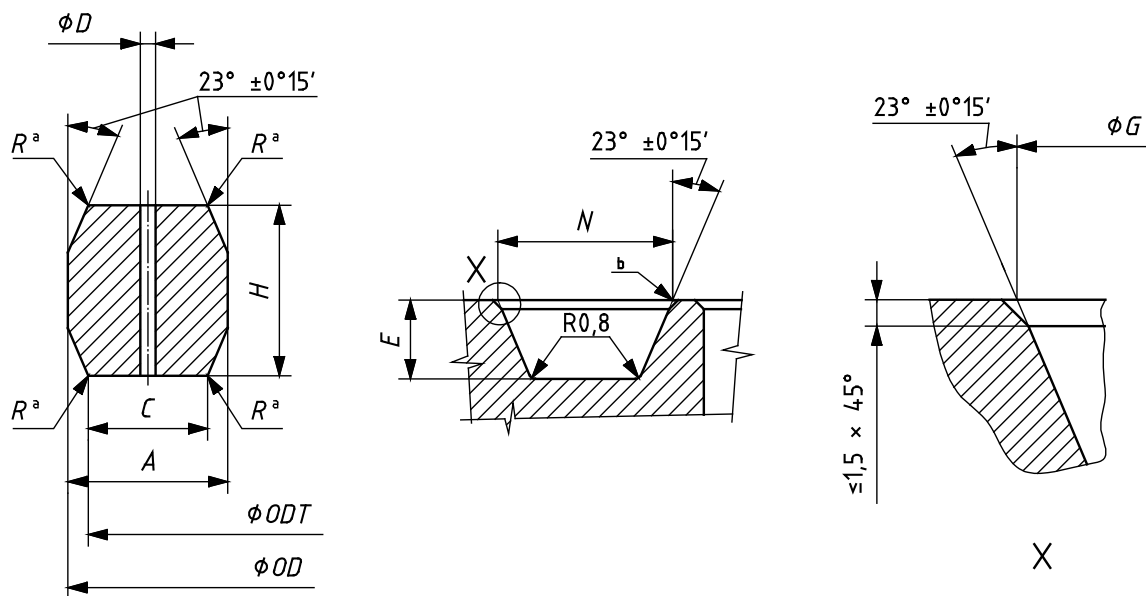
<sup>b</sup> A plus tolerance of 0,20 mm for width  $A$  and height  $H$  is permitted, provided the variation in width or height of any ring does not exceed 0,10 mm throughout its entire circumference.

<sup>c</sup> Tolerance on these dimensions is  $\begin{smallmatrix} 0 \\ -0,38 \end{smallmatrix}$ .

<sup>d</sup> Tolerance on these dimensions is  $\begin{smallmatrix} +0,5 \\ 0 \end{smallmatrix}$ .

**Table 65 — Type BX pressure-energized ring gaskets**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated



- <sup>a</sup> The radius,  $R$ , shall be 8 % to 12 % of the gasket height,  $H$ . One pressure-passage hole per gasket is required on centreline.
- <sup>b</sup> Break sharp corner on inside diameter of groove.

Table 65 (continued)

Dimensions in millimetres unless otherwise indicated

Ring number	Nominal size	Outside diameter of ring <i>OD</i> 0 -0,15	Height of ring <i>H<sup>c</sup></i> +0,2 0	Width of ring <i>A<sup>c</sup></i> +0,2 0	Diameter of flat <i>ODT</i> ± 0,05	Width of flat <i>C</i> +0,15 0	Hole size <i>D</i> ± 0,5	Depth of groove <i>E</i> +0,5 0	Outside diameter of groove <i>G</i> +0,1 0	Width of groove <i>N</i> +0,1 0
BX 150	43	72,19	9,30	9,30	70,87	7,98	1,6	5,56	73,48	11,43
BX 151	46	76,40	9,63	9,63	75,03	8,26	1,6	5,56	77,77	11,84
BX 152	52	84,68	10,24	10,24	83,24	8,79	1,6	5,95	86,23	12,65
BX 153	65	100,94	11,38	11,38	99,31	9,78	1,6	6,75	102,77	14,07
BX 154	78	116,84	12,40	12,40	115,09	10,64	1,6	7,54	119,00	15,39
BX 155	103	147,96	14,22	14,22	145,95	12,22	1,6	8,33	150,62	17,73
BX 156	179	237,92	18,62	18,62	235,28	15,98	3,2	11,11	241,83	23,39
BX 157	228	294,46	20,98	20,98	291,49	18,01	3,2	12,70	299,06	26,39
BX 158	279	352,04	23,14	23,14	348,77	19,86	3,2	14,29	357,23	29,18
BX 159	346	426,72	25,70	25,70	423,09	22,07	3,2	15,88	432,64	32,49
BX 160	346	402,59	23,83	13,74	399,21	10,36	3,2	14,29	408,00	19,96
BX 161	425	491,41	28,07	16,21	487,45	12,24	3,2	17,07	497,94	23,62
BX 162	425	475,49	14,22	14,22	473,48	12,22	1,6	8,33	478,33	17,91
BX 163	476	556,16	30,10	17,37	551,89	13,11	3,2	18,26	563,50	25,55
BX 164	476	570,56	30,10	24,59	566,29	20,32	3,2	18,26	577,90	32,77
BX 165	540	624,71	32,03	18,49	620,19	13,97	3,2	19,05	632,56	27,20
BX 166	540	640,03	32,03	26,14	635,51	21,62	3,2	19,05	647,88	34,87
BX 167	679	759,36	35,87	13,11	754,28	8,03	1,6	21,43	768,33	22,91
BX 168	679	765,25	35,87	16,05	760,17	10,97	1,6	21,43	774,22	25,86
BX 169	130	173,51	15,85	12,93	171,27	10,69	1,6	9,53	176,66	16,92
BX 170	228	218,03	14,22	14,22	216,03	12,22	1,6	8,33	220,88	17,91
BX 171	279	267,44	14,22	14,22	265,43	12,22	1,6	8,33	270,28	17,91
BX 172	346	333,07	14,22	14,22	331,06	12,22	1,6	8,33	335,92	17,91
BX 303	762	852,75	37,95	16,97	847,37	11,61	1,6	22,62	862,30	27,38

<sup>c</sup> A plus tolerance of 0,20 mm for width *A* and height *H* is permitted, provided the variation in width or height of any ring does not exceed 0,10 mm throughout its entire circumference.

## 10.5 Valves

### 10.5.1 General

The requirements stipulated in 10.5.2 to 10.5.7 are for valves including multiple, actuated shutoff and check valves, and for valves with rated working pressures equal to and greater than 13,8 MPa (2 000 psi). Valves shall meet all the requirements of Clause 4.

Valves may be used for well control, flowline control, repressuring and cycling services.

### 10.5.2 Performance requirements

Valves shall meet the general performance requirements of 4.1 when operating as indicated in Table 66. This includes manually actuated valves and valves designed for actuators.

**Table 66 — Operating cycle requirements for valves**

Performance requirement level	Operating cycles
PR1	3 cycles
PR2	200 cycles

### 10.5.3 Design

#### 10.5.3.1 Dimensions

The following apply:

a) nominal size:

Valves shall be identified by the nominal valve size in Tables 67\* through 72\*.

b) face-to-face dimensions:

1) general:

The face-to-face dimension is defined as the longest overall distance measured on the horizontal centreline of the valve between machined surfaces.

2) flanged valves:

Flanged face-to-face dimensions shall correspond to the dimensions shown in Tables 67\* through 72\*, as applicable.

3) valves with any other end connector:

There are no requirements for the face-to-face dimensions of these valves.

4) reduced-opening gate valve:

There are no requirements for face-to-face dimensions of reduced-opening gate valves.

c) full-bore valves:

All full-bore valves shall have round passageways (bores) through the bodies, seats, gates or plugs, and end connections. Body bore diameter shall conform to the bore dimensions given in Tables 67\* through 72\*. The bore diameter of seats, gates, plugs or other related internal parts shall have the same dimensions or larger.

### **10.5.3.2 End flanges**

Valve end flanges shall conform to the requirements of 10.1.

### **10.5.3.3 End threads**

Threaded valves shall have line-pipe, casing or tubing threads conforming to 10.2.

### **10.5.3.4 Threaded valve limitations**

Threaded valves shall be supplied only in sizes of 52 mm to 103 mm ( $2 \frac{1}{16}$  in to  $4 \frac{1}{16}$  in) and for rated working pressures of 13,8 MPa; 20,7 MPa and 34,5 MPa (2 000 psi; 3 000 psi and 5 000 psi) in accordance with 4.2.1.

### **10.5.3.5 Stuffing boxes**

Open slots in glands or stuffing box flanges are not permitted.

### **10.5.3.6 Repacking**

All gate valves shall be provided with a back seat or other means for repacking the stuffing box while the valve is in service and at the maximum pressure for which the valve is rated.

### **10.5.3.7 Direction of operation**

Mechanically operated valves shall be turned in the anti-clockwise direction to open and the clockwise direction to close.

### **10.5.3.8 Operating mechanisms**

Manually operated gate valves shall be supplied with a handwheel. Manually operated plug valves shall be furnished with a wrench- (or bar-) operated mechanism or with a handwheel-actuated gear mechanism. All handwheels shall be replaceable while in service.

### **10.5.3.9 Operating gears**

Design of the geared operating mechanism shall permit opening and closing of the valve at the maximum working pressure differential without aid of tools or bars.

### **10.5.3.10 Documentation**

Manufacturers shall document flow characteristics and pressure drop for reduced-opening valves.

### **10.5.3.11 Material**

The following apply:

- a) for body, bonnet, and end connectors:

Body, bonnet, and end-connector material shall comply with Clause 5.

- b) for other parts:

Materials for internal valve parts, such as gates, plugs, seats and stems, shall meet the requirements of Clause 5.

**10.5.3.12 Testing**

The following apply:

a) for drift test:

All assembled full-bore valves shall pass a drift test as described in 7.4.9.3.1.

b) for other testing:

All assembled valves shall successfully complete all applicable tests required and described in 7.4.9.

**10.5.3.13 Marking**

Valves shall be marked to conform to Clause 8.

**10.5.3.14 Storing and shipping**

All valves shall be stored and shipped in accordance with Clause 9.

**Table 67 — Flanged, gate, plug and ball valves for 13,8 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valve bore	Face-to-face valve length ± 2		
			Full-bore gate valves	Plug valves	
				Full-bore plug valves	Full-bore and reduced-opening ball valves
mm	(in)	+0,8 0			
52 ´ 46	2 <sup>1</sup> / <sub>16</sub> ´ 1 <sup>13</sup> / <sub>16</sub>	46,0	295	—	—
52	2 <sup>1</sup> / <sub>16</sub>	52,4	295	333	295
65	2 <sup>9</sup> / <sub>16</sub>	65,1	333	384	333
79	3 <sup>1</sup> / <sub>8</sub>	79,4	359	448	359
79 ´ 81	3 <sup>1</sup> / <sub>8</sub> ´ 3 <sup>3</sup> / <sub>16</sub>	81,0	359	448	—
103	4 <sup>1</sup> / <sub>16</sub>	103,2	435	511	435
103 ´ 105	4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>8</sub>	104,8	435	511	—
103 ´ 108	4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>4</sub>	108,0	435	511	—
130	5 <sup>1</sup> / <sub>8</sub>	130,2	562	638	—
179 ´ 152	7 <sup>1</sup> / <sub>16</sub> ´ 6	152,4	562	727	562
179 ´ 162	7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>3</sup> / <sub>8</sub>	161,9	562	—	—
179 ´ 168	7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>5</sup> / <sub>8</sub>	168,3	562	—	—
179	7 <sup>1</sup> / <sub>16</sub>	179,4	664	740	—
179 ´ 181	7 <sup>1</sup> / <sub>16</sub> ´ 7 <sup>1</sup> / <sub>8</sub>	181,0	664	740	—

**Table 68 — Flanged, gate, plug and ball valves for 20,7 MPa rated working pressure**

(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valve bore	Face-to-face valve length		
			± 2		
			Full-bore gate valves	Plug valves	
mm	(in)	+0,8 0		Full-bore plug valves	Full-bore and reduced-opening ball valves
52 ´ 46	2 1/16 ´ 1 13/16	46,0	371	—	—
52	2 1/16	52,4	371	384	371
65	2 9/16	65,1	422	435	422
79	3 1/8	79,4	435	473	384
79 ´ 81	3 1/8 ´ 3 3/16	81,0	435	473	—
103	4 1/16	103,2	511	562	460
103 ´ 105	4 1/16 ´ 4 1/8	104,8	511	562	—
103 ´ 108	4 1/16 ´ 4 1/4	108,0	511	562	—
130	5 1/8	130,2	613	664	—
179 ´ 152	7 1/16 ´ 6	152,4	613	765	613
179 ´ 162	7 1/16 ´ 6 3/8	161,9	613	—	—
179 ´ 168	7 1/16 ´ 6 5/8	168,3	613	—	—
179	7 1/16	179,4	714	803	—
179 ´ 181	7 1/16 ´ 7 1/8	181,0	714	803	—

**Table 69 — Flanged, gate, plug and ball valves for 34,5 MPa rated working pressure**

(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valve bore	Face-to-face valve length		
			± 2		
			Full-bore gate valves	Plug valves	
mm	(in)	+0,8 0		Full-bore plug valves	Full-bore and reduced-opening ball valves
52 ´ 46	2 1/16 ´ 1 13/16	46,0	371	—	—
52	2 1/16	52,4	371	394	371
65	2 9/16	65,1	422	457	473
79	3 1/8	79,4	473	527	473
79 ´ 81	3 1/8 ´ 3 3/16	81,0	473	527	—
103	4 1/16	103,2	549	629	549
103 ´ 105	4 1/16 ´ 4 1/8	104,8	549	629	—
103 ´ 108	4 1/16 ´ 4 1/4	108,0	549	629	—
130	5 1/8	130,2	727	—	—
179 ´ 130	7 1/16 ´ 5 1/8	130,2	737	—	—
179 ´ 152	7 1/16 ´ 6	152,4	737	—	711
179 ´ 155	7 1/16 ´ 6 1/8	155,6	737	—	—
179 ´ 162	7 1/16 ´ 6 3/8	161,9	737	—	—
179 ´ 168	7 1/16 ´ 6 5/8	168,3	737	—	—
179	7 1/16	179,4	813	978	—
179 ´ 181	7 1/16 ´ 7 1/8	181,0	813	978	—
228	9	228,6	1 041	—	—

**Table 70 — Flanged, gate, plug and ball valves for 69,0 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valves	
		Bore	Face-to-face valve length
mm	(in)	+0,8 0	± 2
46	1 <sup>13</sup> / <sub>16</sub>	46,0	464
52	2 <sup>1</sup> / <sub>16</sub>	52,4	521
65	2 <sup>9</sup> / <sub>16</sub>	65,1	565
78	3 <sup>1</sup> / <sub>16</sub>	77,8	619
103	4 <sup>1</sup> / <sub>16</sub>	103,2	670
130	5 <sup>1</sup> / <sub>8</sub>	130,2	737
179 - 162	7 <sup>1</sup> / <sub>16</sub> - 6 <sup>3</sup> / <sub>8</sub>	161,9	889
179	7 <sup>1</sup> / <sub>16</sub>	179,4	889

**Table 71 — Flanged plug and gate valves for 103,5 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valves	
		Bore	Face-to-face valve length
mm	(in)	+0,8 0	± 2
46	1 <sup>13</sup> / <sub>16</sub>	46,0	457
52	2 <sup>1</sup> / <sub>16</sub>	52,4	483
65	2 <sup>9</sup> / <sub>16</sub>	65,1	533
78	3 <sup>1</sup> / <sub>16</sub>	77,8	598
103	4 <sup>1</sup> / <sub>16</sub>	103,2	737
130	5 <sup>1</sup> / <sub>8</sub>	130,2 <sup>a</sup>	889

<sup>a</sup> Tolerance on 5 1/8 bore is <sup>+1,0</sup>/<sub>0</sub>.

**Table 72 — Flanged plug and gate valves for 138,0 MPa rated working pressure**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Full-bore valves	
		Bore	Face-to-face valve length
mm	(in)	+0,8 0	± 2
46	1 <sup>13</sup> / <sub>16</sub>	46,0	533
52	2 <sup>1</sup> / <sub>16</sub>	52,4	584
65	2 <sup>9</sup> / <sub>16</sub>	65,1	673
78	3 <sup>1</sup> / <sub>16</sub>	77,8	775

## **10.5.4 Multiple valves**

### **10.5.4.1 General**

Multiple valves are full-bore, gate or plug valves. They are used in dual, triple, quadruple and quintuple parallel-string completions for production well control, repressuring and cycling service.

### **10.5.4.2 Design**

#### **10.5.4.2.1 General**

Multiple valves are a composite arrangement of valves covered by 10.5.3. Multiple valves have the conduits of the several bores terminating in, and integral with or permanently attached to, single connectors at each end. Multiple valves shall meet all the design requirements of valves in 10.5.3, unless otherwise indicated.

#### **10.5.4.2.2 Dimensions**

The following apply:

a) valve size:

Tables 73\* and 74\* specify the maximum valve size for a given bore centre-to-centre, or flange centre to bore centre. Smaller nominal-sized valves may be furnished on the specified centre-to-centre. The flange shown is the minimum required for a specified centre-to-centre. A larger flange may be used.

b) end-to-end dimensions:

There are no end-to-end dimension requirements for multiple valves.

#### **10.5.4.2.3 Bore locations**

Dimensions are measured from end-connector centre.

Based on the centreline of the end connectors, the several bores of the multiple valve shall be located according to Tables 73\* and 74\*.

#### **10.5.4.2.4 End-connector size determination**

The end-connector size is determined by the nominal size of the tubing head or tubing-head adapter to which the lowermost tree valve is being attached.

#### **10.5.4.2.5 Bore seals**

This International Standard is not applicable to bore seals.

#### **10.5.4.2.6 Test port**

The lower end connector shall have a test port extending from a point on the connector face between the bore seals and end-connector seal to the OD of the connector. This test port shall be as specified in 4.4.4.

#### **10.5.4.2.7 Bolt-hole location for flanges**

A pair of bolt holes in both end flanges shall straddle the common centreline.

**10.5.4.2.8 Testing**

The following apply:

## a) drift test:

All assembled multiple valves shall pass a drift test as described in 7.4.9.3.1.

## b) other testing:

All assembled multiple valves shall successfully complete all applicable tests required by and described in 7.4.9.

**10.5.4.2.9 Marking**

Multiple valves shall be marked in accordance with Clause 8.

**10.5.4.2.10 Storing and shipping**

Multiple valves shall be stored and shipped in accordance with Clause 9.

**Table 73 — Centre distances of conduit bores for dual parallel bore valves  
for 13,8 MPa; 20,7 MPa; 34,5 MPa and 69,0 MPa rated working pressures  
(see Annex B for USC units)**

Dimensions in millimetres unless otherwise indicated

Maximum valve size		Bore centre to bore centre	Large-bore centre to end- connector centre	Small bore to end- connector centre	Minimum end- connector size	Basic casing size	
mm	(in)					OD	Lineic mass kg/m
13,8 MPa; 20,7 MPa and 34,5 MPa							
46	1 <sup>13</sup> / <sub>16</sub>	70,64	35,32	35,32	179	139,7	25
52	2 <sup>1</sup> / <sub>16</sub>	90,09	45,05	45,05	179	177,8	57
65 ´ 52	2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	90,09	41,91	48,18	179	177,8	43
65 ´ 52	2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	101,60	47,63	53,98	228	193,7	58
65	2 <sup>9</sup> / <sub>16</sub>	101,60	50,80	50,80	228	193,7	44
65	2 <sup>9</sup> / <sub>16</sub>	114,30	57,15	57,15	228	219,1	73
79 ´ 52	3 <sup>1</sup> / <sub>8</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	116,28	51,00	65,28	228	219,1	73
79 ´ 65	3 <sup>1</sup> / <sub>8</sub> ´ 2 <sup>9</sup> / <sub>16</sub>	128,19	64,10	64,10	279	244,5	80
79	3 <sup>1</sup> / <sub>8</sub>	128,19	64,10	64,10	279	244,5	80
69,0 MPa							
46	1 <sup>13</sup> / <sub>16</sub>	70,64	35,32	35,32	179	139,7	25
52	2 <sup>1</sup> / <sub>16</sub>	90,09	45,05	45,05	179	177,8	57
65 ´ 52	2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	90,09	41,91	48,18	179	177,8	43
65 ´ 52	2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	101,60	47,63	53,98	228	193,7	58
65	2 <sup>9</sup> / <sub>16</sub>	101,60	50,80	50,80	228	193,7	44
65	2 <sup>9</sup> / <sub>16</sub>	114,30	57,15	57,15	228	219,1	73
78	3 <sup>1</sup> / <sub>16</sub>	128,19	64,10	64,10	279	244,5	80

**Table 74 — Centre distances of conduit bores for triple, quadruple and quintuple parallel bore valves**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Maximum valve size mm	Nominal size (in)	Flange centre to bore centre	Minimum end-connector size	Basic casing size	
				OD	Lineic mass kg/m
13,8 MPa; 20,7 MPa and 34,5 MPa rated working pressures					
Triple valve					
1 <sup>13</sup> / <sub>16</sub>	46	47,63	179	168,3	35,7
2 <sup>1</sup> / <sub>16</sub>	52	49,21	228	177,8	38,7
2 <sup>1</sup> / <sub>16</sub>	52	53,98	228	193,7	58,0
2 <sup>9</sup> / <sub>16</sub>	65	71,44	279	244,5	79,6
Quadruple valve					
46	1 <sup>13</sup> / <sub>16</sub>	73,03	279	219,1	53,6
46	1 <sup>13</sup> / <sub>16</sub>	77,79	279	244,5	All
52	2 <sup>1</sup> / <sub>16</sub>	77,79	279	244,5	79,6
65	2 <sup>9</sup> / <sub>16</sub>	87,31	279	273,1	82,6
65	2 <sup>9</sup> / <sub>16</sub>	101,60	346	298,5	80,4
Quintuple valve					
52	2 <sup>1</sup> / <sub>16</sub>	77,79	279	244,5	79,6
69,0 MPa rated working pressure					
Triple valve					
46	1 <sup>13</sup> / <sub>16</sub>	47,63	179	168,3	35,7
52	2 <sup>1</sup> / <sub>16</sub>	49,21	228	177,8	38,7
52	2 <sup>1</sup> / <sub>16</sub>	53,98	228	193,7	58,0
65	2 <sup>9</sup> / <sub>16</sub>	71,44	279	244,5	79,6
Quadruple valve					
65	2 <sup>9</sup> / <sub>16</sub>	87,31	279	273,1	82,6

### 10.5.5 Actuated valves

The following apply:

a) general:

Actuated valves are provided with an actuator to automatically open or close the valve. Actuated valves can be flanged, threaded, or other end-connected, full-bore or reduced-opening, gate valves or plug type valves.

b) design:

Valves shall meet the requirements of 10.5.3. Actuators shall meet the requirements of 10.16.3.

c) material:

Material for actuated valves shall meet the requirements of Clause 5 or 10.16, as applicable.

d) testing:

Assembled actuated valves shall successfully complete all applicable tests required by and described in 7.4.9.

e) marking:

Actuated valves shall be marked in accordance with Clause 8.

f) storing and shipping:

Actuated valves shall be stored and shipped in accordance with Clause 9.

### **10.5.6 Valves prepared for actuators**

The following apply:

a) general:

Valves, including multiple, prepared for actuators shall include all parts required to properly function when assembled with the actuator. The valve bonnet assembly, including associated parts, such as stem and seals, shall be part of either the valve or actuator. The valve prepared for actuator, if assembled with the actuator, shall meet all the requirements of 10.5.5. Actuator specifications are contained in 10.16.

b) design:

Valves prepared for actuators shall meet the applicable requirements for actuated valves of 10.5.5.

c) material:

Valves prepared for actuators shall meet the requirements of 10.5.3.11.

d) testing:

Valves prepared for actuators shall successfully pass all tests specified in 7.4.9. If a bonnet assembly is not included with the valve as a unit, back-seat testing is not required, but shall be performed at assembly with the actuator. Required testing may be performed using the test fixtures in lieu of the bonnet and actuator.

e) marking:

Valves prepared for actuators shall be marked in accordance with Clause 8.

f) storage and shipping:

Valves prepared for actuators shall be stored and shipped in accordance with Clause 9.

### **10.5.7 Check valves**

#### **10.5.7.1 General**

Check valves are of the swing and lift check types. The valves may be full-opening or reduced-opening and are used to permit fluid flow in only one direction.

### **10.5.7.2 Design**

#### **10.5.7.2.1 General**

Check valves may be furnished in the following types:

- regular swing check; see Figure 13;
- full-opening swing check; see Figure 14;
- regular lift check; see Figure 15.

#### **10.5.7.2.2 Dimensions**

The following apply:

- a) nominal size:

Check valves shall be identified by the nominal valve size in column 2 of Tables 75\*, 76\*, 77, 78 and 79.

- b) face-to-face dimension:

The face-to-face dimension for flanged-end check valves shall correspond to the dimensions shown in Tables 75\*, 77, 78 and 79.

- c) bores, of the following types:

- full-opening:

All full-opening valves shall have round passageways through the body and seats. Bore diameter shall conform to the bore dimensions given in Table 76\*.

- reduced-opening:

Regular-lift and swing check valves are customarily made with reduced bores through the seat and are sized at the option of the manufacturer.

#### **10.5.7.2.3 End flanges**

Valve end flanges shall conform to the requirements of 10.1.

#### **10.5.7.2.4 Reduced-opening valves**

For reduced-opening valves, manufacturers shall document flow characteristics and pressure drop.

### **10.5.7.3 Material**

All material shall be in accordance with Clause 5.

#### **10.5.7.4 Testing-**

The following apply:

- a) drift test:

Check valves do not require a drift test.

- b) other testing:

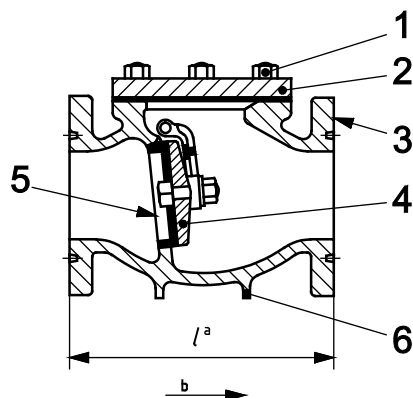
All assembled check valves shall successfully complete all applicable tests required and described in 7.4.9.

### 10.5.7.5 Marking

Valves shall be marked to conform to Clause 8.

### 10.5.7.6 Storing and shipping

All check valves shall be stored and shipped in accordance with Clause 9.



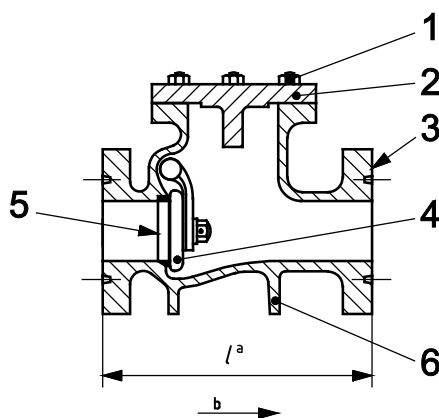
#### Key

- |   |                      |   |                      |
|---|----------------------|---|----------------------|
| 1 | cover studs and nuts | 4 | disc                 |
| 2 | cover                | 5 | seat ring            |
| 3 | body                 | 6 | support ribs or legs |

a Face-to-face dimension.

b Direction of flow.

**Figure 13 — Regular swing check valve**



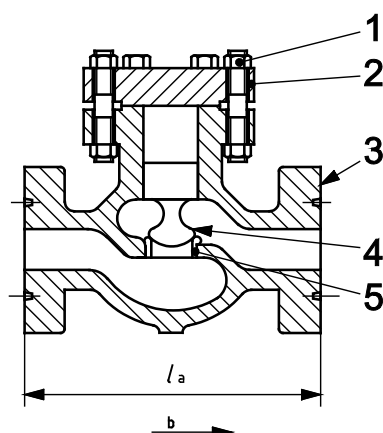
#### Key

- |   |                      |   |                      |
|---|----------------------|---|----------------------|
| 1 | cover studs and nuts | 4 | disc                 |
| 2 | cover                | 5 | seat ring            |
| 3 | body                 | 6 | support ribs or legs |

a Face-to-face dimension.

b Direction of flow.

**Figure 14 — Full-opening swing check valve**

**Key**

- 1 cover studs and nuts
- 2 cover
- 3 body
- 4 piston
- 5 seat ring

a Face-to-face dimension.

b Direction of flow.

**Figure 15 — Regular lift check valve**

**Table 75 — Regular and full-opening flanged swing and lift check valves  
for 13,8 MPa; 20,7 MPa and 34,5 MPa rated working pressures**  
(see Annex B for USC units)

Dimensions in millimetres unless otherwise indicated

Nominal size		Face-to-face valve length ± 2				
		Short pattern			Long pattern	
mm	(in)	13,8 MPa	20,7 MPa	34,5 MPa	20,7 MPa	34,5 MPa
52	2 <sup>1</sup> / <sub>16</sub>	295	371	371	—	—
65	2 <sup>9</sup> / <sub>16</sub>	333	422	422	—	—
79	3 <sup>1</sup> / <sub>8</sub>	359	384	473	435	—
103	4 <sup>1</sup> / <sub>16</sub>	435	460	549	511	—
179	7 <sup>1</sup> / <sub>16</sub>	562	613	711	—	737
228	9	664	740	841	—	—
279	11	790	841	1 000	—	—

**Table 76 — Minimum bore sizes for full-opening check valves  
for 13,8 MPa; 20,7 MPa and 34,5 MPa rated working pressures  
(see Annex B for USC units)**

Dimensions in millimetres unless otherwise indicated

Nominal size		Minimum bore size +1,6 0		
mm	(in)	13,8 MPa	20,7 MPa	34,5 MPa
52	2 <sup>1</sup> / <sub>16</sub>	52,5	49,3	42,9
65	2 <sup>9</sup> / <sub>16</sub>	62,7	59,0	54,0
79	3 <sup>1</sup> / <sub>8</sub>	77,9	73,7	66,6
103	4 <sup>1</sup> / <sub>16</sub>	102,3	97,2	87,3
179	7 <sup>1</sup> / <sub>16</sub>	146,3	146,3	131,8
228	9	198,5	189,0	173,1
279	11	247,7	236,6	215,9

**Table 77 — Regular and full-opening flanged swing and lift check valves for  
69,0 MPa (10 000 psi) rated working pressure**

Nominal size		Face-to-face valve length ± 2 mm (± 0,06 in)	
mm	(in)	mm	(in)
46	1 <sup>13</sup> / <sub>16</sub>	464	(18,25)
52	2 <sup>1</sup> / <sub>16</sub>	521	(20,50)
65	2 <sup>9</sup> / <sub>16</sub>	565	(22,25)
78	3 <sup>1</sup> / <sub>16</sub>	619	(24,38)
103	4 <sup>1</sup> / <sub>16</sub>	670	(26,38)
130	5 <sup>1</sup> / <sub>8</sub>	737	(29,00)
179	7 <sup>1</sup> / <sub>16</sub>	889	(35,00)

**Table 78 — Regular and full-opening flanged swing and lift check valves for  
103,5 MPa (15 000 psi) rated working pressure**

Nominal size		Face-to-face valve length ± 2 mm (± 0,06 in)	
mm	(in)	mm	(in)
46	1 <sup>13</sup> / <sub>16</sub>	457	(18,00)
52	2 <sup>1</sup> / <sub>16</sub>	483	(19,00)
65	2 <sup>9</sup> / <sub>16</sub>	533	(21,00)
78	3 <sup>1</sup> / <sub>16</sub>	598	(23,56)
103	4 <sup>1</sup> / <sub>16</sub>	737	(29,00)

**Table 79 — Regular and full-opening flanged swing and lift check valves for 138,0 MPa (20 000 psi) rated working pressure**

Nominal size		Face-to-face valve length ± 2 mm (± 0,06 in)	
mm	(in)	mm	(in)
46	1 <sup>13</sup> / <sub>16</sub>	533	(21,00)
52	2 <sup>1</sup> / <sub>16</sub>	584	(23,00)
65	2 <sup>9</sup> / <sub>16</sub>	673	(26,50)
78	3 <sup>1</sup> / <sub>16</sub>	775	(30,50)

## 10.6 Casing and tubing heads

### 10.6.1 General

The following apply:

a) casing-head housings and spools:

Casing-head housings are attached to the upper end of the surface casing. Casing-head spools are attached to the top connector of housings or other spools. Both are designed to accept hanging and packing mechanisms that suspend and seal casing strings.

b) tubing-head spools:

Tubing-head spools are attached to the top connector of casing-head housings or spools. Tubing-head spools are designed to accept packing mechanisms that seal casing strings and hanger and packing mechanisms that can be used to suspend and seal tubing strings.

### 10.6.2 Performance requirements

The products mentioned in 10.6.1 with penetrations shall meet the requirements of 10.17 in addition to the requirements of 4.1.

### 10.6.3 Design

#### 10.6.3.1 Loads

The following loads shall be considered when designing heads:

- hanging tubular loads;
- thermal tubular loads;
- pressure loads from blow-out-preventer testing and field pressure-testing of hanger packing mechanisms;
- external axial and bending loads consistent with the capabilities of the end connectors on the heads.

#### 10.6.3.2 End connectors

The following apply:

a) general:

All head ends using flanged end connectors shall be flanged or studded in accordance with 10.1.

- b) casing-head housing with threaded bottom connector:

Threaded bottom connectors for housings shall be threaded in accordance with 10.2.

- c) other end connectors:

Other end connectors shall be in accordance with 10.18.

This International Standard is not applicable to housing-to-casing weld preparations.

#### **10.6.3.3 Outlet connectors**

The following apply:

- a) general: pressure rating:

Pressure rating of outlet connectors shall be consistent with that of the upper end connector.

- b) flanged or studded:

Flanged or studded outlet connectors shall be in accordance with 10.1. Also, flanged or studded outlets 79 mm (3 1/8 in) and smaller shall be furnished with valve-removal plug preparation. Flanged or studded outlets 103 mm (4 1/16 in) or larger may be furnished with or without valve-removal plug preparation.

Valve-removal plug preparations shall be in accordance with Annex L.

- c) API Spec 5B threaded:

API Spec 5B threaded outlets shall be in accordance with 10.2.

- d) other end connectors:

Other end connectors shall be in accordance with 10.18.

#### **10.6.3.4 Flange counter-bores**

The provisions of this International Standard are not applicable to the diameter and depth of over-size counter-bores intended to accept wear bushings and packer mechanisms. However, if such counter-bores are used in flanged or studded connectors, the manufacturer shall ensure that the over-size preparation does not cause the flange stresses to exceed the design allowables.

#### **10.6.3.5 Vertical bores**

The following apply:

- a) for full-opening vertical bore:

In order to permit internal passage of tools or bottom-hole equipment, the minimum vertical bore of wellhead bodies shall be 0,8 mm (0,03 in) larger than the drift diameter (Table 80\*) of the largest casing over which the body is being used.

Wellhead bodies conforming to this requirement are referred to as having full-opening bores. The minimum vertical full-opening wellhead body bore, for the maximum casing size with which the bodies can be used, shall be as shown in Table 80\*.

- b) for reduced-opening vertical bore:

The vertical bores specified in Table 80\* may be adapted to casing sizes smaller than those listed in the tabulation by suitable reducing threads, pilot rings, etc. The through-bore of these elements shall be 0,8 mm (0,03 in) larger than the drift diameter of the casing over which the unit is used.

Typical illustrations of such adaptations are shown in Figure 16. Reduced vertical bores may also be supplied for weights of casing heavier than those listed in Table 80\*. Reduced vertical bores for this application shall be 0,8 mm (0,03 in) larger than the drift diameter of the heaviest wall casing over which it is being used.

- c) for increased-opening vertical bore:

In order to accept wear bushings and packer mechanisms, the vertical bore may be increased above the values in column 7 of Table 80\*. However, it is the responsibility of the manufacturer to ensure that the over-size preparation does not cause the body stress to exceed the design allowables.

#### **10.6.3.6 Rated working pressure**

The rated working pressure of heads shall be in accordance with 4.2.1. Account shall be taken of the rated working pressure limitations for threaded connectors based on size and type of thread.

#### **10.6.3.7 Test, vent, injection and gauge connectors**

The following apply:

- a) general:

Test, vent, injection and gauge connectors shall be in accordance with 4.4.4.

- b) special test port requirement:

Casing-head spools and tubing-head spools with either a secondary seal or a cross-over seal shall be provided with a test port in the lower connector.

- c) trapped pressure:

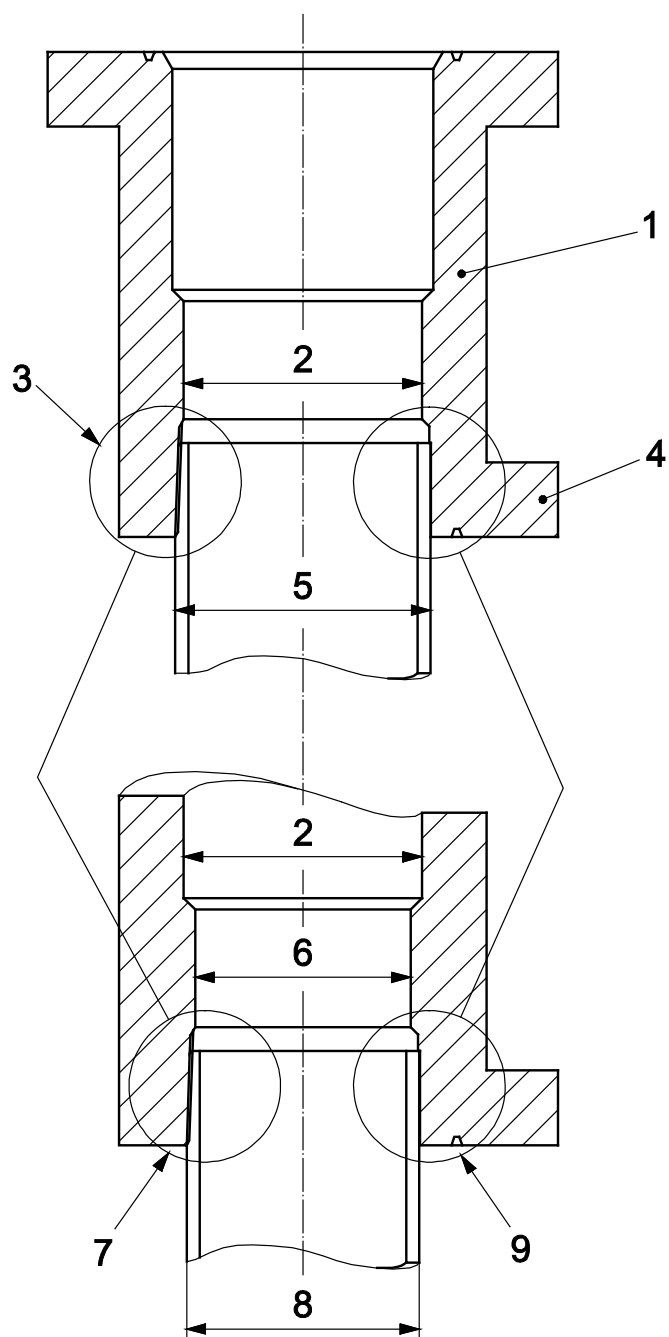
A means shall be provided such that any pressure behind a test, vent, injection and gauge connector can be vented prior to opening the connection.

#### **10.6.3.8 Cross-over spools**

If casing-head spools or tubing-head spools are used as cross-over spools, they shall satisfy the requirements of 10.14.

#### **10.6.3.9 Wear bushings**

Wear bushings shall be as specified in Annex H.

**Key**

- |   |  |   |                                 |
|---|--|---|---------------------------------|
| 1 | wellhead body                                      | 6 | reduced full-opening bore       |
| 2 | regular full-opening bore                          | 7 | casing thread                   |
| 3 | threaded bottom connection                         | 8 | smaller size casing             |
| 4 | bottom connector                                   | 9 | integral bore, adapter or pilot |
| 5 | maximum size casing (attached or beneath the body) |   |                                 |

**Figure 16 — Typical reduced-opening vertical bore**

**Table 80 — Minimum vertical full-opening body bores and maximum casing sizes**  
(see Annex B for USC units)

Nominal connector <sup>a</sup>			Casing beneath body			Minimum vertical full-opening wellhead body bore
Nominal size and bore of connector		Rated working pressure	Label <sup>b</sup>	Nominal lineic mass <sup>b</sup>	Specified drift diameter	
mm	(in)					
179	7 <sup>1</sup> / <sub>16</sub>	13,8	7	25,30	162,89	163,8
179	7 <sup>1</sup> / <sub>16</sub>	20,7	7	29,76	160,81	161,5
179	7 <sup>1</sup> / <sub>16</sub>	34,5	7	34,23	158,52	159,5
179	7 <sup>1</sup> / <sub>16</sub>	69,0	7	43,16	153,90	154,7
179	7 <sup>1</sup> / <sub>16</sub>	103,5	7	56,55	147,19	148,1
179	7 <sup>1</sup> / <sub>16</sub>	138,0	7	56,55	147,19	148,1
228	9	13,8	8 <sup>5</sup> / <sub>8</sub>	35,72	202,49	203,2
228	9	20,7	8 <sup>5</sup> / <sub>8</sub>	47,62	198,02	198,9
228	9	34,5	8 <sup>5</sup> / <sub>8</sub>	53,57	195,58	196,3
228	9	69,0	8 <sup>5</sup> / <sub>8</sub>	59,53	193,04	193,5
228	9	103,5	8 <sup>5</sup> / <sub>8</sub>	72,92	187,60	188,2
279	11	13,8	10 <sup>3</sup> / <sub>4</sub>	60,27	251,31	252,0
279	11	20,7	10 <sup>3</sup> / <sub>4</sub>	60,27	251,31	252,0
279	11	34,5	10 <sup>3</sup> / <sub>4</sub>	75,90	246,23	247,1
279	11	69,0	9 <sup>5</sup> / <sub>8</sub>	79,62	212,83	213,6
279	11	103,5	9 <sup>5</sup> / <sub>8</sub>	79,62	212,83	213,6
346	13 <sup>5</sup> / <sub>8</sub>	13,8	13 <sup>3</sup> / <sub>8</sub>	81,10	316,46	317,5
346	13 <sup>5</sup> / <sub>8</sub>	20,7	13 <sup>3</sup> / <sub>8</sub>	90,78	313,92	314,7
346	13 <sup>5</sup> / <sub>8</sub>	34,5	13 <sup>3</sup> / <sub>8</sub>	107,15	309,65	310,4
346	13 <sup>5</sup> / <sub>8</sub>	69,0	11 <sup>3</sup> / <sub>4</sub>	89,29	269,65	270,8
425	16 <sup>3</sup> / <sub>4</sub>	13,8	16	96,73	382,58	383,3
425	16 <sup>3</sup> / <sub>4</sub>	20,7	16	125,01	376,48	377,4
425	16 <sup>3</sup> / <sub>4</sub>	34,5	16	125,01	376,48	377,4
425	16 <sup>3</sup> / <sub>4</sub>	69,0	16	125,01	376,48	377,4
476	18 <sup>3</sup> / <sub>4</sub>	34,5	18 <sup>5</sup> / <sub>8</sub>	130,21	446,20	446,8
476	18 <sup>3</sup> / <sub>4</sub>	69,0	18 <sup>5</sup> / <sub>8</sub>	130,21	446,20	446,8
527	20 <sup>3</sup> / <sub>4</sub>	20,7	20	139,89	480,97	481,8
540	21 <sup>1</sup> / <sub>4</sub>	13,8	20	139,89	480,97	481,8
540	21 <sup>1</sup> / <sub>4</sub>	34,5	20	139,89	480,97	481,8
540	21 <sup>1</sup> / <sub>4</sub>	69,0	20	139,89	480,97	481,8

<sup>a</sup> Upper-end connections of wellhead body.

<sup>b</sup> Maximum size and minimum mass of casing on which bore is based.

#### **10.6.4 Materials**

The following apply:

- a) for bodies, flanges and other connectors:

Material used for bodies, flanges and other connectors shall comply with Clause 5.

- b) for other parts:

Material for lock screws and other parts shall meet the requirements of Clause 5.

#### **10.6.5 Manufacturing — Landing bases (casing-head housing)**

Landing bases for casing-head housings shall be attached to the housing body in accordance with the manufacturer's written specification. This International Standard is not applicable to landing bases.

#### **10.6.6 Testing**

All heads shall successfully complete the tests required and described in 7.4.9.

#### **10.6.7 Marking**

The following apply:

- a) general:

All heads shall be marked in accordance with Clause 8.

- b) cross-over spools:

All casing-head spools and tubing-head spools used as cross-over spools shall additionally be marked in accordance with Clause 8.

#### **10.6.8 Storing and shipping**

All heads shall be stored and shipped in accordance with Clause 9.

### **10.7 Casing and tubing hangers**

#### **10.7.1 General**

##### **10.7.1.1 Features of casing and tubing hangers**

The following apply:

- a) group 1:

- hangs pipe,
- no annular seal;

- b) group 2:

- hangs pipe,
- seals pressure from one direction;

## c) group 3:

- hangs pipe,
- seals pressure from top and bottom with or without ring-joint isolation seal and downhole lines;

## d) group 4:

same as group 3, with the hanger held in place by mechanical means applied to a retention feature; retention of the hanger is independent of any subsequent member or wellhead component;

## e) group 5:

same as group 4, with the hanger receiving back-pressure valve.

**10.7.1.2 General performance requirements**

The following apply:

## a) group 1:

- shall be able to suspend manufacturer's rated load without collapsing the tubulars or hangers below drift diameter,
- threaded connectors shall meet pressure-retaining requirements;

## b) group 2:

same as group 1 with the addition that the pressure load shall be considered with the hanging load;

## c) group 3:

same as group 2 with the addition that

- all seals shall retain rated pressure from either direction,
- if a cross-over seal is included on the hanger, then it shall hold the higher rated working pressure from above,
- if downhole lines are included, they shall hold the rated working pressure of the hanger and any effects of the pressure load shall be included in the load rating;

## d) group 4:

same as group 3 with the addition that the minimum retention load capacity of the hanger's retention feature shall be equal to the force generated by the working pressure on the annular area;

## e) group 5:

same as group 3 with the addition that

- minimum retention load capacity of the hanger's retention feature shall be equal to the force generated by the working pressure acting on the full area of the largest hanger seal,
- back-pressure valve preparations shall be capable of holding rated working pressure from below.

The load and pressure ratings for casing and tubing hangers may be a function of the tubular grade of material and wall section as well as the wellhead equipment in which it is installed. Manufacturers shall be responsible for supplying information about the load/pressure ratings of such hangers.

Field test pressures may be different from the rated working pressure of a hanger due to casing-collapse restrictions or load-shoulder limits.

Nothing in 10.7.1.2 shall be interpreted as being a requirement for a wrap-around seal type tubing hanger.

## 10.7.2 Specific performance requirements

### 10.7.2.1 Slip hangers

The following apply:

a) load capacity:

The load capacity for slip hangers shall be as specified in Table 81.

b) temperature rating:

The temperature rating of slip hangers shall be in accordance with 4.2.2. Choosing the temperature rating is ultimately the responsibility of the user. In making these selections, the user should consider the temperature the equipment is expected to experience in drilling and/or production service.

The temperature rating of the slip hanger may be less than the temperature rating of the wellhead and/or tree.

c) performance requirements for group 1 slip hangers:

Group 1 slip hangers shall meet the general requirements of 4.1, except that they are not required to have pressure integrity.

d) performance requirements for group 2 slip hangers:

Group 2 slip hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure in one direction across the annular seal at the rated load capacity for that pressure.

e) performance requirements for group 3 slip hangers:

Group 3 slip hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure above and below the annular seal at the rated load capacity for that pressure. If a cross-over pack-off is included on the hanger, then it shall hold the higher rated working pressure from above. If downhole lines are included, they shall hold the rated working pressure of the hanger. Any effect of the pressure load shall be included in the load rating.

f) performance requirements for group 4 slip hangers:

Group 4 slip hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure above and below the annular seal at the rated load capacity for that pressure. They shall also seal maximum rated pressure from below the annular seal while the hanger is retained in the bowl with the hanger retention feature. If a cross-over pack-off is included on the hanger, then it shall hold the higher rated working pressure from above. If downhole lines are included, they shall hold the rated working pressure of the hanger and any effect of the pressure load shall be included in the load rating.

**Table 81 — Performance requirements for slip hangers**

Performance requirement level	Load capacity
PR1	1 cycle at minimum rated load to maximum rated load
PR2	3 cycles at minimum rated load to maximum rated load

### 10.7.2.2 Mandrel hangers

The following apply:

a) load capacity:

The load capacity for mandrel hangers shall be as specified in Table 82. They shall seal the maximum rated pressure internally at the rated load capacity.

b) performance requirements for group 1 mandrel hangers:

Group 1 mandrel hangers shall meet the general requirements of 4.1, except that they are not required to have pressure integrity.

c) performance requirements for group 2 mandrel hangers:

Group 2 mandrel hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure in one direction across the annular seal at the rated load capacity for that pressure.

d) performance requirements for group 3 mandrel hangers:

Group 3 mandrel hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure above and below the annular seal at the rated load capacity for that pressure. If a cross-over pack-off is included on the hanger, then it shall hold the higher rated working pressure from above. If downhole lines are included, they shall hold the rated working pressure from above, and shall hold the rated working pressure of the hanger. Any effect of the pressure load shall be included in the load rating.

e) performance requirements for group 4 mandrel hangers:

Group 4 mandrel hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure above and below the annular seal at the rated load capacity for that pressure. They shall also seal the maximum rated pressure from below the annular seal while the hanger is retained in the bowl with the hanger retention feature. If a cross-over pack-off is included on the hanger, then it shall hold the higher rated working pressure from above. If downhole lines are included, they shall hold the rated working pressure of the hanger and any effect of the pressure load shall be included in the load rating.

f) performance requirements for group 5 mandrel hangers:

Group 5 mandrel hangers shall meet the general requirements of 4.1. They shall seal the maximum rated pressure above and below the annular seal at the rated load capacity for that pressure. They shall also seal the maximum rated pressure from below with the ID of the hanger blanked off with no pipe suspended, while the hanger is retained in the bowl with the hanger-retention feature. Back-pressure valve preparations shall be capable of holding rated working pressure from below. If a cross-over pack-off is included on the hanger, then it shall hold the higher rated working pressure from above. If downhole lines are included, they shall hold the rated working pressure of the hanger and any effect of the pressure load shall be included in the load rating.

**Table 82 — Performance requirements for mandrel hangers**

Performance requirement level	Load capacity
PR1	1 cycle at minimum rated load to maximum rated load
PR2	3 cycles at minimum rated load to maximum rated load

### **10.7.3 Design**

#### **10.7.3.1 Loads**

The following loads shall be considered when designing any hanger:

- radial loads on hanger body due to tapered landing shoulder;
- tensile loads throughout hanger body due to weight of suspended tubulars;
- loads imparted to hanger due to field pressure test.

#### **10.7.3.2 Threaded connectors**

Threads on threaded mandrel-type casing and tubing hangers shall be in accordance with 10.2. Other threaded connectors shall be in accordance with 10.18.

#### **10.7.3.3 Maximum diameter**

The maximum outside diameter of any hanger that it is intended to run through a blowout preventer shall not exceed that shown in Table 83.

#### **10.7.3.4 Vertical bore**

The vertical through-bore of a tubing hanger shall provide full opening to the drift diameter of the suspended tubular or tree drift bar, whichever is smaller. Casing hangers shall be full-opening to the drift diameter of the suspended tubular. Back-pressure valve preparation shall also meet this through-bore requirement.

#### **10.7.3.5 Rated working pressure**

##### **10.7.3.5.1 Threaded mandrel-type casing or tubing hangers**

The following apply:

- a) with no extended seal neck:

The rated working pressure for hanger body and primary seal shall be equal to the working pressure of the head in which it is landed, if no extended seal neck is provided.

- b) with extended seal neck:

Maximum pressure rating for the hanger body and extended neck seal, if a cross-over type seal is provided, shall be the working pressure of the next casing or tubing head or tubing-head adapter above the hanger.

- c) limitation:

Hangers can have a limitation on the pressure rating due to the pressure limitations of the threaded connectors.

##### **10.7.3.5.2 Slip-type casing hangers**

There is no requirement for slip hangers to have a pressure rating.

#### **10.7.3.6 Welds**

The design of any weld shall be such that it satisfies all the design requirements of 10.7.3.

### 10.7.3.7 Pipe dimensions

Slip-type hangers and sealing systems to seal on casing or tubing shall be designed to accommodate the OD pipe tolerance as specified in ISO 11960.

**CAUTION —** Manufacturers and users are reminded that the tolerances of casing and tubing outside diameters vary substantially between the various editions of ISO 11960 and API Spec 5CT. In general, the tolerance has increased over time; this can affect equipment interchangeability.

**Table 83 — Maximum hanger outside diameter for wellheads**

Nominal size <sup>a</sup> and minimum through-bore of drill-through equipment		Rated working pressure		Maximum outside diameter of hanger	
		MPa	(psi)	mm	(in)
179	7 <sup>1</sup> / <sub>16</sub>	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	178,05	(7,010)
179	7 <sup>1</sup> / <sub>16</sub>	69,0; 103,5 and 138,0	(10 000; 15 000 and 20 000)	178,05	(7,010)
228	9	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	226,90	(8,933)
228	9	69,0 and 103,5	(10 000 and 15 000)	226,90	(8,933)
279	11	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	277,32	(10,918)
279	11	69,0 and 103,5	(10 000 and 15 000)	277,32	(10,918)
346	13 <sup>5</sup> / <sub>8</sub>	13,8 and 20,7	(2 000 and 3 000)	343,48	(13,523)
346	13 <sup>5</sup> / <sub>8</sub>	34,5 and 69,0	(5 000 and 10 000)	343,48	(13,523)
425	16 <sup>3</sup> / <sub>4</sub>	13,8 and 20,7	(2 000 and 3 000)	422,28	(16,625)
425	16 <sup>3</sup> / <sub>4</sub>	34,5 and 69,0	(5 000 and 10 000)	422,28	(16,625)
476	18 <sup>3</sup> / <sub>4</sub>	34,5 and 69,0	(5 000 and 10 000)	473,08	(18,625)
540	21 <sup>1</sup> / <sub>4</sub>	13,8	(2 000)	536,58	(21,125)
527	20 <sup>3</sup> / <sub>4</sub>	20,7	(3 000)	523,88	(20,625)
540	21 <sup>1</sup> / <sub>4</sub>	34,5 and 69,0	(5 000 and 10 000)	536,58	(21,125)

<sup>a</sup> Nominal size of upper end connection of wellhead body in which the hanger is used.

### 10.7.4 Materials

All materials shall meet the requirements of Clause 5. Material selection shall provide a joint strength in the hanger threads equal to, or greater than, that of the casing or tubing.

### 10.7.5 Manufacturing — Welding

Welding shall conform to the requirements of Clause 6.

### 10.7.6 Testing

It is not necessary that hangers be hydrostatically tested, but they shall be capable of passing a hydrostatic test equal to the rated working pressure.

### 10.7.7 Marking

Hangers shall be marked in accordance with Clause 8. The slips in a slip hanger shall be sequentially marked if they are not interchangeable.

## 10.7.8 Installation

For running and retrieving tools for casing and tubing hangers, see Annex H.

## 10.7.9 Storing and shipping

Hangers shall be stored and shipped in accordance with Clause 9. The slips of a slip hanger shall be stored and shipped as a set.

## 10.8 Tubing-head adapters

### 10.8.1 General

Tubing-head-to-master-valve adapters may be either integral with the master valve as its lower end connector, or an independent piece of equipment. Configurations are dependent on the completion method being used. In addition to serving as adapters, they can also provide a means to connect and seal the tubing bore(s) to that of the master valve or to suspend the tubing string(s). Group 1 tubing-head adapters seal the wellbore from the annulus. Group 2 tubing-head adapters seal the wellbore from the annulus and suspend the tubing.

### 10.8.2 Performance requirements

The following apply:

- a) performance requirements for group 1 tubing-head adapters:

These products shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 84.

- b) performance requirements for group 2 tubing-head adapters:

These products shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 85.

### 10.8.3 Design

#### 10.8.3.1 Loads

The following loads shall be considered when designing tubing-head adapters:

- hanging and thermal tubular loads on adapters that incorporate hanger mechanisms;
- external axial and bending loads consistent with the capabilities of the end connectors.

#### 10.8.3.2 End connectors

The following apply:

- a) lower connector:

Flanged or studded lower connectors shall be in accordance with 10.1. Other connectors shall be in accordance with 10.18.

- b) upper connector:

The upper connector of an independent adapter shall be flanged or studded, in accordance with 10.1, or threaded, in accordance with 10.2, or have an other-end connector in accordance with 10.18 or clamp hub end connectors in accordance with ISO 13533 or swivel flanges in accordance with ISO 13628-4. The bores of upper threaded connectors having a 2 1/2 in, 3 in, or 4 in nominal sized male line-pipe threads shall not

exceed 53,2 mm, 65,9 mm and 80,2 mm (2,09 in, 2,59 in and 3,16 in), respectively. Tolerances on these dimensions are + 00,8 mm (00,03 in).

**Table 84 — Performance requirements for group 1 tubing-head adapters**

Performance requirement level	Pressure integrity <sup>a</sup>
PR1	1 cycle
PR2	3 cycles
<sup>a</sup> Shall withstand maximum rated pressure internally.	

**Table 85 — Performance requirements for group 2 tubing-head adapters**

Performance requirement level	Pressure integrity <sup>a</sup>	Load capacity <sup>b</sup>
PR1	1 cycle	1 cycle
PR2	3 cycles	3 cycles
<sup>a</sup> Shall withstand maximum rated pressure internally.		
<sup>b</sup> At minimum rated load to maximum rated load.		

### 10.8.3.3 Rated working pressure

The rated working pressure of tubing-head adapters shall be in accordance with 4.2.1. Account shall be taken of the rated working pressure limitations for threaded connections, if applicable.

### 10.8.3.4 Test, vent and injection connectors

Testing, vent and injection connectors used in tubing-head adapters shall be in accordance with 4.4.4.

### 10.8.3.5 Cross-over adapters

If tubing-head adapters are used as cross-over adapters they shall satisfy the requirements of 10.14.

### 10.8.3.6 Penetrations

The products with penetrations shall meet the requirements of 10.17.

## 10.8.4 Materials

All materials shall comply with Clause 5.

## 10.8.5 Testing

All tubing-head adapters shall successfully complete the tests required by and described in 7.4.9.

## 10.8.6 Marking

Tubing-head adapters shall be marked in accordance with Clause 8.

## 10.8.7 Storing and shipping

All adapters shall be stored and shipped in accordance with Clause 9.

## 10.9 Chokes

### 10.9.1 General

Positive and adjustable chokes are chokes that include restrictions or orifices to control the flow rate of fluids. Chokes are not intended to be used as shutoff valves.

The following apply:

a) adjustable chokes:

Adjustable chokes have an externally controlled variable-area orifice coupled with an orifice-area-indicating mechanism as shown in Figure 17. Actuators for adjustable chokes are covered under 10.16.

b) positive chokes:

Positive chokes accommodate replaceable parts having fixed orifice dimensions, which are commonly called flow beans, as shown in Figure 18.

### 10.9.2 Performance requirements

Chokes shall meet the general performance requirements of 4.1 and shall be capable of performing as outlined in Table 86. This includes positive chokes, manually actuated chokes and chokes designed for actuators.

### 10.9.3 Design

#### 10.9.3.1 General

Chokes shall meet the requirements of Clause 4 in addition to those in 10.9.3.2 through 10.9.3.8.

#### 10.9.3.2 End connectors

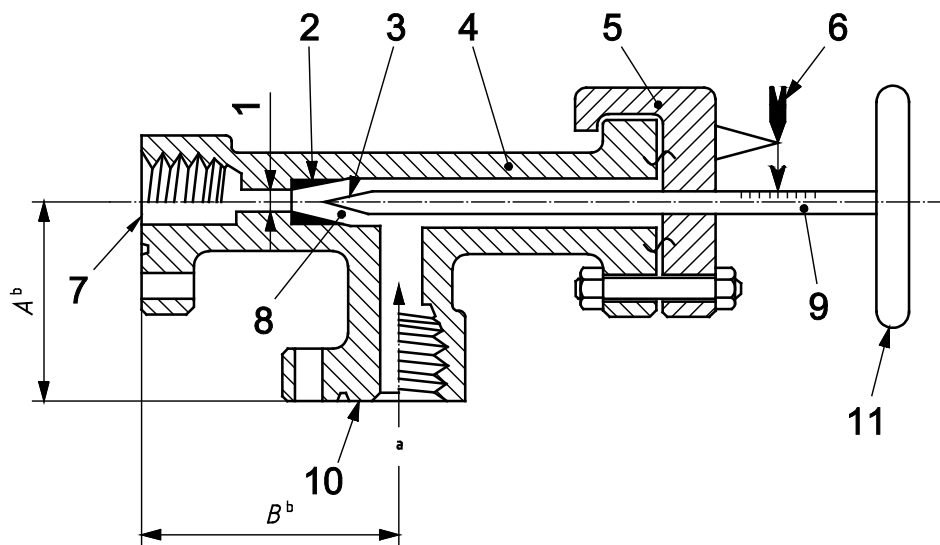
End connectors shall conform to 10.1, 10.2, or 10.18.

#### 10.9.3.3 Nominal size

The nominal size designation of the choke shall be the inlet connector size, followed by the maximum orifice size available for that choke in units of 0,4 mm ( $1/64$  in). If the choke orifice is not a single circular orifice, the maximum size shown shall be the diameter of a circle, in increments of 0,4 mm ( $1/64$  in), whose area is equal to the total choke orifice area.

**Table 86 — Performance requirements for chokes**

Performance requirement level	Operating cycles <sup>a</sup>	Seat-to-body sealing
PR1	3 cycles	1 cycle
PR2	200 cycles	3 cycles
<sup>a</sup> Operating cycles do not apply to positive chokes.		

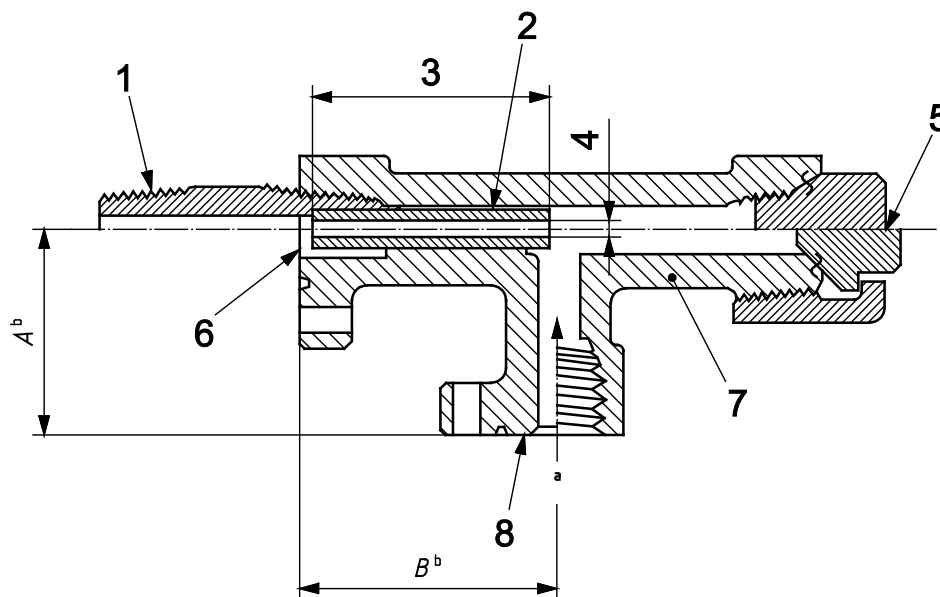
**Key**

- |   |                       |
|---|-----------------------|
| 1 maximum orifice diameter                | 7 outlet connection   |
| 2 removable seat                          | 8 orifice area        |
| 3 stem tip                                | 9 stem                |
| 4 body                                    | 10 inlet connection   |
| 5 bonnet                                  | 11 handwheel or lever |
| 6 indicating mechanism (type is optional) |                       |

a Flow direction.

b Dimensions  $A$  and  $B$  are agreed between manufacturer and purchaser and may be specified using Figure A.10.

**Figure 17 — Typical adjustable choke**

**Key**

- |                          |                     |
|--------------------------|---------------------|
| 1 cage nipple (optional) | 5 plug or cap       |
| 2 removable flow bean    | 6 outlet connection |
| 3 orifice length         | 7 body              |
| 4 orifice diameter       | 8 inlet connection  |

a Flow direction.

b Dimensions  $A$  and  $B$  are agreed between manufacturer and purchaser and may be specified using Figure A.10.

**Figure 18 — Typical positive choke**

#### 10.9.3.4 Rated working pressure

The following apply:

- a) end connectors with equal rated working pressures:

For chokes having end connectors of the same rated working pressure, the rated working pressure of the choke shall be the rated working pressure of the end connectors.

- b) end connectors with different rated working pressures:

For chokes having an upstream end connector of higher rated working pressure than the downstream end connector, the choke shall have a two-part rated working pressure consisting of the rated working pressure of the upstream end connector and the rated working pressure of the downstream end connector, e.g. 20,7 MPa ´ 13,8 MPa (3 000 psi ´ 2 000 psi).

#### 10.9.3.5 Flow design

Chokes shall be designed to direct flow away from the bonnet of adjustable chokes and the cap, or blanking plug, of positive chokes.

#### 10.9.3.6 Vent requirement

All chokes shall be designed to vent trapped pressure prior to releasing the body-to-bonnet connector on adjustable chokes or the body-to-cap connector on positive chokes.

#### 10.9.3.7 Flow beans for positive chokes

Flow beans are defined as the replaceable orifice parts of positive chokes.

The orifice size of any individual production flow bean and the increment between sizes are optional with the manufacturer but shall be specified in diameter increments of 0,4 mm ( $\frac{1}{64}$  in).

The following apply:

- a) proration beans:

Proration beans shall have a net effective orifice length of 152,4 mm  $\pm$  1,5 mm (6 in  $\pm$  0,06 in). The orifice diameters of these beans shall be specified in  $\frac{1}{64}$  in diametrical increments, i.e.  $\frac{5}{64}$  in,  $\frac{6}{64}$  in,  $\frac{7}{64}$  in,  $\frac{8}{64}$  in.

- b) production beans:

The orifice size of any individual production bean and the increment between sizes are optional with the manufacturer.

#### 10.9.3.8 Adjustable choke indicating mechanism

Adjustable chokes shall be equipped with a visible orifice-area-indicating mechanism to define the orifice area at any adjusted choke setting throughout its operating range. This mechanism shall be calibrated to indicate diameters of circular orifices having areas equivalent to the minimum flow areas at any adjustable choke setting. These markings shall be in diametrical increments of either 0,8 mm ( $\frac{1}{32}$  in) or 0,4 mm ( $\frac{1}{64}$  in). It is not required to equip actuated chokes with an indicating mechanism.

### 10.9.4 Material

The following apply:

- a) bodies, bonnets, plugs or caps, and end connectors:

Materials for these parts shall comply with Clause 5.

- b) other parts:

Material for all other parts shall meet the requirements of Clause 5 or 10.16, as applicable. Additionally, special corrosion- and abrasion-resistant materials, coatings or overlays shall be used for adjustable-choke stem tips and positive-choke flow beans.

### 10.9.5 Testing

Assembled chokes shall successfully complete the tests required by and described in 7.4.9.

### 10.9.6 Marking

All choke bodies and flow beans shall be marked in accordance with Clause 8.

### 10.9.7 Storing and shipping

Chokes shall be stored and shipped in accordance with Clause 9.

## 10.10 Tees and crosses

### 10.10.1 General

Additional requirements for tees and crosses are given in 10.10

### 10.10.2 Design

#### 10.10.2.1 Nominal size and pressure rating

Nominal sizes and pressure ratings for tees and crosses shall be as specified in Tables 87\* and 88\*, with the following exceptions: over-size entrance bores of 81 mm  $^{+0,8}_{0}$  mm and 108 mm  $^{+0,8}_{0}$  mm ( $3 \frac{3}{16}$  in  $^{+0,03}_{0}$  in and  $4 \frac{1}{4}$  in  $^{+0,03}_{0}$  in) are allowable for 79 mm and 103 mm ( $3 \frac{1}{8}$  in and  $4 \frac{1}{16}$  in) nominal sizes for rated working pressures of 13,8 MPa; 20,7 MPa and 34,5 MPa (2 000 psi; 3 000 psi and 5 000 psi) for use with valves with oversize bores as listed in Tables 67\*; 68\* and 69\*.

#### 10.10.2.2 End connectors

All end connectors shall conform to 10.1 or 10.18.

#### 10.10.2.3 Dimensions

Bore and centre-to-face dimensions shall conform to those shown in Tables 87\* and 88\*.

### 10.10.3 Materials

Materials for tees and crosses shall comply with Clause 5.

### 10.10.4 Testing

Tees and crosses shall successfully complete the tests required and described in 7.4.9.

### 10.10.5 Marking

Marking shall comply with Clause 8.

### 10.10.6 Storing and shipping

Tees and crosses shall be stored and shipped in accordance with Clause 9.

**Table 87 — Flanged crosses and tees for 13,8 MPa; 20,7 MPa; 34,5 MPa;  
69,0 MPa; 103,5 MPa and 138,0 MPa rated working pressures**  
(see Annex B for USC units)

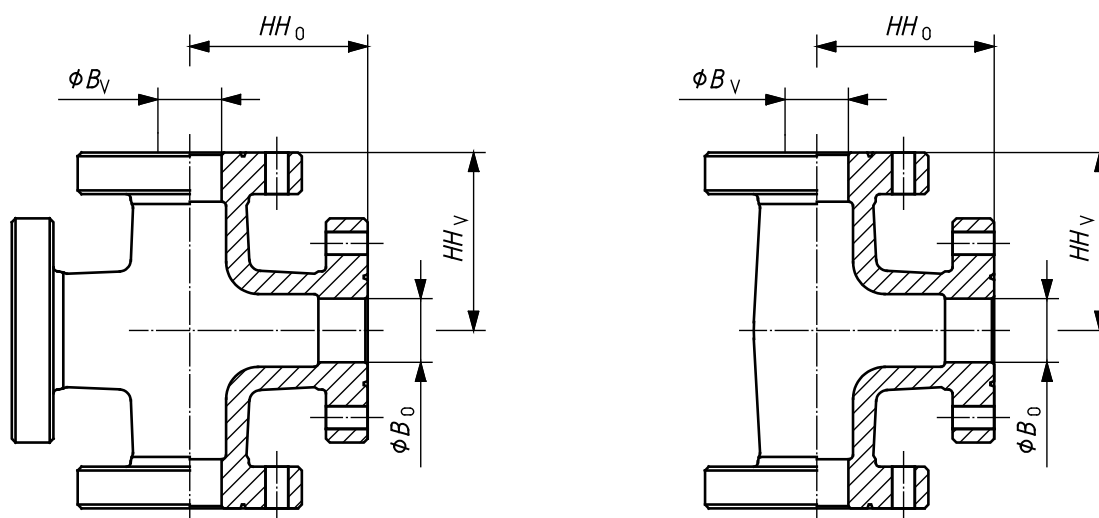


Table 87 (continued)

Dimensions in millimetres

Nominal size and bore		Centre- to-face vertical run $HH_V$ $\pm 0,8$	Centre- to-face horizontal run $HH_0$ $\pm 0,8$	Nominal size and bore		Centre- to-face vertical run $HH_V$ $\pm 0,8$	Centre- to-face horizontal run $HH_0$ $\pm 0,8$
Vertical $B_V$ +0,8 0	Outlet $B_0$ +0,8 0			Vertical $B_V$ +0,8 0	Outlet $B_0$ +0,8 0		
13,8 MPa				103,5 MPa			
52	52	147,5	147,5	52	46	186,5	188,0
65	52	151,0	160,5	52	52	193,5	193,5
65	65	166,5	166,5	65	46	193,0	204,0
79	52	154,0	170,0	65	52	200,0	209,5
79	65	166,5	173,0	65	65	216,0	216,0
79	79	179,5	179,5	78	46	199,5	220,5
103	52	160,5	201,5	78	52	207,0	226,0
103	65	173,0	205,0	78	65	223,0	232,5
103	79	182,5	208,0	78	78	239,5	239,5
103	103	217,5	217,5	103	46	220,5	260,5
20,7 MPa				103	52	228,0	266,0
79	52	185,5	198,5	103	65	243,5	272,5
79	65	200,0	201,5	103	78	260,5	279,5
79	79	192,0	192,0	103	103	297,0	297,0
103	52	192,0	224,0	130	46	238,0	290,5
103	65	206,5	227,0	130	52	244,5	295,5
103	79	205,0	224,0	130	65	260,5	301,5
103	103	230,0	230,0	130	78	278,0	309,5
34,5 MPa				130	103	314,5	324,0
52	52	185,5	185,5	130	130	343,0	343,0
65	52	189,0	200,0	138,0 MPa			
65	65	211,0	211,0	46	46	227,0	227,0
79	52	195,5	211,0	52	46	235,0	242,0
79	65	209,5	214,5	52	52	250,0	250,0
79	79	236,5	236,5	65	46	243,0	261,0
103	52	201,5	233,5	65	52	258,0	269,0
103	65	216,0	236,5	65	65	277,0	277,0
103	79	227,0	243,0	78	46	252,5	277,0
103	103	274,5	274,5	78	52	267,5	259,5
130	52	230,0	268,5	78	65	286,5	293,0
130	65	244,5	271,5	78	78	302,5	302,5
130	79	255,5	278,0	103	46	282,5	321,5
130	103	278,0	284,0	103	52	297,5	321,5
130	130	309,5	309,5	103	65	316,5	337,5
69,0 MPa				103	78	332,5	347,0
52	46	169,5	174,0	103	103	377,0	377,0
52	52	176,0	176,0				
65	46	176,5	189,5				
65	52	183,0	191,5				
65	65	199,0	199,0				
78	46	183,5	209,0				
78	52	190,0	210,5				
78	65	206,0	218,0				
78	78	225,0	225,0				
103	46	198,5	235,0				
103	52	205,0	237,0				
103	65	220,5	244,0				
103	78	239,5	251,0				
103	103	262,5	262,5				
130	46	208,0	255,5				
130	52	214,5	257,0				
130	65	230,0	264,5				
130	78	249,0	271,5				
130	103	272,5	284,0				
130	130	293,0	293,0				

**Table 88 — Studded crosses and tees for 13,8 MPa; 20,7 MPa; 34,5 MPa;  
69,0 MPa; 103,5 MPa and 138,0 MPa rated working pressures**  
(see Annex B for USC units)

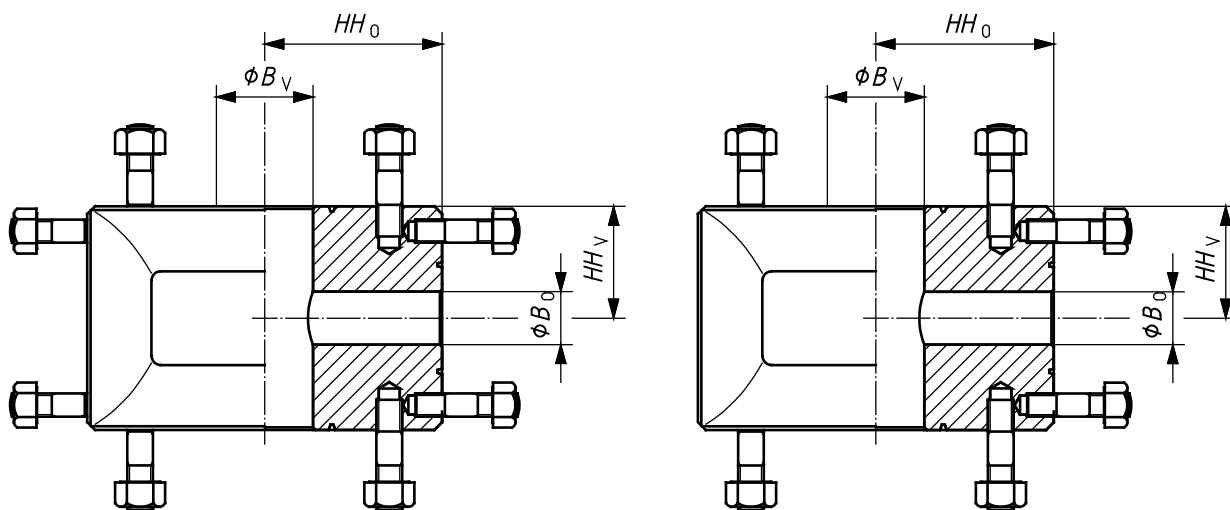


Table 88 (continued)

Dimensions in millimetres

Nominal size and bore		Centre- to-face vertical run $HH_V$ $\pm 0,8$	Centre- to-face horizontal run $HH_0$ $\pm 0,8$	Nominal size and bore		Centre- to-face vertical run $HH_V$ $\pm 0,8$	Centre- to-face horizontal run $HH_0$ $\pm 0,8$
Vertical $B_V$ +0,8 0	Outlet $B_0$ +0,8 0			Vertical $B_V$ +0,8 0	Outlet $B_0$ +0,8 0		
13,8 MPa				103,5 MPa			
52	52	89,0	89,0	46	46	127,0	127,0
65	52	89,0	101,5	52	46	127,0	127,0
65	65	114,5	114,5	52	52	127,0	127,0
79	52	89,0	114,5	65	46	139,5	139,5
79	65	114,5	114,5	65	52	139,5	139,5
79	79	114,5	114,5	65	65	139,5	139,5
103	52	114,5	139,5	78	46	160,5	160,5
103	65	114,5	139,5	78	52	160,5	160,5
103	79	114,5	139,5	78	65	160,5	160,5
103	103	139,5	139,5	78	78	160,5	160,5
20,7 MPa				103	46	193,5	193,5
79	52	114,5	127,0	103	52	193,5	193,5
79	65	127,0	127,0	103	65	193,5	193,5
79	79	127,0	127,0	103	78	193,5	193,5
103	52	114,5	155,5	103	103	193,5	193,5
103	65	127,0	155,5	130	46	168,0	222,0
103	79	127,0	155,5	130	52	168,0	222,0
103	103	155,5	155,5	130	65	168,0	222,0
34,5 MPa				130	78	168,0	222,0
52	52	114,5	114,5	130	103	235,0	235,0
65	52	114,5	127,0	130	130	235,0	235,0
65	65	127,0	127,0	138,0 MPa			
79	52	114,5	139,5	46	46	164,5	164,5
79	65	139,5	139,5	52	46	164,5	164,5
79	79	139,5	139,5	52	52	164,5	164,5
103	52	114,5	165,0	65	46	185,0	185,0
103	65	127,0	165,0	65	52	185,0	185,0
103	79	139,5	165,0	65	65	185,0	185,0
103	103	165,0	165,0	78	46	202,5	202,5
130	52	155,5	193,5	78	52	202,5	202,5
130	65	155,5	193,5	78	65	202,5	202,5
130	79	155,5	193,5	78	78	202,5	202,5
130	103	202,5	202,5	103	46	251,5	251,5
130	130	202,5	202,5	103	52	251,5	251,5
69,0 MPa				103	65	251,5	251,5
46	46	111,0	111,0	103	78	251,5	251,5
52	46	111,0	111,0	103	103	251,5	251,5
52	52	111,0	111,0				
65	46	114,5	130,0				
65	52	114,5	130,0				
65	65	130,0	130,0				
78	46	114,5	149,0				
78	52	114,5	149,0				
78	65	130,0	149,0				
78	78	149,0	149,0				
103	46	114,5	174,5				
103	52	114,5	174,5				
103	65	130,0	174,5				
103	78	149,0	174,5				
103	103	174,5	174,5				
130	46	133,5	197,0				
130	52	133,5	197,0				
130	65	133,5	197,0				
130	78	171,5	197,0				
130	103	171,5	197,0				
130	130	197,0	197,0				

## **10.11 Test and gauge connections for 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi) equipment**

### **10.11.1 General**

Test and gauge connections for use on 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi) equipment are covered in 10.11. Connections of lower-pressure equipment are described in 4.4.4.

### **10.11.2 Design**

The following apply:

a) types:

Types I, II and III connections are defined and illustrated in Figure 19.

b) dimensions:

Types I, II and III connections shall conform to the dimensions in accordance with Figure 19.

c) threads:

All parallel threads shall be in accordance with ASME B1.1. Male threads shall be class 2A, female threads shall be class 2B.

d) mating components:

Components attached to types I, II and III connections shall comply with the design methods of 4.3.1 or 4.3.3.

### **10.11.3 Material**

For 103,5 MPa or 138,0 MPa (15 000 psi or 20 000 psi) rated working pressure applications, the materials shall be 78 HRB minimum. For material classes DD, EE, FF, and HH, the material shall also conform to ISO 15156 (all parts) (NACE MR0175; see Clause 2).

### **10.11.4 Testing**

The equipment furnished under 10.11 is not regularly subjected to a hydrostatic test, but shall be rated for the hydrostatic test described in 7.4.9.

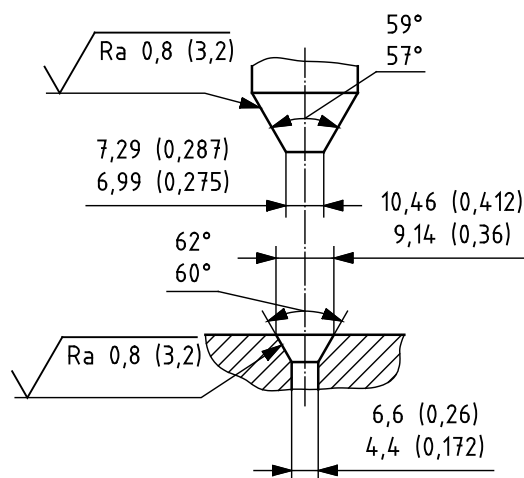
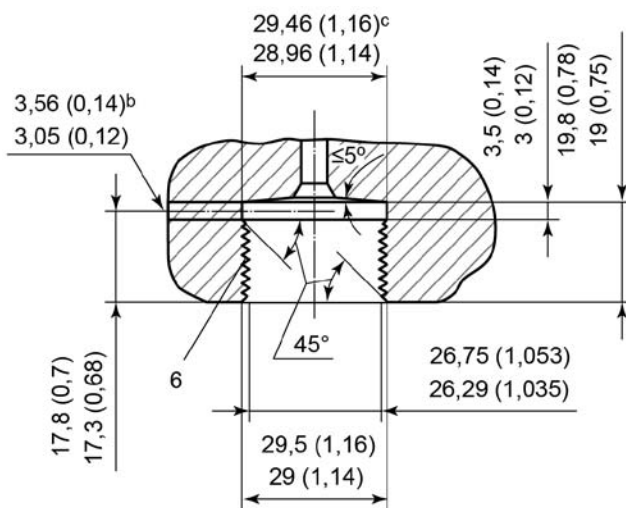
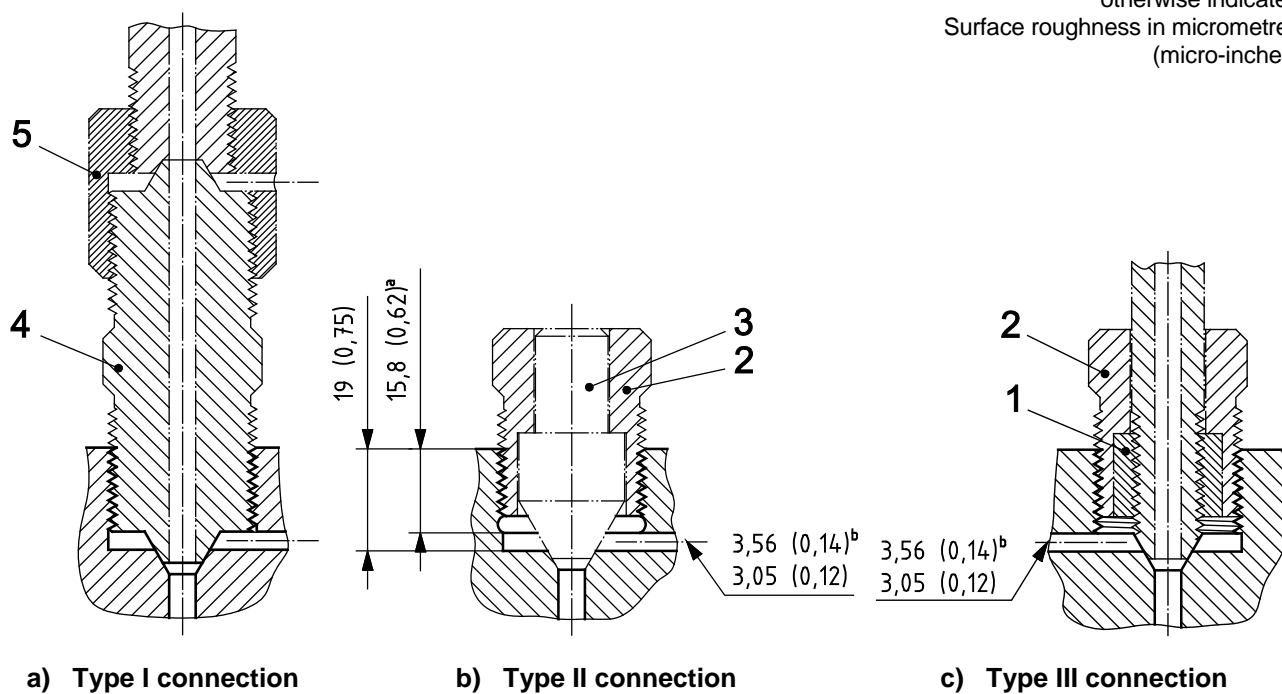
### **10.11.5 Marking**

There are no requirements for marking test and gauge connections.

### **10.11.6 Storage and shipping**

Connectors shall be stored and shipped in accordance with Clause 9.

Dimensions in millimetres (inches) unless  
otherwise indicated  
Surface roughness in micrometres  
(micro-inches)



### Key

1 collar	4 male by male
2 gland	5 coupling
3 plug	6 1 1/8 - 12 UNF - 2B

a Minimum depth perfect female thread.

b Drill for vent optional but recommended.

c 15,7 (0,62) minimum thread length or undercut to thread relief as an option.

**Figure 19 — Test and gauge connections for 103,5 MPa and 138,0 MPa  
(15 000 psi and 20 000 psi) rated working pressure**

## 10.12 Fluid sampling devices

### 10.12.1 General

Sampling devices used for sampling the well fluid are covered in 10.12. Fluid sampling devices having end connections and bodies shall satisfy all the requirements for bodies and end connectors in this International Standard.

### 10.12.2 Performance requirements

These products shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 89.

**Table 89 — Performance requirements for fluid sampling devices**

Performance requirement level	Pressure integrity <sup>a</sup>
PR1	1 cycle
PR2	3 cycles
<sup>a</sup> Shall seal maximum rated pressure internally.	

### 10.12.3 Design

The following apply:

a) end connectors:

End connectors shall be in accordance with 10.1, 10.2 or 10.18.

b) nominal size and pressure rating:

The nominal size and pressure rating of the sampling device shall be that of the end connector(s).

c) sampling connector:

The sampling connector shall be internally threaded in conformance with 10.2, and shall be not less than 1/2 in line-pipe or NPT size.

d) dimensions:

There are no dimensional requirements for sampling devices except for flanges and threads manufactured according to this and other International Standards.

e) service conditions:

Sampling devices shall be designed for material classes CC, FF or HH, all of which are intended for highly corrosive service.

f) details:

This International Standard is not applicable to details for clean-out arrangements, sample valves, thermometer wells, etc.

### 10.12.4 Materials

Body and end connector material and material for other parts shall meet the requirements of Clause 5.

### **10.12.5 Testing**

All fluid sampling devices shall successfully complete the tests required and described in 7.4.9.

### **10.12.6 Marking**

Devices shall be marked in accordance with Clause 8.

### **10.12.7 Storing and shipping**

Devices shall be stored and shipped in accordance with Clause 9.

## **10.13 Christmas trees**

### **10.13.1 General**

Requirements for christmas trees, including christmas trees for single- and multiple-tubing string installations, and block christmas trees for single- and multiple-tubing string installations, are covered in 10.13.

### **10.13.2 Design**

See design requirements for equipment.

### **10.13.3 Materials**

See material requirements for equipment.

### **10.13.4 Manufacturing — Assembly**

All parts and equipment shall conform to the requirements of this International Standard before being assembled into christmas trees.

### **10.13.5 Testing**

Christmas trees shall successfully complete the tests required by and described in 7.4.9.

### **10.13.6 Marking**

Marking shall be in accordance with 8.9.

### **10.13.7 Storing and shipping**

Christmas trees shall be stored and shipped in accordance with Clause 9. Any disassembly, removal or replacement of parts or equipment after testing shall be as agreed with the purchaser.

## **10.14 Cross-over connectors**

### **10.14.1 General**

Cross-over connector types include cross-over spools, multi-stage cross-over spools, cross-over adapters and cross-over tubing-head adapters. Cross-over spools and multi-stage cross-over spools shall meet the requirements of 10.6. Cross-over adapters and cross-over tubing-head adapters shall meet the requirements of 10.8.

The following apply:

a) cross-over spool:

A cross-over spool shall suspend and seal around a string of casing or tubing and shall be appropriately described as either a cross-over casing spool or a cross-over tubing spool. The spool shall contain a restricted-area sealing means at or near the face of the lower connector, permitting a pressure rating greater than the pressure rating of the lower connector in the section above the restricted-area sealing means.

b) multi-stage cross-over spool:

A multiple stage cross-over spool shall suspend and seal around multiple strings of casing and/or tubing. The multi-stage cross-over spool shall contain restricted-area sealing means at each stage, permitting an increase of one or more pressure ratings greater than the stage or connector immediately below. The upper connector shall be at least one pressure rating greater than the lower connector.

c) cross-over adapter:

A cross-over adapter shall be used between two casing spools, or between casing and tubing spools, to allow an increase in pressure rating between the spools.

d) cross-over tubing-head adapter:

A cross-over tubing-head adapter shall be used between a christmas tree and the tubing head to allow an increase in pressure rating between the two.

### 10.14.2 Performance requirements

Cross-over connectors shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 90.

**Table 90 — Performance requirements for cross-over connectors**

Performance requirement level	Pressure integrity <sup>a</sup>
PR1	1 cycle
PR2	3 cycles
<sup>a</sup> Shall seal maximum rated pressure internally.	

### 10.14.3 Design

#### 10.14.3.1 General

Cross-over connectors shall be designed to be used in an assembly as illustrated in Figures 20, 21, 22 or 23.

#### 10.14.3.2 End connectors

End connectors shall conform to the requirements of 10.1, 10.2, or 10.18.

The upper connector of a cross-over spool shall be at least one pressure rating above the lower connector.

#### 10.14.3.3 Rated working pressure — Body

The section of the body above the restricted-area pack-off of a cross-over connector shall be designed to sustain the rated working pressure of the upper connector. Sections below the restricted-area pack-off shall be designed

to sustain the working pressure of that section plus any pressure-induced loads resulting from the upper pressure acting on the restricted-area pack-off.

The restricted-area pack-off and its retention means shall be designed so that the pressure-induced loads transferred from containment of the full working pressure by the upper connector and/or any upper stage do not exceed the requirements of 4.3.3 at any part of the body or lower connector. See Figures 20, 21 and 22.

#### **10.14.3.4 Restricted-area pack-off**

Each cross-over spool, multi-stage cross-over spool, cross-over adapter and cross-over tubing-head adapter shall have at least one restricted-area pack-off.

Restricted-area pack-offs to seal on casing or tubing shall be designed to accommodate the OD pipe tolerances as specified in ISO 11960.

**CAUTION — Manufacturers and users are reminded that the tolerances of casing and tubing outside diameters vary substantially between the various editions of ISO 11960 and API Spec 5CT. In general, the tolerance has increased over time; this can affect equipment interchangeability.**

#### **10.14.3.5 Cross-over connectors and restricted-area pack-offs**

Cross-over connectors and restricted-area pack-offs shall be designed to comply with 4.3.3.

#### **10.14.3.6 Test, vent, gauge and injection connectors**

Test, vent, gauge and injection connectors, located above the restricted-area pack-off in cross-over connectors, shall have a pressure rating equal to or greater than the highest rated working pressure.

### **10.14.4 Materials**

The following apply.

- a) Pressure-containing components that come into contact with internal fluids shall conform to the requirements of Clause 5.
- b) Structural and sealing members shall meet the manufacturer's written specification in accordance with 5.2.

### **10.14.5 Testing**

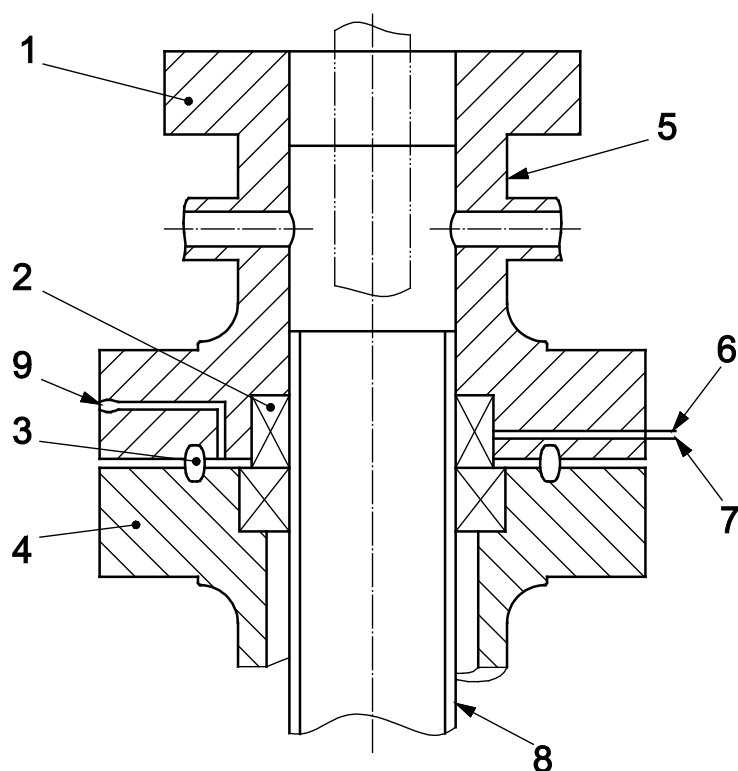
Cross-over connectors shall successfully complete the testing required and described in 7.4.9.

### **10.14.6 Marking**

Cross-over connectors shall be marked in accordance with Clause 8.

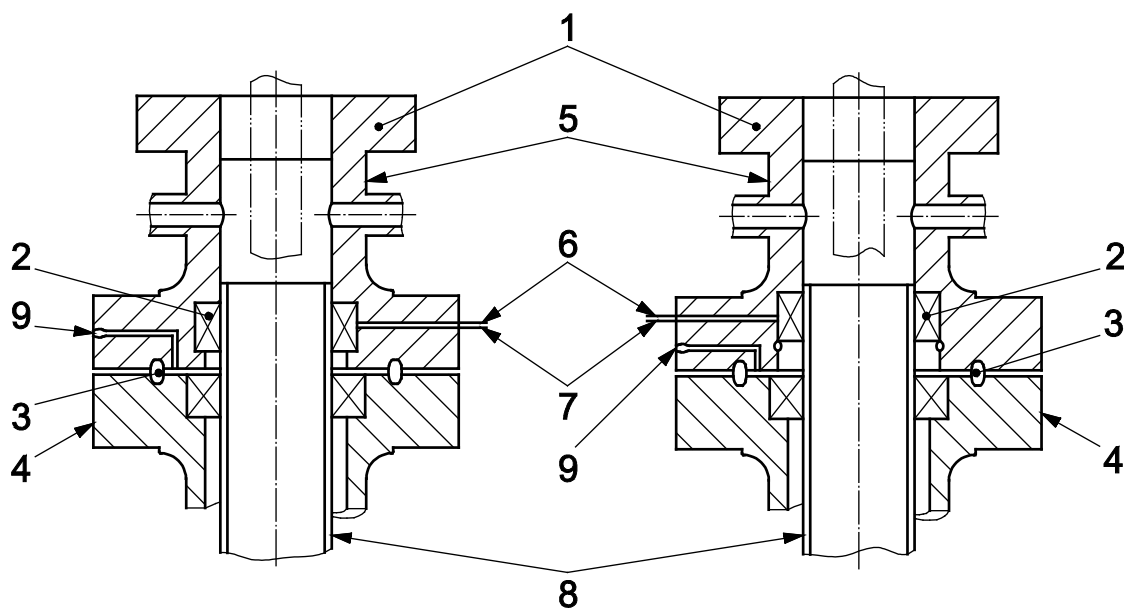
### **10.14.7 Storing and shipping**

All cross-over connectors shall be stored and shipped in accordance with Clause 9.

**Key**

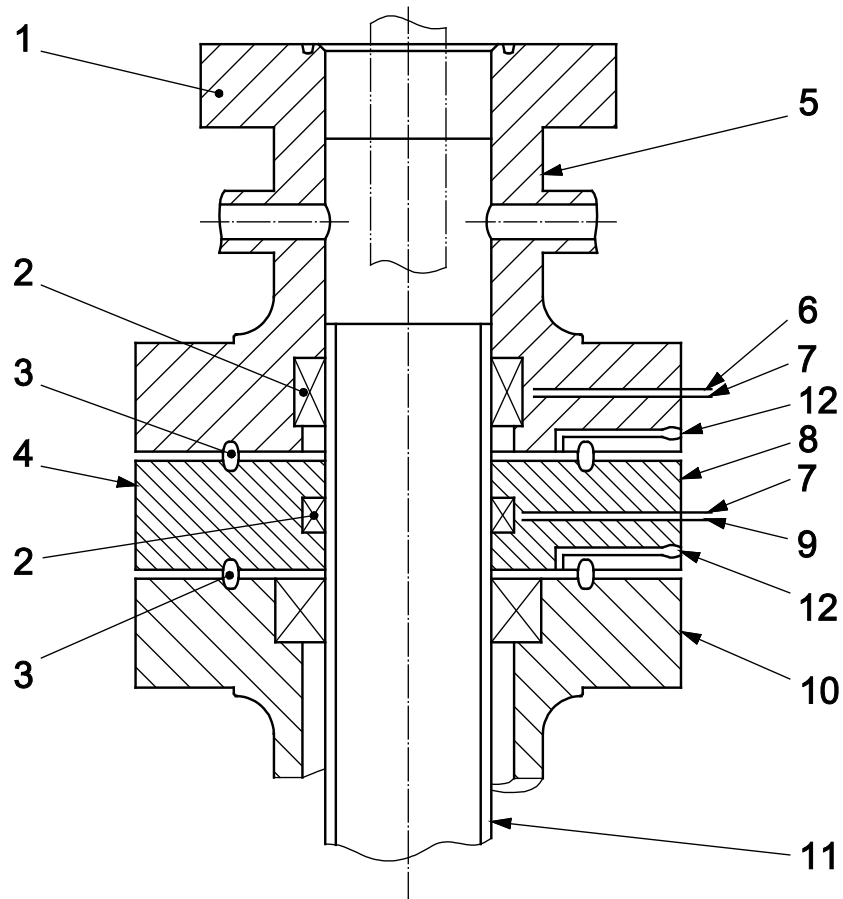
- |                                |                         |                         |
|--------------------------------|-------------------------|-------------------------|
| 1 upper connector of the spool | 4 lower connector       | 7 lower pressure rating |
| 2 restricted-area pack-off     | 5 spool                 | 8 inner casing          |
| 3 ring gasket                  | 6 upper pressure rating | 9 test port             |

**Figure 20 — Cross-over spool with restricted-area pack-off supported by the lower head**

**Key**

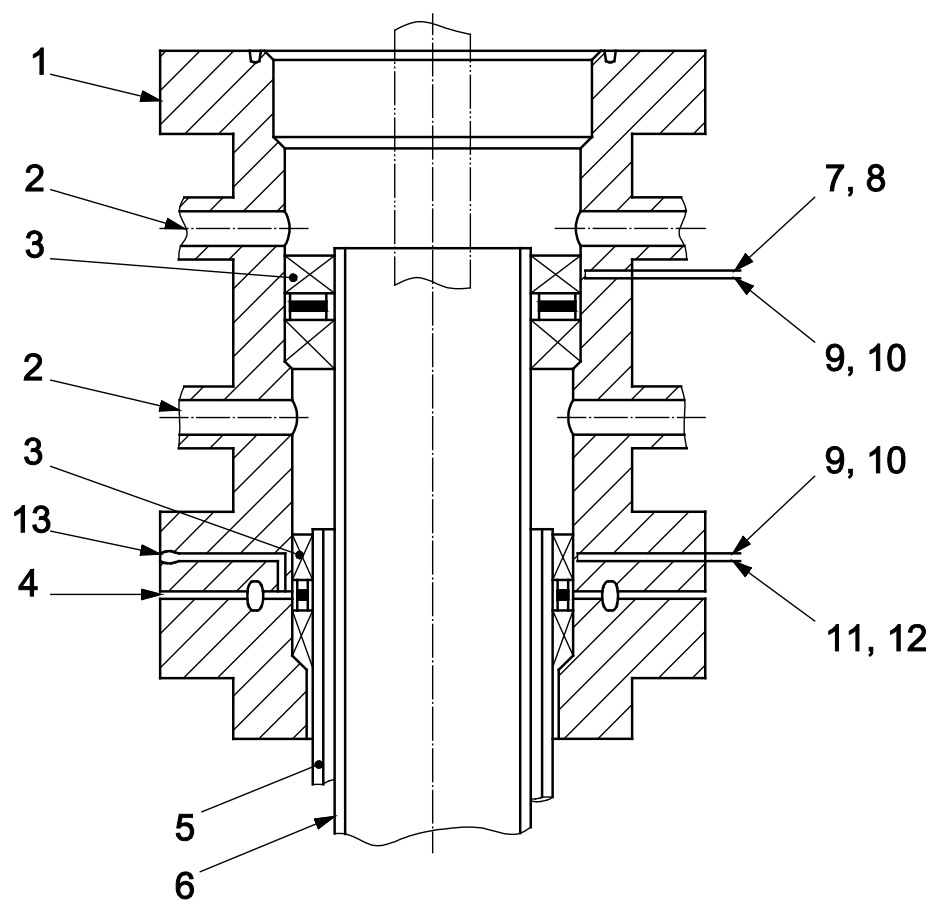
- |                                |                         |                         |
|--------------------------------|-------------------------|-------------------------|
| 1 upper connector of the spool | 4 lower connector       | 7 lower pressure rating |
| 2 restricted-area pack-off     | 5 spool                 | 8 inner casing          |
| 3 ring gasket                  | 6 upper pressure rating | 9 test port             |

**Figure 21 — Cross-over spool with restricted-area pack-offs supported by the upper spool**

**Key**

- |   |                              |    |                        |
|---|------------------------------|----|------------------------|
| 1 | upper connector of the spool | 7  | second pressure rating |
| 2 | restricted-area pack-off     | 8  | cross-over             |
| 3 | ring gasket                  | 9  | lower pressure rating  |
| 4 | second connector             | 10 | lower connector        |
| 5 | spool                        | 11 | inner casing           |
| 6 | upper pressure rating        | 12 | test port              |

**Figure 22 — Cross-over flange**

**Key**

- 1 upper connector of the spool
- 2 outlet
- 3 restricted-area pack-off
- 4 lower connector
- 5 inner string 1
- 6 inner string 2

- 7 stage 3
- 8 higher-pressure rating
- 9 stage 2
- 10 intermediate pressure rating
- 11 stage 1
- 12 lower-pressure rating
- 13 test port

**Figure 23 — Multi-stage cross-over spool****10.15 Adapter and spacer spools****10.15.1 General**

Adapter and spacer spools are wellhead sections that have no provision for suspension of tubular members, and that can have no provision for sealing of tubular members.

The following apply.

- a) Spacer spools have end connectors of the same size, rated working pressure and design.
- b) Adapter spools have end connectors of different sizes, pressure ratings and/or designs.

### 10.15.2 Design

The following apply:

a) rated working pressure:

The rated working pressure of the adapter or spacer spool shall be the lowest rating of the end and outlet connectors on the adapter.

b) end and outlet connectors:

End and outlet connectors may be flanged or studded in accordance with 10.1, threaded in accordance with 10.2, or have other end connectors in accordance with 10.18 or clamp hubs in accordance with ISO 13533.

### 10.15.3 Materials

Materials shall conform with Clause 5.

### 10.15.4 Testing

All adapter and spacer spools shall pass the tests of 7.4.9.

### 10.15.5 Marking

All adapter and spacer spools shall be marked in accordance with Clause 8.

### 10.15.6 Storing and shipping

All adapter and spacer spools shall be stored and shipped in accordance with Clause 9.

## 10.16 Actuators

### 10.16.1 General

Hydraulic, pneumatic and electric-powered actuators for wellhead and christmas tree equipment are covered in 10.16. These include single-acting and double-acting linear and limited-turn rotary actuators. If the actuator is supplied with the associated parts of the valve or choke (bonnet, stem, seals), these parts are considered part of the actuator and shall meet the requirements of 10.5 or 10.9, respectively. The actuator, if assembled with a valve prepared for an actuator, shall meet the requirements of 10.5.5.

### 10.16.2 Performance requirements

The upper limit of the rated temperature range for hydraulic and pneumatic actuators shall be at least 65 °C (150 °F). The upper limit of the rated temperature range for retained fluid-powered actuators shall be at least the upper-limit temperature rating of the mating equipment. Actuators shall be capable of performing as outlined in Table 91.

**Table 91 — Performance requirements for actuators**

Performance requirement level	Number of operating cycles
PR1	3
PR2	200

### **10.16.3 Design**

#### **10.16.3.1 General**

Actuators shall meet the requirements of Clause 4 in addition to the requirements in 10.16.3.2 to 10.16.3.8.

#### **10.16.3.2 Pressure**

Hydraulic and pneumatic actuators shall have a rated working pressure equal to or greater than the maximum pressure supplied by the actuation media. Actuators powered by well fluids shall be designed for both pressure and fluid compatibility. The hydrostatic test pressure condition shall be considered in the design. Pressure-containing parts of the actuator include components such as

- cylinder and cylinder closure,
- piston,
- diaphragm housing,
- stem.

These actuator parts shall contain either well fluids at or below full line pressure (retained fluid-powered) or control fluids (be pneumatically or hydraulically powered).

#### **10.16.3.3 Fluid connectors**

Fluid connectors shall be in accordance with 4.4.4. Pneumatically or hydraulically powered actuators may have connections smaller than  $\frac{1}{2}$  in line-pipe or NPT size.

#### **10.16.3.4 Material class**

Components shall be capable of functioning while subjected to test fluid consistent with the material classes specified in Table 3.

#### **10.16.3.5 Pressure relief**

In pneumatically operated actuators, a relief device shall be provided to relieve at no higher than the rated working pressure of the actuator. Actuators with maximum working pressures equal to or less than 0,2 MPa (30 psig) do not require a relief device. All actuators shall be designed to prevent pressure build-up within the actuator case due to leakage from the valve, choke or actuator.

#### **10.16.3.6 Electrical specifications**

Electrical components shall be in accordance with the requirements of API RP 14F or the applicable standards of IEC/CENELEC. Control latching (hold-open) power shall be in accordance with manufacturer's written specification. This should include end of valve or choke service life considerations. Thermal protection for the motor shall be provided.

#### **10.16.3.7 Actuation forces**

This should include considerations for the end of service life of the valve or choke. Actuator output forces shall meet or exceed the operating requirements specified by the valve or choke manufacturer.

#### **10.16.3.8 Interface requirements**

Components shall comply with applicable interface dimensions and other requirements specified by the valve manufacturer.

## **10.16.4 Materials**

### **10.16.4.1 Retained-fluid powered actuators**

Materials wetted by retained fluids and used in actuators connected to PSL 1 to PSL 4 valves or chokes shall be in accordance with 5.2 and 5.4.

### **10.16.4.2 Pneumatically or hydraulically powered actuators**

Metallic and non-metallic materials used in actuators exposed only to control fluids suitable for use with material class AA (Table 3) shall require written material specifications. The manufacturer's written specifications shall define the following:

- mechanical property requirements;
- chemical compositions;
- heat-treatment procedure.

Impact values shall be in accordance with 5.4.1 b), PSL 1 requirements.

### **10.16.4.3 Electric actuators**

Materials used for electric actuators shall conform to manufacturer's written specifications.

### **10.16.4.4 Traceability**

Pressure-containing parts of actuators having a maximum working pressure greater than 2,6 MPa (375 psig) require material traceability. Traceability is considered sufficient if the part can be traced to a job lot that identifies the included heat lot(s). All components in a multi-heat job lot shall be rejected if any heat lot does not comply with the manufacturer's written specifications. If heat-lot traceability is maintained, it is only necessary that non-complying heat lots be rejected. For retained-fluid powered actuators, traceability shall be in accordance with 7.4.2 for the applicable PSL.

### **10.16.4.5 Materials for sulfide stress cracking service**

Actuators powered by well fluids or control fluids that can cause sulfide stress cracking shall meet the requirements of 7.4.1.

### **10.16.4.6 Non-metallic sealing elements**

#### **a) General**

Non-metallic seal materials shall be capable of withstanding the maximum working pressure within the temperature rating specified by the manufacturer, and shall be compatible with the designated service.

#### **b) Elastomeric materials**

Sealing elements shall be controlled in accordance with 7.4.8.

### 10.16.5 Welding requirements

The following apply:

a) retained-fluid powered actuators:

Welding on pressure-containing parts of well-fluid powered actuators connected to PSL 1 to PSL 3 valves or to PSL 1 to PSL 3 chokes shall be in accordance with 6.3 and 6.4 for the appropriate PSL. Welding is not permitted on actuators connected to PSL 4 valves or chokes.

b) pneumatic, hydraulic or electric actuators:

Welding on parts that meet material class AA (Table 3) criteria shall be in accordance with 6.3, except that quality-control requirements shall be visual examination for fabrication welds. Repair welds shall include liquid-penetrant or magnetic-particle examination, as applicable, for material defects only.

### 10.16.6 Testing

#### 10.16.6.1 Hydrostatic testing

Pressure-containing parts shall be subjected to a hydrostatic test to demonstrate structural integrity. The pressure-containing parts may be hydrostatically tested simultaneously or separately. In case the bonnet for the mating valve forms an integral part of a loose actuator, the bonnet shall satisfy the requirements of 10.5 and 10.9. It is not necessary to test stems separately.

Water with or without additives, gas or hydraulic fluid may be used as the testing fluid.

The following apply:

a) retained-fluid powered actuators:

The test pressure shall be determined by the working pressure rating for the valve or choke to which the actuator is attached. Tests shall be conducted in accordance with the hydrostatic body test (see 7.4.9) for the applicable PSL.

b) pneumatic, hydraulic or electric actuators:

For actuators with a maximum working pressure less than or equal to 138 MPa (20 000 psi), the test pressure shall be a minimum of 1,5 times the maximum working pressure. For actuators with a maximum working pressure greater than 138 MPa (20 000 psi), the test pressure shall be a minimum of 1,25 times the maximum working pressure. The test shall consist of three parts:

- primary pressure-holding period;
- reduction of the pressure to zero;
- secondary pressure-holding period.

Both pressure-holding periods shall not be less than 3 min. The test period shall not begin until the test pressure has been reached and has stabilized, the equipment and the pressure-monitoring device have been isolated from the pressure source, and the external surfaces of the parts have been thoroughly dried.

c) acceptance criteria:

The equipment shall show no visible leakage during each holding period.

### 10.16.6.2 Functional testing

Each actuator shall be subjected to a functional test to demonstrate proper assembly and operation. The actuator may be tested with the equipment for which it is intended, or tested separately. Test media for pneumatic actuators shall be a gas, such as air or nitrogen. Test media for hydraulic actuators shall be a suitable hydraulic fluid or a gas, such as air or nitrogen. Test power supplied to electric actuators shall be in accordance with the electrical design requirements.

The following apply:

a) test for hydraulic and pneumatic actuator seal:

The actuator seals shall be pressure-tested in two steps by applying pressures of 20 % and 100 % of the maximum working pressure to the actuator. No visible leakage is allowed. The minimum test duration for each test pressure shall be 10 min at 20 % pressure and 5 min at 100 % pressure for pneumatic actuators and 3 min at each test pressure for hydraulic actuators. This test period shall not begin until the test pressure has been reached and has stabilized, and the pressure-monitoring device has been isolated from the pressure source. The test pressure reading and time at the beginning and at the end of each pressure-holding period shall be recorded.

b) operational test:

The actuator shall be tested for proper operation by cycling the actuator, from the normal position to the fully stroked position, a minimum of three times. The actuator shall operate smoothly in both directions and without noticeable stick-slip or chattering behaviour. The final assembly of actuator to valve or choke shall be tested in accordance with 7.4.9 for the appropriate PSL of the equipment. The latching (hold-open) mechanism power requirements for electric actuators shall be tested during the tests required by 7.4.9.

c) gas back-seat test:

If the bonnet and actuator are furnished as a unit for PSL 4 valves, a test shall be conducted in accordance with 7.4.9.6.8. If the bonnet and actuator are furnished as a unit for PSL 3G valves, a test may be conducted in accordance with 7.4.9.5.9.

### 10.16.7 Marking

All actuators shall be marked in accordance with the requirements of Clause 8.

### 10.16.8 Storage and shipping

#### 10.16.8.1 Retained-fluid powered actuators

These shall be stored and shipped in accordance with the requirements of Clause 9 for the applicable PSL.

#### 10.16.8.2 Pneumatic, hydraulic and electric actuators

These shall be stored and shipped in accordance with the following:

a) draining after testing (does not apply to electric actuators):

Actuators shall be drained and lubricated after testing and prior to storage or shipment.

b) rust prevention:

Prior to shipment, exposed metallic surfaces of parts and equipment shall be protected with a rust preventative that does not become fluid and run at a temperature less than 50 °C (125 °F). Inherently corrosion-resistant materials do not require protection.

## c) sealing-surface protection:

Exposed sealing surfaces shall be protected from mechanical damage during shipping.

## d) drawings and instructions:

The manufacturer shall furnish to the purchaser suitable drawings and instructions concerning field assembly and maintenance of actuators, if requested.

## 10.17 Packing mechanisms for lock screws, alignment pins and retainer screws

### 10.17.1 General

This International Standard is not applicable to lock screws, alignment pins and retainer screws. The packing mechanisms, however, shall be capable of maintaining a leak-tight seal at the rated working pressure of the head.

### 10.17.2 Performance requirements

These products shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 92.

**Table 92 — Performance requirements for packing mechanisms for lock screws, alignment pins and retainer screws**

Performance requirement level	Pressure integrity <sup>a</sup>
PR1	1 cycle
PR2	3 cycles
<sup>a</sup> Shall seal maximum rated pressure internally.	

### 10.17.3 Design

The following apply:

## a) tubing-head requirement:

Lock screws, if installed in tubing heads, shall have adequate number, size and strength to hold a load equivalent to the working pressure of the spool acting on the full area of the largest tubing-hanger primary seal.

## b) penetrations:

This International Standard is not applicable to the design of lock-screw penetrations. However, if such penetrations are made in flanged connectors as specified in this International Standard, it is the responsibility of the manufacturer to ensure that the penetrations do not cause the flange stresses to exceed the design allowables.

## c) trapped pressure:

A means shall be provided in the wellhead installation such that any pressure behind a lock screw, alignment pin and retainer screw can be vented prior to release.

## 10.18 Other end connectors

### 10.18.1 General

Other end connectors (OECs) that may be used for joining pressure-containing or pressure-controlling equipment and whose dimensions are not specified in this International Standard are covered in 10.18.

### 10.18.2 Performance requirements

These products shall meet the general requirements of 4.1 and shall be capable of performing as outlined in Table 93.

**Table 93 — Performance requirements for other end connectors**

Performance requirement level	Pressure integrity <sup>a</sup>	Bending moments	Make-and-break
PR1	1 cycle	b	c
PR2	3 cycles	b	c
<sup>a</sup> Shall seal maximum rated pressure internally. <sup>b</sup> Shall withstand manufacturer's rated bending moments, if applicable. <sup>c</sup> Shall withstand manufacturer's make-and-break cycles, if applicable.			

### 10.18.3 Design

The following apply:

a) general:

OECs shall be designed in accordance with 4.3.3 and 4.3.4, as appropriate.

b) nominal size and pressure rating:

OECs shall be designed with the same nominal sizes and pressure ratings shown in 10.1, or if appropriate, the sizes shown in 10.2.

c) dimensions:

There are no dimensional requirements for OECs except as in b) above.

### 10.18.4 Materials

OEC materials shall meet the requirements of Clause 5.

### 10.18.5 Testing

Equipment that utilizes OECs shall successfully complete the tests required in 7.4.9 and the appropriate subclause of Clause 10. It is not necessary to test loose OECs.

### 10.18.6 Marking

OECs shall be marked in accordance with Clause 8.

### **10.18.7 Storing and shipping**

OECs shall be stored and shipped in accordance with Clause 9.

## **10.19 Top connectors**

### **10.19.1 General**

Top connectors that provide access to the christmas tree bore are covered in 10.19. Lift threads in top connectors are not designed for pressure containment and shall be used for lifting purposes only. This International Standard is not applicable to these lift threads.

### **10.19.2 Design**

The following apply.

- a) Top connectors shall be designed to satisfy the service conditions specified in 4.2.
- b) Top connectors shall be designed to satisfy the requirements of 4.3.3 and 4.3.5.
- c) Top connectors shall conform to the requirements of 4.4, 4.5, 4.6 and 4.7.
- d) A means shall be provided such that any pressure underneath the top connector can be vented prior to top connector release.

### **10.19.3 Materials**

The following apply.

- a) Pressure-containing components of the top connector that come into contact with internal fluids shall conform to all the requirements of Clause 5.
- b) Structural and sealing members of the top connector, such as caps, collars, hammer nuts, clamps and bolting, shall meet the manufacturer's written specification in accordance with 5.2.

### **10.19.4 Dimensions**

The following apply.

- a) Top connectors that use end connectors as specified in this International Standard shall conform to the requirements of 10.1, 10.2 and 10.4.
- b) Top connectors that use other end connectors shall conform to the requirements of 10.18.
- c) For recommended dimensions of cap, collar and upper connection of the top connector, see Annex K.

### **10.19.5 Welding**

The following apply.

- a) Any welding performed on the pressure-containing parts of the top connector shall conform to the requirements of 6.3 and 6.4.
- b) Any welding performed on the structural members of the top connector shall conform to the requirements of 6.2.

### 10.19.6 Quality control

The following apply.

- a) Quality-control requirements for pressure-containing parts of the top connector shall conform to the requirements of 7.4.2.
- b) Quality-control requirements for structural members of the top connector shall conform to the requirements of 7.4.7 (studs and nuts).

### 10.19.7 Hydrostatic testing

Top-connector assemblies shall be tested in accordance with 7.4.9 (see Table 31). Acceptance criteria shall be in accordance with 7.4.9.3.3.

### 10.19.8 Marking

Marking shall conform with Clause 8.

### 10.19.9 Storage and shipping

Top connectors shall be stored and shipped in accordance with the requirements of Clause 9.

## 10.20 Surface and underwater safety valves and actuators

### 10.20.1 General

Safety valves and actuators used in the secondary master position in surface and underwater wellhead applications are covered in 10.20. Safety valves are non-threaded, actuated valves designed to close on loss of power supply. Included are complete assemblies, valves adapted for actuators, actuators and heat-sensitive lock-open devices.

The following apply:

- a) valves:

Safety valves shall meet the requirements defined in 10.5 for PR2 and those specified for PSL 2 as a minimum. Safety valves shall meet the performance requirements specified in Annex I and those shown in Table 94.

**Table 94 — Operating cycle requirements for safety valves**

Class	Operating cycles requirements <sup>a</sup>	
	Number of cycles	Medium
I	500	Water or other suitable fluid
II	500	2 % sand slurry mixture
<sup>a</sup> See 10.20.4.3 a).		

- b) actuators:

Actuators shall meet the minimum performance requirements of 10.16.2.

## 10.20.2 Design

### 10.20.2.1 General

Surface safety valves (SSV) and underwater safety valves (USV) designed and manufactured in accordance with this International Standard shall be constructed of materials in accordance with Clause 5 and shall perform satisfactorily in the tests required by 10.20.4. The SSV/USV shall be of a normally closed design. The SSV/USV shall be designed to operate, without damage to the SSV/USV valve or SSV/USV actuator, when SSV/USV energy is instantaneously applied or lost under any condition of SSV/USV valve-body pressure within its pressure rating. Design criteria for USVs shall also include maximum water depth. If grease or sealant is required in the SSV/USV valve body or stem area, provisions shall be made for injecting the grease or sealant without reducing the pressure in the SSV/USV valve.

### 10.20.2.2 SSV valve design

Flanged end valves, or valves with other end connections, non-threaded and multiple or block-type valves used as surface safety valves are covered in 10.20.

A multiple or block-type valve qualifies as a wellhead SSV for performance requirement PR2 and Annex I class I or II service, without validation testing, if it is of the same internal design as an SSV valve within the manufacturer's product line which has passed the validation test in Annex I. Such valves shall be manufactured and supplied in accordance with all other applicable requirements of this International Standard.

### 10.20.2.3 USV valve design

USV valve designs shall meet the requirements for SSV valve design, with the following exceptions:

- USV valves may use end connections as specified in ISO 13628-4.
- USVs may be of non-standard bores and/or face-to-face lengths. End connections shall meet all other requirements of this International Standard. Reduced-opening USV flow ports should be sized after consideration of through-flowline (TFL) operations, as specified in ISO 13628-3.

### 10.20.2.4 Actuator design

Actuators shall meet the requirements of 10.16.3. The actuator closing force shall be sufficient to close the SSV/USV valve when it is at the most severe design-closing condition specified by the valve manufacturer. Internal components shall be resistant to environmental corrosion, the operation medium, and the wellstream fluid, to which it can be exposed under normal operation conditions. Permanently attached lock-open features are not permitted on SSV actuators.

### 10.20.2.5 Heat-sensitive lock-open devices

Heat-sensitive lock-open devices shall maintain the SSV valve in the fully open position at atmospheric temperatures up to 65 °C (150 °F) with the SSV valve body pressurized to its rated working pressure and the SSV actuator cylinder bled to atmospheric conditions. The lock-open device shall be designed such that any component part released upon actuation of the device shall not present itself as a potential hazard to personnel. The following temperature actuation conditions shall be met.

- a) The lock-open device shall allow the SSV valve to automatically close from SSV actuator forces alone (i.e. no pressure in the SSV valve body or energy supply to the SSV actuator cylinder) within 6 min after being subjected to, and maintained in, a controlled environmental temperature of 540 °C ± 14 °C (1 000 °F ± 25 °F).
- b) Eutectic materials used shall meet the manufacturer's design requirements for fusing within a temperature range of ± 10 % around the nominal melting point. The heat-sensitive device shall be designed to actuate at a maximum sustained temperature of 200 °C (400 °F).

### **10.20.3 Material**

The following apply:

a) valves:

Materials for pressure-containing and pressure-controlling parts shall comply with Clause 5.

b) actuators:

Materials for SSV/USV actuators shall meet the requirements of 10.16.4.

### **10.20.4 Testing**

#### **10.20.4.1 Drift test**

All assembled safety valves or safety valves adapted for actuators with simulated bonnets shall pass a drift test as described in 7.4.9.3.1.

#### **10.20.4.2 Other testing**

All assembled safety valves or safety valves adapted for actuators with simulated bonnets shall pass all applicable tests required and described in 7.4.9, as a minimum. All test data shall be recorded on a test data sheet similar to that shown in Figure 24.

#### **10.20.4.3 Validation testing**

The following apply:

a) class I and II service:

To validate a specific PR2 standard service valve for a SSV/USV design, the manufacturer shall satisfy the class I or class II test in accordance with Annex I.

b) test requirements:

Any significant change in the design or materials of construction that can affect the SSV/USV valve-bore sealing mechanism shall require re-qualification by validation testing. Qualification of an SSV qualifies a USV with the same SSV valve-bore sealing mechanism and vice versa. The valve may be tested with or without the actuator.

c) test agency:

To validate a specific class II SSV/USV design, the manufacturer shall submit an SSV/USV of the same basic design and materials of construction to a test agency (3.1.119). Validation testing at a test agency is not required for SSV/USV equipment other than valve bore sealing mechanisms, class II, sandy service.

The test agency and test report number for class II SSV/USV valves shall be identified in the shipping report, as shown in Figure 25.

#### **10.20.4.4 Validation testing of heat-sensitive lock-open devices**

Tests to confirm the design requirements of 10.20.2.5 shall be done in an air environment with air velocity past the SSV actuator due to natural air convection only. The manufacturer shall have data available to show that the device has been sufficiently tested to ensure that it is capable of satisfying the design requirements.

### **10.20.5 Marking**

SSV/USV valves and actuators shall be marked in accordance with Table 39 and 8.5.

### **10.20.6 Storage and shipping**

The following apply:

a) valves:

All SSV/USV valves shall be stored and shipped in accordance with Clause 9.

b) actuators:

All SSV/USV actuators shall be stored and shipped in accordance with 10.16.8.

c) all assembled SSV/USV:

All assembled SSV/USV shall be stored and shipped in accordance with Clause 9.

### **10.20.7 Quality control records requirements**

#### **10.20.7.1 General**

Record requirements for SSV/USV valves shall be in accordance with 7.5 and the additional requirements given in 10.20.7.2 and 10.20.7.3.

#### **10.20.7.2 Records furnished to purchaser**

The following shall be furnished to the purchaser:

a) functional test data sheet:

Each SSV/USV shall be delivered to the purchaser with a completed SSV/USV functional test data sheet in accordance with Figure 24.

b) shipping report:

A report in accordance with Figure 25 shall be furnished to the purchaser.

c) operating manual:

An operating manual meeting the requirements of 10.20.7.3 shall be furnished to the purchaser.

<b>SSV/USV functional test data sheet (example)</b>			
<b>SSV/USV valve data:</b>			
Manufacturer _____			
Valve catalog or model No. _____		Serial No. _____ Size _____	
Rated working pressure _____		Temperature class _____	
Valve bore _____		Material class _____ PSL _____ PR2 class _____	
Class II SSV/USV valve performance test agency _____			Test report No. _____
<b>SSV/USV actuator data:</b>			
Manufacturer _____			
Actuator catalog or model No. _____		Serial No. _____ Size _____	
Rated working pressure _____		Temperature rating _____	
Material class _____		PSL _____ PR 2 class _____	
Functional test data:			
<b>I. SSV/USV actuator seal test</b> _____		Performed by _____	
Pneumatic _____		Hydraulic _____	
At 20 % of working pressure rating			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
At 100 % of working pressure rating			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
<b>II. Drift check</b>			
Drift mandrel OD _____			
Visual inspection _____		Performed by _____	
<b>III. SSV/USV actuator operational test</b> _____		Performed by _____	
Number of cycles completed _____			
<b>IV. SSV/USV valve body and bonnet hydrostatic test performed by</b> _____			
Required test pressure _____			
Primary pressure-holding period			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
Secondary pressure-holding period			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
<b>V. SSV/USV valve seat test performed by</b> _____			
SSV/USV valve type: Unidirectional _____		Bidirectional _____	
Required test pressure _____			
Primary seat test (pressure applied from downstream end)			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
Secondary seat test (pressure applied from downstream end)			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
Tertiary seat test (pressure applied from downstream end)			
Beginning time _____		Test gauge pressure reading _____	
Ending time _____		Test gauge pressure reading _____	
Certified by _____		Company _____	
Title _____		Date _____	

Figure 24 — Example of an SSV/USV functional test data sheet

Surface safety valve or underwater safety valve shipping report (example)		
<b>SSV/USV valve data:</b>		
Manufacturer _____		
Catalogue or model No. _____	Serial No. _____	Size _____
Working pressure rating _____	Temperature rating: Max. _____	Min. _____
Material class _____	PSL _____	PR2 class _____
Date of manufacture (month and year) _____		
Class II SSV/USV valve performance test agency _____		Test report No. _____
<b>SSV/USV actuator data:</b>		
Manufacturer _____		
Catalogue or model No. _____	Serial No. _____	Size _____
Working pressure rating _____	Temperature rating: Max. _____	Min. _____
Material class _____	PSL _____	
Date of manufacture (month and year) _____		
Customer _____	Purchase order No. _____	
Function test date _____	Shipment date _____	
Inspected by _____		

**Figure 25 — Example of a surface safety valve or underwater safety valve shipping report**

### 10.20.7.3 Minimum contents of manufacturer's operating manual

#### 10.20.7.3.1 Design information

The following minimum design information shall be included:

- type, model and size for which the manual is applicable;
- performance requirements for which these types, model, and sizes are suitable;
- temperature and working pressure ranges for which the unit(s) are designed;
- drawings and illustrations giving dimensional data of unit(s), as required, for installation or operation;
- parts list.

#### 10.20.7.3.2 Inspection and testing

The following minimum inspection and testing information shall be included:

- checklist for visual inspection prior to hook-up;
- written and graphic instructions for field hook-ups;
- appropriate test procedures.

#### 10.20.7.3.3 Installation

Proper installation methods shall be clearly written and illustrated as necessary. Any necessary preliminary lubrication or greasing shall be specified in detail. Warnings to indicate potential danger to personnel or cautions to indicate potential danger to equipment shall be clearly marked "Warning" or "Caution".

#### **10.20.7.3.4 Operation and maintenance**

The following minimum operation and maintenance information shall be included:

- a) maintenance requirements, including recommended intervals of maintenance;
- b) proper operating techniques;
- c) disassembly and assembly instructions;
- d) assembly diagram showing individual parts in proper relationship to one another;
- e) repair instructions and precautions, including a chart listing symptoms, probable cause(s) of the problem, and repairs necessary.

#### **10.20.7.3.5 Repair and remanufacture**

Requirements for repair and remanufacture of SSV/USV equipment shall be included, as specified in Annex J.

#### **10.20.7.4 Failure reporting**

After receiving a failure report from the operator, the manufacturer of the SSV/USV equipment shall respond within six weeks of receipt, describing progress in the failure analysis. The manufacturer shall also notify the operator in writing of the final results of the analysis and the corrective action. If the failure analysis causes the equipment manufacturer to change the design, assembly, or operating procedures of a model of equipment, the manufacturer shall, within 30 days of such changes, report them in writing to all purchasers and known operators of equipment having potential problems.

### **10.21 Bullplugs**

#### **10.21.1 General**

Bullplugs shall meet the applicable requirements specified for loose connectors.

#### **10.21.2 Design**

##### **10.21.2.1 General**

The materials and design of bullplugs and threaded connections shall be considered in determining the working pressure and external load capacity.

##### **10.21.2.2 Dimensions**

Bullplugs shall conform to the dimensions and tolerances in Table 95\*. Threaded connections shall conform to 10.2. This International Standard is not applicable to bullplugs smaller than 1/2 in line pipe or NPT size and larger than 4 in line pipe size.

##### **10.21.2.3 Rated working pressure**

The maximum rated working pressure for bullplugs with line pipe or NPT threads 12,7 mm to 50,8 mm (1/2 in to 2 in) shall be as specified in Table 1. This International Standard is not applicable to bullplugs of stronger materials, larger thread dimensions and/or larger designs which are rated for higher working pressures.

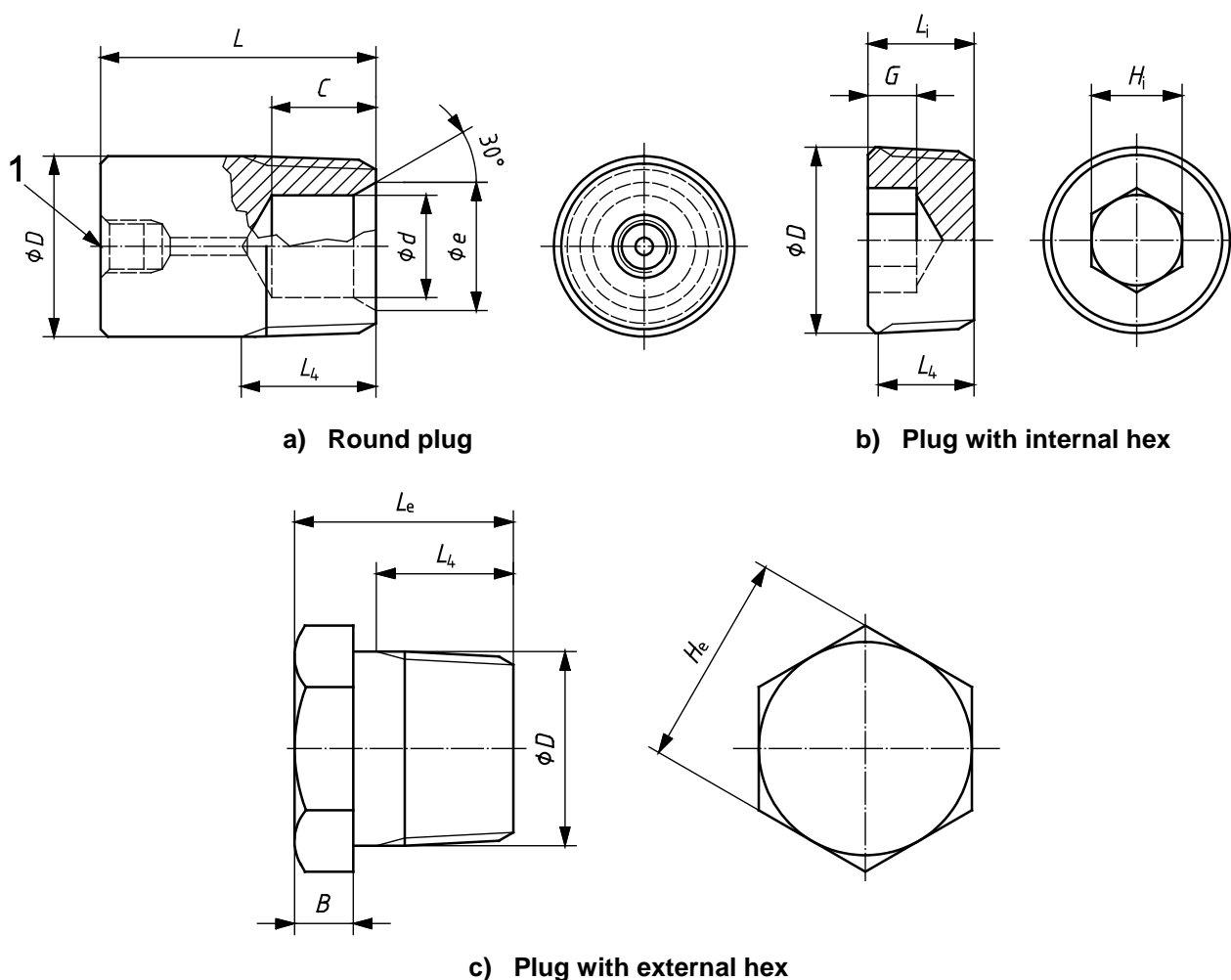
### 10.21.2.4 Thread engagement

Threaded connections shall comply with 10.2. Bullplugs with API Spec 5B line pipe threads shall be assembled with mating parts in conformance with Table 96. Thread compounds tested in accordance with ISO 13678 shall be used.

### 10.21.3 Materials

Bullplug material shall, as a minimum, meet the requirements of 5.2, PSL 3 and 5.4, PSL 3. Material shall be in accordance with material designation 60K for 13,8 MPa (2 000 psi) to 69,0 MPa (10 000 psi) working pressure. Bullplugs shall be material class DD, FF or HH. This International Standard is not applicable to bullplugs and threaded connections with components of less than material designation 60K.

**Table 95 — Bullplugs**  
(see Annex B for USC units)



#### Key

1 test or gauge port (optional)

NOTE See API Spec 5B for thread dimensions and tolerances.

**Table 95 (continued)**

Dimensions in millimetres unless otherwise indicated

Nominal thread size (in)	All bullplugs					Round plugs	Plugs with external hex			Plugs with internal hex		
	Diameter of round <i>D</i>	Minimum length of thread to vanish point <i>L<sub>4</sub></i>	Depth of counter-bore <sup>a</sup> <i>C</i>	Diameter of counter-bore <sup>b</sup> <i>d</i>	Diameter of chamfer <sup>k</sup> <i>e</i>	Overall length <sup>b</sup> <i>L</i>	Hex size (across flats) <i>H<sub>e</sub></i>	Height of hex <sup>b</sup> <i>B</i>	Length of plug with external hex <sup>b</sup> <i>L<sub>e</sub></i>	Internal hex size <i>H<sub>i</sub></i>	Depth of hex <sup>b</sup> <i>G</i>	Length of plug with internal hex <sup>b</sup> <i>L<sub>i</sub></i>
1/2	21,43 <sup>c</sup>	19,85	None	None	None	51,0	22,2 <sup>e</sup>	7,9	28,7	9,7 <sup>h</sup>	7,9	25,4
3/4	26,59 <sup>c</sup>	20,15	None	None	None	51,0	27,0 <sup>f</sup>	9,7	31,8	14,2 <sup>i</sup>	7,9	25,4
1	33,34 <sup>d</sup>	25,01	None	None	None	51,0	34,9 <sup>g</sup>	9,7	35,1	16,0 <sup>j</sup>	9,7	25,4
1 1/4	42,07 <sup>d</sup>	25,62	27,0	22,4	None	51,0	—	—	—	—	—	—
1 1/2	48,42 <sup>d</sup>	26,04	27,0	25,4	None	51,0	—	—	—	—	—	—
2	60,33 <sup>d</sup>	26,88	64,0	41,0	50,8	102,0	—	—	—	—	—	—
2 1/2	73,03 <sup>d</sup>	39,91	41,5	44,5	None	102,0	—	—	—	—	—	—
3	88,90 <sup>d</sup>	41,50	41,5	57,2	None	102,0	—	—	—	—	—	—
3 1/2	101,60 <sup>d</sup>	42,77	44,5	69,9	None	102,0	—	—	—	—	—	—
4	114,30 <sup>d</sup>	44,04	44,5	76,2	None	102,0	—	—	—	—	—	—
<sup>a</sup> Tolerance ± 0,5. <sup>e</sup> Tolerance 0 / -0,64 <sup>i</sup> Tolerance 0 / -0,13 <sup>b</sup> Tolerance +1,0 / 0 <sup>f</sup> Tolerance 0 / -0,79 <sup>j</sup> Tolerance 0 / -0,15 <sup>c</sup> Tolerance +0,20 / 0 <sup>g</sup> Tolerance 0 / -1,04 <sup>k</sup> Tolerance +0,5 / 0 <sup>d</sup> Tolerance +0,25 / 0 <sup>h</sup> Tolerance 0 / -0,10												

**Table 96 — Recommended bullplug installation procedure**

Size (in)	Minimum recommended turns past hand-tight condition <sup>a</sup>
1/2, 3/4 and 1	1 1/2
2 through 4	2
Thread compounds tested in accordance with ISO 13678 shall be used and shall be in serviceable condition in order to provide leak-free performance.	
<sup>a</sup> Recommended turns past hand-tight is normally sufficient to contain rated working pressure and test pressures up to 103,5 MPa. However, re-tightening up to an additional one or two turns may be required in some cases.	

#### 10.21.4 Coating

Bullplug threads shall be coated to minimize galling and develop maximum leak resistance. The threads shall be gauged after coating.

#### 10.21.5 Quality control

Product specification levels are not applicable to bullplugs. The quality control requirements shall be in accordance with Table 38.

### **10.21.6 Marking**

Bullplugs shall be marked in accordance with 8.11.

### **10.21.7 Storing and shipping**

Bullplugs shall be stored and shipped in accordance with Clause 9.

## **10.22 Valve-removal plugs**

### **10.22.1 General**

Valve-removal preparations and valve-removal plugs are specified in 10.22 and Annex L. There are four sizes and two pressure ratings.

Valve-removal plugs in this International Standard are not designed for use with test and blind flanges manufactured with the standard dimensions of 10.1.

### **10.22.2 Design**

Internal pressure-relief check valves, internal threaded connections and other internal devices are permitted for valve-removal plugs but are not specified in this International Standard.

### **10.22.3 Dimensions**

Dimensions of valve-removal plugs and dimensions for valve-removal plug preparations in bodies shall be in accordance with Annex L.

### **10.22.4 Materials**

Valve-removal-plug body material shall, as a minimum, meet the requirements of 5.2, PSL 3 and 5.4, PSL 3. Material shall be in accordance with material designation 60K for 13,8 MPa (2 000 psi) to 69,0 MPa (10 000 psi) working pressure and 75K for 103,5 MPa (15 000 psi) to 138,0 MPa (20 000 psi) working pressure. Valve-removal plugs shall be material class DD, FF or HH. This International Standard is not applicable to valve removal plugs of less than material designation 60K.

### **10.22.5 Coating**

VR plug threads shall be coated to minimize galling and develop maximum leak resistance. The threads shall be gauged after coating.

### **10.22.6 Quality control**

Product specification levels are not applicable to valve-removal plugs. The quality-control requirements shall be in accordance with Table 38. Pressure testing is not required for valve-removal preparations and valve-removal plugs.

### **10.22.7 Marking**

Marking shall be in accordance with 8.10.

### **10.22.8 Storing and shipping**

Valve-removal plugs shall be stored and shipped in accordance with Clause 9.

## **10.23 Other pressure-boundary penetrations**

### **10.23.1 General**

Other pressure-boundary penetrations shall be capable of maintaining a leak-tight seal at the rated working pressure and temperatures.

### **10.23.2 Performance requirements**

Other pressure-boundary penetrations shall be capable of meeting the general requirements of 4.1 and, when installed in equipment, shall be capable of performing their intended function to applicable PR1 or PR2 requirements for the equipment in which they are used.

### **10.23.3 Design**

This International Standard is not applicable to the design of other pressure-boundary penetrations. However, it is the responsibility of the manufacturer to specify other pressure-boundary penetrations that have been qualified to meet performance requirements.

### **10.23.4 Materials**

Body material shall meet the requirements of the manufacturer's written specifications and shall be compatible with the well fluid.

### **10.23.5 Marking**

There are no marking requirements.

### **10.23.6 Storing and shipping**

Storing and shipping shall be in accordance with Clause 9.

## **10.24 Back-pressure valves**

### **10.24.1 General**

Back-pressure valves shall meet the applicable requirements of tubing hangers.

### **10.24.2 Design**

See 10.21.2.

### **10.24.3 Materials**

Body material shall, as a minimum, meet the requirements of 5.3, PSL 3 tubing hangers. Material for other parts shall be in accordance with the manufacturer's written specifications.

### **10.24.4 Quality control**

Product specification levels are not applicable to back-pressure valves. The quality control requirements shall be in accordance with Table 38.

### **10.24.5 Marking**

Marking shall be in accordance with 8.12.

**10.24.6 Storing and shipping**

Storing and shipping shall be in accordance with Clause 9.

**11 Repair and remanufacture**

Requirements for repair and remanufacture are specified in Annex J.

## **Annex A**

### **(informative)**

## **Purchasing guidelines**

### **A.1 General**

Annex A provides guidelines for enquiry and purchase of wellhead and christmas tree equipment. These guidelines consist of data sheets for completion by the purchaser, a series of typical wellhead and christmas tree configurations, and a decision tree for determining product specification levels. An electronic, revisable form of each data sheet can be accessed by clicking on the figure title, as indicated.

The data sheets are designed to perform two functions:

- a) assist the purchaser in deciding what he wants;
- b) assist the purchaser in communicating his particular needs and requirements, as well as information on the well environment, to the manufacturer for his use in designing and producing equipment.

To use this annex, a copy of the data sheets should be completed as accurately as possible. The typical configurations should be referred to, as needed, to select the required equipment. The decision tree, given in Figure A.14, together with its instructions, provides the recommended practice as to which PSL each piece of equipment should be manufactured. A copy of the data sheet should then be attached to the purchase order or request for proposal.

### **A.2 Data sheets**

The following pages contain questions and information that can be used to select wellhead equipment, including chokes and actuators. Figure A.1 contains general information that pertains to the entire well. Figures A.2 to A.11 are designed for use with each type of equipment.

The effects of external loads (i.e. bending moments, tensions, etc.) on the assembly of components are not explicitly addressed by this International Standard (see 4.2.1.3). The purchaser should specify any exceptional loading configuration.

The purchaser should specify whether the design validation procedures in Annex F are applicable.

### **A.3 Typical wellhead and christmas tree configurations**

Examples of typical wellhead and christmas tree configurations are shown in Figures A.12 and A.13. Also included are examples of casing and bit programmes that are consistent with the wellheads shown.

### **A.4 Product specification levels**

#### **A.4.1 General**

Product specification level (PSL) 1 includes practices currently being implemented by a broad spectrum of the industry for service conditions recommended in this annex.

PSL 2 includes all the requirements of PSL 1 plus additional practices currently being implemented by a broad spectrum of the industry for a specific range of service conditions, as described in this annex.

PSL 3 includes all the requirements of PSL 2 plus additional practices currently being implemented by a broad spectrum of the industry for a specific range of service conditions, as described in this annex.

PSL 3G includes all the requirements of PSL 3 plus additional practices currently being implemented by a broad spectrum of the industry for a specific range of service conditions, as described in this annex. The designation PSL 3G is utilized only in those clauses, subclauses and tables where it is necessary to define the additional gas-testing requirements of equipment that can be gas-tested.

PSL 4 includes all the requirements of PSL 3G plus certain additional requirements and is intended for applications that exceed the service conditions usually identified within the scope of this International Standard, and is normally used only for primary equipment.

Figure A.14 shows the recommended specification level for primary equipment. Primary equipment of a wellhead assembly includes the following, as a minimum:

- tubing head;
- tubing hanger;
- tubing-head adapter;
- lower master valve.

All other wellhead parts are classified as secondary. The specification level for secondary equipment may be the same as or less than the level for primary equipment.

The selection of a PSL should be based on a quantitative risk analysis, which is a formal and systematic approach to identifying potentially hazardous events and estimating the likelihood and consequences to people, environment and resources, of accidents developing from these events.

The following comments apply to the basic questions asked in Figure A.14.

#### **A.4.2 ISO 15156 (all parts) (NACE MR0175; see Clause 2)**

This applies if the partial pressure of hydrogen sulfide ( $H_2S$ ) in the produced fluid equals or exceeds the minimum amount specified by ISO 15156 (all parts) (NACE MR0175; see Clause 2) for sour service.

#### **A.4.3 High $H_2S$ concentration**

Use “Yes” if the  $H_2S$  concentration of the produced fluid is such that in air an  $H_2S$  concentration of 70 ml/m<sup>3</sup> [70 ppm (parts per million)] can develop in case of a leak (human sense of smell cannot detect concentrations higher than 70 ml/m<sup>3</sup>).

Alternatively, use “Yes” if the radius of exposure (ROE) to 100 ml/m<sup>3</sup> (100 ppm)  $H_2S$  is greater than 15 m (50 ft) from the wellhead. ROE is defined in Texas Administrative Code, Title 16, Part 1, Chapter 3, Rule 3.36, b) 3); see A.4.5. Other methods of calculating ROE may apply, depending on local regulations.

The above requires the knowledge of the adjusted open-flow rate of offset wells. If this is not available, but if hydrogen sulfide can be expected, a 100 ml/m<sup>3</sup> (100 ppm) ROE equal to 1 000 m (3 000 ft) may be assumed.

#### **A.4.4 Close proximity**

Users who are accustomed to the use of the close-proximity and radius-of-exposure concepts may substitute close proximity for gas well in Figure A.14.

The proximity assessment should consider the potential impact of an uncontrolled emission of H<sub>2</sub>S threatening life and environment near the wellhead. The following list of items can be used for determining potential risk:

- a) 100 ml/m<sup>3</sup> (100 ppm) ROE of H<sub>2</sub>S is greater than 15 m (50 ft) from the wellhead and includes any part of a public area except a public road. ROE is defined in A.4.5. "Public area" means a dwelling, place of business, place of worship, school, hospital, school bus stop, government building, a public road, all or any portion of a park, city, town, village, or other similar area that one can expect to be populated. "Public road" means any street or road owned or maintained for public access or use;
- b) 500 ml/m<sup>3</sup> (500 ppm) ROE of H<sub>2</sub>S is greater than 15 m (50 ft) from the wellhead and includes any part of a public area including a public road;
- c) well is located in any environmentally sensitive area, such as a park, wildlife preserve, city limits, etc.;
- d) well is located within 46 m (150 ft) of an open flame or fired equipment;
- e) well is located within 15 m (50 ft) of a public road;
- f) well is located in or near inland navigable waters;
- g) well is located in or near surface domestic water supplies;
- h) well is located within 107 m (350 ft) of any dwelling.

These conditions are recommended minimum considerations. Any local regulatory requirements should be met.

#### A.4.5 Radius of exposure of H<sub>2</sub>S

**A.4.5.1** The following information is taken from Texas Railroad Commission Rule 36. SI metric-equivalent rules are not given, as the method of determining the ROE is used in the United States only. Other methods of calculating ROE may apply, depending on local regulations.

**A.4.5.2** The location,  $X_{100}$ , of the 100 ml/m<sup>3</sup> (100 ppm) ROE is determined as given in Equation (A.1):

$$X_{100} = [(1,589)(y_{\text{H}_2\text{S}})(q)]^{0,625\ 8} \quad (\text{A.1})$$

The location,  $X_{500}$ , of the 500 ml/m<sup>3</sup> (500 ppm) ROE is determined as given in Equation (A.2):

$$X_{500} = [(0,454\ 6)(y_{\text{H}_2\text{S}})(q)]^{0,625\ 8} \quad (\text{A.2})$$

where

$y_{\text{H}_2\text{S}}$  is the mole fraction H<sub>2</sub>S in the gaseous mixture available for escape;

$X$  is the radius of exposure, expressed in feet;

$q$  is the maximum volume flow rate determined to be available for escape, expressed in cubic feet per day.

**A.4.5.3** The volume flow rate used as the escape rate in determining the radius of exposure shall be that specified below, as applicable.

- a) For new wells in developed areas, the escape rate shall be determined by using the current-adjusted open flow rate of offset wells, or the field-average current-adjusted open flow rate, whichever is larger.
- b) The escape rate used in determining the radius of exposure shall be corrected to standard conditions of 0,101 Mpa (14,65 psia) and 16 °C (60 °F).

## A.5 Corrosivity of retained fluid

To select the desired material class in Table 3, the purchaser should determine the corrosivity of the retained, produced or injected fluid by considering the various environmental factors and production variables listed in Figure A.1. General corrosion, stress-corrosion cracking (SCC), erosion-corrosion and sulfide stress cracking (SSC) are all influenced by the interaction of the environmental factors and the production variables. Other factors and variables not listed in Figure A.1 may also influence fluid corrosivity.

The purchaser should determine whether materials shall meet ISO 15156 (all parts) (NACE MR0175; see Clause 2) for sour service. ISO 15156 (all parts) (NACE MR0175; see Clause 2) is concerned only with the metallic material requirements to prevent sulfide stress cracking and not with resistance to general corrosion. Consideration should also be given to the partial pressure of carbon dioxide, which generally relates to corrosivity in wells, as shown in Table A.1. This table is a guideline only.

Analysis of produced fluids might not predict the field performance of metallic or non-metallic material.

The minimum partial pressure of carbon dioxide required to initiate corrosion and the relative effect of increasing partial pressures on the corrosion rate are strongly influenced by other environmental factors and production variables, such as

- a) temperature;
- b) H<sub>2</sub>S level;
- c) pH;
- d) chloride ion concentration;
- e) sand production;
- f) water production and composition;
- g) types and relative amounts of produced hydrocarbons.

Finally, the purchaser should consider future service of the well when selecting a material class. This not only should not be limited to anticipated changes in the acid-gas partial pressures for production or increased water production with or without increased chloride content, but also should include consideration of operations such as acidification or other well treatments.

**Table A.1 — Relative corrosivity of retained fluids  
as indicated by CO<sub>2</sub> partial pressure**

Retained fluids	Relative corrosivity	Partial pressure of CO <sub>2</sub>	
		MPa	(psia)
General service	non-corrosive	< 0,05	(< 7)
General service	slightly corrosive	0,05 to 0,21	(7 to 30)
General service	moderately to highly corrosive	> 0,21	(> 30)
Sour service	non-corrosive	< 0,05	(< 7)
Sour service	slightly corrosive	0,05 to 0,21	(7 to 30)
Sour service	moderately to highly corrosive	> 0,21	(> 30)

<b>Wellhead equipment data sheet — General</b>						
Well name(s) and location(s): _____						
Maximum operating pressure: _____						
Anticipated wellhead shut-in pressure: _____						
Temperature ranges anticipated: _____						
Minimum ambient temperature: _____						
Maximum flowing fluid temperature at wellhead: _____						
Anticipated composition of produced fluids: CO <sub>2</sub> _____ (mg) _____ Chlorides _____ (mg)						
_____ H <sub>2</sub> S _____ (mg) _____ Other _____						
Anticipated completion or future workover or recovery operations which would affect pressure, temperature or fluid content: _____						
New values: _____						
Are there any government regulations that apply or must be met by this equipment? _____						
If so, which one(s)? _____						
Water or brine pH: _____						
Does ISO 15156 (all parts) (NACE MR0175; see Clause 2) apply? _____						
Will scale, paraffin, corrosion or other types of inhibitors be used? _____						
Inhibitor type: _____ Inhibitor carrier: _____ Batch or continuous inhibition? _____						
Will acidification be performed? _____ Type of acid: _____						
Anticipated production rates: _____ m <sup>3</sup> /d oil/condensate						
_____ m <sup>3</sup> /d gas						
_____ m <sup>3</sup> /d S&W <sup>a</sup>						
Will erosion be a concern? _____ Cause: _____						
External coating? Yes, type _____ No _____						
Internal coating? Yes, type _____ No _____						
Delivery requirements: _____						
Special shipping, packing and storage instructions: _____						
Casing programme						
			<b>Top joint in string</b>			
	<b>Size (OD)</b>	<b>kg/m (lb/ft)</b>	<b>Grade</b>	<b>Connection</b>	<b>Total string hanging wt daN (lbs)</b>	<b>Bit size mm (in)</b>
Conductor	_____	_____	_____	_____	_____	_____
Surface casing	_____	_____	_____	_____	_____	_____
Protective casing	_____	_____	_____	_____	_____	_____
Production casing	_____	_____	_____	_____	_____	_____
Tubing	_____	_____	_____	_____	_____	_____
Type of completion: single or multiple	_____	_____	_____	_____	_____	_____
<sup>a</sup> Sand and water.						

Figure A.1 — Wellhead equipment data sheet — General

<b>Wellhead equipment data sheet — Casing-head housing</b>			
Casing-head housing		PSL: _____	PR: _____
Bottom connection:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
Top connection:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
Outlets:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
		Number: _____	
Equipment for outlets:		Valve-removal plug: _____	
		Valves (inboard): Qty _____	PSL: _____ PR: _____
		Valves (other): Qty _____	PSL: _____ PR: _____
		Companion flanges: Qty _____	PSL: _____
		Bullplugs: Qty _____	
		Nipples: Qty _____	
		Needle valves: Qty _____	
		Gauges: Qty _____	
Lock screws? Yes _____	No _____	Lock screw function: _____	
Baseplate requirements: _____			
Special material requirements: _____			
Casing hanger:			
		Size: _____	
		Type: _____	
		PSL: _____	
		PR: _____	
Temperature rating (Table 2): _____			
Material class (Table 3): _____			
Retained fluid corrosivity (Table A.1): _____			
Witness? Yes <sup>a</sup> _____		No _____	
External coating? No _____ Yes _____		If yes, type _____	
Internal coating? No _____ Yes _____		If yes, type _____	
Flange bolting requirements (Table 62)		Non-exposed _____	Exposed _____ Exposed (low strength) _____
Main run (studs): _____		(nuts): _____	
Outlet inboard (studs): _____		(nuts): _____	
Outlet other (studs): _____		(nuts): _____	
Test and auxiliary equipment:			
Wear bushing: _____			
Running and retrieving tools: _____			
Test plug: _____			
Other requirements: _____			
<sup>a</sup> If yes, specify what and by whom.			

**Figure A.2 — Wellhead equipment data sheet — Casing-head housing**

<b>Wellhead equipment data sheet — Casing-head spool</b>	
Casing-head spool	PSL: _____ PR: _____
Bottom connection:	Size: _____ Rated working pressure: _____ Type: _____
Top connection:	Size: _____ Rated working pressure: _____ Type: _____
Outlets:	Size: _____ Rated working pressure: _____ Type: _____ Number: _____
Equipment for outlets:	Valve-removal plug: _____ Valves (inboard): Qty _____ PSL: _____ PR: _____ Valves (other): Qty _____ PSL: _____ PR: _____ Companion flanges: Qty _____ PSL: _____ Bullplugs: Qty _____ Nipples: Qty _____ Needle valves: Qty _____ Gauges: Qty _____
Lock screws? Yes _____ No _____	Lock screw function: _____
Special material requirements: _____	
Bottom casing spool pack-off size: _____ Type: _____ PR: _____	
Casing hanger:	Size: _____ Type: _____ PSL: _____ PR: _____
Temperature rating (Table 2): _____	
Material class (Table 3): _____	
Retained fluid corrosivity (Table A.1): _____	
Witness? Yes <sup>a</sup> _____ No _____	
External coating? No _____ Yes _____ If yes, type _____	
Internal coating? No _____ Yes _____ If yes, type _____	
Flange bolting requirements (Table 62) Exposed _____ Non-exposed _____	
Outlet inboard (studs): _____ (nuts): _____	
Outlet other (studs): _____ (nuts): _____	
Test and auxiliary equipment:	
Wear bushing: _____	
Running and retrieving tools: _____	
Test plug: _____	
Other requirements: _____	
<sup>a</sup> If yes, specify what and by whom.	

**Figure A.3 — Wellhead equipment data sheet — Casing-head spool**

<b>Wellhead equipment data sheet — Tubing-head spool</b>			
Tubing-head spool		PSL: _____	PR: _____
Bottom connection:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
Top connection:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
Outlets:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
		Number: _____	
Equipment for outlets:		Valve-removal plug: _____	
		Valves (inboard): Qty _____	PSL: _____ PR: _____
		Valves (other): Qty _____	PSL: _____ PR: _____
		Companion flanges: Qty _____ PSL: _____	
		Bullplugs: Qty _____	
		Nipples: Qty _____	
		Needle valves: Qty _____	
		Gauges: Qty _____	
Lock screws? Yes _____	No _____	Lock screw function: _____	
Material requirements: _____			
Bottom tubing spool pack-off:		Size: _____	
		Type: _____	
		PR: _____	
Tubing hanger:		Size: _____	
		Type: _____	
		PSL: _____	
		PR: _____	
		Back-pressure valve type: _____	
		Surface-controlled subsurface valve control lines: _____	
Temperature rating (Table 2): _____			
Material class (Table 3): _____			
Retained fluid corrosivity (Table A.1): _____			
Witness? Yes <sup>a</sup> _____		No _____	
External coating? No _____ Yes _____		If yes, type _____	
Internal coating? No _____ Yes _____		If yes, type _____	
Flange bolting requirements (Table 62)		Non-exposed _____	Exposed _____ Exposed (low strength) _____
Main run (studs): _____		(nuts): _____	
Outlet inboard (studs): _____		(nuts): _____	
Outlet other (studs): _____		(nuts): _____	
Test and auxiliary equipment:			
Wear bushing: _____			
Running and retrieving tools: _____			
Test plug: _____			
Other requirements: _____			

<sup>a</sup> If yes, specify what and by whom.

**Figure A.4 — Wellhead equipment data sheet — Tubing-head spool**

<b>Wellhead equipment data sheet — Cross-over flange</b>	
Cross-over flange	PSL: _____ PR: _____
Bottom connection:	Size: _____
	Rated working pressure: _____
	Type: _____
Top connection:	Size: _____
	Rated working pressure: _____
	Type: _____
Pack-off type: _____	
Size: _____	
Temperature rating (Table 2): _____	
Material class (Table 3): _____	
Retained fluid corrosivity (Table A.1): _____	
Witness? Yes <sup>a</sup> _____	No _____
External coating? No _____ Yes _____	If yes, type _____
Internal coating? No _____ Yes _____	If yes, type _____
Flange bolting requirement (Table 62)	Non-exposed _____ Exposed _____ Exposed (low strength) _____
Main run (studs): _____	(nuts): _____
<sup>a</sup> If yes, specify what and by whom.	

**Figure A.5 — Wellhead equipment data sheet — Cross-over flange**

<b>Wellhead equipment data sheet — Tubing head adaptor</b>	
Tubing head adaptor	PSL: _____ PR: _____
Bottom connection:	Size: _____
	Rated working pressure: _____
	Type: _____
Top connection:	Size: _____
	Rated working pressure: _____
	Type: _____
Surface-controlled subsurface safety valve outlets: _____	
Number: _____	
Size: _____	
Electrical feed-through connection? _____	
Special material requirements: _____	
Temperature rating (Table 2): _____	
Material class (Table 3): _____	
Retained fluid corrosivity (Table A.1): _____	
Witness? Yes <sup>a</sup> _____	No _____
External coating? No _____ Yes _____	If yes, type _____
Internal coating? No _____ Yes _____	If yes, type _____
Flange bolting requirement (Table 62)	Non-exposed _____ Exposed _____ Exposed (low strength) _____
Main run (studs): _____	(nuts): _____
<sup>a</sup> If yes, specify what and by whom.	

**Figure A.6 — Wellhead equipment data sheet — Tubing head adaptor**

<b>Wellhead equipment data sheet — Christmas tree and choke</b>									
Christmas tree – Single ____ Dual ____ Solid block ____ Stacked ____									
	Size	Material <sup>a</sup>	PSL	PR	Witness? <sup>b</sup>	External coating? If yes, state type	Flanged bolting requirements <sup>c</sup> Studs Nuts	Ring gasket type	
Lower master valve _____									
Upper master valve _____									
Swab (crown) valve _____									
Wing valve—inboard _____									
Wing valve(s)—other _____									
Tee/cross (circle one) _____									
Choke _____									
End flange _____									
Companion flanges _____									
Instrument flanges _____									
Tree cap/top conn. _____									
Rated working pressure: _____									
Retained fluid corrosivity (Table A.1): _____									
Temperature rating (Table 2): _____									
Material class (Table 3): _____									
Upper master prepared for actuator:			Yes ____	No ____	If yes, specify class I or II below PR column				
Wing valve—inboard prepared for actuator:			Yes ____	No ____	If yes, specify class I or II below PR column				
Wing valve—other prepared for actuator:			Yes ____	No ____	If yes, specify class I or II below PR column				
Choke: adjustable or fixed: _____									
Orifice size: _____ Nominal size: _____									
Pressure drop: _____									
Flowline connection:		Size: _____							
		Type: _____							
Special material requirements: _____									
Other requirements:									
Upper master valve type actuator requirements:			Pneu./piston _____		Hydr./piston _____		Electric ____		
Supply pressure/power _____			Pneu./diaphragm _____		Hydr./diaphragm _____		Electric ____		
Air _____ Gas _____									
Wing valve type actuator requirements:			Pneu./piston _____		Hydr./piston _____		Electric ____		
			Pneu./diaphragm _____		Hydr./diaphragm _____		Electric ____		
Supply pressure: _____									
Other: _____									
_____									
_____									
_____									

<sup>a</sup> Define or specify material requirements and, if cladding or other corrosion-resistant materials are to be inlaid, state base material type/clad material type, e.g. 4130/625.

<sup>b</sup> If yes, specify what and by whom.

<sup>c</sup> Indicate required bolting for the applicable retained fluid and temperature classification specified in Table 62.

**Figure A.7 — Wellhead equipment data sheet — Christmas tree and choke**

<b>Wellhead equipment data sheet — Compact casing-head housing</b>			
<b>Compact casing-head housing</b>		PSL: _____ PR: _____	
<b>A. Bottom connection:</b>		Size: _____	
		Rated working pressure: _____	
		Type: _____	
Outlets:		Size: _____	
		Rated working pressure: _____	
		Type: _____	
		Number: _____	
Equipment for outlets:		Valve-removal plug: _____	
		Valves (inboard): Qty _____ PSL: _____ PR: _____	
		Valves (other): Qty _____ PSL: _____ PR: _____	
		Companion flanges: Qty _____ PSL: _____	
		Bullplugs: Qty _____	
		Nipples: Qty _____	
		Needle valves: Qty _____	
		Gauges: Qty _____	
Lock screws? Yes _____ No _____		Lock screw function: _____	
Base plate requirements: _____			
Witness? No _____ Yes <sup>a</sup> _____			
Special material requirements: _____			
Bottom casing spool pack-off:		Size: _____	
		Type: _____	
Casing hanger:		Size: _____	
		Type: _____	
		PR: _____	
		PSL: _____	
Temperature rating (Table 2): _____			
Material class (Table 3): _____			
Retained fluid corrosivity (Table A.1): _____			
External coating? No _____ Yes _____		If yes, type: _____	
Internal coating? No _____ Yes _____		If yes, type: _____	
Flange bolting requirements (Table 62)		Non-exposed _____ Exposed _____ Exposed (low strength) _____	
Outlet inboard (studs): _____		(nuts): _____	
Outlet other (studs): _____		(nuts): _____	
Other requirements: _____			

<sup>a</sup> If yes, specify what and by whom.

**Figure A.8 — Wellhead equipment data sheet — Compact casing-head housing**

<b>B. Top connection:</b>	Size: _____
	Rated working pressure: _____
	Type: _____
Outlets:	Size: _____
	Rated working pressure: _____
	Type: _____
	Number: _____
Equipment for outlets:	Valve-removal plug: _____
	Valves (inboard): Qty _____ PSL: _____ PR: _____
	Valves (other): Qty _____ PSL: _____ PR: _____
	Companion flanges: Qty _____ PSL: _____
	Bullplugs: Qty _____
	Nipples: Qty _____
	Needle valves: Qty _____
	Gauges: Qty _____
Lock screws? Yes _____ No _____	Lock screw function: _____
Special material requirements:	_____
Casing hanger:	
	Size: _____
	Type: _____
	PSL: _____
	PR: _____
Temperature rating (Table 2):	_____
Material class (Table 3):	_____
Retained fluid corrosivity (Table A.1):	_____
External coating? No _____ Yes _____	If yes, type: _____
Internal coating? No _____ Yes _____	If yes, type: _____
Flange bolting requirements (Table 62)	Non-exposed _____ Exposed _____ Exposed (low strength) _____
Outlet inboard (studs): _____	(nuts): _____
Outlet other (studs): _____	(nuts): _____
Test and auxiliary equipment: (top and/or bottom)	_____
Wear bushings:	_____
Running and retrieving tools:	_____
Test plugs:	_____
Other requirements:	_____

Figure A.8 (continued)

<b>Wellhead equipment data sheet — Wellhead safety valves</b>	
<b>Wellhead safety valves</b>	
General	
Special environmental conditions _____	Unusual ambient or operating temperatures, or atmospheric conditions conducive to corrosion or underwater use.
Coating _____	
Shipping instructions _____	
SSV/USV Valve	
Performance test agency (PR2 SSV/USV Valves) _____	
Manufacturer _____	Model and type _____
Size _____	
Rated working pressure _____	
Temperature range _____	
SSV/USV Actuator	
Manufacturer _____	Model and type _____
Cylinder rated working pressure _____	
Operating pressure _____	Purchaser to specify available supply pressure, if applicable.
Temperature range _____	
Lock-open device _____	
USV _____	Working water depth _____

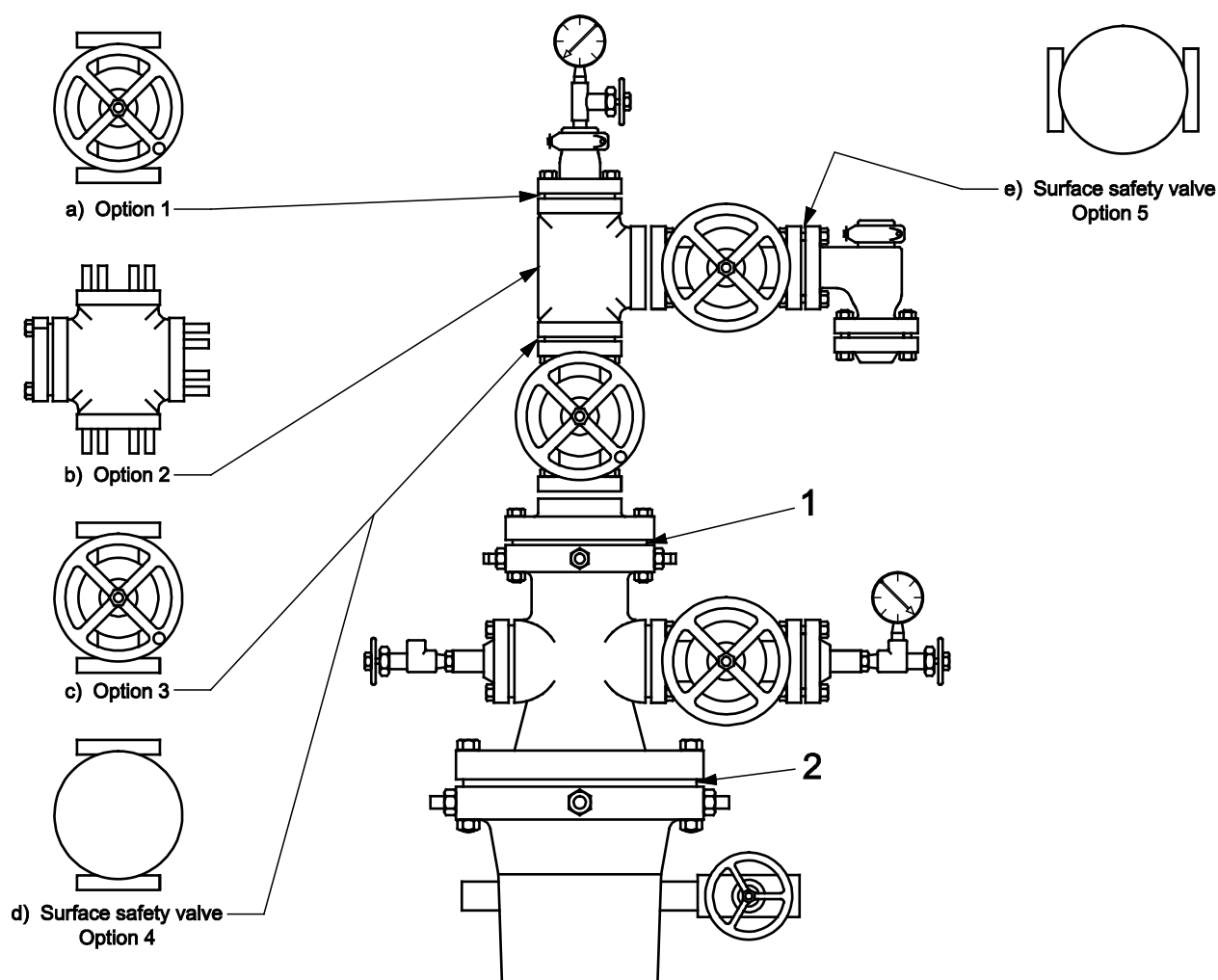
**Figure A.9 — Wellhead equipment data sheet — Wellhead safety valves**

Wellhead equipment data sheet — Choke sizing									
Application									
Fluid									
Quantity									
End connections/A&B Dimensions <sup>a</sup>									
Pressure rating/Inlet						Outlet			
Temperature rating									
Material class			Body				Trim		
PSL			PR						
Service conditions at			Max. flow (Units)		Normal flow (Units)			Min. flow (Units)	
Pressure	Inlet								
	Outlet or $\Delta P$								
Temperature at inlet									
Oil	Flow rate								
	S.G. (if available)								
Gas	Flow rate								
	or G.O.R.								
	S.G. (if available)								
Liquid	Flow rate								
	S.G. (if available)								
Manual/actuated									
Actuator type/make/model									
Power source									
Manual override									
Position indication		Local				Remote/position transmitter			
Positioner									
Additional comments Adjustable or positive :  maximum orifice diameter:  type of flow bean:									
<sup>a</sup> See Figures 17 and 18.									

Figure A.10 — Wellhead equipment data sheet — Choke sizing

Wellhead equipment data sheet — Actuator and bonnet									
		Quantity				Quantity			
<b>Pneumatic</b>				<b>Hydraulic</b>				<b>Electric</b>	
Diaphragm		Single		Conventional		Rising stem			
		Double				Non-rising stem			
Piston		Single		Retained fluid		Rising stem			
		Double				Non-rising stem			
				Wirecutter				Wire/cable size	
				Self-contained				Stand-alone power source	
<b>Supply requirements/specifications</b>									
<b>Pneumatic</b>					<b>Hydraulic</b>				
Availability _____ MPa (psi)					Availability _____ MPa (psi)				
Max. _____ Min. _____					Max. _____ Min. _____				
Clean air _____					Well fluid _____				
Nitrogen _____					non-sour _____ sour _____				
Well gas _____ non-sour _____					Self-contained _____				
Other _____ sour _____					Other _____				
<b>Electric</b>									
Voltage _____									
DC _____ AC _____ Phase _____ Frequency _____									
Current available _____									
Other _____									
<b>Actuator requirements</b>					<b>Field data</b>				
<b>Specifications</b>					<b>Customer</b> _____				
<b>Actuator</b>					<b>Field location</b> _____				
Temperature rating (Table 2)					<b>Platform</b> _____				
Retained fluid (Table A.1)					<b>Well No.</b> _____				
Materials class (Table 3)					<b>Closed-in tubing head pressure</b> _____ MPa (psi)				
External coating? No _____ Yes _____					<b>Accessories</b>				
If yes type _____					Fusible hold-open device _____				
					Manual hold-open device _____				
					Quick exhaust valve _____				
					Position indication a) local _____				
					b) remote _____				
<b>Bonnet requirements</b>									
Size _____					<b>Specification</b>		<b>PSL</b>		
Model _____					SSV PR2 _____		2 _____		
Maximum working pressure _____ MPa (psi)							3 _____		
							3G _____		
							4 _____		
<b>Material class:</b>					<b>Temperature rating:</b>				

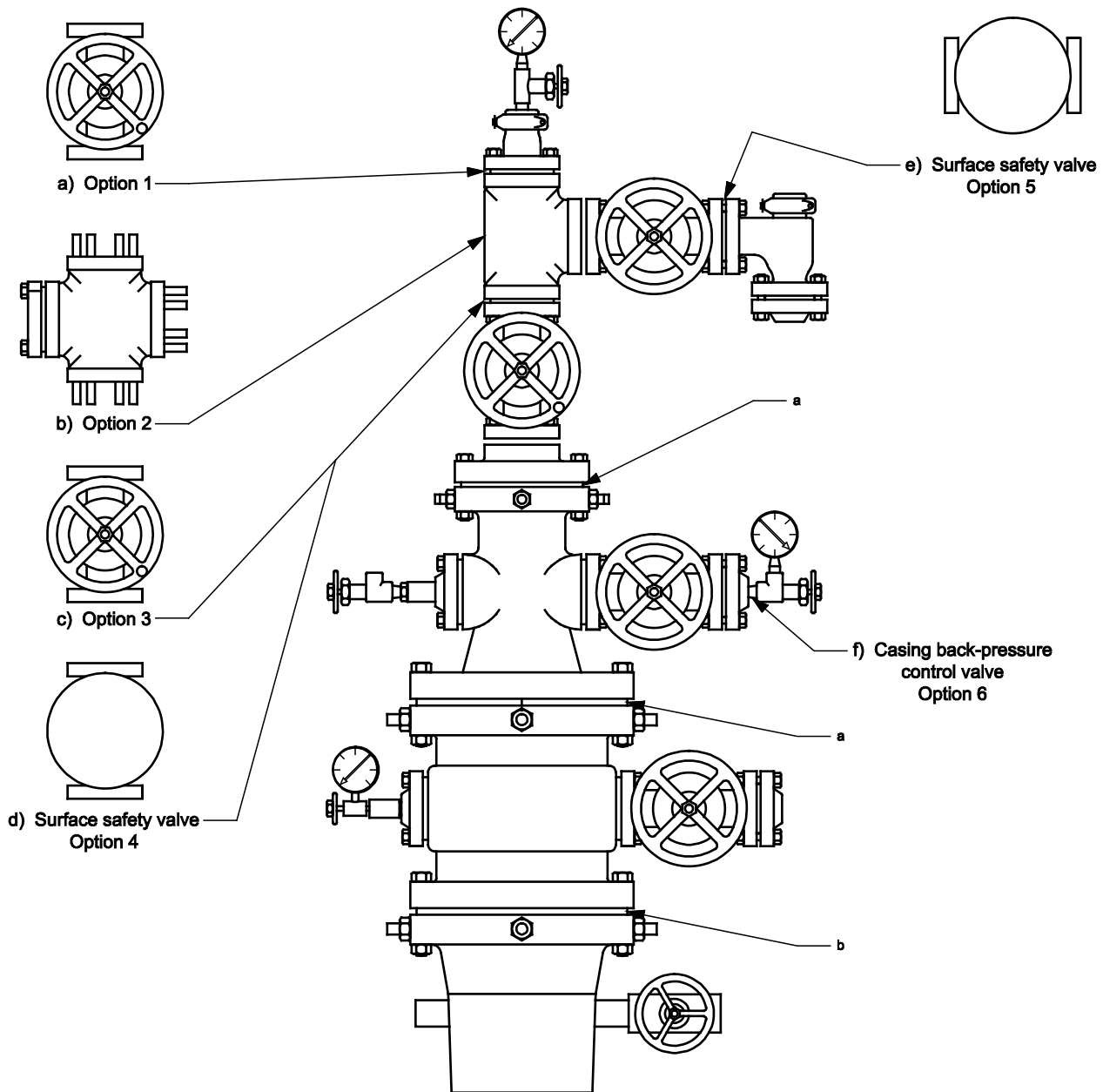
**Figure A.11 — Wellhead equipment data sheet — Actuator and bonnet**

**Key**

- 1 tubing-head top flange 34,5 MPa (5 000 psi)
- 2 casing-head top flange 20,7 MPa (3 000 psi) or 34,5 MPa (5 000 psi)

Typical programmes			
Casing programme mm (in)	Bit programme mm (in)	Casing head top flange mm; MPa (in; psi)	Tubing head top flange mm; MPa (in; psi)
219,1 (8 <sup>5</sup> / <sub>8</sub> ) ´ 139,7 (5 <sup>1</sup> / <sub>2</sub> )	200,0 (7 <sup>7</sup> / <sub>8</sub> )	279; 20,7 (11; 3 000)	179; 34,5 (7 <sup>1</sup> / <sub>16</sub> ; 5 000)
244,5 (9 <sup>5</sup> / <sub>8</sub> ) ´ 177,8 (7)	215,9 (8 <sup>1</sup> / <sub>2</sub> ) or 222,2 (8 <sup>3</sup> / <sub>4</sub> )	or	
273,1 (10 <sup>3</sup> / <sub>4</sub> ) ´ 193,7 (7 <sup>5</sup> / <sub>8</sub> )	250,8 (9 <sup>7</sup> / <sub>8</sub> )	279; 34,5 (11; 5 000)	

**Figure A.12 — Typical wellhead and tree configuration  
for a 34,5 MPa (5 000 psi) rated working pressure**



a 69,0 MPa (10 000 psi).

b 34,5 MPa (5 000 psi).

**Figure A.13 — Typical wellhead and tree configuration for a 69,0 MPa (10 000 psi) rated working pressure**

Typical programmes (SI units)				
Casing programme mm	Bit programme mm	Casing-head housing top flange mm; MPa	Casing-head spool top flange mm; MPa	Tubing-head top flange mm; MPa
406,4 ´ 273,1 ´ 193,7	374,7 ´ 250,8 or 241,3	425; 34,5	279; 69,0	179; 69,0
406,4 ´ 298,5 ´ 244,5 ´ 177,8 liner	374,7 ´ 269,9 ´ 215,9	425; 34,5	346; 69,0	179; 69,0
			279; 69,0	
339,7 ´ 244,5 ´ 177,8	311,2 ´ 215,9 ´ 152,4	346; 34,5	279; 69,0	179; 69,0
273,1 ´ 193,7 ´ 127,0	250,8 ´ 165,1	279; 34,5	279; 69,0	179; 69,0

Typical programmes (USC units)				
Casing programme in	Bit programme in	Casing-head housing top flange in; psi	Casing-head spool top flange in; psi	Tubing-head top flange in; psi
16 ´ 10 <sup>3</sup> / <sub>4</sub> ´ 7 <sup>5</sup> / <sub>8</sub>	14 <sup>3</sup> / <sub>4</sub> ´ 9 <sup>7</sup> / <sub>8</sub> or 9 <sup>1</sup> / <sub>2</sub>	16 <sup>3</sup> / <sub>4</sub> ; 5 000	11; 10 000	7 <sup>1</sup> / <sub>16</sub> ; 10 000
16 ´ 11 <sup>3</sup> / <sub>4</sub> ´ 9 <sup>5</sup> / <sub>8</sub> ´ 7 liner	14 <sup>3</sup> / <sub>4</sub> ´ 10 <sup>5</sup> / <sub>8</sub> ´ 8 <sup>1</sup> / <sub>2</sub>	16 <sup>3</sup> / <sub>4</sub> ; 5 000	13 <sup>5</sup> / <sub>8</sub> ; 10 000	7 <sup>1</sup> / <sub>16</sub> ; 10 000
			11; 10 000	
13 <sup>3</sup> / <sub>8</sub> ´ 9 <sup>5</sup> / <sub>8</sub> ´ 7	12 <sup>1</sup> / <sub>4</sub> ´ 8 <sup>1</sup> / <sub>2</sub> ´ 6	13 <sup>5</sup> / <sub>8</sub> ; 5 000	11; 10 000	7 <sup>1</sup> / <sub>16</sub> ; 10 000
10 <sup>3</sup> / <sub>4</sub> ´ 7 <sup>5</sup> / <sub>8</sub> ´ 5	9 <sup>7</sup> / <sub>8</sub> ´ 6 <sup>1</sup> / <sub>2</sub>	11; 5 000	11; 10 000	7 <sup>1</sup> / <sub>16</sub> ; 10 000

Figure A.13 (continued)



## **Annex B**

(informative)

### **USC unit tables and data for this International Standard**

#### **B.1 General information**

##### **B.1.1 Purpose**

Annex B provides dimensions and data expressed in US Customary (USC) units, which may be used as alternative units to those SI units used in the body of this International Standard.

##### **B.1.2 Conversion rules**

The dimensions in SI units were obtained by converting from dimensional tables of API Spec 6A in accordance with ISO 31-0. The conversion is illustrated in the following example.

- a) Convert first from decimal inch to exact fraction, then express this as an exact decimal value. This is done to account for the fact that API designs originated in the fractional inch system.

EXAMPLE      A dimension of 4,31 in the tables actually means  $4 \frac{5}{16}$  or 4,312 5 in.

- b) Then, multiply the resulting exact decimal equivalent of the fractional-inch dimension by 25,4 mm to obtain the exact millimetre dimension.

EXAMPLE       $4,312\ 5\ \text{in} \times 25,4 = 109,537\ 5\ \text{mm}$ .

NOTE      The comma is always used as the decimal sign.

- c) Then, do the rounding indicated for the particular dimension. Rounding rules differ for different dimensions, depending on the application of the dimension.

EXAMPLE      If the above dimension were to be rounded to the nearest even 5 mm, the resulting dimension would be 110 mm.

In summary, the conversion is in three steps, as follows:  $4,31\ \text{in} \Rightarrow 4,312\ 5\ \text{in} \Rightarrow 109,537\ 5\ \text{mm} \Rightarrow 110\ \text{mm}$ .

In all cases, interchangeability takes preference over mathematical conversion.

The same holds true for conversions from metric dimensional units of future specified equipment into USC units.

## B.2 6B and 6BX flanges

### B.2.1 Pressure ratings

The selected ratings in megapascals have been converted from the dimensional tables of API Spec 6A in such a way as to preserve the ratio of pressure ratings, expressed in pounds per square inch, while still using convenient simple numbers, as given in Table B.1:

**Table B.1 — Converted dimensions for 6B and 6BX flanges**

Megapascals	Pounds per square inch
13,8	2 000
20,7	3 000
34,5	5 000
69,0	10 000
103,5	15 000
138,0	20 000

### B.2.2 Nominal sizes

Nominal bore sizes for flanges in this International Standard were converted from the rounded USC unit values to SI unit values, to the nearest millimetre. Thus, the nominal sizes given in Table B.2 are equivalent:

**Table B.2 — Nominal size equivalents**

Millimetres	Inches
46	1 <sup>13</sup> / <sub>16</sub>
52	2 <sup>1</sup> / <sub>16</sub>
65	2 <sup>9</sup> / <sub>16</sub>
78	3 <sup>1</sup> / <sub>16</sub>
79	3 <sup>1</sup> / <sub>8</sub>
103	4 <sup>1</sup> / <sub>16</sub>
105	4 <sup>1</sup> / <sub>8</sub>
130	5 <sup>1</sup> / <sub>8</sub>
179	7 <sup>1</sup> / <sub>16</sub>
228	9
279	11
346	13 <sup>5</sup> / <sub>8</sub>
425	16 <sup>3</sup> / <sub>4</sub>
476	18 <sup>3</sup> / <sub>4</sub>
527	20 <sup>3</sup> / <sub>4</sub>
540	21 <sup>1</sup> / <sub>4</sub>
679	26 <sup>3</sup> / <sub>4</sub>
762	30

### B.2.3 Rounding rules

The following rules were used to develop flange dimensions:

- a) For the maximum bore, round to the nearest 0,1 mm.

EXAMPLE 2,09 in  $\Rightarrow$  2,093 75 in  $\Rightarrow$  53,181 25 mm  $\Rightarrow$  53,2 mm.

- b) For the flange OD, round to the nearest 5 mm. This is consistent with ANSI practice.

EXAMPLE 1 8,12 in  $\Rightarrow$  8,125 in  $\Rightarrow$  206,375 mm  $\Rightarrow$  205 mm.

EXAMPLE 2 For the tolerance: 0,06 in  $\Rightarrow$  2 mm; 0,12 in  $\Rightarrow$  3 mm.

- c) For the maximum chamfer:

EXAMPLE 0,12 in  $\Rightarrow$  3 mm; 0,25 in  $\Rightarrow$  6 mm.

- d) For the raised-face diameter, round to nearest 1 mm with a tolerance of  ${}^{+1}_0$  mm.

- e) For the thickness of flange, round up to the next 0,1 mm with a tolerance of  ${}^{+3}_0$  mm.

- f) For the dimensions  $J_1$ ,  $J_2$  and  $J_3$ , round to nearest 0,1 mm with a tolerance of  ${}^0_{-3}$  mm.

- g) For the radius at back face, convert as given in Table B.3:

**Table B.3 — Conversions for the radius at back face**

Millimetres	Inches
10	0,38
16	0,62
19	0,75
21	0,81
25	1,00

- h) For the tolerance for the bolt hole location,  $\pm 0,8$  mm.

- i) For the bolt circle, round to nearest 0,1 mm.

- j) For the bolt hole diameter, round up to next even millimetre. Tolerances are as given in Table B.4:

**Table B.4 — Rounding values for hole sizes and tolerances**

Hole size	Tolerance mm
< 42 mm	+2 -0,5
$\geq 42$ mm	+2,5 -0,5
> 74 mm	+3 -0,5

- k) For the stud lengths, recalculate in metric units and round to nearest 5 mm.

- l) For the segmented flange dimensions, segmented flange dimensions are as follows:
- E dimension: Round to nearest 0,1 mm;
  - F dimension: 0,12 in becomes 3 mm;
  - K dimension: Round to nearest 0,1 mm with a tolerance of  $^{+0,5}_0$  mm .
  - Q dimension: Round to nearest 0,01 mm with a tolerance of  $^{+0,25}_0$  mm .
- m) For the rough machine dimensions for inlaid ring grooves, round all dimensions up to the nearest 0,5 mm with a tolerance of  $^{+0,8}_0$  mm .
- n) For the ring gasket and groove dimensions, convert exactly to the nearest 0,01 mm, except for the hole size D of the RX and BX ring joints.

## B.3 Other equipment dimensions

### B.3.1 Valve end-to-end dimensions — Interchangeability

For all valves having corresponding end-to-end dimensions in ASME B16.34, the ASME B16.34 metric dimensions have been used. For all other valves, the dimension is rounded to the nearest 1 mm, with a tolerance of  $\pm 2$  mm.

### B.3.2 Cross and tee centre-to-end dimensions

These dimensions are rounded to the nearest 0,5 mm with a tolerance of  $\pm 0,8$  mm.

### B.3.3 Multiple completion centreline spacing

These dimensions are converted and expressed to two decimals. The resulting dimension and tolerance shall be selected so that the physical size is always within the tolerance range of  $\pm 0,005$  in when a tolerance of  $\pm 0,12$  mm is applied.

EXAMPLE Dimension, 1,390 in from flange centre,  $\pm 0,005$  in. Alternatives are as follows:

- Lower limit: 1,385 in  $\Rightarrow$  35,179 mm (35,18 or 35,19);
- Centre: 1,390 in  $\Rightarrow$  35,306 mm (35,30 or 35,31);
- Upper limit: 1,395 in  $\Rightarrow$  35,433 mm (35,42 or 35,43).
- Choose the first centre dimension, 35,30 mm, since it is a round number.

## B.4 Conversion factors

### B.4.1 Length

1 inch (in) equals 25,4 millimetres (mm), exactly.

### B.4.2 Pressure/stress

1 pound-force per square inch (psi) = 0,006 894 757 megapascal (MPa).

1 megapascal (MPa) equals 1 newton per square millimetre (N/mm<sup>2</sup>).

NOTE 1 bar = 0,1 MPa.

### B.4.3 Impact energy

1 foot-pound (ft-lb) equals 1,355 818 joule (J).

### B.4.4 Torque

1 foot-pound (ft-lb) equals 1,355 818 newton metre (N·m).

### B.4.5 Temperature

Degrees Celsius equals 5/9 (degrees Fahrenheit minus 32).

### B.4.6 Force

1 pound-force (lbf) equals 4,448 222 newton (N).

### B.4.7 Mass

1 pound-mass (lbm) equals 0,453 592 37 kilogram (kg) exactly.

## B.5 USC unit tables and figures

USC unit versions of the data in tables and figures given in SI units in the main body of this International Standard are included in this annex to prevent cluttering the tables or figures with more numbers than can easily be read without confusion. For the convenience of the user, the figures and tables are numbered in this annex using numbers identical to those in the main body but with the prefix "B". Users of this International Standard should review all notes and explanations that accompany the analogous table specified in the main body of this International Standard.

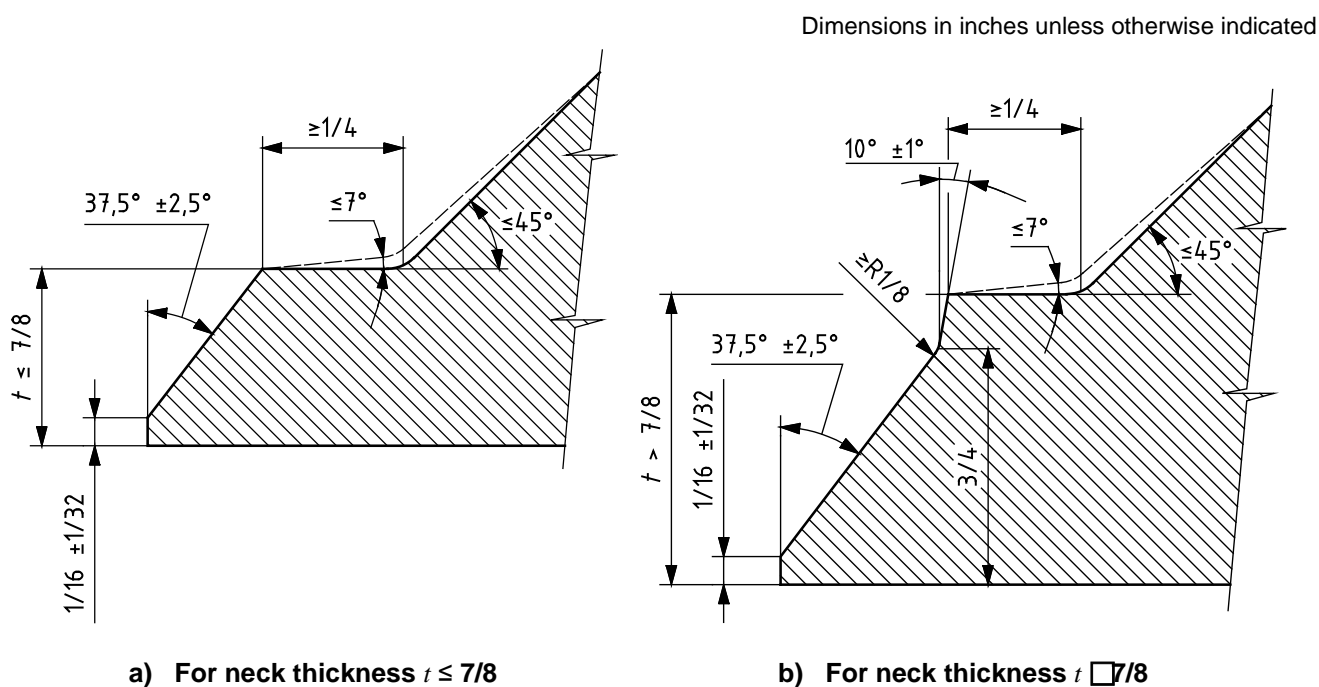
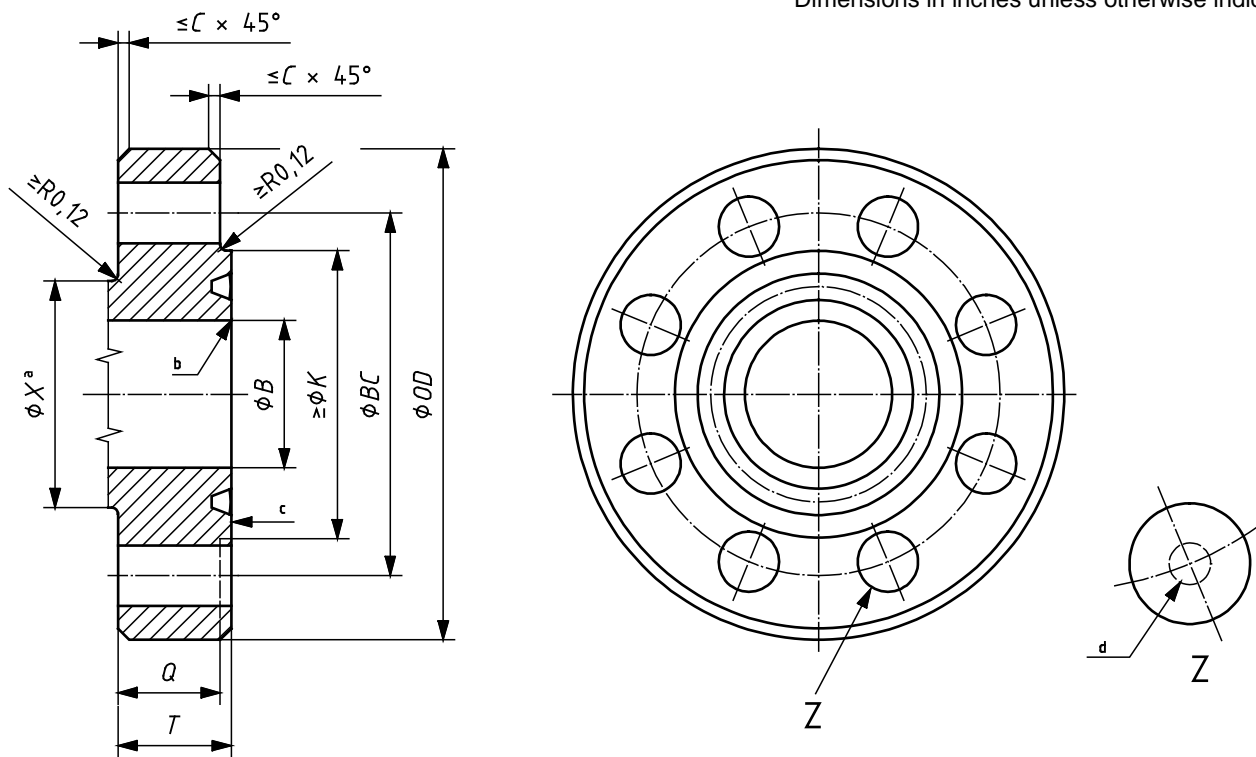


Figure B.9 — Weld end preparation for type 6B and 6BX welding neck flanges (USC units)

**Table B.49 — Type 6B flanges for 2 000 psi rated working pressure (USC units)**

Dimensions in inches unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,03 in of theoretical  $BC$  and equal spacing.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

**a) Flange section integral flange**

Table B.49 (continued)

Dimensions in inches

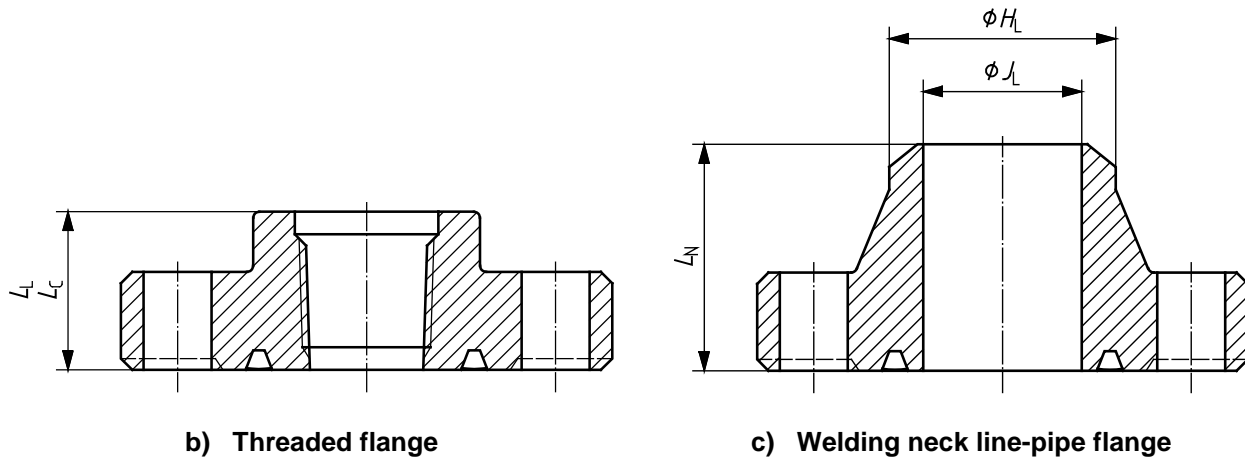
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nominal size and bore of flange	Basic flange dimensions							
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> +0,12 0	<i>Q</i>	<i>X</i>
2 <sup>1</sup> / <sub>16</sub>	2,09	6,50	± 0,06	0,12	4,25	1,31	1,00	3,31
2 <sup>9</sup> / <sub>16</sub>	2,59	7,50	± 0,06	0,12	5,00	1,44	1,12	3,94
3 <sup>1</sup> / <sub>8</sub>	3,22	8,25	± 0,06	0,12	5,75	1,56	1,25	4,62
4 <sup>1</sup> / <sub>16</sub>	4,28	10,75	± 0,06	0,12	6,88	1,81	1,50	6,00
5 <sup>1</sup> / <sub>8</sub>	5,16	13,00	± 0,06	0,12	8,25	2,06	1,75	7,44
7 <sup>1</sup> / <sub>16</sub>	7,16	14,00	± 0,12	0,25	9,50	2,19	1,88	8,75
9	9,03	16,50	± 0,12	0,25	11,88	2,50	2,19	10,75
11	11,03	20,00	± 0,12	0,25	14,00	2,81	2,50	13,50
13 <sup>5</sup> / <sub>8</sub>	13,66	22,00	± 0,12	0,25	16,25	2,94	2,62	15,75
16 <sup>3</sup> / <sub>4</sub>	16,78	27,00	± 0,12	0,25	20,00	3,31	3,00	19,50
21 <sup>1</sup> / <sub>4</sub>	21,28	32,00	± 0,12	0,25	25,00	3,88	3,50	24,00

Dimensions in inches

(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
2 <sup>1</sup> / <sub>16</sub>	5,00	8	<sup>5</sup> / <sub>8</sub>	0,75	+ 0,06	4,50	23
2 <sup>9</sup> / <sub>16</sub>	5,88	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,00	26
3 <sup>1</sup> / <sub>8</sub>	6,62	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,25	31
4 <sup>1</sup> / <sub>16</sub>	8,50	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	37
5 <sup>1</sup> / <sub>8</sub>	10,50	8	1	1,12	+ 0,06	6,75	41
7 <sup>1</sup> / <sub>16</sub>	11,50	12	1	1,12	+ 0,06	7,00	45
9	13,75	12	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,00	49
11	17,00	16	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	8,75	53
13 <sup>5</sup> / <sub>8</sub>	19,25	20	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	9,00	57
16 <sup>3</sup> / <sub>4</sub>	23,75	20	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	10,25	65
21 <sup>1</sup> / <sub>4</sub>	28,50	24	1 <sup>5</sup> / <sub>8</sub>	1,75	+ 0,09	11,75	73

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

Table B.49 (continued)



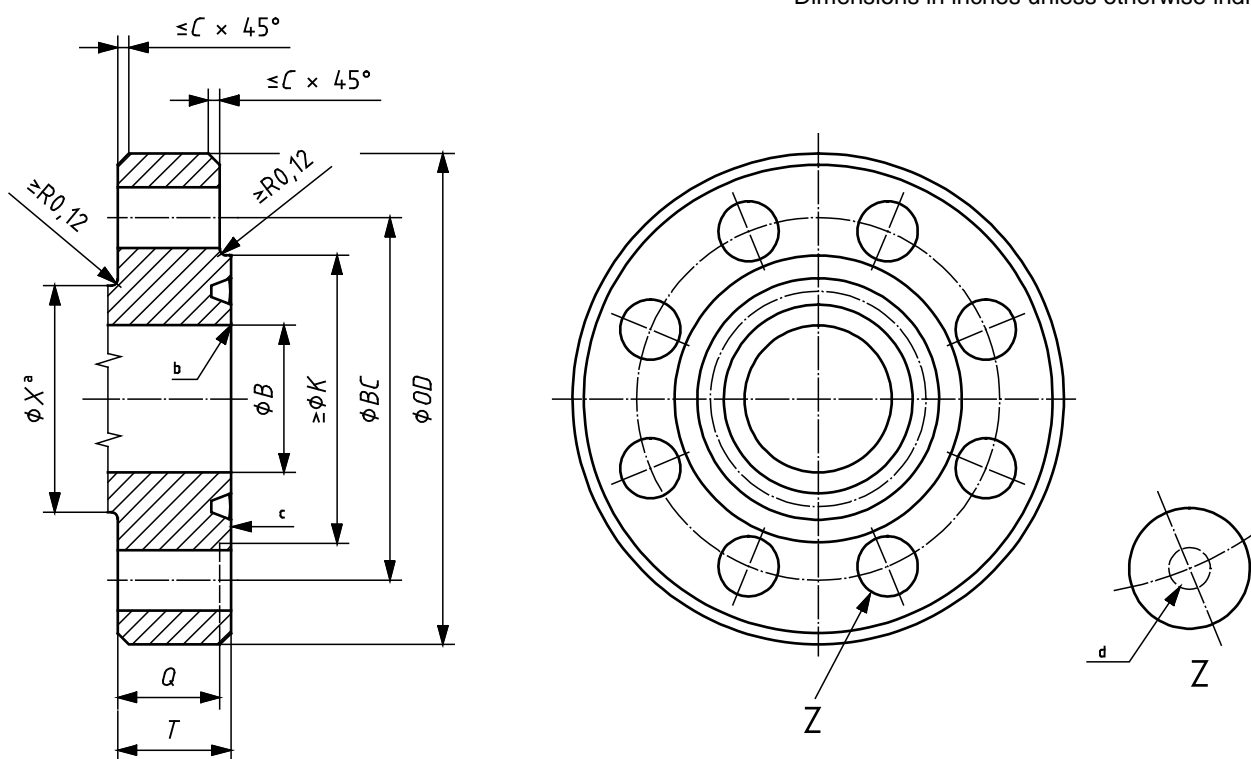
Dimensions in inches

(1)	(17)	(18)	(19)	(20)	(21)	(22)
Nominal size and bore of flange	Hub and bore dimensions					
	Hub length threaded line-pipe flange	Hub length threaded casing flange	Hub length welding neck line-pipe flange	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange
	$L_L$	$L_C$	$L_N \pm 0,06$	$H_L$	tol. <sup>f</sup>	$J_L$
2 <sup>1</sup> / <sub>16</sub>	1,75	—	3,19	2,38	+ 0,09	2,10
2 <sup>9</sup> / <sub>16</sub>	1,94	—	3,44	2,88	+ 0,09	2,50
3 <sup>1</sup> / <sub>8</sub>	2,12	—	3,56	3,50	+ 0,09	3,10
4 <sup>1</sup> / <sub>16</sub>	2,44	3,50	4,31	4,50	+ 0,09	4,06
5 <sup>1</sup> / <sub>8</sub>	2,69	4,00	4,81	5,56	+ 0,09	4,84
7 <sup>1</sup> / <sub>16</sub>	2,94	4,50	4,94	6,63	+ 0,16	5,79
9	3,31	5,00	5,56	8,63	+ 0,16	7,84
11	3,69	5,25	6,31	10,75	+ 0,16	9,78
13 <sup>5</sup> / <sub>8</sub>	3,94	3,94	—	—	—	—
16 <sup>3</sup> / <sub>4</sub>	4,50	4,50	—	—	—	—
21 <sup>1</sup> / <sub>4</sub>	5,38	5,38	—	—	—	—

<sup>f</sup> Minimum tolerance for this dimension is – 0,03.

**Table B.50 — Type 6B flanges for 3 000 psi rated working pressure (USC units)**

Dimensions in inches unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,03 in of theoretical  $BC$  and equal spacing.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

**a) Flange section integral flange**

Table B.50 (continued)

Dimensions in inches

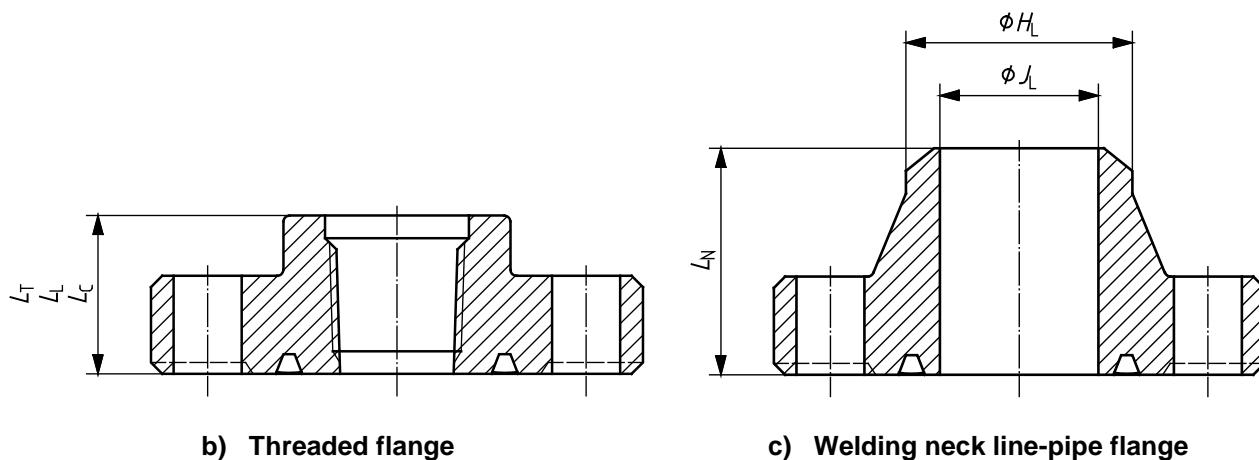
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nominal size and bore of flange	Basic flange dimensions							
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> +0,12 0	<i>Q</i>	<i>X</i>
2 <sup>1</sup> / <sub>16</sub>	2,09	8,50	± 0,06	0,12	4,88	1,81	1,50	4,12
2 <sup>9</sup> / <sub>16</sub>	2,59	9,62	± 0,06	0,12	5,38	1,94	1,62	4,88
3 <sup>1</sup> / <sub>8</sub>	3,22	9,50	± 0,06	0,12	6,12	1,81	1,50	5,00
4 <sup>1</sup> / <sub>16</sub>	4,28	11,50	± 0,06	0,12	7,12	2,06	1,75	6,25
5 <sup>1</sup> / <sub>8</sub>	5,16	13,75	± 0,06	0,12	8,50	2,31	2,00	7,50
7 <sup>1</sup> / <sub>16</sub>	7,16	15,00	± 0,12	0,25	9,50	2,50	2,19	9,25
9	9,03	18,50	± 0,12	0,25	12,12	2,81	2,50	11,75
11	11,03	21,50	± 0,12	0,25	14,25	3,06	2,75	14,50
13 <sup>5</sup> / <sub>8</sub>	13,66	24,00	± 0,12	0,25	16,50	3,44	3,12	16,50
16 <sup>3</sup> / <sub>4</sub>	16,78	27,75	± 0,12	0,25	20,62	3,94	3,50	20,00
20 <sup>3</sup> / <sub>4</sub>	20,78	33,75	± 0,12	0,25	25,50	4,75	4,25	24,50

Dimensions in inches

(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
2 <sup>1</sup> / <sub>16</sub>	6,50	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	24
2 <sup>9</sup> / <sub>16</sub>	7,50	8	1	1,12	+ 0,06	6,50	27
3 <sup>1</sup> / <sub>8</sub>	7,50	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	31
4 <sup>1</sup> / <sub>16</sub>	9,25	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	7,00	37
5 <sup>1</sup> / <sub>8</sub>	11,00	8	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	7,75	41
7 <sup>1</sup> / <sub>16</sub>	12,50	12	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,00	45
9	15,50	12	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	9,00	49
11	18,50	16	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	9,50	53
13 <sup>5</sup> / <sub>8</sub>	21,00	20	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	10,25	57
16 <sup>3</sup> / <sub>4</sub>	24,25	20	1 <sup>5</sup> / <sub>8</sub>	1,75	+ 0,09	11,75	66
20 <sup>3</sup> / <sub>4</sub>	29,50	20	2	2,12	+ 0,09	14,50	74

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

Table B.50 (continued)



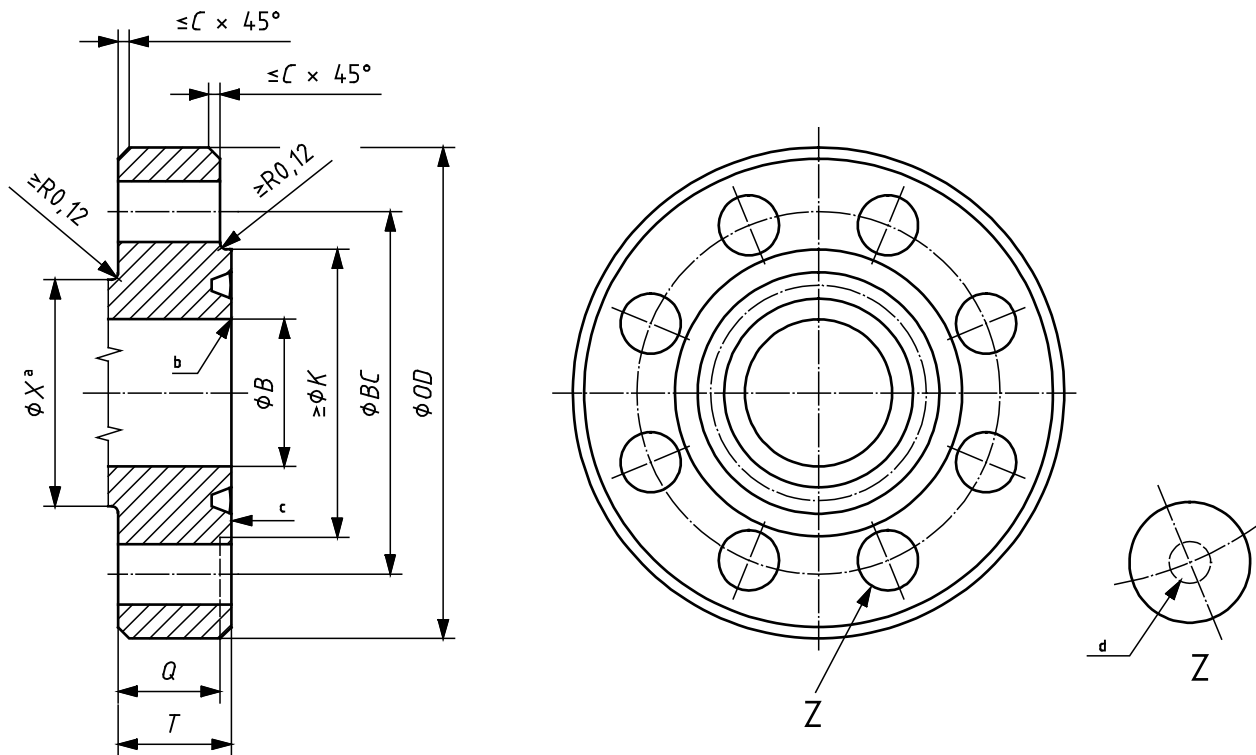
Dimensions in inches

(1)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Nominal size and bore of flange	Hub and bore dimensions						
	Hub length threaded line-pipe flange	Hub length threaded casing flange	Hub length tubing flange	Hub length welding neck line-pipe flange	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange
	$L_L$	$L_C$	$L_T$	$L_N \pm 0,06$	$H_L$	tol. <sup>f</sup>	$J_L$
2 <sup>1</sup> / <sub>16</sub>	2,56	—	2,56	4,31	2,38	+ 0,09	1,97
2 <sup>9</sup> / <sub>16</sub>	2,81	—	2,81	4,44	2,88	+ 0,09	2,35
3 <sup>1</sup> / <sub>8</sub>	2,44	—	2,94	4,31	3,50	+ 0,09	2,93
4 <sup>1</sup> / <sub>16</sub>	3,06	3,50	3,50	4,81	4,50	+ 0,09	3,86
5 <sup>1</sup> / <sub>8</sub>	3 44	4,00	—	5,31	5,56	+ 0,09	4,84
7 <sup>1</sup> / <sub>16</sub>	3,69	4,50	—	5,81	6,63	+ 0,16	5,79
9	4,31	5,00	—	6,69	8,63	+ 0,16	7,47
11	4,56	5,25	—	7,56	10,75	+ 0,16	9,34
13 <sup>5</sup> / <sub>8</sub>	4,94	4,94	—	—	—	—	—
16 <sup>3</sup> / <sub>4</sub>	5,06	5,69	—	—	—	—	—
20 <sup>3</sup> / <sub>4</sub>	6,75	6,75	—	—	—	—	—

<sup>f</sup> Minimum tolerance for this dimension is – 0,03.

**Table B.51 — Type 6B flanges for 5 000 psi rated working pressure (USC units)**

Dimensions in inches unless otherwise indicated



- a Reference dimension.
- b Break sharp corners.
- c Top.
- d Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

**a) Flange section integral flange**

Table B.51 (continued)

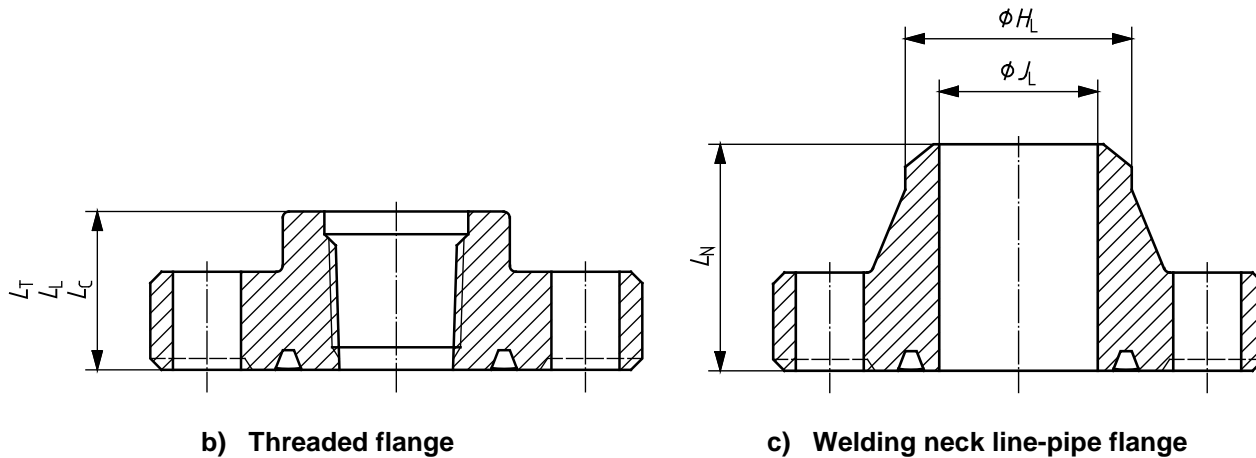
Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nominal size and bore of flange	Basic flange dimensions							
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Basic thickness of flange	Diameter of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i>	<i>T</i> +0,12 0	<i>Q</i>	<i>X</i>
2 <sup>1</sup> / <sub>16</sub>	2,09	8,50	± 0,06	0,12	4,88	1,81	1,50	4,12
2 <sup>9</sup> / <sub>16</sub>	2,59	9,62	± 0,06	0,12	5,38	1,94	1,62	4,88
3 <sup>1</sup> / <sub>8</sub>	3,22	10,50	± 0,06	0,12	6,62	2,19	1,88	5,25
4 <sup>1</sup> / <sub>16</sub>	4,28	12,25	± 0,06	0,12	7,62	2,44	2,12	6,38
5 <sup>1</sup> / <sub>8</sub>	5,16	14,75	± 0,06	0,12	9,00	3,19	2,88	7,75
7 <sup>1</sup> / <sub>16</sub>	7,16	15,50	± 0,12	0,25	9,75	3,62	3,25	9,00
9	9,03	19,00	± 0,12	0,25	12,50	4,06	3,62	11,50
11	11,03	23,00	± 0,12	0,25	14,63	4,69	4,25	14,50

Dimensions in inches

(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>e</sup>	<i>L<sub>ssb</sub></i>	R or RX
2 <sup>1</sup> / <sub>16</sub>	6,50	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	24
2 <sup>9</sup> / <sub>16</sub>	7,50	8	1	1,12	+ 0,06	6,50	27
3 <sup>1</sup> / <sub>8</sub>	8,00	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	7,25	35
4 <sup>1</sup> / <sub>16</sub>	9,50	8	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	8,00	39
5 <sup>1</sup> / <sub>8</sub>	11,50	8	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,06	10,00	44
7 <sup>1</sup> / <sub>16</sub>	12,50	12	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	10,75	46
9	15,50	12	1 <sup>5</sup> / <sub>8</sub>	1,75	+ 0,09	12,00	50
11	19,00	12	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	13,75	54

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

**Table B.51** (continued)

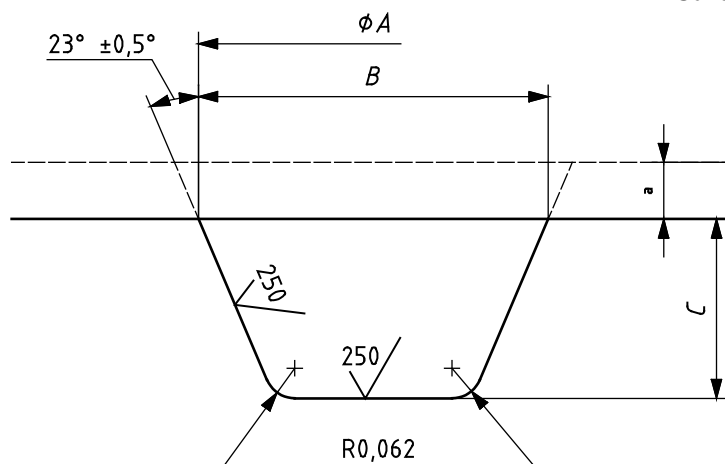
Dimensions in inches

(1)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Hub and bore dimensions							
Nominal size and bore of flange	Hub length threaded line-pipe flange $L_L$	Hub length threaded casing flange $L_C$	Hub length tubing flange $L_T$	Hub length welding neck line-pipe flange $L_N \pm 0,06$	Neck diameter welding neck line-pipe flange		Maximum bore of welding neck flange $J_L$
					$H_L$	tol. <sup>f</sup>	
2 <sup>1</sup> / <sub>16</sub>	2,56	—	2,56	4,31	2,38	+ 0,09	1,72
2 <sup>9</sup> / <sub>16</sub>	2,81	—	2,81	4,44	2,88	+ 0,09	2,16
3 <sup>1</sup> / <sub>8</sub>	3,19	—	3,19	4,94	3,50	+ 0,09	2,65
4 <sup>1</sup> / <sub>16</sub>	3,88	3,88	3,88	5,19	4,50	+ 0,09	3,47
5 <sup>1</sup> / <sub>8</sub>	4,44	4,44	—	6,44	5,56	+ 0,09	4,34
7 <sup>1</sup> / <sub>16</sub>	5,06	5,06	—	7,13	6,63	+ 0,16	5,22
9	6,06	6,06	—	8,81	8,63	+ 0,16	6,84
11	6,69	6,69	—	10,44	10,75	+ 0,16	8,53

<sup>f</sup> Minimum tolerance for this dimension is – 0,03.

**Table B.52 — Rough machining detail for corrosion-resistant ring groove (USC units)**

Dimensions in inches unless otherwise indicated  
 Surface roughness in micro-inches



- <sup>a</sup> Allow 1/8 in or greater for final machining of weld overlay.

**Table B.52** (continued)

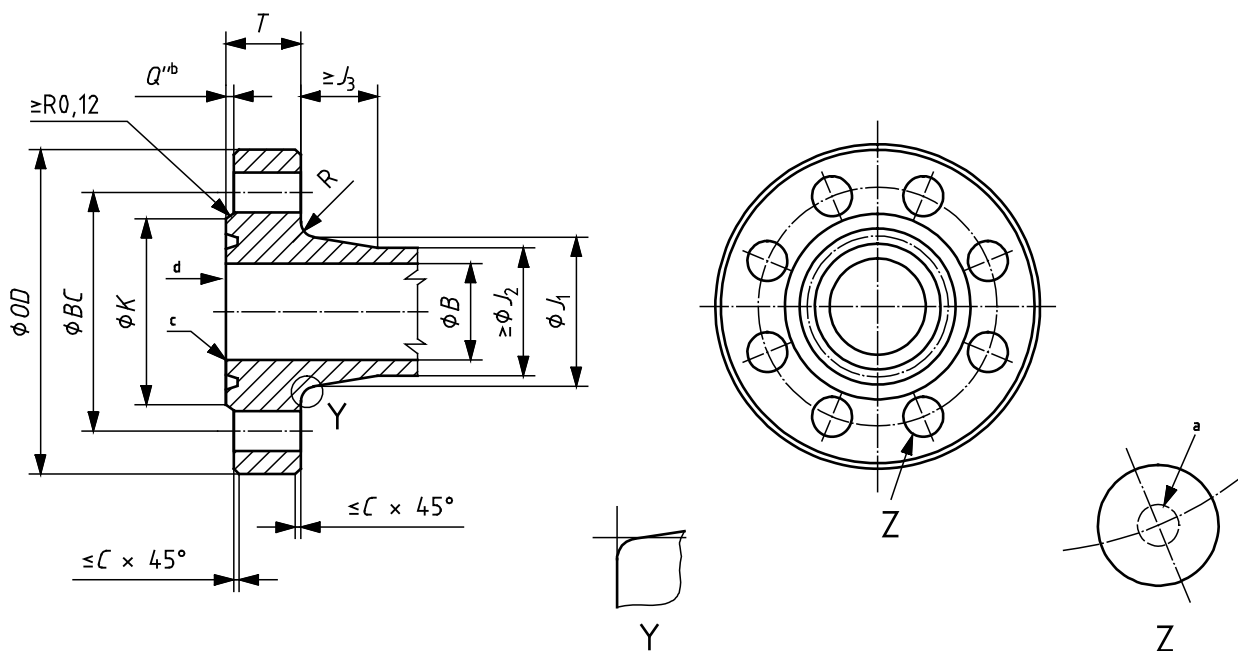
Dimensions in inches

Ring number	Outside diameter of groove <i>A</i> +0,03 0	Width of groove <i>B</i> +0,03 0	Depth of groove <i>C</i> +0,03 0	Ring number	Outside diameter of groove <i>A</i> +0,03 0	Width of groove <i>B</i> +0,03 0	Depth of groove <i>C</i> +0,03 0
BX 150	3,22	0,72	0,36	R 41	7,92	0,75	0,45
BX 151	3,39	0,74	0,36	R 44	8,42	0,75	0,45
BX 152	3,72	0,77	0,38	R 45	9,11	0,75	0,45
BX 153	4,38	0,83	0,41	R 46	9,17	0,81	0,52
BX 154	5,01	0,88	0,44	R 47	10,11	1,06	0,64
BX 155	6,26	0,97	0,47	R 49	11,42	0,75	0,45
BX 156	9,85	1,20	0,58	R 50	11,61	0,94	0,58
BX 157	12,10	1,32	0,64	R 53	13,55	0,75	0,45
BX 158	14,39	1,42	0,70	R 54	13,74	0,94	0,58
BX 159	17,36	1,55	0,77	R 57	15,80	0,75	0,45
BX 160	16,39	1,06	0,70	R 63	17,89	1,34	0,77
BX 162	19,16	0,98	0,47	R 65	19,30	0,75	0,45
BX 163	22,51	1,28	0,86	R 66	19,49	0,94	0,58
BX 164	23,08	1,57	0,86	R 69	21,80	0,75	0,45
BX 165	25,23	1,35	0,89	R 70	22,11	1,06	0,64
BX 166	25,84	1,65	0,89	R 73	23,86	0,81	0,52
BX 167	30,58	1,18	0,98	R 74	24,11	1,06	0,64
BX 168	30,81	1,29	0,98	R 82	3,05	0,75	0,45
BX 169	7,29	0,94	0,52	R 84	3,30	0,75	0,45
BX 303	34,33	1,46	1,17	R 85	3,99	0,81	0,52
R 20 <sup>b</sup>	3,36	0,62	0,39	R 86	4,55	0,94	0,58
R 23	4,05	0,75	0,45	R 87	4,92	0,94	0,58
R 24	4,55	0,75	0,45	R 88	5,99	1,06	0,64
R 25 <sup>b</sup>	4,67	0,62	0,39	R 89	5,61	1,06	0,64
R 26	4,80	0,75	0,45	R 90	7,36	1,19	0,70
R 27	5,05	0,75	0,45	R 91	11,89	1,59	0,83
R 31	5,67	0,75	0,45	R 99	10,05	0,75	0,45
R 35	6,17	0,75	0,45	R 201 <sup>b</sup>	2,36	0,50	0,30
R 37	6,67	0,75	0,45	R 205 <sup>b</sup>	2,80	0,50	0,42
R 39	7,17	0,75	0,45	R 210 <sup>b</sup>	4,20	0,66	0,39
				R 215 <sup>b</sup>	5,92	0,75	0,45

<sup>b</sup> See 10.1.2.4.5.

**Table B.53 — Type 6BX integral flanges for 2 000 psi; 3 000 psi; 5 000 psi  
and 10 000 psi rated working pressures (USC units)**

Dimensions in inches unless otherwise indicated



- a The bolt-hole centreline is located within 0,03 in of theoretical  $BC$  and equal spacing.
- b  $Q''_{max} = E$  (Table B.65).  
 $Q''_{min} = 0,12$  in.  
 $Q''$  may be omitted on studded flanges.
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

Table B.53 (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 0,06	<i>T</i> $\begin{smallmatrix} +0,12 \\ 0 \end{smallmatrix}$	<i>J</i> <sub>1</sub> $\begin{smallmatrix} 0 \\ -0,12 \end{smallmatrix}$	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
2 000 psi										
26 <sup>3</sup> / <sub>4</sub>	26,78	41,00	± 0,12	0,25	31,69	4,97	32,91	29,25	7,31	0,62
30	30,03	44,19	± 0,12	0,25	35,75	5,28	36,69	32,80	7,75	0,62
3 000 psi										
26 <sup>3</sup> / <sub>4</sub>	26,78	43,38	± 0,12	0,25	32,75	6,34	34,25	30,56	7,31	0,62
30	30,03	46,68	± 0,12	0,25	36,31	6,58	38,19	34,30	7,75	0,62
5 000 psi										
13 <sup>5</sup> / <sub>8</sub>	13,66	26,50	± 0,12	0,25	18,00	4,44	18,94	16,69	4,50	0,62
16 <sup>3</sup> / <sub>4</sub>	16,78	30,38	± 0,12	0,25	21,06	5,12	21,88	20,75	3,00	0,75
18 <sup>3</sup> / <sub>4</sub>	18,78	35,62	± 0,12	0,25	24,69	6,53	26,56	23,56	6,00	0,62
21 <sup>1</sup> / <sub>4</sub>	21,28	39,00	± 0,12	0,25	27,62	7,12	29,88	26,75	6,50	0,69
10 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	7,38	± 0,06	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	7,88	± 0,06	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	9,12	± 0,06	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	10,62	± 0,06	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	12,44	± 0,06	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 <sup>1</sup> / <sub>8</sub>	5,16	14,06	± 0,06	0,12	8,69	3,12	8,81	7,19	3,19	0,38
7 <sup>1</sup> / <sub>16</sub>	7,09	18,88	± 0,12	0,25	11,88	4,06	11,88	10,00	3,75	0,62
9	9,03	21,75	± 0,12	0,25	14,12	4,88	14,75	12,88	3,69	0,62
11	11,03	25,75	± 0,12	0,25	16,88	5,56	17,75	15,75	4,06	0,62
13 <sup>5</sup> / <sub>8</sub>	13,66	30,25	± 0,12	0,25	20,38	6,62	21,75	19,50	4,50	0,62
16 <sup>3</sup> / <sub>4</sub>	16,78	34,31	± 0,12	0,25	22,69	6,62	25,81	23,69	3,00	0,75
18 <sup>3</sup> / <sub>4</sub>	18,78	40,94	± 0,12	0,25	27,44	8,78	29,62	26,56	6,12	0,62
21 <sup>1</sup> / <sub>4</sub>	21,28	45,00	± 0,12	0,25	30,75	9,50	33,38	30,00	6,50	0,81

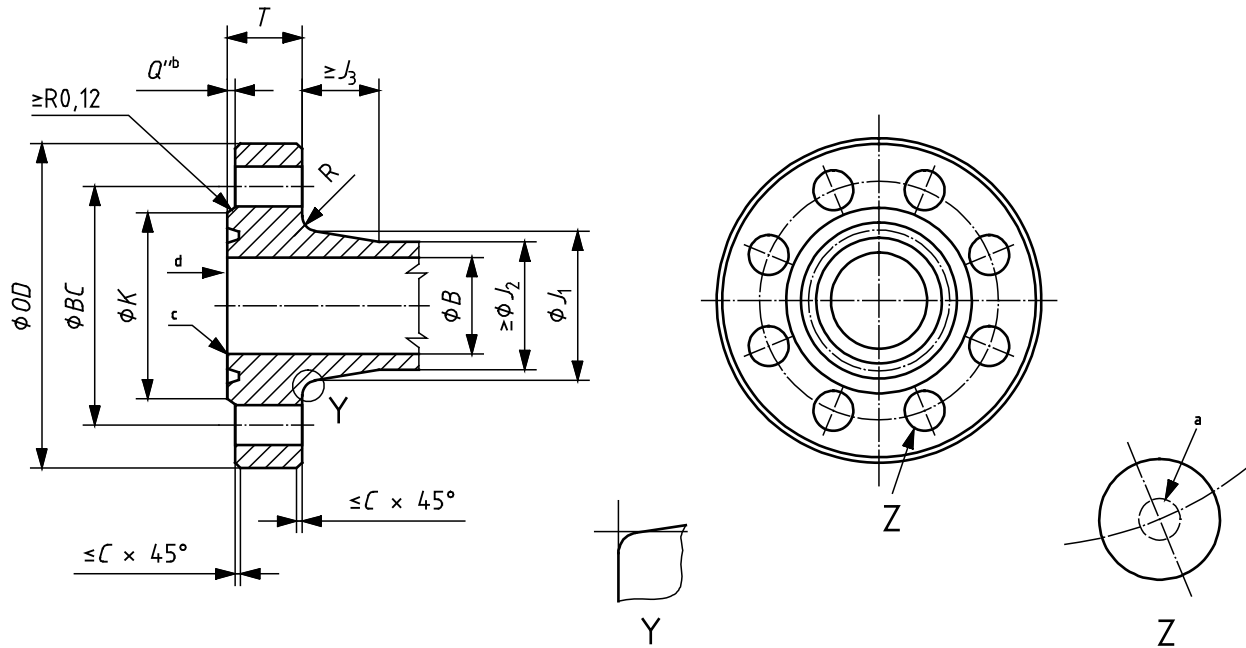
Dimensions in inches

(1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
				diameter	tol. <sup>e</sup>		
	BC					L <sub>ssb</sub>	BX
2 000 psi							
26 <sup>3</sup> / <sub>4</sub>	37,50	20	1 <sup>3</sup> / <sub>4</sub>	1,88	+ 0,09	13,75	167
30	40,94	32	1 <sup>5</sup> / <sub>8</sub>	1,75	+ 0,09	14,25	303
3 000 psi							
26 <sup>3</sup> / <sub>4</sub>	39,38	24	2	2,12	+ 0,09	17,00	168
30	42,94	32	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	17,75	303
5 000 psi							
13 <sup>5</sup> / <sub>8</sub>	23,25	16	1 <sup>5</sup> / <sub>8</sub>	1,75	+ 0,09	12,50	160
16 <sup>3</sup> / <sub>4</sub>	26,62	16	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	14,50	162
18 <sup>3</sup> / <sub>4</sub>	31,62	20	2	2,12	+ 0,09	17,50	163
21 <sup>1</sup> / <sub>4</sub>	34,88	24	2	2,12	+ 0,09	18,75	165
10 000 psi							
1 <sup>13</sup> / <sub>16</sub>	5,75	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,00	151
2 <sup>1</sup> / <sub>16</sub>	6,25	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,25	152
2 <sup>9</sup> / <sub>16</sub>	7,25	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	153
3 <sup>1</sup> / <sub>16</sub>	8,50	8	1	1,12	+ 0,06	6,75	154
4 <sup>1</sup> / <sub>16</sub>	10,19	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,00	155
5 <sup>1</sup> / <sub>8</sub>	11,81	12	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,75	169
7 <sup>1</sup> / <sub>16</sub>	15,88	12	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	11,25	156
9	18,75	16	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	13,00	157
11	22,25	16	1 <sup>3</sup> / <sub>4</sub>	1,88	+ 0,09	15,00	158
13 <sup>5</sup> / <sub>8</sub>	26,50	20	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	17,25	159
16 <sup>3</sup> / <sub>4</sub>	30,56	24	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	17,50	162
18 <sup>3</sup> / <sub>4</sub>	36,44	24	2 <sup>1</sup> / <sub>4</sub>	2,38	+ 0,09	22,50	164
21 <sup>1</sup> / <sub>4</sub>	40,25	24	2 <sup>1</sup> / <sub>2</sub>	2,62	+ 0,09	24,50	166

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

**Table B.54 — Type 6BX integral flanges for 15 000 psi and 20 000 psi rated working pressures (USC units)**

Dimensions in inches unless otherwise indicated



- a Bolt hole centreline is located within 0,03 in of theoretical  $BC$  and equal spacing.
- b  $Q''_{\max} = E$  (Table B.65).  
 $Q''_{\min} = 0,12$  in.  
 $Q''$  may be omitted on studded flanges.
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

Table B.54 (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 0,06	<i>T</i> +0,12 0	<i>J</i> <sub>1</sub> 0 -0,12	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
15 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	8,19	± 0,06	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	8,75	± 0,06	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	10,00	± 0,06	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	11,31	± 0,06	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	14,19	± 0,06	0,12	7,62	3,09	7,69	6,25	2,88	0,38
5 <sup>1</sup> / <sub>8</sub>	5,16	16,50	± 0,06	0,12	8,88	3,88	9,62	7,88	3,22	0,62
7 <sup>1</sup> / <sub>16</sub>	7,09	19,88	± 0,12	0,25	12,00	4,69	12,81	10,88	3,62	0,62
9	9,03	25,50	± 0,12	0,25	15,00	5,75	17,00	13,75	4,88	0,62
11	11,03	32,00	± 0,12	0,25	17,88	7,38	23,00	16,81	9,28	0,62
13 <sup>5</sup> / <sub>8</sub>	13,66	34,88	± 0,12	0,25	21,31	8,06	23,44	20,81	4,50	1,00
18 <sup>3</sup> / <sub>4</sub>	18,78	45,75	± 0,12	0,25	28,44	10,06	32,00	28,75	6,12	1,00
20 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	10,12	± 0,06	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	11,31	± 0,06	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	12,81	± 0,06	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	14,06	± 0,06	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	17,56	± 0,06	0,12	8,62	4,19	9,56	8,12	2,88	0,38
7 <sup>1</sup> / <sub>16</sub>	7,09	25,81	± 0,12	0,25	13,88	6,50	15,19	13,31	3,81	0,62
9	9,03	31,69	± 0,12	0,25	17,38	8,06	18,94	16,88	4,25	1,00
11	11,03	34,75	± 0,12	0,25	19,88	8,81	22,31	20,00	4,06	1,00
13 <sup>5</sup> / <sub>8</sub>	13,66	45,75	± 0,12	0,25	24,19	11,50	27,31	24,75	5,25	1,00

Dimensions in inches

<sup>e</sup> Minimum bolt hole tolerance is  $-0,02$ .



Table B.55 (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	$B$	$OD$	tol.	$C$	$K$ $\pm 0,06$	$T$ $+0,12$ $0$	$J_1$ $0$ $-0,12$	$J_2$	$J_3$	$R$
<b>10 000 psi</b>										
1 $\frac{13}{16}$	1,84	7,38	$\pm 0,06$	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 $\frac{1}{16}$	2,09	7,88	$\pm 0,06$	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 $\frac{9}{16}$	2,59	9,12	$\pm 0,06$	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 $\frac{1}{16}$	3,09	10,62	$\pm 0,06$	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 $\frac{1}{16}$	4,09	12,44	$\pm 0,06$	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 $\frac{1}{8}$	5,16	14,06	$\pm 0,06$	0,12	8,69	3,12	8,81	7,19	3,19	0,38
7 $\frac{1}{16}$	7,09	18,88	$\pm 0,12$	0,25	11,88	4,06	11,88	10,00	3,75	0,62
9	9,03	21,75	$\pm 0,12$	0,25	14,12	4,88	14,75	12,88	3,69	0,62
11	11,03	25,75	$\pm 0,12$	0,25	16,88	5,56	17,75	15,75	4,06	0,62
13 $\frac{5}{8}$	13,66	30,25	$\pm 0,12$	0,25	20,38	6,62	21,75	19,50	4,50	0,62
16 $\frac{3}{4}$	16,78	34,31	$\pm 0,12$	0,25	22,69	6,62	25,81	23,69	3,00	0,75
<b>15 000 psi</b>										
1 $\frac{13}{16}$	1,84	8,19	$\pm 0,06$	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 $\frac{1}{16}$	2,09	8,75	$\pm 0,06$	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 $\frac{9}{16}$	2,59	10,00	$\pm 0,06$	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 $\frac{1}{16}$	3,09	11,31	$\pm 0,06$	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 $\frac{1}{16}$	4,09	14,19	$\pm 0,06$	0,12	7,62	3,09	7,69	6,25	2,88	0,38
5 $\frac{1}{8}$	5,16	16,50	$\pm 0,06$	0,12	8,88	3,88	9,62	7,88	3,22	0,62
7 $\frac{1}{16}$	7,09	19,88	$\pm 0,12$	0,25	12,00	4,69	12,81	10,88	3,62	0,62

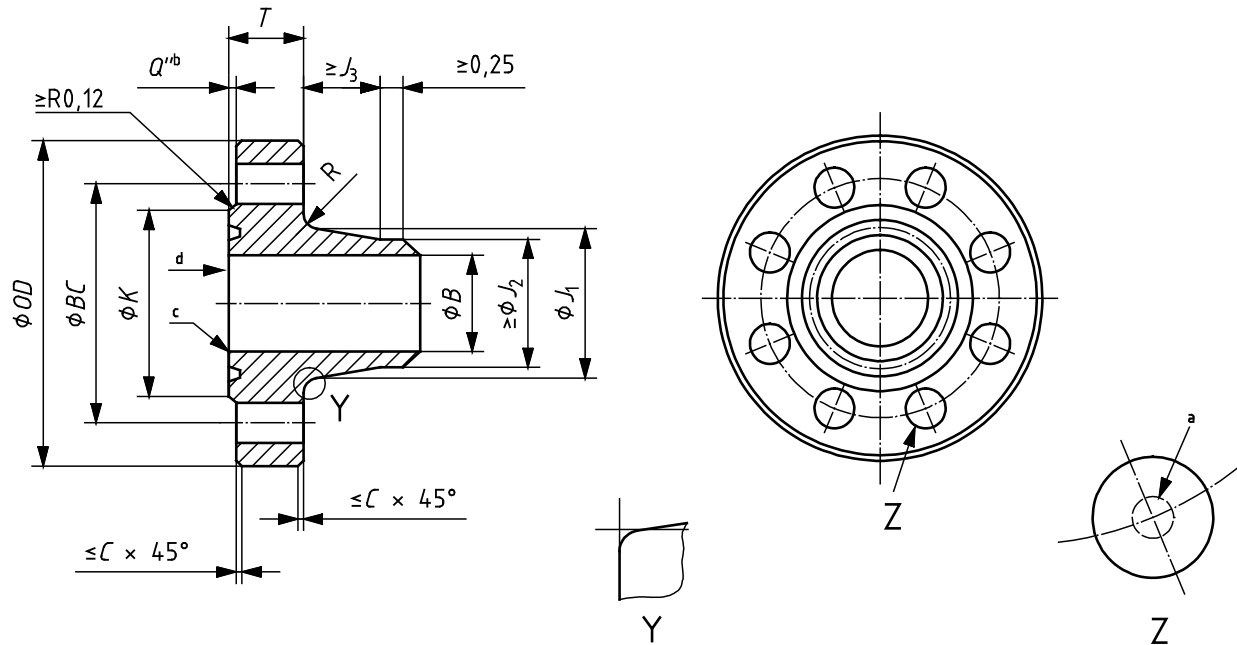
Dimensions in inches

(1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
	BC			diameter	tol. <sup>e</sup>	L <sub>ssb</sub>	BX
10 000 psi							
1 <sup>13</sup> / <sub>16</sub>	5,75	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,00	151
2 <sup>1</sup> / <sub>16</sub>	6,25	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,25	152
2 <sup>9</sup> / <sub>16</sub>	7,25	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	153
3 <sup>1</sup> / <sub>16</sub>	8,50	8	1	1,12	+ 0,06	6,75	154
4 <sup>1</sup> / <sub>16</sub>	10,19	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,00	155
5 <sup>1</sup> / <sub>8</sub>	11,81	12	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,75	169
7 <sup>1</sup> / <sub>16</sub>	15,88	12	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	11,25	156
9	18,75	16	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	13,00	157
11	22,25	16	1 <sup>3</sup> / <sub>4</sub>	1,88	+ 0,09	15,00	158
13 <sup>5</sup> / <sub>8</sub>	26,50	20	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	17,25	159
16 <sup>3</sup> / <sub>4</sub>	30,56	24	1 <sup>7</sup> / <sub>8</sub>	2,00	+ 0,09	17,50	162
15 000 psi							
1 <sup>13</sup> / <sub>16</sub>	6,31	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	5,50	151
2 <sup>1</sup> / <sub>16</sub>	6,88	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	152
2 <sup>9</sup> / <sub>16</sub>	7,88	8	1	1,12	+ 0,06	6,75	153
3 <sup>1</sup> / <sub>16</sub>	9,06	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	7,50	154
4 <sup>1</sup> / <sub>16</sub>	11,44	8	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	9,25	155
5 <sup>1</sup> / <sub>8</sub>	13,50	12	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	11,50	169
7 <sup>1</sup> / <sub>16</sub>	16,88	16	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	12,75	156

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

**Table B.56 — Type 6BX welding neck flanges for 20 000 psi  
rated working pressure (USC units)**

Dimensions in inches unless otherwise indicated



- a Bolt hole centreline is located within 0,03 in of theoretical  $BC$  and equal spacing.
- b  $Q'_{\max} = E$  (Table B.65).  
 $Q'_{\min} = 0,12$  in.
- c Break sharp corners.
- d Top.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

Table B.56 (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 0,06	<i>T</i> +0,12 0	<i>J</i> <sub>1</sub> 0 -0,12	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
20 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	10,12	± 0,06	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	11,31	± 0,06	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	12,81	± 0,06	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	14,06	± 0,06	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	17,56	± 0,06	0,12	8,62	4,19	9,56	8,12	2,88	0,38
7 <sup>1</sup> / <sub>16</sub>	7,09	25,81	± 0,12	0,25	13,88	6,50	15,19	13,31	3,81	0,62

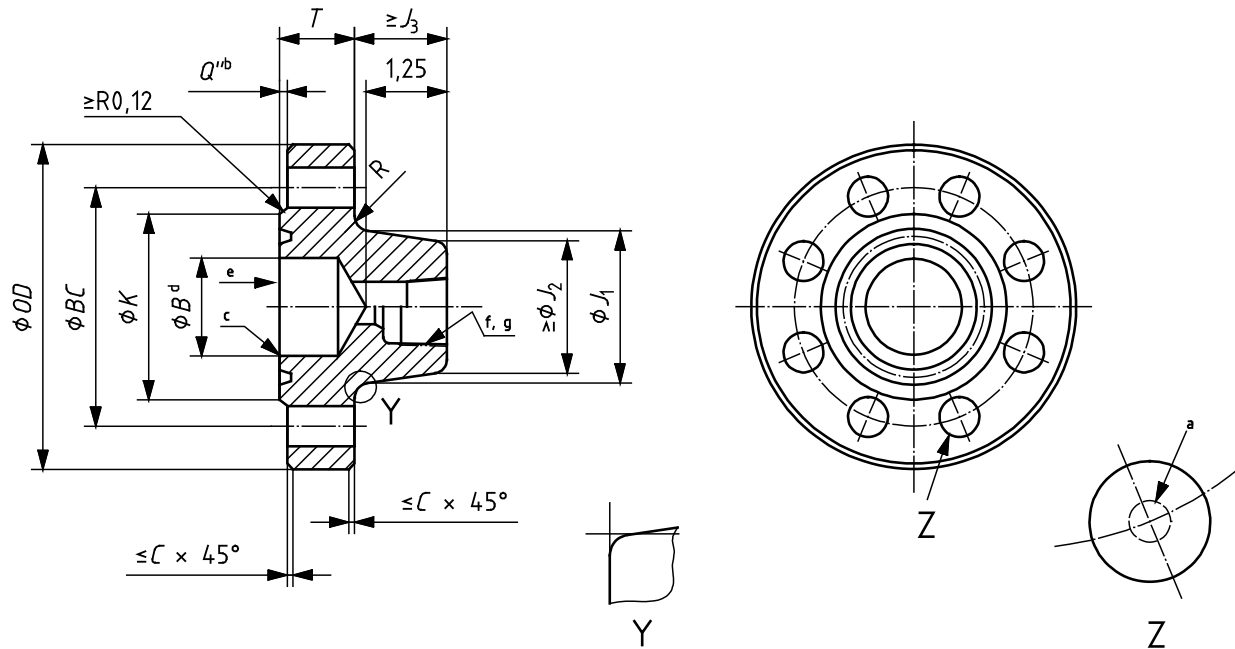
Dimensions in inches

(1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>e</sup>	<i>L</i> <sub>ssb</sub>	BX
20 000 psi							
1 <sup>13</sup> / <sub>16</sub>	8,00	8	1	1,12	+ 0,06	7,50	151
2 <sup>1</sup> / <sub>16</sub>	9,06	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,25	152
2 <sup>9</sup> / <sub>16</sub>	10,31	8	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	9,25	153
3 <sup>1</sup> / <sub>16</sub>	11,31	8	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	10,00	154
4 <sup>1</sup> / <sub>16</sub>	14,06	8	1 <sup>3</sup> / <sub>4</sub>	1,88	+ 0,09	12,25	155
7 <sup>1</sup> / <sub>16</sub>	21,81	16	2	2,12	+ 0,09	17,50	156

<sup>e</sup> Minimum bolt hole tolerance is – 0,02.

**Table B.57 — Type 6BX blind and test flanges for 10 000 psi and 15 000 psi rated working pressures (USC units)**

Dimensions in inches unless otherwise indicated



- a Bolt hole centreline is located within 0,03 in of theoretical  $BC$  and equal spacing.
- b  $Q''_{\max} = E$  (Table B.65).  
 $Q''_{\min} = 0,12$  in.
- c Break sharp corners.
- d This bore is optional.
- e Top.
- f Test connection. See Figure 19.
- g  $1/2$  inch line-pipe or NPT threads (maximum 10 000 psi working pressure).

Ring groove shall be concentric with bore within 0,010 total indicator runout.

Table B.57 (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> ± 0,06	<i>T</i> +0,12 0	<i>J</i> <sub>1</sub> 0 -0,12	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
10 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	7,38	± 0,06	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	7,88	± 0,06	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	9,12	± 0,06	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	10,62	± 0,06	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	12,44	± 0,06	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 <sup>1</sup> / <sub>8</sub>	5,16	14,06	± 0,06	0,12	8,69	3,12	8,81	7,19	3,19	0,38
15 000 psi										
1 <sup>13</sup> / <sub>16</sub>	1,84	8,19	± 0,06	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	8,75	± 0,06	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	10,00	± 0,06	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	11,31	± 0,06	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	14,19	± 0,06	0,12	7,62	3,09	7,69	6,25	2,88	0,38

Dimensions in inches

(1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>h</sup>	<i>L<sub>ssb</sub></i>	BX
<b>10 000 psi</b>							
1 <sup>13</sup> / <sub>16</sub>	5,75	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,00	151
2 <sup>1</sup> / <sub>16</sub>	6,25	8	<sup>3</sup> / <sub>4</sub>	0,88	+ 0,06	5,25	152
2 <sup>9</sup> / <sub>16</sub>	7,25	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	153
3 <sup>1</sup> / <sub>16</sub>	8,50	8	1	1,12	+ 0,06	6,75	154
4 <sup>1</sup> / <sub>16</sub>	10,19	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,00	155
5 <sup>1</sup> / <sub>8</sub>	11,81	12	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,75	169
<b>15 000 psi</b>							
1 <sup>13</sup> / <sub>16</sub>	6,31	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	5,50	151
2 <sup>1</sup> / <sub>16</sub>	6,88	8	<sup>7</sup> / <sub>8</sub>	1,00	+ 0,06	6,00	152
2 <sup>9</sup> / <sub>16</sub>	7,88	8	1	1,12	+ 0,06	6,75	153
3 <sup>1</sup> / <sub>16</sub>	9,06	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	7,50	154
4 <sup>1</sup> / <sub>16</sub>	11,44	8	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	9,25	155

<sup>h</sup> Minimum bolt hole tolerance is – 0,02.



**Table B.58** (continued)

Dimensions in inches

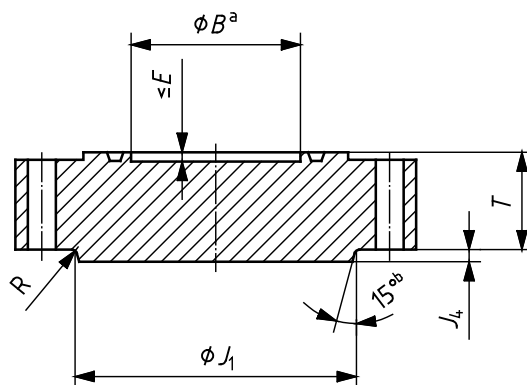
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	Basic flange dimensions									
	Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
	<i>B</i>	<i>OD</i>	tol.	<i>C</i>	<i>K</i> $\pm 0,06$	<i>T</i> $\begin{smallmatrix} +0,12 \\ 0 \end{smallmatrix}$	<i>J</i> <sub>1</sub> $\begin{smallmatrix} 0 \\ -0,12 \end{smallmatrix}$	<i>J</i> <sub>2</sub>	<i>J</i> <sub>3</sub>	<i>R</i>
<b>15 000 psi</b>										
5 <sup>1</sup> / <sub>8</sub>	5,16	16,50	$\pm 0,06$	0,12	8,88	3,88	9,62	7,88	3,22	0,62
<b>20 000 psi</b>										
1 <sup>13</sup> / <sub>16</sub>	1,84	10,12	$\pm 0,06$	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 <sup>1</sup> / <sub>16</sub>	2,09	11,31	$\pm 0,06$	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 <sup>9</sup> / <sub>16</sub>	2,59	12,81	$\pm 0,06$	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 <sup>1</sup> / <sub>16</sub>	3,09	14,06	$\pm 0,06$	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 <sup>1</sup> / <sub>16</sub>	4,09	17,56	$\pm 0,06$	0,12	8,62	4,19	9,56	8,12	2,88	0,38

Dimensions in inches

(1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Nominal size and bore of flange	Bolting dimensions						
	Diameter of bolt circle	Number of bolts	Diameter of bolts	Bolt holes		Minimum length of stud bolts	Ring number
	<i>BC</i>			diameter	tol. <sup>9</sup>	<i>L</i> <sub>ssb</sub>	BX
<b>15 000 psi</b>							
5 <sup>1</sup> / <sub>8</sub>	13,50	12	1 <sup>1</sup> / <sub>2</sub>	1,62	+ 0,09	11,50	169
<b>20 000 psi</b>							
1 <sup>13</sup> / <sub>16</sub>	8,00	8	1	1,12	+ 0,06	7,50	151
2 <sup>1</sup> / <sub>16</sub>	9,06	8	1 <sup>1</sup> / <sub>8</sub>	1,25	+ 0,06	8,25	152
2 <sup>9</sup> / <sub>16</sub>	10,31	8	1 <sup>1</sup> / <sub>4</sub>	1,38	+ 0,06	9,25	153
3 <sup>1</sup> / <sub>16</sub>	11,31	8	1 <sup>3</sup> / <sub>8</sub>	1,50	+ 0,06	10,00	154
4 <sup>1</sup> / <sub>16</sub>	14,06	8	1 <sup>3</sup> / <sub>4</sub>	1,88	+ 0,09	12,25	155

<sup>9</sup> Minimum bolt hole tolerance is – 0,02.

**Table B.59 — Type 6BX blind flanges for 2 000 psi; 3 000 psi; 5 000 psi; 10 000 psi; 15 000 psi and 20 000 psi rated working pressures (USC units)**



- a Counter-bore.  
b Maximum slope.

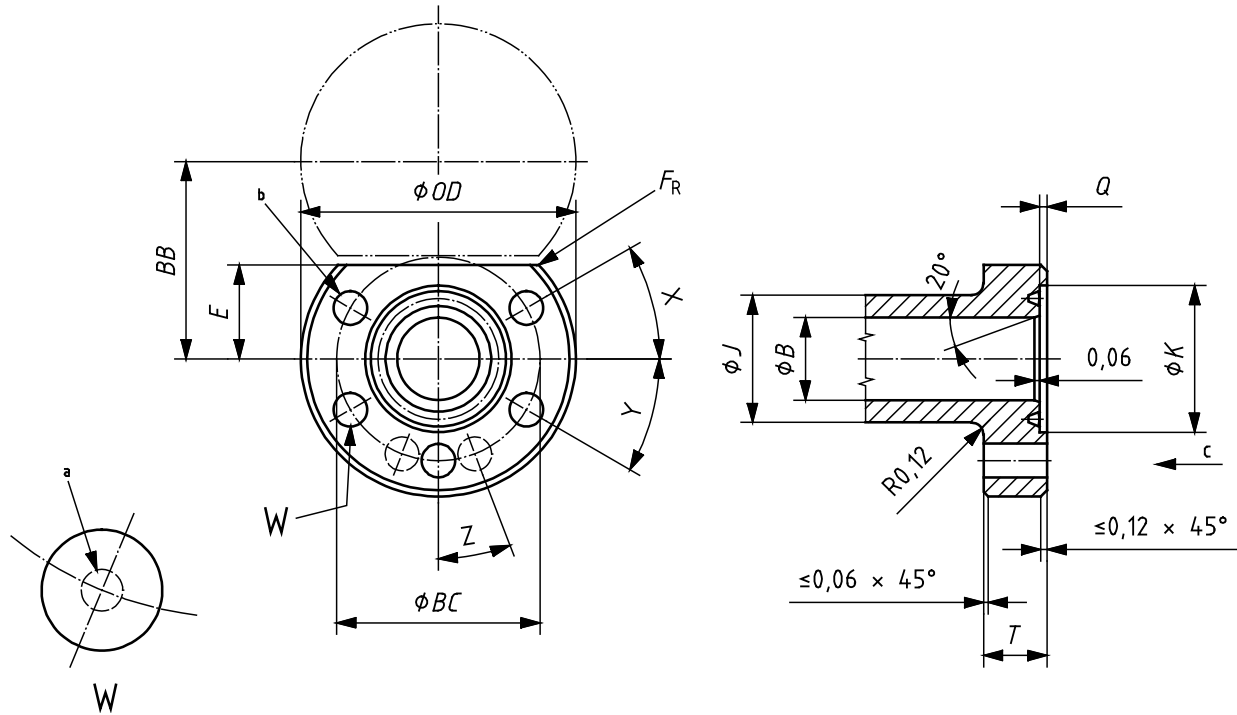
**Table B.59** (continued)

Dimensions in inches

Nominal size of flange <i>B</i>	Flange thickness <i>T</i> +0,12 0	Hub diameter <i>J</i> <sub>1</sub> 0 -0,12	Counter-bore depth <i>E</i>	Added hub thickness <i>J</i> <sub>4</sub> min.
<b>2 000 psi</b>				
26 <sup>3</sup> / <sub>4</sub>	4,97	32,91	0,844	0,38
30	5,28	36,69	0,906	0,69
<b>3 000 psi</b>				
26 <sup>3</sup> / <sub>4</sub>	6,34	34,25	0,844	0,00
30	6,58	38,19	0,906	0,50
<b>5 000 psi</b>				
13 <sup>5</sup> / <sub>8</sub>	4,44	18,94	0,562	0,94
16 <sup>3</sup> / <sub>4</sub>	5,12	21,88	0,328	0,69
18 <sup>3</sup> / <sub>4</sub>	6,53	26,56	0,719	0,75
21 <sup>1</sup> / <sub>4</sub>	7,12	29,88	0,750	0,88
<b>10 000 psi</b>				
5 <sup>1</sup> / <sub>8</sub>	3,12	8,81	0,375	0,25
7 <sup>1</sup> / <sub>16</sub>	4,06	11,88	0,438	0,38
9	4,88	14,75	0,500	0,38
11	5,56	17,75	0,562	0,56
13 <sup>5</sup> / <sub>8</sub>	6,62	21,75	0,625	0,69
16 <sup>3</sup> / <sub>4</sub>	6,62	25,81	0,328	1,19
18 <sup>3</sup> / <sub>4</sub>	8,78	29,62	0,719	1,00
21 <sup>1</sup> / <sub>4</sub>	9,50	33,38	0,750	1,25
<b>15 000 psi</b>				
5 <sup>1</sup> / <sub>8</sub>	3,88	9,62	0,375	0,25
7 <sup>1</sup> / <sub>16</sub>	4,69	12,81	0,438	0,31
9	5,75	17,00	0,500	0,56
11	7,38	23,00	0,562	0,50
13 <sup>5</sup> / <sub>8</sub>	8,06	23,44	0,625	0,69
18 <sup>3</sup> / <sub>4</sub>	10,06	32,00	0,719	1,38
<b>20 000 psi</b>				
7 <sup>1</sup> / <sub>16</sub>	6,50	15,19	0,438	0,31
9	8,06	18,94	0,500	0,25
11	8,81	22,31	0,562	0,50
13 <sup>5</sup> / <sub>8</sub>	11,50	27,31	0,625	0,56
NOTE For dimensions not listed, see Tables B.53 to B.58, as applicable.				

**Table B.60 — Dimensions for 5 000 psi rated working pressure, segmented flanges for dual completion (USC units)**

Dimensions in inches unless otherwise specified



- a Bolt hole centreline is located within 0,03 in of theoretical  $BC$  and equal spacing.
- b Bolt holes:  $L$ ,  $M$ .
- c Top.

Ring groove shall be concentric with bore within 0,010 total indicator runout.

Table B.60 (continued)

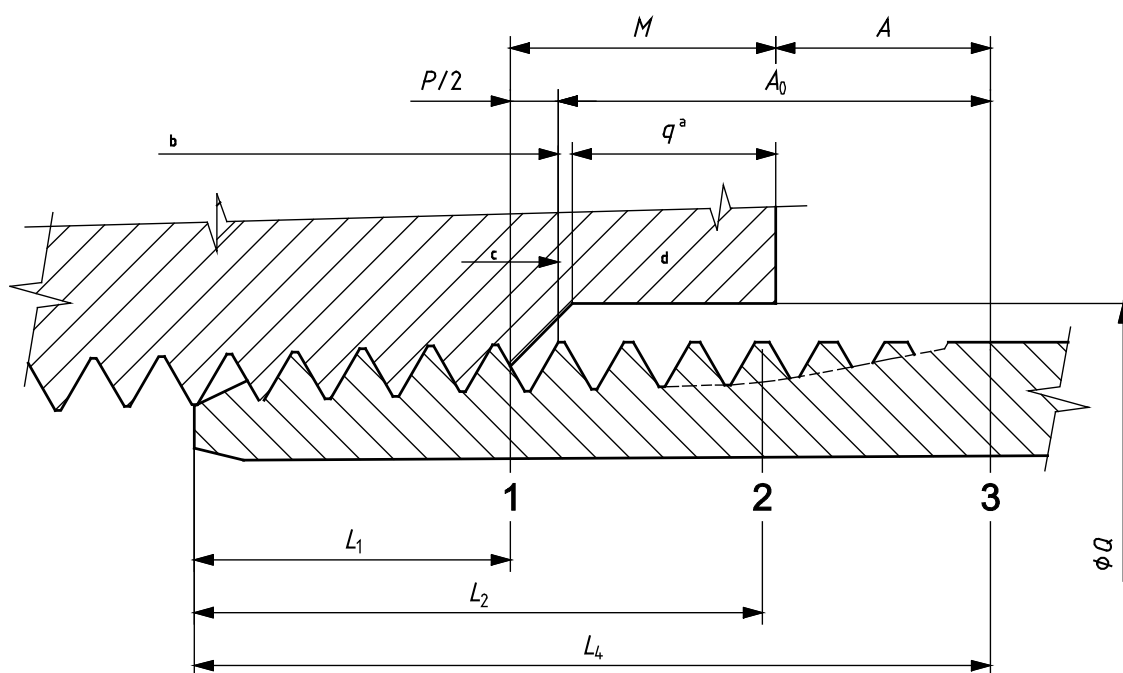
Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange	Basic flange dimensions										
	Maximum bore	Outside diameter of flange		Total thickness of flange	Distance flat to centre	Minimum radius	Diameter of hub		Diameter of counter-bore	Depth of counter-bore	Ring number
	<i>B</i>	<i>OD</i>	tol.	<i>T</i> +0,12 0	<i>E</i> − 0,02	<i>F<sub>R</sub></i>	<i>J</i>	tol.	<i>K</i>	<i>Q</i> + 0,010	RX
1 3/8	1,39	5,12	± 0,06	1,56	1,16	0,25	2,22	− 0,02	2,06	0,109	201
1 13/16	1,83	6,12	± 0,06	2,06	1,38	0,12	2,75	− 0,02	2,62	0,072	205
2 1/16	2,09	6,56	± 0,06	2,12	1,75	0,12	3,03	− 0,03	3,12	0,145	20
2 9/16	2,59	8,38	± 0,06	2,50	2,22	0,12	3,69	− 0,03	4,00	0,145	210
3 1/8	3,16	9,12	± 0,06	2,75	2,50	0,12	4,50	− 0,03	4,56	0,130	25
4 1/16	4,09	10,62	± 0,06	2,75	2,94	1,00	5,25	− 0,03	5,69	0,210	215
4 1/16 × 4 1/4	4,28	10,62	± 0,06	2,75	2,94	1,00	5,25	− 0,03	5,69	0,210	215

Dimensions in inches

(1)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Nominal size and bore of flange	Bolting dimensions										
	Diameter of bolt circle	Diameter of bolt holes		Number of bolt holes	Degrees	Degrees	Degrees	Diameter of bolt	Length of double-ended stud bolt	Length of threaded stud bolt	Bore-to-bore equal size
	<i>BC</i>	<i>L</i>	tol. <sup>d</sup>	<i>M</i>	<i>X</i>	<i>Y</i>	<i>Z</i>				<i>BB</i>
1 3/8	3,88	0,62	+ 0,06	5	13	38,5	—	1/2	2,75	4,50	—
1 13/16	4,62	0,75	+ 0,06	5	16	37	—	5/8	3,50	5,75	2,78
2 1/16	5,12	0,88	+ 0,06	5	19	35,5	—	3/4	3,75	6,00	3,55
2 9/16	6,38	1,12	+ 0,06	5	21	34,5	—	1	4,75	7,25	4,50
3 1/8	7,06	1,12	+ 0,06	5	23	33,5	—	1	5,00	7,75	5,05
4 1/16	8,12	1,25	+ 0,06	6	28,5	19	23,5	1 1/8	5,25	8,25	—
4 1/16 × 4 1/4	8,12	1,25	+ 0,06	6	28,5	19	23,5	1 1/8	5,25	8,25	—

<sup>d</sup> Minimum bolt hole tolerance is − 0,02.

**Table B.61 — Pipe thread counter-bore and stand-off dimensions (USC units)****Key**

- 1 plane of hand-tight engagement
  - 2 plane of effective thread length
  - 3 plane of vanish point
- a See 10.2.2.3.
  - b Internal thread length.
  - c Without counter-bore.
  - d With counter-bore.

NOTE See API Spec 5B for dimensions  $L_1$ ,  $L_2$  and  $L_4$ .

**Table B.61** (continued)

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nominal thread size	Length: plane of vanish point to hand- tight plane  <i>A + M</i>	Hand-tight standoff		Length: face of counter- bore to hand- tight plane  <i>M</i>	Counter-bore	
		Thread without counter-bore  <i>A<sub>0</sub></i>	Thread with shallow counter-bore  <i>A</i>		Diameter  <i>Q</i>	Depth  <i>q</i>
Line-pipe threads						
<sup>1</sup> / <sub>8</sub>	0,212 4	0,193 9	0,039 8	0,172 6	0,47	0,13
<sup>1</sup> / <sub>4</sub>	0,394 6	0,366 8	0,214 5	0,180 1	0,60	0,13
<sup>3</sup> / <sub>8</sub>	0,360 6	0,332 8	0,179 1	0,181 5	0,74	0,13
<sup>1</sup> / <sub>2</sub>	0,461 5	0,425 8	0,135 7	0,325 8	0,93	0,25
<sup>3</sup> / <sub>4</sub>	0,454 5	0,418 8	0,128 9	0,325 6	1,14	0,25
1	0,584 5	0,541 0	0,248 8	0,335 7	1,41	0,25
1 <sup>1</sup> / <sub>4</sub>	0,588 5	0,545 0	0,255 2	0,333 3	1,75	0,25
1 <sup>1</sup> / <sub>2</sub>	0,605 2	0,561 7	0,271 4	0,333 8	1,99	0,25
2	0,622 2	0,578 7	0,270 3	0,351 9	2,50	0,25
2 <sup>1</sup> / <sub>2</sub>	0,889 2	0,826 7	0,395 3	0,493 9	3,00	0,38
3	0,867 7	0,805 2	0,371 9	0,495 8	3,63	0,38
3 <sup>1</sup> / <sub>2</sub>	0,862 7	0,800 2	0,367 1	0,495 6	4,13	0,38
4	0,889 7	0,827 2	0,393 3	0,496 4	4,63	0,38
5	0,903 0	0,840 5	0,407 6	0,495 4	5,69	0,38
6	0,988 2	0,925 7	0,491 2	0,497 0	6,75	0,38
8	1,083 2	1,020 7	0,583 2	0,500 0	8,75	0,38
10	1,148 7	1,086 2	0,644 2	0,504 5	10,88	0,38
12	1,198 7	1,136 2	0,662 6	0,536 1	12,94	0,38
14D	1,121 7	1,059 2	0,588 0	0,533 7	14,19	0,38
16D	1,071 7	1,009 2	0,539 6	0,532 1	16,19	0,38
18D	1,083 7	1,021 2	0,551 2	0,532 5	18,19	0,38
20D	1,158 7	1,096 2	0,623 9	0,534 8	20,19	0,38

Table B.61 (continued)

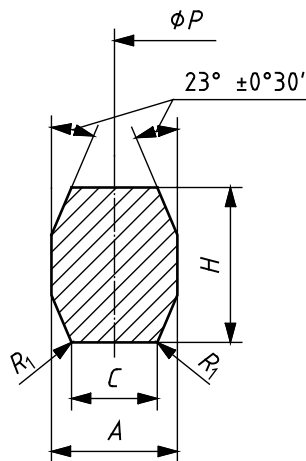
Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nominal thread size	Length: plane of vanish point to hand- tight plane  <i>A + M</i>	Hand-tight standoff		Length: face of counter- bore to hand- tight plane  <i>M</i>	Counter-bore	
		Thread without counter-bore  <i>A</i> <sub>0</sub>	Thread with shallow counter-bore  <i>A</i>		Diameter  <i>Q</i>	Depth  <i>q</i>
Long and short casing threads						
4 1/2	1,079	1,016 5	0,590 7	0,488 3	4,63	0,38
5	1,079	1,016 5	0,590 7	0,488 3	5,13	0,38
5 1/2	1,079	1,016 5	0,590 7	0,488 3	5,63	0,38
6 5/8	1,079	1,016 5	0,593 2	0,485 8	6,75	0,38
7	1,079	1,016 5	0,590 7	0,488 3	7,13	0,38
7 5/8	1,146	1,083 5	0,658 1	0,487 9	7,75	0,38
8 5/8	1,146	1,083 5	0,658 1	0,487 9	8,75	0,38
9 5/8	1,146	1,083 5	0,658 1	0,487 9	9,75	0,38
10 3/4 <sup>e</sup>	1,146	1,083 5	0,655 6	0,490 4	10,88	0,38
11 3/4 <sup>e</sup>	1,146	1,083 5	0,655 6	0,490 4	11,88	0,38
13 3/8 <sup>e</sup>	1,146	1,083 5	0,628 1	0,517 9	13,56	0,38
16 <sup>e</sup>	1,146	1,083 5	0,625 6	0,520 4	16,19	0,38
20 <sup>e</sup>	1,146	1,083 5	0,625 6	0,520 4	20,19	0,38
Non-upset tubing threads						
1,050	0,646	0,596 0	0,320 1	0,325 9	1,14	0,25
1,315	0,646	0,596 0	0,317 6	0,328 4	1,41	0,25
1,660	0,646	0,596 0	0,320 1	0,325 9	1,75	0,25
1,900	0,646	0,596 0	0,320 1	0,325 9	1,99	0,25
2 3/8	0,646	0,596 0	0,302 6	0,343 4	2,50	0,25
2 7/8	0,646	0,596 0	0,177 6	0,468 4	3,00	0,38
3 1/2	0,646	0,596 0	0,175 1	0,470 9	3,63	0,38
4	0,784	0,721 5	0,301 0	0,483 0	4,13	0,38
4 1/2	0,784	0,721 5	0,301 0	0,483 0	4,63	0,38
External upset tubing threads						
1,050	0,646	0,596 0	0,317 6	0,328 4	1,41	0,25
1,315	0,646	0,596 0	0,314 5	0,331 5	1,57	0,25
1,660	0,646	0,596 0	0,316 4	0,329 6	1,91	0,25
1,900	0,646	0,596 0	0,317 0	0,329 0	2,19	0,25
2 3/8	0,784	0,721 5	0,427 9	0,356 1	2,72	0,25
2 7/8	0,784	0,721 5	0,302 9	0,481 1	3,22	0,38
3 1/2	0,784	0,721 5	0,301 0	0,483 0	3,88	0,38
4	0,784	0,721 5	0,301 0	0,483 0	4,38	0,38
4 1/2	0,784	0,721 5	0,301 0	0,483 0	4,88	0,38

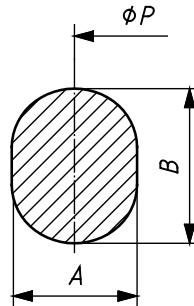
<sup>e</sup> Short casing threads only (long casing threads not covered).

<sup>e</sup> Short casing threads only (long casing threads not covered).

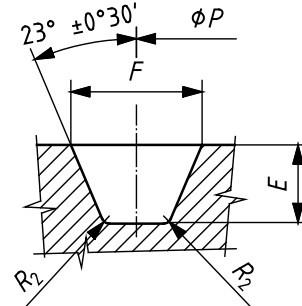
Table B.63 — Type R ring gaskets (USC units)



a) Octagonal



b) Oval



c) Groove

Dimensions in inches

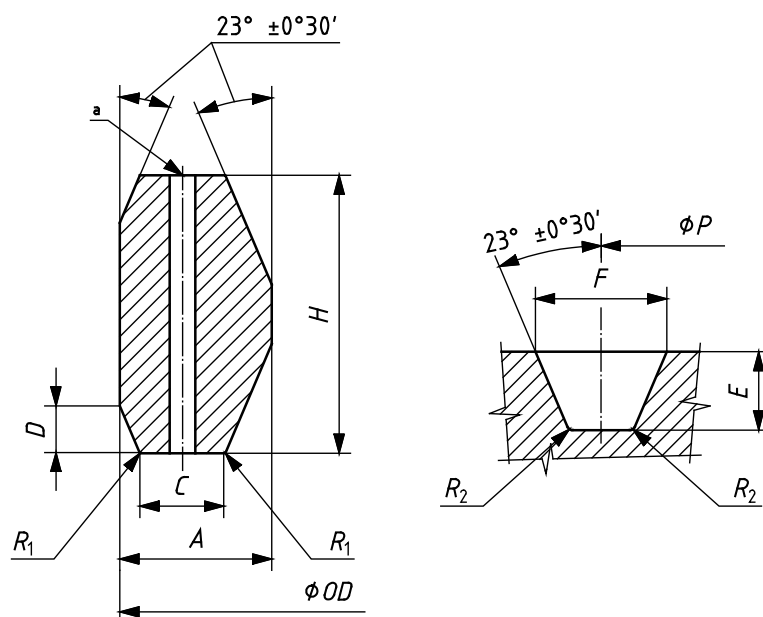
Ring number	Pitch diameter of ring (groove) $P$ $\pm 0,007$ ( $\pm 0,005$ ) <sup>a</sup>	Width of ring $A$ $\pm 0,008$	Height of oval ring $B$ $\pm 0,02$	Height of octagonal ring $H$ $\pm 0,02$	Width of flat of octagonal ring $C$ $\pm 0,008$	Radius in octagonal ring $R_1$ $\pm 0,02$	Depth of groove $E$ $+0,02$ $0$	Width of groove $F$ $\pm 0,008$	Radius in groove $R_2$ max.	Approx. distance between made-up flanges $S$
R 20	2,688	0,313	0,56	0,50	0,206	0,06	0,25	0,344	0,03	0,16
R 23	3,250	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 24	3,750	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 26	4,000	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 27	4,250	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 31	4,875	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 35	5,375	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 37	5,875	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 39	6,375	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 41	7,125	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 44	7,625	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 45	8,313	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 46	8,313	0,500	0,75	0,69	0,341	0,06	0,38	0,531	0,06	0,19
R 47	9,000	0,750	1,00	0,94	0,485	0,06	0,50	0,781	0,06	0,16
R 49	10,625	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 50	10,625	0,625	0,88	0,81	0,413	0,06	0,44	0,656	0,06	0,16

Table B.63 (continued)

Dimensions in inches

Ring number	Pitch diameter of ring (groove) <i>P</i> $\pm 0,007$ ( $\pm 0,005$ ) <sup>a</sup>	Width of ring <i>A</i> $\pm 0,008$	Height of oval ring <i>B</i> $\pm 0,02$	Height of octagonal ring <i>H</i> $\pm 0,02$	Width of flat of octagonal ring <i>C</i> $\pm 0,008$	Radius in octagonal ring <i>R</i> <sub>1</sub> $\pm 0,02$	Depth of groove <i>E</i> $\begin{smallmatrix} +0,02 \\ 0 \end{smallmatrix}$	Width of groove <i>F</i> $\pm 0,008$	Radius in groove <i>R</i> <sub>2</sub> max.	Approx. distance between made-up flanges <i>S</i>
R 53	12,750	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 54	12,750	0,625	0,88	0,81	0,413	0,06	0,44	0,656	0,06	0,16
R 57	15,000	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 63	16,500	1,000	1,31	1,25	0,681	0,09	0,63	1,063	0,09	0,22
R 65	18,500	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 66	18,500	0,625	0,88	0,81	0,413	0,06	0,44	0,656	0,06	0,16
R 69	21,000	0,438	0,69	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 70	21,000	0,750	1,00	0,94	0,485	0,06	0,50	0,781	0,06	0,19
R 73	23,000	0,500	0,75	0,69	0,341	0,06	0,38	0,531	0,06	0,13
R 74	23,000	0,750	1,00	0,94	0,485	0,06	0,50	0,781	0,06	0,19
R 82	2,250	0,438	—	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 84	2,500	0,438	—	0,63	0,305	0,06	0,31	0,469	0,03	0,19
R 85	3,125	0,500	—	0,69	0,341	0,06	0,38	0,531	0,06	0,13
R 86	3,563	0,625	—	0,81	0,413	0,06	0,44	0,656	0,06	0,16
R 87	3,938	0,625	—	0,81	0,413	0,06	0,44	0,656	0,06	0,16
R 88	4,875	0,750	—	0,94	0,485	0,06	0,50	0,781	0,06	0,19
R 89	4,500	0,750	—	0,94	0,485	0,06	0,50	0,781	0,06	0,19
R 90	6,125	0,875	—	1,06	0,583	0,06	0,56	0,906	0,06	0,19
R 91	10,250	1,250	—	1,50	0,879	0,09	0,69	1,313	0,09	0,16
R 99	9,250	0,438	—	0,63	0,305	0,06	0,31	0,469	0,03	0,19

<sup>a</sup> The tolerance in brackets is the tolerance for the groove; the tolerance without the brackets is for the ring.

**Table B.64 — Type RX pressure-energized ring gaskets (USC units)**

<sup>a</sup> The pressure-passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. The centreline of the hole shall be located at midpoint of dimension *C*. The hole diameter shall be 0,06 in for rings RX-82 through RX-85, 0,09 in for rings RX-86 and RX-87 and 0,12 in for rings RX-88 through RX-91.

Dimensions in inches

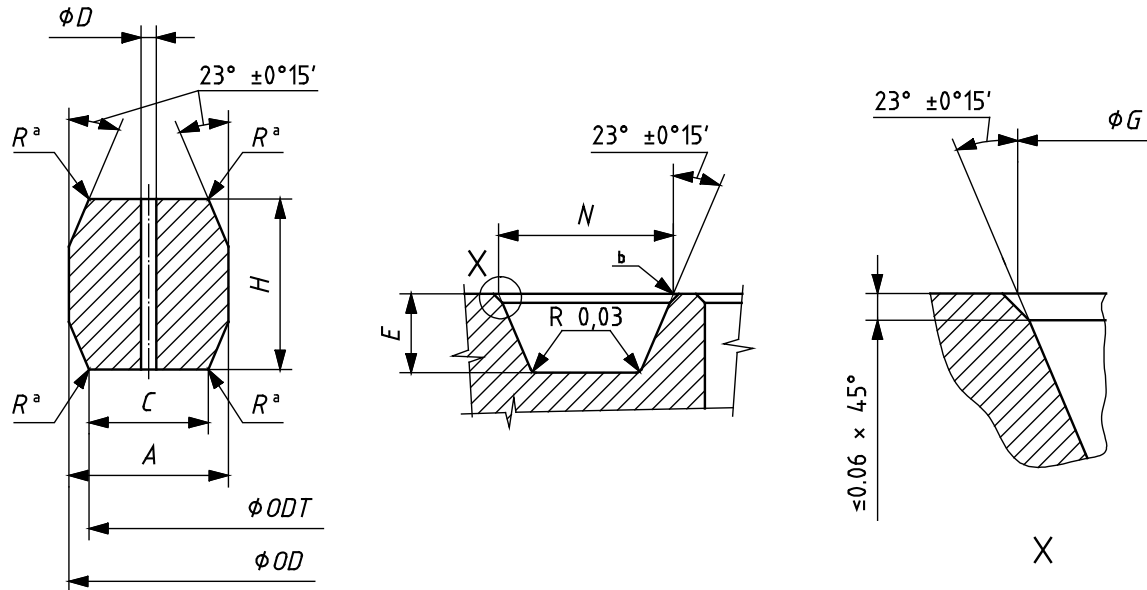
Ring number	Pitch diameter of groove <i>P</i> ± 0,005	Outside diameter of ring <i>OD</i> +0,020 0	Width of ring <i>A</i> <sup>b</sup> +0,008 0	Width of flat <i>C</i> +0,006 0	Height of outside bevel <i>D</i> 0 -0,03	Height of ring <i>H</i> <sup>b</sup> +0,008 0	Radius in ring <i>R</i> <sub>1</sub> ± 0,02	Depth of groove <i>E</i> +0,02 0	Width of groove <i>F</i> ± 0,008	Radius in groove <i>R</i> <sub>2</sub> max.	Approx. distance between made-up flanges <i>S</i>
RX 20	2,688	3,000	0,344	0,182	0,125	0,750	0,06	0,25	0,344	0,03	0,38
RX 23	3,250	3,672	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 24	3,750	4,172	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 25	4,000	4,313	0,344	0,182	0,125	0,750	0,06	0,25	0,344	0,03	—
RX 26	4,000	4,406	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 27	4,250	4,656	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 31	4,875	5,297	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 35	5,375	5,797	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 37	5,875	6,297	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 39	6,375	6,797	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 41	7,125	7,547	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 44	7,625	8,047	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 45	8,313	8,734	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 46	8,313	8,750	0,531	0,263	0,188	1,125	0,06	0,38	0,531	0,06	0,47
RX 47	9,000	9,656	0,781	0,407	0,271	1,625	0,09	0,50	0,781	0,06	0,72
RX 49	10,625	11,047	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 50	10,625	11,156	0,656	0,335	0,208	1,250	0,06	0,44	0,656	0,06	0,47
RX 53	12,750	13,172	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 54	12,750	13,281	0,656	0,335	0,208	1,250	0,06	0,44	0,656	0,06	0,47
RX 57	15,000	15,422	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47

Dimensions in inches

Ring number	Pitch diameter of groove	Outside diameter of ring	Width of ring	Width of flat	Height of outside bevel	Height of ring	Radius in ring	Depth of groove	Width of groove	Radius in groove	Approx. distance between made-up flanges
	$P$ $\pm 0,005$	$OD$ $+0,020$ $0$	$A^b$ $+0,008$ $0$	$C$ $+0,006$ $0$	$D$ $0$ $-0,03$	$H^b$ $+0,008$ $0$	$R_1$ $\pm 0,02$	$E$ $+0,02$ $0$	$F$ $\pm 0,008$	$R_2$ max.	$S$
RX 63	16,500	17,391	1,063	0,582	0,333	2,000	0,09	0,63	1,063	0,09	0,84
RX 65	18,500	18,922	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 66	18,500	19,031	0,656	0,335	0,208	1,250	0,06	0,44	0,656	0,06	0,47
RX 69	21,000	21,422	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 70	21,000	21,656	0,781	0,407	0,271	1,625	0,09	0,50	0,781	0,06	0,72
RX 73	23,000	23,469	0,531	0,263	0,208	1,250	0,06	0,38	0,531	0,06	0,59
RX74	23,000	23,656	0,781	0,407	0,271	1,625	0,09	0,50	0,781	0,06	0,72
RX 82	2,250	2,672	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 84	2,500	2,922	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 85	3,125	3,547	0,531	0,263	0,167	1,000	0,06	0,38	0,531	0,06	0,38
RX 86	3,563	4,078	0,594	0,335	0,188	1,125	0,06	0,44	0,656	0,06	0,38
RX 87	3,938	4,453	0,594	0,335	0,188	1,125	0,06	0,44	0,656	0,06	0,38
RX 88	4,875	5,484	0,688	0,407	0,208	1,250	0,06	0,50	0,781	0,06	0,38
RX 89	4,500	5,109	0,719	0,407	0,208	1,250	0,06	0,50	0,781	0,06	0,38
RX 90	6,125	6,875	0,781	0,479	0,292	1,750	0,09	0,56	0,906	0,06	0,72
RX 91	10,250	11,297	1,188	0,780	0,297	1,781	0,09	0,69	1,313	0,09	0,75
RX 99	9,250	9,672	0,469	0,254	0,167	1,000	0,06	0,31	0,469	0,03	0,47
RX 201	1,813	2,026	0,226	0,126	0,057 <sup>c</sup>	0,445	0,02 <sup>d</sup>	0,16	0,219	0,03	—
RX 205	2,250	2,453	0,219	0,120	0,072 <sup>c</sup>	0,437	0,02 <sup>d</sup>	0,16	0,219	0,02	—
RX 210	3,500	3,844	0,375	0,213	0,125 <sup>c</sup>	0,750	0,03 <sup>d</sup>	0,25	0,375	0,03	—
RX 215	5,125	5,547	0,469	0,210	0,167 <sup>c</sup>	1,000	0,06 <sup>d</sup>	0,31	0,469	0,03	—
<sup>b</sup> A plus tolerance of 0,008 in for width $A$ and height $H$ is permitted, provided the variation in width or height of any ring does not exceed 0,004 in throughout its entire circumference.											
<sup>c</sup> Tolerance on these dimensions is $\begin{smallmatrix} 0 \\ -0,015 \end{smallmatrix}$ .											
<sup>d</sup> Tolerance on these dimensions is $\begin{smallmatrix} +0,020 \\ 0 \end{smallmatrix}$ .											

**Table B.65 — Type BX pressure-energized ring gaskets (USC units)**

Dimensions in inches unless otherwise indicated



<sup>a</sup> Radius,  $R$ , shall be 8 % to 12 % of the gasket height,  $H$ . One pressure-passag hole is required per gasket on the centreline.

<sup>b</sup> Break sharp corner on inside diameter of groove.

Table B.65 (continued)

Dimensions in inches

Ring number	Nominal size	Outside diameter of ring <i>OD</i> 0 -0,006	Height of ring <i>H</i> <sup>c</sup> +0,008 0	Width of ring <i>A</i> <sup>c</sup> +0,008 0	Diameter of flat <i>ODT</i> ± 0,002	Width of flat <i>C</i> +0,006 0	Hole size <i>D</i> ± 0,02	Depth of groove <i>E</i> +0,02 0	Outside diameter of groove <i>G</i> +0,004 0	Width of groove <i>N</i> +0,004 0
BX 150	1 <sup>11</sup> / <sub>16</sub>	2,842	0,366	0,366	2,790	0,314	0,06	0,22	2,893	0,450
BX 151	1 <sup>13</sup> / <sub>16</sub>	3,008	0,379	0,379	2,954	0,325	0,06	0,22	3,062	0,466
BX 152	2 <sup>1</sup> / <sub>16</sub>	3,334	0,403	0,403	3,277	0,346	0,06	0,23	3,395	0,498
BX 153	2 <sup>9</sup> / <sub>16</sub>	3,974	0,448	0,448	3,910	0,385	0,06	0,27	4,046	0,554
BX 154	3 <sup>1</sup> / <sub>16</sub>	4,600	0,488	0,488	4,531	0,419	0,06	0,30	4,685	0,606
BX 155	4 <sup>1</sup> / <sub>16</sub>	5,825	0,560	0,560	5,746	0,481	0,06	0,33	5,930	0,698
BX 156	7 <sup>1</sup> / <sub>16</sub>	9,367	0,733	0,733	9,263	0,629	0,12	0,44	9,521	0,921
BX 157	9	11,593	0,826	0,826	11,476	0,709	0,12	0,50	11,774	1,039
BX 158	11	13,860	0,911	0,911	13,731	0,782	0,12	0,56	14,064	1,149
BX 159	13 <sup>5</sup> / <sub>8</sub>	16,800	1,012	1,012	16,657	0,869	0,12	0,62	17,033	1,279
BX 160	13 <sup>5</sup> / <sub>8</sub>	15,850	0,938	0,541	15,717	0,408	0,12	0,56	16,063	0,786
BX 161	16 <sup>3</sup> / <sub>4</sub>	19,347	1,105	0,638	19,191	0,482	0,12	0,67	19,604	0,930
BX 162	16 <sup>3</sup> / <sub>4</sub>	18,720	0,560	0,560	18,641	0,481	0,06	0,33	18,832	0,705
BX 163	18 <sup>3</sup> / <sub>4</sub>	21,896	1,185	0,684	21,728	0,516	0,12	0,72	22,185	1,006
BX 164	18 <sup>3</sup> / <sub>4</sub>	22,463	1,185	0,968	22,295	0,800	0,12	0,72	22,752	1,290
BX 165	21 <sup>1</sup> / <sub>4</sub>	24,595	1,261	0,728	24,417	0,550	0,12	0,75	24,904	1,071
BX 166	21 <sup>1</sup> / <sub>4</sub>	25,198	1,261	1,029	25,020	0,851	0,12	0,75	25,507	1,373
BX 167	26 <sup>3</sup> / <sub>4</sub>	29,896	1,412	0,516	29,696	0,316	0,06	0,84	30,249	0,902
BX 168	26 <sup>3</sup> / <sub>4</sub>	30,128	1,412	0,632	29,928	0,432	0,06	0,84	30,481	1,018
BX 169	5 <sup>1</sup> / <sub>8</sub>	6,831	0,624	0,509	6,743	0,421	0,06	0,38	6,955	0,666
BX 170	9	8,584	0,560	0,560	8,505	0,481	0,06	0,33	8,696	0,705
BX 171	11	10,529	0,560	0,560	10,450	0,481	0,06	0,33	10,641	0,705
BX 172	13 <sup>5</sup> / <sub>8</sub>	13,113	0,560	0,560	13,034	0,481	0,06	0,33	13,225	0,705
BX 303	30	33,573	1,494	0,668	33,361	0,457	0,06	0,89	33,949	1,078

<sup>c</sup> A plus tolerance of 0,008 in for width *A* and height *H* is permitted, provided the variation in width or height of any ring does not exceed 0,004 in throughout its entire circumference.

**Table B.67 — Flanged, gate, plug and ball valves for 2 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valve bore  +0,03 0	Face-to-face valve length ± 0,06		
		Full-bore gate valves	Plug valves	
			Full-bore plug valves	Full-bore and reduced-opening ball valves
2 <sup>1</sup> / <sub>16</sub> ´ 1 <sup>13</sup> / <sub>16</sub>	1,81	11,62	—	—
2 <sup>1</sup> / <sub>16</sub>	2,06	11,62	13,12	11,62
2 <sup>9</sup> / <sub>16</sub>	2,56	13,12	15,12	13,12
3 <sup>1</sup> / <sub>8</sub>	3,12	14,12	17,62	14,12
3 <sup>1</sup> / <sub>8</sub> ´ 3 <sup>3</sup> / <sub>16</sub>	3,19	14,12	17,62	—
4 <sup>1</sup> / <sub>16</sub>	4,06	17,12	20,12	17,12
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>8</sub>	4,12	17,12	20,12	—
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>4</sub>	4,25	17,12	20,12	—
5 <sup>1</sup> / <sub>8</sub>	5,12	22,12	25,12	—
7 <sup>1</sup> / <sub>16</sub> ´ 6	6,00	22,12	28,62	22,12
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>3</sup> / <sub>8</sub>	6,38	22,12	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>5</sup> / <sub>8</sub>	6,62	22,12	—	—
7 <sup>1</sup> / <sub>16</sub>	7,06	26,12	29,12	—
7 <sup>1</sup> / <sub>16</sub> ´ 7 <sup>1</sup> / <sub>8</sub>	7,12	26,12	29,12	—

**Table B.68 — Flanged, gate, plug and ball valves for 3 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valve bore  +0,03 0	Face-to-face valve length ± 0,06		
		Full-bore gate valves	Plug valves	
			Full-bore plug valves	Full-bore and reduced-opening ball valves
2 <sup>1</sup> / <sub>16</sub> ´ 1 <sup>13</sup> / <sub>16</sub>	1,81	14,62	—	—
2 <sup>1</sup> / <sub>16</sub>	2,06	14,62	15,12	14,62
2 <sup>9</sup> / <sub>16</sub>	2,56	16,62	17,12	16,62
3 <sup>1</sup> / <sub>8</sub>	3,12	17,12	18,62	15,12
3 <sup>1</sup> / <sub>8</sub> ´ 3 <sup>3</sup> / <sub>16</sub>	3,19	17,12	18,62	—
4 <sup>1</sup> / <sub>16</sub>	4,06	20,12	22,12	18,12
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>8</sub>	4,12	20,12	22,12	—
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>4</sub>	4,25	20,12	22,12	—
5 <sup>1</sup> / <sub>8</sub>	5,12	24,12	26,12	—
7 <sup>1</sup> / <sub>16</sub> ´ 6	6,00	24,12	30,12	24,12
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>3</sup> / <sub>8</sub>	6,38	24,12	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>5</sup> / <sub>8</sub>	6,62	24,12	—	—
7 <sup>1</sup> / <sub>16</sub>	7,06	28,12	31,62	—
7 <sup>1</sup> / <sub>16</sub> ´ 7 <sup>1</sup> / <sub>8</sub>	7,12	28,12	31,62	—

**Table B.69 — Flanged, gate, plug and ball valves for 5 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valve bore  +0,03 0	Face-to-face valve length ± 0,06		
		Full-bore gate valves	Plug valves	
			Full-bore plug valves	Full-bore and reduced-opening ball valves
2 <sup>1</sup> / <sub>16</sub> ´ 1 <sup>13</sup> / <sub>16</sub>	1,81	14,62	—	—
2 <sup>1</sup> / <sub>16</sub>	2,06	14,62	15,50	14,62
2 <sup>9</sup> / <sub>16</sub>	2,56	16,62	18,00	18,62
3 <sup>1</sup> / <sub>8</sub>	3,12	18,62	20,75	18,62
3 <sup>1</sup> / <sub>8</sub> ´ 3 <sup>3</sup> / <sub>16</sub>	3,19	18,62	20,75	—
4 <sup>1</sup> / <sub>16</sub>	4,06	21,62	24,75	21,62
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>8</sub>	4,12	21,62	24,75	—
4 <sup>1</sup> / <sub>16</sub> ´ 4 <sup>1</sup> / <sub>4</sub>	4,25	21,62	24,75	—
5 <sup>1</sup> / <sub>8</sub>	5,12	28,62	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 5 <sup>1</sup> / <sub>8</sub>	5,12	29,00	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 6	6,00	29,00	—	28,00
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>1</sup> / <sub>8</sub>	6,12	29,00	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>3</sup> / <sub>8</sub>	6,38	29,00	—	—
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>5</sup> / <sub>8</sub>	6,62	29,00	—	—
7 <sup>1</sup> / <sub>16</sub>	7,06	32,00	38,50	—
7 <sup>1</sup> / <sub>16</sub> ´ 7 <sup>1</sup> / <sub>8</sub>	7,12	32,00	38,50	—
9	9,00	41,00	—	—

**Table B.70 — Flanged, gate, plug and ball valves for 10 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valves	
	Bore +0,03 0	Face-to-face valve length ± 0,06
1 <sup>13</sup> / <sub>16</sub>	1,81	18,25
2 <sup>1</sup> / <sub>16</sub>	2,06	20,50
2 <sup>9</sup> / <sub>16</sub>	2,56	22,25
3 <sup>1</sup> / <sub>16</sub>	3,06	24,38
4 <sup>1</sup> / <sub>16</sub>	4,06	26,38
5 <sup>1</sup> / <sub>8</sub>	5,12	29,00
7 <sup>1</sup> / <sub>16</sub> ´ 6 <sup>3</sup> / <sub>8</sub>	6,38	35,00
7 <sup>1</sup> / <sub>16</sub>	7,06	35,00

**Table B.71 — Flanged plug and gate valves for 15 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valves	
	Bore $+0,03$ 0	Face-to-face valve length $\pm 0,06$
1 $\frac{13}{16}$	1,81	18,00
2 $\frac{1}{16}$	2,06	19,00
2 $\frac{9}{16}$	2,56	21,00
3 $\frac{1}{16}$	3,06	23,56
4 $\frac{1}{16}$	4,06	29,00
5 $\frac{1}{8}$	5,12 <sup>a</sup>	35,00
<sup>a</sup> Tolerance on 5 1/8 bore is $\frac{+0,04}{0}$ .		

**Table B.72 — Flanged plug and gate valves for 20 000 psi rated working pressure (USC units)**

Dimensions in inches

Nominal size	Full-bore valves	
	Bore $+0,03$ 0	Face-to-face valve length $\pm 0,06$
1 $\frac{13}{16}$	1,81	21,00
2 $\frac{1}{16}$	2,06	23,00
2 $\frac{9}{16}$	2,56	26,50
3 $\frac{1}{16}$	3,06	30,50

**Table B.73 — Centre distances of conduit bores for dual parallel bore valves  
for 2 000 psi; 3 000 psi; 5 000 psi and 10 000 psi rated working pressures (USC units)**

Dimensions in inches

Maximum valve size	Bore centre to bore centre	Large-bore centre to end-connector centre	Small bore to end-connector centre	Minimum end-connector size	Basic casing size	
					OD	Lineic mass lb/ft
2 000 psi; 3 000 psi and 5 000 psi						
1 <sup>13</sup> / <sub>16</sub>	2,781	1,390	1,390	7 <sup>1</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>2</sub>	17
2 <sup>1</sup> / <sub>16</sub>	3,547	1,774	1,774	7 <sup>1</sup> / <sub>16</sub>	7	38
2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	3,547	1,650	1,897	7 <sup>1</sup> / <sub>16</sub>	7	29
2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	4,000	1,875	2,125	9	7 <sup>5</sup> / <sub>8</sub>	39
2 <sup>9</sup> / <sub>16</sub>	4,000	2,000	2,000	9	7 <sup>5</sup> / <sub>8</sub>	29,7
2 <sup>9</sup> / <sub>16</sub>	4,500	2,250	2,250	9	8 <sup>5</sup> / <sub>8</sub>	49
3 <sup>1</sup> / <sub>8</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	4,578	2,008	2,570	9	8 <sup>5</sup> / <sub>8</sub>	49
3 <sup>1</sup> / <sub>8</sub> ´ 2 <sup>9</sup> / <sub>16</sub>	5,047	2,524	2,524	11	9 <sup>5</sup> / <sub>8</sub>	53,5
3 <sup>1</sup> / <sub>8</sub>	5,047	2,524	2,524	11	9 <sup>5</sup> / <sub>8</sub>	53,5
10 000 psi						
1 <sup>13</sup> / <sub>16</sub>	2,781	1,390	1,390	7 <sup>1</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>2</sub>	17
2 <sup>1</sup> / <sub>16</sub>	3,547	1,774	1,774	7 <sup>1</sup> / <sub>16</sub>	7	38
2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	3,547	1,650	1,897	7 <sup>1</sup> / <sub>16</sub>	7	29
2 <sup>9</sup> / <sub>16</sub> ´ 2 <sup>1</sup> / <sub>16</sub>	4,000	1,875	2,125	9	7 <sup>5</sup> / <sub>8</sub>	39
2 <sup>9</sup> / <sub>16</sub>	4,000	2,000	2,000	9	7 <sup>5</sup> / <sub>8</sub>	29,7
2 <sup>9</sup> / <sub>16</sub>	4,500	2,250	2,250	9	8 <sup>5</sup> / <sub>8</sub>	49
3 <sup>1</sup> / <sub>16</sub>	5,047	2,524	2,524	11	9 <sup>5</sup> / <sub>8</sub>	53,5

**Table B.74 — Centre distances of conduit bores  
for triple, quadruple and quintuple parallel bore valves (USC units)**

Dimensions in inches

Maximum valve size	Flange centre to bore centre	Minimum end-connector size	Basic casing size	
			OD	Lineic mass lb/ft
2 000 psi; 3 000 psi and 5 000 psi rated working pressures				
Triple valve				
1 <sup>13</sup> / <sub>16</sub>	1,875	7 <sup>1</sup> / <sub>16</sub>	6 <sup>5</sup> / <sub>8</sub>	24
2 <sup>1</sup> / <sub>16</sub>	1,938	9	7	26
2 <sup>1</sup> / <sub>16</sub>	2,125	9	7 <sup>5</sup> / <sub>8</sub>	39
2 <sup>9</sup> / <sub>16</sub>	2,812	11	9 <sup>5</sup> / <sub>8</sub>	53,5
Quadruple valve				
1 <sup>13</sup> / <sub>16</sub>	2,875	11	8 <sup>5</sup> / <sub>8</sub>	36
1 <sup>13</sup> / <sub>16</sub>	3,062	11	9 <sup>5</sup> / <sub>8</sub>	All
2 <sup>1</sup> / <sub>16</sub>	3,062	11	9 <sup>5</sup> / <sub>8</sub>	53,5
2 <sup>9</sup> / <sub>16</sub>	3,438	11	10 <sup>3</sup> / <sub>4</sub>	55,5
2 <sup>9</sup> / <sub>16</sub>	4,000	13 <sup>5</sup> / <sub>8</sub>	11 <sup>3</sup> / <sub>4</sub>	54
Quintuple valve				
2 <sup>1</sup> / <sub>16</sub>	3,062	11	9 <sup>5</sup> / <sub>8</sub>	53,5
10 000 psi rated working pressure				
Triple valve				
1 <sup>13</sup> / <sub>16</sub>	1,875	7 <sup>1</sup> / <sub>16</sub>	6 <sup>5</sup> / <sub>8</sub>	24
2 <sup>1</sup> / <sub>16</sub>	1,938	9	7	26
2 <sup>1</sup> / <sub>16</sub>	2,125	9	7 <sup>5</sup> / <sub>8</sub>	39
2 <sup>9</sup> / <sub>16</sub>	2,812	11	9 <sup>5</sup> / <sub>8</sub>	53,5
Quadruple valve				
2 <sup>9</sup> / <sub>16</sub>	3,438	11	10 <sup>3</sup> / <sub>4</sub>	55,5

**Table B.75 — Regular and full-opening flanged swing and lift check valves  
for 2 000 psi; 3 000 psi and 5 000 psi rated working pressures (USC units)**

Dimensions in inches

Nominal size	Face-to-face valve length ± 0,06				
	Short pattern			Long pattern	
	2 000 psi	3 000 psi	5 000 psi	3 000 psi	5 000 psi
2 <sup>1</sup> / <sub>16</sub>	11,62	14,62	14,62	—	—
2 <sup>9</sup> / <sub>16</sub>	13,12	16,62	16,62	—	—
3 <sup>1</sup> / <sub>8</sub>	14,12	15,12	18,62	17,12	—
4 <sup>1</sup> / <sub>16</sub>	17,12	18,12	21,62	20,12	—
7 <sup>1</sup> / <sub>16</sub>	22,12	24,12	28,00	—	29,00
9	26,12	29,12	33,12	—	—
11	31,12	33,12	39,38	—	—

**Table B.76 — Minimum bore sizes for full-opening check valves  
for 2 000 psi; 3 000 psi and 5 000 psi rated working pressures (USC units)**

Dimensions in inches

Nominal size	Minimum bore size +0,06 0		
	2 000 psi	3 000 psi	5 000 psi
2 <sup>1</sup> / <sub>16</sub>	2,067	1,939	1,689
2 <sup>9</sup> / <sub>16</sub>	2,469	2,323	2,125
3 <sup>1</sup> / <sub>8</sub>	3,068	2,900	2,624
4 <sup>1</sup> / <sub>16</sub>	4,026	3,826	3,438
7 <sup>1</sup> / <sub>16</sub>	5,761	5,761	5,189
9	7,813	7,439	6,813
11	9,750	9,314	8,500

**Table B.80 — Minimum vertical full-opening body bores  
and maximum casing sizes (USC units)**

Nominal connector <sup>a</sup>		Casing beneath body			Minimum vertical full-opening wellhead body bore
Nominal size and bore of connector	Rated working pressure	Label <sup>b</sup>	Nominal lineic mass <sup>b</sup>	Specified drift diameter	
in	psi	OD	lb/ft	in	in
7 1/16	2 000	7	17	6,413	6,45
7 1/16	3 000	7	20	6,331	6,36
7 1/16	5 000	7	23	6,241	6,28
7 1/16	10 000	7	29	6,059	6,09
7 1/16	15 000	7	38	5,795	5,83
7 1/16	20 000	7	38	5,795	5,83
9	2 000	8 5/8	24	7,972	8,00
9	3 000	8 5/8	32	7,796	7,83
9	5 000	8 5/8	36	7,700	7,73
9	10 000	8 5/8	40	7,600	7,62
9	15 000	8 5/8	49	7,386	7,41
11	2 000	10 3/4	40,5	9,894	9,92
11	3 000	10 3/4	40,5	9,894	9,92
11	5 000	10 3/4	51,0	9,694	9,73
11	10 000	9 5/8	53,5	8,379	8,41
11	15 000	9 5/8	53,5	8,379	8,41
13 5/8	2 000	13 3/8	54,5	12,459	12,50
13 5/8	3 000	13 3/8	61,0	12,359	12,39
13 5/8	5 000	13 3/8	72,0	12,191	12,22
13 5/8	10 000	11 3/4	60,0	10,616	10,66
16 3/4	2 000	16	65	15,062	15,09
16 3/4	3 000	16	84	14,822	14,86
16 3/4	5 000	16	84	14,822	14,86
16 3/4	10 000	16	84	14,822	14,86
18 3/4	5 000	18 5/8	87,5	17,567	17,59
18 3/4	10 000	18 5/8	87,5	17,567	17,59
20 3/4	3 000	20	94	18,936	18,97
21 1/4	2 000	20	94	18,936	18,97
21 1/4	5 000	20	94	18,936	18,97
21 1/4	10 000	20	94	18,936	18,97

<sup>a</sup> Upper-end connections of wellhead body.

<sup>b</sup> Maximum size and minimum mass of casing on which bore is based.

**Table B.87 — Flanged crosses and tees for 2 000 psi; 3 000 psi; 5 000 psi;  
10 000 psi; 15 000 psi and 20 000 psi rated working pressures (USC units)**

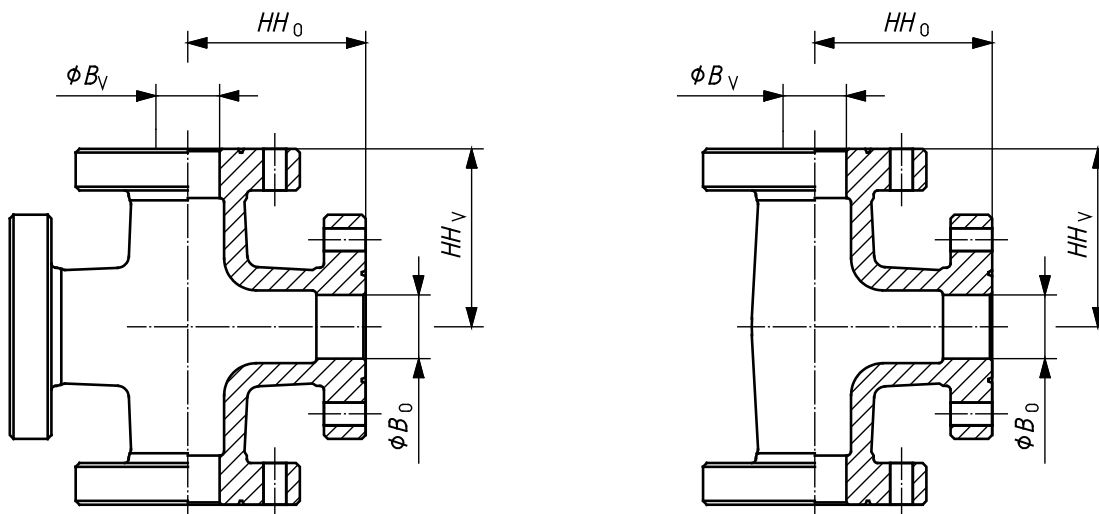


Table B.87 (continued)

Dimensions in inches

Nominal size and bore		Centre-to-face vertical run $HH_V$ $\pm 0,03$	Centre-to-face horizontal run $HH_0$ $\pm 0,03$	Nominal size and bore		Centre-to-face vertical run $HH_V$ $\pm 0,03$	Centre-to-face horizontal run $HH_0$ $\pm 0,03$
Vertical $B_V$	Outlet $B_0$			Vertical $B_V$	Outlet $B_0$		
+0,03 0	+0,03 0			+0,03 0	+0,03 0		
2 000 psi				15 000 psi			
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	5,81	5,81	2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,34	7,41
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	5,94	6,31	2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,62	7,62
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	6,56	6,56	2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,59	8,03
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	6,06	6,69	2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,88	8,25
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	6,56	6,81	2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,50	8,50
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	7,06	7,06	3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,86	8,69
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	6,31	7,94	3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	8,16	8,91
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	6,81	8,06	3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,78	9,16
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	7,19	8,19	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	9,44	9,44
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	8,56	8,56	4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	8,69	10,25
3 000 psi				4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	8,97	10,47
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	7,31	7,81	4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	9,59	10,72
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	7,88	7,94	4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	10,25	11,00
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	7,56	7,56	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	11,69	11,69
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,56	8,81	5 <sup>1</sup> / <sub>8</sub>	1 <sup>13</sup> / <sub>16</sub>	9,38	11,44
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,12	8,94	5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	9,63	11,63
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	8,06	8,81	5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	10,25	11,88
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	9,06	9,06	5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	10,94	12,18
5 000 psi				5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	12,38	12,75
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,31	7,31	5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	13,50	13,50
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,44	7,88	20 000 psi			
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,31	8,31	1 <sup>13</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	8,94	8,94
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	7,69	8,31	2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	9,25	9,53
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	8,25	8,44	2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	9,84	9,84
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	9,31	9,31	2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	9,56	10,28
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,94	9,19	2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	10,16	10,59
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,50	9,31	2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	10,91	10,91
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	8,94	9,56	3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	9,94	10,91
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	10,81	10,81	3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	10,53	10,22
5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	9,06	10,56	3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	11,28	11,53
5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	9,62	10,69	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	11,91	11,91
5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	10,06	10,94	4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	11,12	12,66
5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	10,93	11,19	4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	11,72	12,66
5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	12,19	12,19	4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	12,47	13,28
10 000 psi				4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	13,09	13,66
2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	6,67	6,84	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	14,84	14,84
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	6,92	6,92				
2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	6,95	7,47				
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,20	7,55				
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	7,83	7,83				
3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,23	8,22				
3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,48	8,30				
3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,11	8,58				
3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	8,86	8,86				
4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,81	9,25				
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	8,06	9,33				
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	8,69	9,61				
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	9,44	9,89				
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	10,34	10,34				
5 <sup>1</sup> / <sub>8</sub>	1 <sup>13</sup> / <sub>16</sub>	8,19	10,06				
5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	8,44	10,12				
5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	9,06	10,42				
5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	9,81	10,69				
5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	10,72	11,19				
5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	11,53	11,53				

**Table B.88 — Studded crosses and tees for 2 000 psi; 3 000 psi; 5 000 psi;  
10 000 psi; 15 000 psi and 20 000 psi rated working pressures (USC units)**

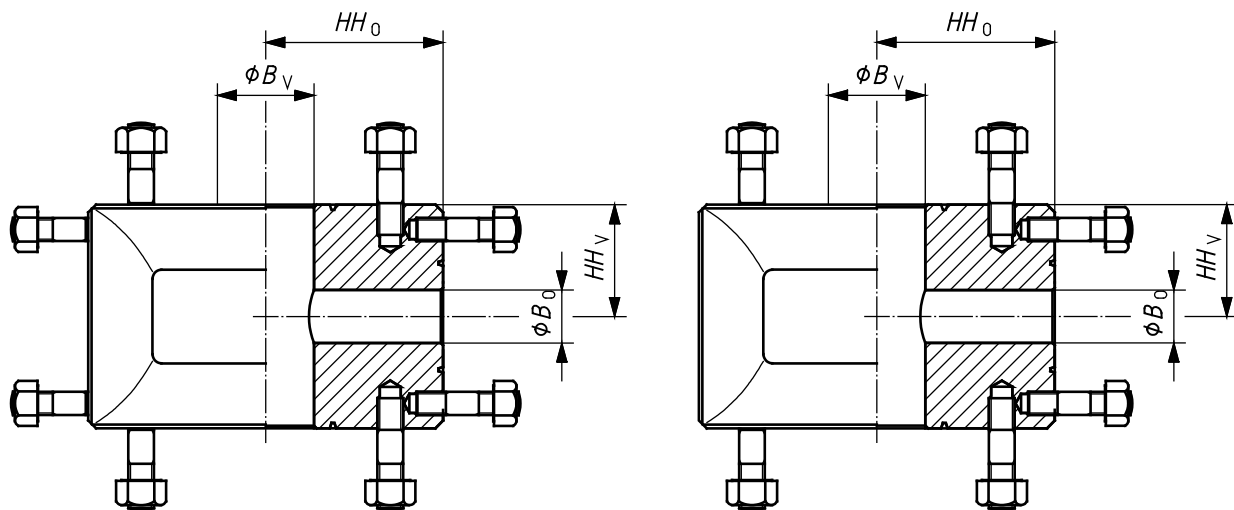
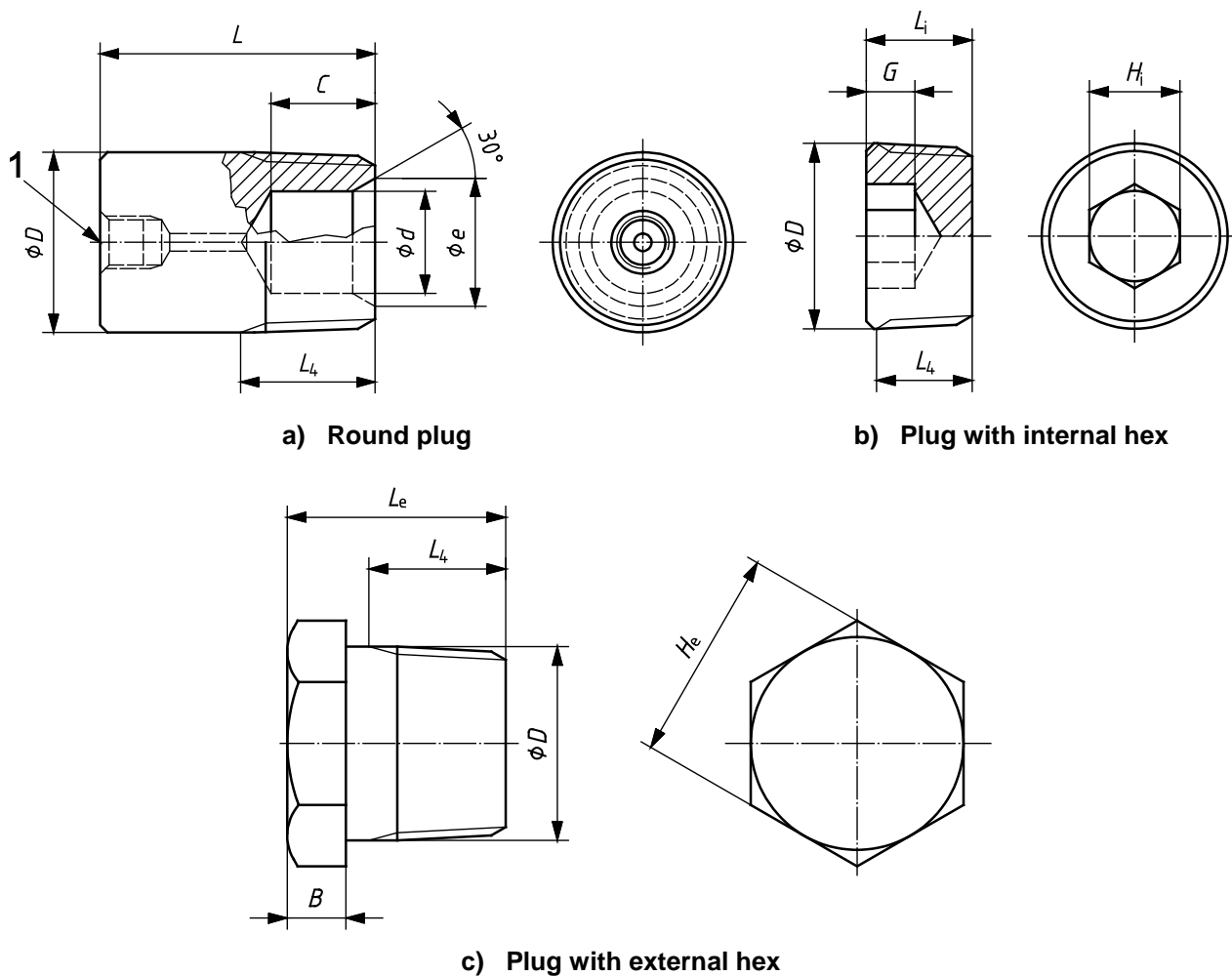


Table B.88 (continued)

Dimensions in inches

Nominal size and bore		Centre-to-face vertical run	Centre-to-face horizontal run	Nominal size and bore		Centre-to-face vertical run	Centre-to-face horizontal run
Vertical $B_V$ +0,03 0	Outlet $B_O$ +0,03 0			Vertical $B_V$ +0,03 0	Outlet $B_O$ +0,03 0		
		$HH_V$ $\pm 0,03$	$HH_O$ $\pm 0,03$			$HH_V$ $\pm 0,03$	$HH_O$ $\pm 0,03$
2 000 psi				15 000 psi			
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	3,50	3,50	1 <sup>13</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	5,00	5,00
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	3,50	4,00	2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	5,00	5,00
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	4,50	4,50	2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	5,00	5,00
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	3,50	4,50	2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	5,50	5,50
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	4,50	4,50	2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	5,50	5,50
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	4,50	4,50	2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,50	5,50
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,50	3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	6,31	6,31
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	4,50	5,50	3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	6,31	6,31
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	4,50	5,50	3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	6,31	6,31
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	5,50	5,50	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	6,31	6,31
3 000 psi				4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,62	7,62
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,00	4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,62	7,62
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	5,00	5,00	4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	7,62	7,62
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	5,00	5,00	4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	7,62	7,62
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	6,12	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	7,62	7,62
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,00	6,12	5 <sup>1</sup> / <sub>8</sub>	1 <sup>13</sup> / <sub>16</sub>	6,62	8,75
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	5,00	6,12	5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	6,62	8,75
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	6,12	6,12	5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	6,62	8,75
5 000 psi				5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	6,62	8,75
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	4,50	5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	9,25	9,25
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,00	5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	9,25	9,25
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,00	5,00	20 000 psi			
3 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,50	1 <sup>13</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	6,47	6,47
3 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	5,50	5,50	2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	6,47	6,47
3 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	5,50	5,50	2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	6,47	6,47
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	6,50	2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,28	7,28
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,00	6,50	2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,28	7,28
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>8</sub>	5,50	6,50	2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	7,28	7,28
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	6,50	6,50	3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	7,97	7,97
5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	6,12	7,62	3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	7,97	7,97
5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	6,12	7,62	3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	7,97	7,97
5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	6,12	7,62	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	7,97	7,97
5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	7,97	7,97	4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	9,91	9,91
5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	7,97	7,97	4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	9,91	9,91
10 000 psi				4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	9,91	9,91
1 <sup>13</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4,38	4,38	4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	9,91	9,91
2 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4,38	4,38	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	9,91	9,91
2 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,38	4,38				
2 <sup>9</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4,50	5,12				
2 <sup>9</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,12				
2 <sup>9</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,12	5,12				
3 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4,50	5,88				
3 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	5,88				
3 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,12	5,88				
3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	5,88	5,88				
4 <sup>1</sup> / <sub>16</sub>	1 <sup>13</sup> / <sub>16</sub>	4,50	6,88				
4 <sup>1</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>16</sub>	4,50	6,88				
4 <sup>1</sup> / <sub>16</sub>	2 <sup>9</sup> / <sub>16</sub>	5,12	6,88				
4 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>16</sub>	5,88	6,88				
4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>16</sub>	6,88	6,88				
5 <sup>1</sup> / <sub>8</sub>	1 <sup>13</sup> / <sub>16</sub>	5,25	7,75				
5 <sup>1</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	5,25	7,75				
5 <sup>1</sup> / <sub>8</sub>	2 <sup>9</sup> / <sub>16</sub>	5,25	7,75				
5 <sup>1</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>16</sub>	6,75	7,75				
5 <sup>1</sup> / <sub>8</sub>	4 <sup>1</sup> / <sub>16</sub>	6,75	7,75				
5 <sup>1</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>8</sub>	7,75	7,75				

**Table B.95 — Bullplugs (USC units)****Key**

1 test or gauge port (optional)

NOTE See API Spec 5B for thread dimensions and tolerances.

Dimensions in inches

Nominal thread size	All bullplugs					Round plugs	Plugs with external hex			Plugs with internal hex		
	Diameter of round	Minimum length of thread to vanish point	Depth of counter- bore <sup>a</sup>	Diameter of counter- bore <sup>b</sup>	Diameter of chamfer <sup>k</sup>	Overall length <sup>b</sup>	Hex size (across flats)	Height of hex <sup>b</sup>	Length of plug with external hex <sup>b</sup>	Internal hex size	Depth of hex <sup>b</sup>	Length of plug with internal hex <sup>b</sup>
	<i>D</i>	<i>L</i> <sub>4</sub>	<i>C</i>	<i>d</i>	<i>e</i>	<i>L</i>	<i>H</i> <sub>e</sub>	<i>B</i>	<i>L</i> <sub>e</sub>	<i>H</i> <sub>i</sub>	<i>G</i>	<i>L</i> <sub>i</sub>
<sup>1</sup> / <sub>2</sub>	0,84 <sup>c</sup>	0,781 5	None	None	None	2	0,88 <sup>e</sup>	0,31	1,13	0,38 <sup>h</sup>	0,31	1,00
<sup>3</sup> / <sub>4</sub>	1,05 <sup>c</sup>	0,793 5	None	None	None	2	1,06 <sup>f</sup>	0,38	1,25	0,56 <sup>i</sup>	0,31	1,00
1	1,32 <sup>d</sup>	0,984 5	None	None	None	2	1,38 <sup>g</sup>	0,38	1,38	0,63 <sup>j</sup>	0,38	1,00
1 <sup>1</sup> / <sub>4</sub>	1,66 <sup>d</sup>	1,008 5	1,06	0,88	None	2	—	—	—	—	—	—
1 <sup>1</sup> / <sub>2</sub>	1,90 <sup>d</sup>	1,025 2	1,06	1,00	None	2	—	—	—	—	—	—
2	2,38 <sup>d</sup>	1,058 2	2,52	1,61	2,00	4	—	—	—	—	—	—
2 <sup>1</sup> / <sub>2</sub>	2,88 <sup>d</sup>	1,571 2	1,63	1,75	None	4	—	—	—	—	—	—
3	3,50 <sup>d</sup>	1,633 7	1,63	2,25	None	4	—	—	—	—	—	—
3 <sup>1</sup> / <sub>2</sub>	4,00 <sup>d</sup>	1,683 7	1,75	2,75	None	4	—	—	—	—	—	—
4	4,50 <sup>d</sup>	1,733 7	1,75	3,00	None	4	—	—	—	—	—	—
a	Tolerance	± 0,020.	e	Tolerance	0 −0,025.	i	Tolerance	0 −0,005.				
b	Tolerance	+0,04 0.	f	Tolerance	0 −0,031.	j	Tolerance	0 −0,006.				
c	Tolerance	+0,008 0.	g	Tolerance	0 −0,041.	k	Tolerance	+0,020 0.				
d	Tolerance	+0,010 0.	h	Tolerance	0 −0,004.							

## Annex C (informative)

### Method of calculating stud bolt lengths for type 6B and 6BX flanges

#### C.1 Calculation

##### C.1.1 General

The following equations were used in establishing stud bolt lengths listed in the tables and are included here for the convenience of the user in determining lengths not given in the tables.

NOTE Metric equivalents are not included in this annex since these calculations are applicable to ASME B1.1 threaded fasteners only.

##### C.1.2 Calculated stud bolt length

The calculated stud bolt length (effective thread length, excluding end points),  $L_{CSB}$ , is calculated as given in Equation (C.1):

$$L_{CSB} = A + n \quad (C.1)$$

where

$n$  is the negative tolerance on bolt length, equal to:

$\frac{1}{16}$  in for lengths up to 12 in inclusive;  
 $\frac{1}{8}$  in for lengths over 12 in to 18 in inclusive;  
 $\frac{1}{4}$  in for lengths over 18 in;

$A$  is the stud bolt length exclusive of negative length tolerance,  $n$ , as given in Equation (C.2):

$$A = 2(T + 0,50l + d) + S \quad (C.2)$$

where

$T$  is the total flange thickness;

$l$  is the plus tolerance for flange thickness;

$d$  is the heavy nut thickness (equals nominal bolt diameter; see ASME B18.2.2);

$S$  is the flange face stand-off. See dimension,  $S$ , in Tables 63\* and 64\* for R and RX stand-off values;  $S$  equals zero for BX assemblies. See C.4 and Figure C.1.

##### C.1.3 Specified stud bolt length

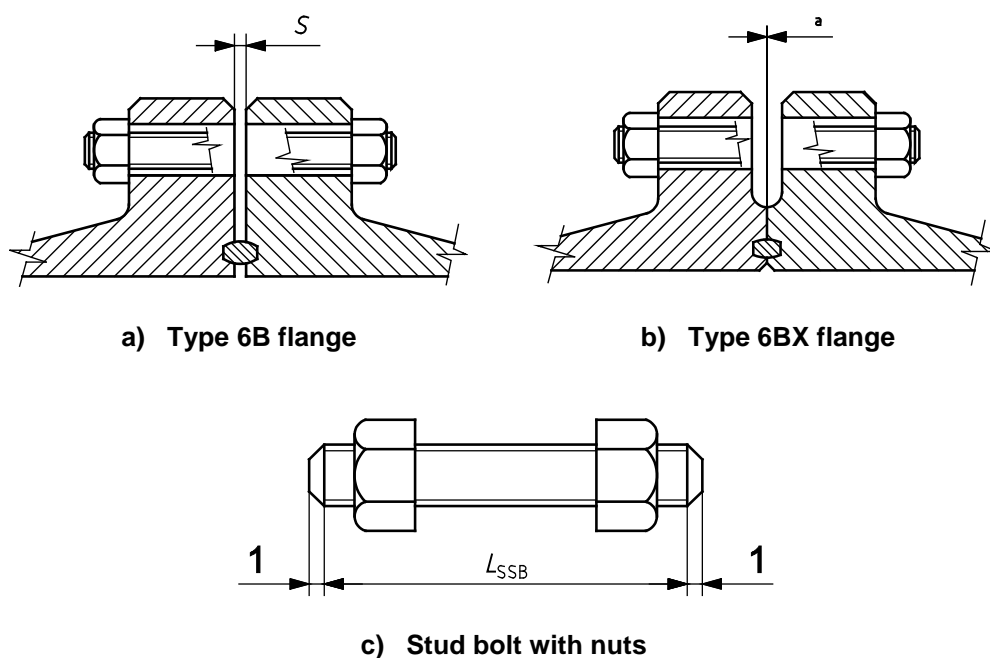
The specified stud bolt length (effective thread length, excluding end points),  $L_{SSB}$ , is  $L_{CSB}$  rounded off to the nearest commercially available length.

## C.2 Rounding-off procedure

If  $L_{CSB}$  is 0,010 in (or more) greater than any  $\frac{1}{4}$  in increment, round off upward to the next  $\frac{1}{4}$  in increment; if less than 0,010 in, round off downward to the next  $\frac{1}{4}$  in increment.

## C.3 End-point height of stud bolts

An end point is that part of a stud bolt beyond the thread, and shall be chamfered or rounded. The height of each end point shall not exceed the values given in Table C.1.



### Key

1 point height

a No standoff.

Figure C.1 — Flange make-up and stud length

Table C.1 — Point-height of stud bolts

Bolt diameter in	Maximum point height	
	mm	(in)
$\frac{1}{2}$ to $\frac{7}{8}$	3,2	(0,12)
Over $\frac{7}{8}$ to $1 \frac{1}{8}$	4,8	(0,19)
Over $1 \frac{1}{8}$ to $1 \frac{5}{8}$	6,4	(0,25)
Over $1 \frac{5}{8}$ to $1 \frac{7}{8}$	7,9	(0,31)
Over $1 \frac{7}{8}$	9,5	(0,38)

## C.4 Flange face stand-off values, $S$

The approximate distance between faces of made-up flanges,  $S$ , is given in Tables 63\* and 64\* for ring gaskets. Since  $S$  values for 6B flanges assembled with type RX gaskets are greater than  $S$  values when the same flanges are assembled with type R gaskets, it is recommended that  $S$  values for RX gaskets be used in calculating stud bolt lengths to ensure ample stud length for either type ring gasket.

## Annex D (informative)

### Recommended flange bolt torque

#### D.1 General

It has been shown that the torque values given in the tables of this annex are acceptable values for use in type 6B and 6BX flanges in some services. The user should refer to API TR 6AF, API TR 6AF1, API TR 6AF2 and API Spec 6FA for data on the effects on flange performance of bolt preload stress and other factors. It should be recognized that torque applied to a nut is only one of several ways to approximate the tension and stress in a fastener.

#### D.2 Basis of tables

The tables in this annex are for the convenience of the user only, and are based on calculations that assume certain friction coefficients for the friction between the studs and nuts, and between the nuts and the flange face.

Some factors that affect the relationship between nut torque and stud stress are

- thread dimensions and form;
- surface finish of studs, nuts, and flange face;
- degree of parallelism between nut face and flange face;
- type of lubrication and coatings of the threads and nut bearing surface areas.

Two coefficients of friction are used in the tables. A coefficient of friction of 0,13 approximates the friction with threads and nut bearing surfaces being bare metal well lubricated with thread compound tested in accordance with ISO 13678. A coefficient of friction of 0,07 approximates threads and nut face coated with fluoropolymer material.

The tables show material properties equivalent to ASTM A193/A193M Grades B7 and B7M, which are the most commonly used. Values of torque for materials having other strength levels may be obtained by multiplying the tabulated torque value by the ratio of the new material's yield strength to the tabulated material's yield strength.

#### D.3 Equations

For the values in Tables D.1 and D.2, the stress area,  $A_s$ , expressed in square millimetres (square inches), is calculated as given in Equation (D.1); the force per stud,  $F$ , expressed in newtons (pound-force), is calculated as given in Equation (D.2); the torque,  $\tau$ , is calculated as given in Equation (D.3):

$$A_s = \frac{\pi}{4} [D - 0,974 3 P]^2 \quad (D.1)$$

$$F = \sigma A_s \quad (D.2)$$

$$\tau = \frac{F \cdot E \left[ P + \frac{\pi f \cdot E}{\cos(\pi/6)} \right]}{2 \left[ \pi E - \frac{P \cdot f}{\cos(\pi/6)} \right]} + F \cdot f \left[ \frac{H + D + K}{4} \right] \quad (\text{D.3})$$

where

- $D$  is the thread major diameter, expressed in millimetres (inches);
- $E$  is the pitch diameter of thread, expressed in millimetres (inches);
- $f$  is the friction coefficient;
- $H$  is the hex size (nut), equal to  $1,5 D + 3,175$  mm (0,125 in);
- $K$  is the nut internal chamfer, equal to 3,175 mm (0,125 in);
- $P$  is the thread pitch, equal to  $\frac{1}{\text{number of threads per unit length}}$ , expressed in millimetres (inches);
- $\sigma$  is the stress in stud.

The torque obtained using units of millimetres and newtons is in units of newton-millimetres and can be divided by 1 000 to obtain newton-metres (N·m). The torque obtained using units of inches and pounds is in units of inches-pound-force and can be divided by 12 to obtain foot-pound-force (ft·lbf).

NOTE The stresses in these calculations are based on stress area, and not thread-root area as required for stress calculations in 4.3.4.

## D.4 Recommendation for specific flanges

The following flanges should not be made up beyond 275 MPa (40 000 psi) bolt stress, due to potentially high flange stresses:

346 mm (13 <sup>5</sup>/<sub>8</sub> in): 13,8 MPa (2 000 psi)

425 mm (16 <sup>3</sup>/<sub>4</sub> in): 13,8 MPa (2 000 psi)

540 mm (21 <sup>1</sup>/<sub>4</sub> in): 13,8 MPa (2 000 psi)

346 mm (13 <sup>5</sup>/<sub>8</sub> in): 20,7 MPa (3 000 psi)

**Table D.1 — Recommended torques for flange bolting (SI units)**

Stud diameter		Thread pitch	Studs with $S_y = 550$ MPa Bolt stress equal to 275 MPa			Studs with $S_y = 720$ MPa Bolt stress equal to 360 MPa			Studs with $S_y = 655$ MPa Bolt stress equal to 327,5 MPa		
			Tension	Torque	Torque	Tension	Torque	Torque	Tension	Torque	Torque
$D$		$P$	$F$	$f = 0,07$	$f = 0,13$	$F$	$f = 0,07$	$f = 0,13$	$F$	$f = 0,07$	$f = 0,13$
mm	(in)	mm	kN	Nxm	Nxm	kN	Nxm	Nxm	kN	Nxm	Nxm
12,70	0,500	1,954	25	36	61	33	48	80	—	—	—
15,88	0,625	2,309	40	70	118	52	92	155	—	—	—
19,05	0,750	2,540	59	122	206	78	160	270	—	—	—
22,23	0,875	2,822	82	193	328	107	253	429	—	—	—
25,40	1,000	3,175	107	288	488	141	376	639	—	—	—
28,58	1,125	3,175	140	413	706	184	540	925	—	—	—
31,75	1,250	3,175	177	569	981	232	745	1 285	—	—	—
34,93	1,375	3,175	219	761	1 320	286	996	1 727	—	—	—
38,10	1,500	3,175	265	991	1 727	346	1 297	2 261	—	—	—
41,28	1,625	3,175	315	1 263	2 211	412	1 653	2 894	—	—	—
44,45	1,750	3,175	369	1 581	2 777	484	2 069	3 636	—	—	—
47,63	1,875	3,175	428	1 947	3 433	561	2 549	4 493	—	—	—
50,80	2,000	3,175	492	2 366	4 183	644	3 097	5 476	—	—	—
57,15	2,250	3,175	631	3 375	5 997	826	4 418	7 851	—	—	—
63,50	2,500	3,175	788	4 635	8 271	1 032	6 068	10 828	—	—	—
66,68	2,625	3,175	—	—	—	—	—	—	1 040	6 394	11 429
69,85	2,750	3,175	—	—	—	—	—	—	1 146	7 354	13 168
76,20	3,000	3,175	—	—	—	—	—	—	1 375	9 555	17 156
82,55	3,250	3,175	—	—	—	—	—	—	1 624	12 154	21 878
95,25	3,750	3,175	—	—	—	—	—	—	2 185	18 685	33 766
98,43	3,875	3,175	—	—	—	—	—	—	2 338	20 620	37 293
101,6	4,000	3,175	—	—	—	—	—	—	2 496	22 683	41 057

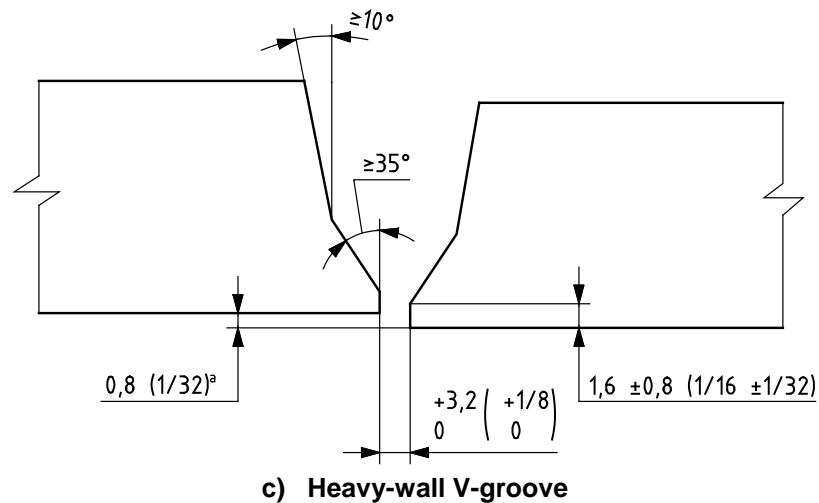
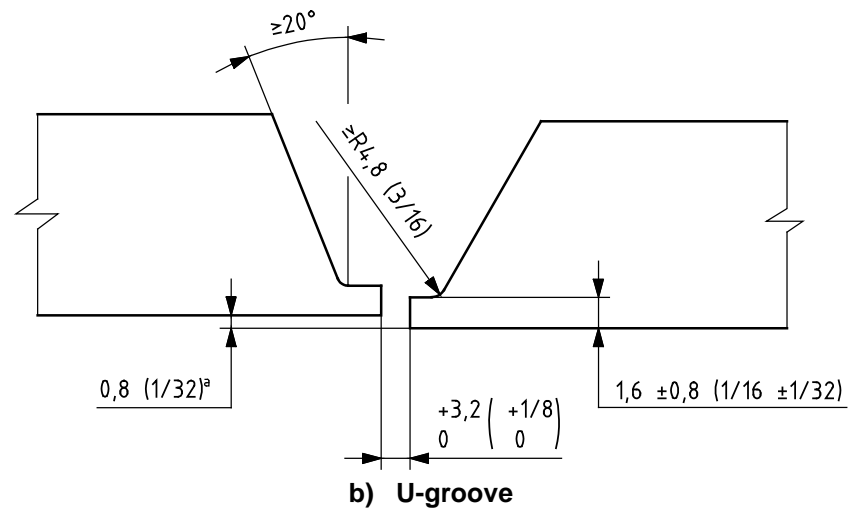
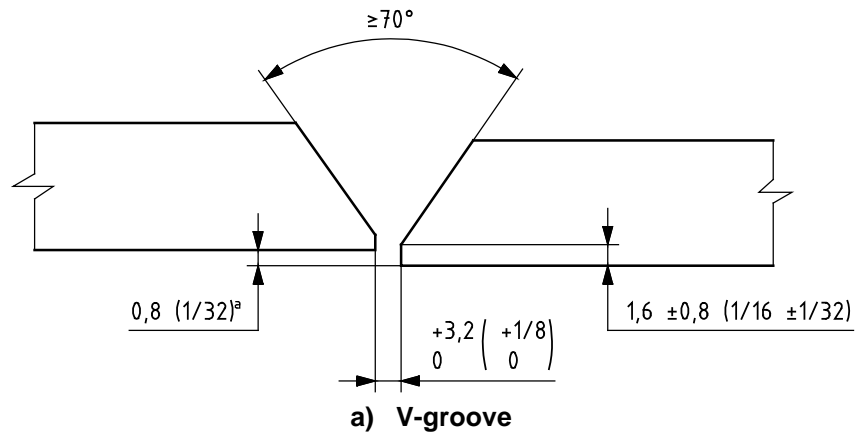
**Table D.2 — Recommended torques for flange bolting (USC units)**

Stud diameter <i>D</i> in	Threads per in <i>N</i> 1/in	Studs with $S_y = 80$ ksi Bolt stress equal to 40 ksi			Studs with $S_y = 105$ ksi Bolt stress equal to 52,5 ksi			Studs with $S_y = 95$ ksi Bolt stress equal to 47,5 ksi		
		Tension <i>F</i> lbf	Torque <i>f</i> = 0,07 ft·lbf	Torque <i>f</i> = 0,13 ft·lbf	Tension <i>F</i> lbf	Torque <i>f</i> = 0,07 ft·lbf	Torque <i>f</i> = 0,13 ft·lbf	Tension <i>F</i> lbf	Torque <i>f</i> = 0,07 ft·lbf	Torque <i>f</i> = 0,13 ft·lbf
0,500	13	5 676	27	45	7 450	35	59	—	—	—
0,625	11	9 040	52	88	11 865	68	115	—	—	—
0,750	10	13 378	90	153	17 559	118	200	—	—	—
0,875	9	18 469	143	243	24 241	188	319	—	—	—
1,000	8	24 230	213	361	31 802	279	474	—	—	—
1,125	8	31 618	305	523	41 499	401	686	—	—	—
1,250	8	39 988	421	726	52 484	553	953	—	—	—
1,375	8	49 340	563	976	64 759	739	1 281	—	—	—
1,500	8	59 674	733	1 278	78 322	962	1 677	—	—	—
1,625	8	70 989	934	1 635	93 173	1 226	2 146	—	—	—
1,750	8	83 286	1 169	2 054	109 313	1 534	2 696	—	—	—
1,875	8	96 565	1 440	2 539	126 741	1 890	3 332	—	—	—
2,000	8	110 825	1 750	3 094	145 458	2 297	4 061	—	—	—
2,250	8	142 292	2 496	4 436	186 758	3 276	5 822	—	—	—
2,500	8	177 685	3 429	6 118	233 212	4 500	8 030	—	—	—
2,625	8	—	—	—	—	—	—	233 765	4 716	8 430
2,750	8	—	—	—	—	—	—	257 694	5 424	9 712
3,000	8	—	—	—	—	—	—	309 050	7 047	12 654
3,250	8	—	—	—	—	—	—	365 070	8 965	16 136
3,750	8	—	—	—	—	—	—	491 099	13 782	24 905
3,875	8	—	—	—	—	—	—	525 521	15 208	27 506
4,000	8	—	—	—	—	—	—	561 108	16 730	30 282

## Annex E (informative)

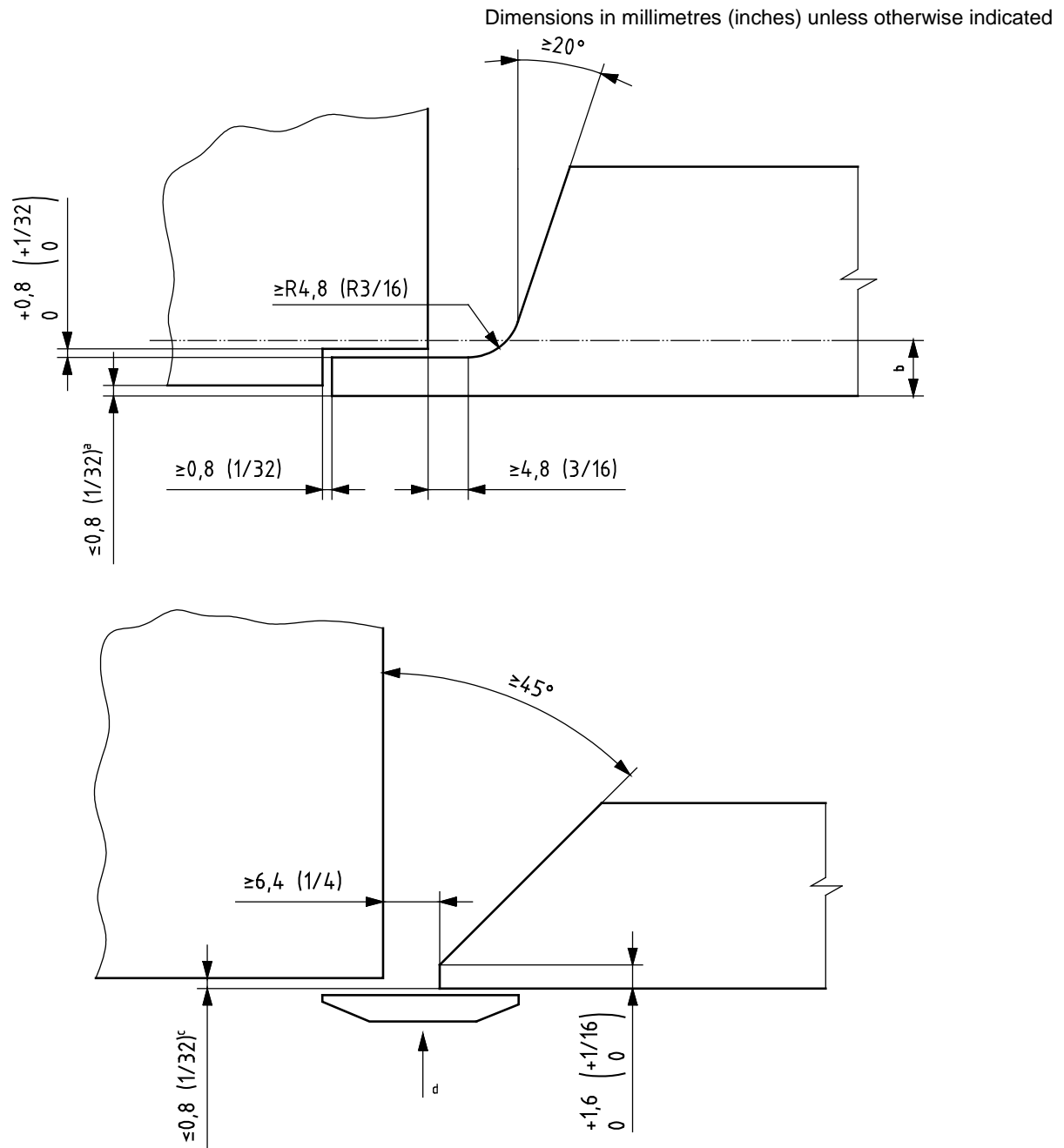
### Recommended weld preparation design dimensions

Dimensions in millimetres (inches) unless otherwise indicated



<sup>a</sup> Maximum misalignment.

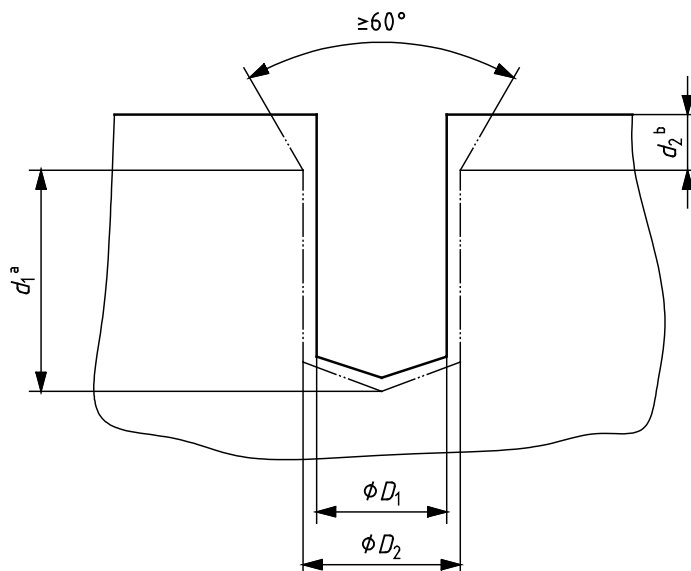
Figure E.1 — Pipe butt welds



- a Maximum misalignment (unless removed by machining).
- b Remove to sound metal by machining.
- c Maximum misalignment.
- d Backing shall be removed. Material shall be compatible with base material.

### Figure E.2 — Attachment welds

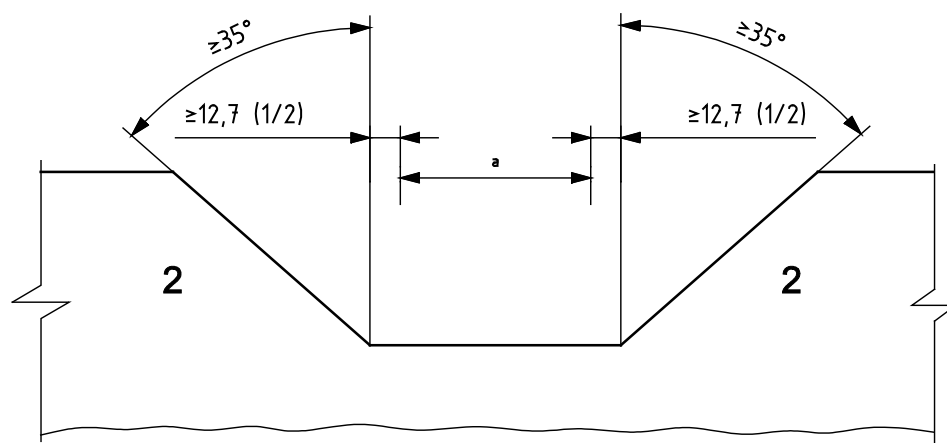
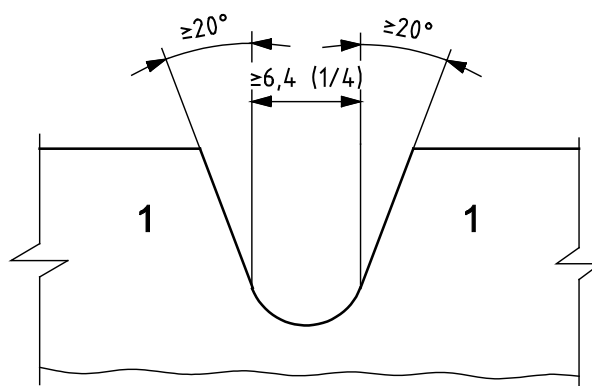
Dimensions in millimetres (inches) unless otherwise indicated



a Ratio of  $d_1$  to  $D_2$  shall not exceed 1,5:1.

b Depth required to maintain a maximum of 1,5:1 depth,  $d_1$ , to diameter,  $D_2$ , ratio.

#### a) Hole repair



#### Key

1 side

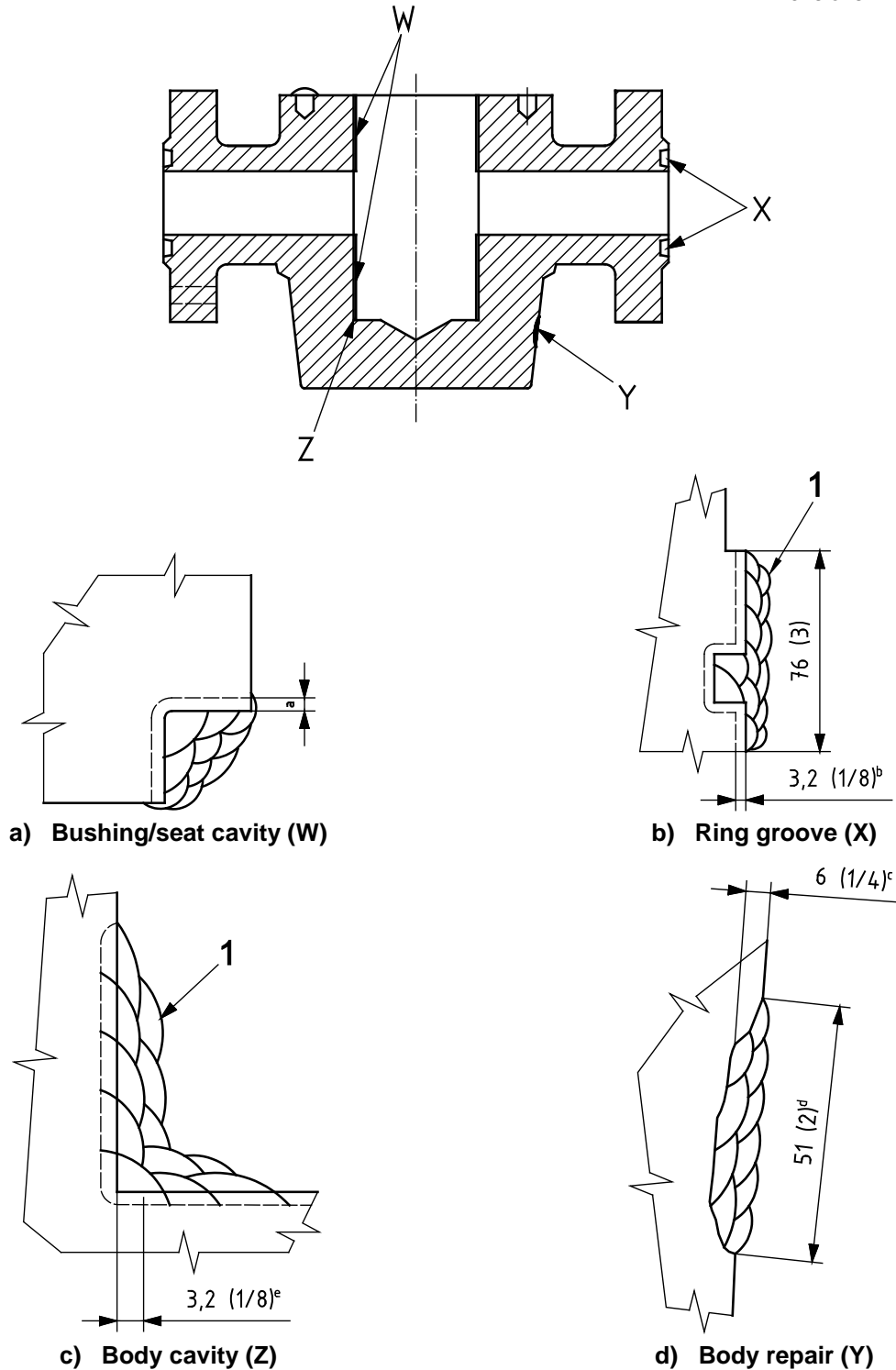
2 end

a Original area.

b) Excavation for repair (removal of sample discontinuities in weld metal and base metal)

Figure E.3 — Repairs

Dimensions in millimetres (inches)

**Key**

1 optional additional layers

a Thickness of weld after machining equal to approx.  $5 \left(\frac{3}{16}\right)$ .

b Weld thickness after machining.

c Maximum weld after machining (approx.).

d By  $19 \left(\frac{3}{4}\right)$  width.

e Minimum build-up.

**Figure E.4 — Weld repair and overlay, typical weld bead sequences**

## **Annex F** (informative)

### **Design validation procedures**

#### **F.1 Design validation — General requirements**

##### **F.1.1 Application**

###### **F.1.1.1 General**

This annex provides design validation procedures for qualification of equipment specified by this International Standard, which shall be applied if specified by the manufacturer or purchaser.

The performance requirements apply to all products being manufactured and delivered for service (see 4.1). If this annex is applied, the design validation procedures in this annex shall be applied to designs of products, including design changes. It is intended that the validation specified in this annex be performed on prototypes or production models (see also 4.7).

###### **F.1.1.2 Alternative procedures**

Other procedures may be used, provided the test requirements of this annex are met or exceeded.

###### **F.1.1.3 Other validation tests**

Validation tests that have been completed in accordance with validation requirements of Appendix/Annex F of previous editions of API Spec 6A or this International Standard, satisfy the requirements of this annex.

##### **F.1.2 Effect of changes in product**

The following apply:

###### **a) design changes:**

A design that undergoes a substantive change becomes a new design requiring design validation. A substantive change is a change identified by the manufacturer that affects the performance of the product in the intended service condition. This may include changes in fit, form, function or material.

Fit, when defined as the geometric relationship between parts, includes the tolerance criteria used during the design of a part and its mating parts. Fit, when defined as the state of being adjusted to or shaped for, includes the tolerance criteria used during the design of a seal and its mating parts.

###### **b) metallic materials:**

A change in metallic materials might not require new design validation if the suitability of the new material can be substantiated by other means.

###### **c) non-metallic seals:**

A change in non-metallic materials might not require new design validation if the suitability of the new material can be substantiated by other means. Substantive changes in the original, documented design configuration of non-metallic seals resulting in a new design, shall require design validation in accordance with F.1.13.

### **F.1.3 Compliance**

All products evaluated in design validation tests shall comply with the applicable design requirements of this International Standard. Test articles shall be hydrostatically tested to PSL1 prior to validation.

### **F.1.4 Products for design validation**

#### **F.1.4.1 General**

Design validation, if applicable, shall be performed on prototypes or production models of equipment made in accordance with this International Standard to confirm that the performance requirements specified for pressure, temperature, load, mechanical cycles and standard test fluids are met in the design of the product.

#### **F.1.4.2 Testing product**

Design validation shall be conducted on full-size products or fixtures that represent the specified dimensions for the relevant components of the end product being validated, unless otherwise specified in this annex.

#### **F.1.4.3 Product dimensions**

The actual dimensions of equipment subjected to validation shall be within the allowable tolerance range for dimensions specified for normal production equipment. Worst-case conditions for dimensional tolerances should be addressed by the manufacturer, giving consideration to concerns such as sealing and mechanical functioning.

#### **F.1.4.4 External paint or coatings**

The product used in any pressure test shall be free of paint or other coatings that can impede leak detection and/or leak observation.

#### **F.1.4.5 Maintenance procedures**

The manufacturer's published recommended maintenance procedures may be used on equipment, including lubrication of valves.

### **F.1.5 Safety**

Due consideration shall be given to the safety of personnel and equipment.

### **F.1.6 Acceptance criteria**

#### **F.1.6.1 General**

Design validation of the product shall include all of the testing requirements of the applicable PR level in this annex.

#### **F.1.6.2 Structural integrity**

The product tested shall not permanently deform to the extent that any other performance requirement cannot be met. Products that support tubulars shall be capable of supporting the rated load without collapsing the tubulars below the drift diameter.

### F.1.6.3 Pressure integrity

The following apply:

a) hydrostatic test at room temperature:

The hydrostatic test at room temperature is passed if no visible leakage occurs during the specified pressure hold periods of the test. The pressure change observed on the pressure-measuring device during the hold period shall be less than 5 % of the test pressure or 3,45 MPa (500 psi), whichever is less.

b) gas test at room temperature:

Prior to design validation, all production testing requirements shall have been met. The gas test at room temperature shall be acceptable if no sustained bubbles are observed. If leakage is observed, the rate shall be less than the rates shown in Table F.1, measured at atmospheric pressure, during specified pressure-hold periods.

**Table F.1 — Room temperature gas leakage acceptance criteria**

Equipment	Seal type	Allowable leakage
Valves, gate and plug	Through-bore	30 cm <sup>3</sup> /hr/25,4 mm of nominal bore size
	Stem seal	60 cm <sup>3</sup> /h
	Static (bonnet seal, end connections)	20 cm <sup>3</sup> /h
Valves, check	Through-bore	5 cm <sup>3</sup> /min/25,4 mm of nominal bore size
	Stem seal	60 cm <sup>3</sup> /h
	Static (bonnet seal, end connections)	20 cm <sup>3</sup> /h
Chokes	Dynamic (stem seal)	60 cm <sup>3</sup> /h
	Static (bonnet seal, end connections)	20 cm <sup>3</sup> /h
Actuators	All actuator fluid retaining seals	60 cm <sup>3</sup> /h
Hangers	Annular pack-off or bottom casing/tubing pack-off	10 cm <sup>3</sup> /hr/25,4 mm of nominal bore size
Tubing-head adapter, other end connections, fluid sampling devices, closures according this International Standard	External closure	20 cm <sup>3</sup> /h

c) minimum/maximum temperature tests:

The hydrostatic or gas test at high or low temperature shall be acceptable if the pressure change observed on the pressure-measuring device is less than 5 % of the test pressure or 3,45 MPa (500 psi), whichever is less.

### F.1.6.4 Fluid compatibility of non-metallic seals

The acceptance criteria for the standard test fluid compatibility of non-metallic seals shall be as specified in F.1.13.6.

### F.1.6.5 Post-test examination

The tested prototype shall be disassembled and inspected. All relevant items should be photographed. The examination shall include a written statement that neither the product nor component design contains defects to the extent that any performance requirement is not met.

### **F.1.7 Hydrostatic testing**

The following apply:

a) testing medium:

The testing medium shall be a fluid suitable for the testing temperatures. Water with or without additives, gas, hydraulic fluid, or other mixtures of fluids may be used as the testing medium. The testing medium shall be a fluid that remains in the liquid or gaseous state throughout the test.

b) substitution of gas:

The manufacturer may substitute gas for liquid if hydrostatic testing is specified, provided the testing method and acceptance criteria for gas testing are used.

### **F.1.8 Gas testing**

The following apply:

a) testing medium:

Air, nitrogen, methane or other gases or mixtures of gases may be used.

b) equipment for 69,0 MPa (10 000 psi) and above:

Gas testing is required for equipment for rated working pressures of 69,0 MPa (10 000 psi) and higher.

c) leak detection:

Gas testing at room temperature shall be conducted with a method for leak detection. The product may be completely submerged in a liquid, or the product may be flooded in the seal areas being validated, such that all possible leak paths are covered. The product may be assembled with one end of a tube connected to a blind connector enclosing all possible leak paths being validated. The other end of the tube shall be immersed in a liquid or attached to a leakage measurement device. Other methods that can detect leakage accurately are acceptable.

### **F.1.9 Temperature testing**

The following apply:

a) location of temperature measurement:

The temperature shall be measured in contact with the equipment being tested and within 13 mm (0,5 in) of the through-bore, where applicable, and within 13 mm (0,5 in) of the surface wetted by the retained fluid on other equipment.

As an alternative for maximum-temperature measurement, the temperature of the fluid used for heating may be employed, as long as the part is not artificially cooled. Ambient conditions shall be room temperature.

b) application of heating for maximum temperature testing:

The heating for maximum-temperature testing may be applied internally in the through-bore or externally. The heating shall be applied such that the entire through-bore or equivalent wetted surface is at or above the maximum temperature, or such that all fluid used for heating contained within the test articles is at or above the maximum temperature.

c) application of cooling for minimum temperature testing:

The cooling for minimum temperature testing shall be applied to the entire external surface of the equipment.

### **F.1.10 Hold periods**

The following apply:

a) start of hold periods:

Hold periods shall start after pressure and temperature stabilization has occurred and the equipment with a pressure-monitoring device has been isolated from the pressure source. The time specified for hold times shall be a minimum.

b) pressure stabilization:

Pressure shall be considered stabilized when the rate of change is no more than 5 % of the test pressure per hour or 3,45 MPa/h (500 psi/h), whichever is less. Pressure shall remain within 5 % of the test pressure or within 3,45 MPa (500 psi), whichever is less, during the hold period.

c) temperature stabilization:

Temperature shall be considered stabilized when the rate of change is less than 0,5 °C/min (1 °F/min). The temperature shall remain at or beyond the extreme during the hold period, but shall not exceed the extreme by more than 11 °C (20 °F).

### **F.1.11 Pressure and temperature cycles**

#### **F.1.11.1 Pressure/temperature cycles**

Pressure/temperature cycles shall be performed as specified in F.1.11.3, unless otherwise specified in F.2 for the specific product being tested.

#### **F.1.11.2 Test pressure and temperature**

The test pressure and temperature extremes shall be as specified in 4.2.

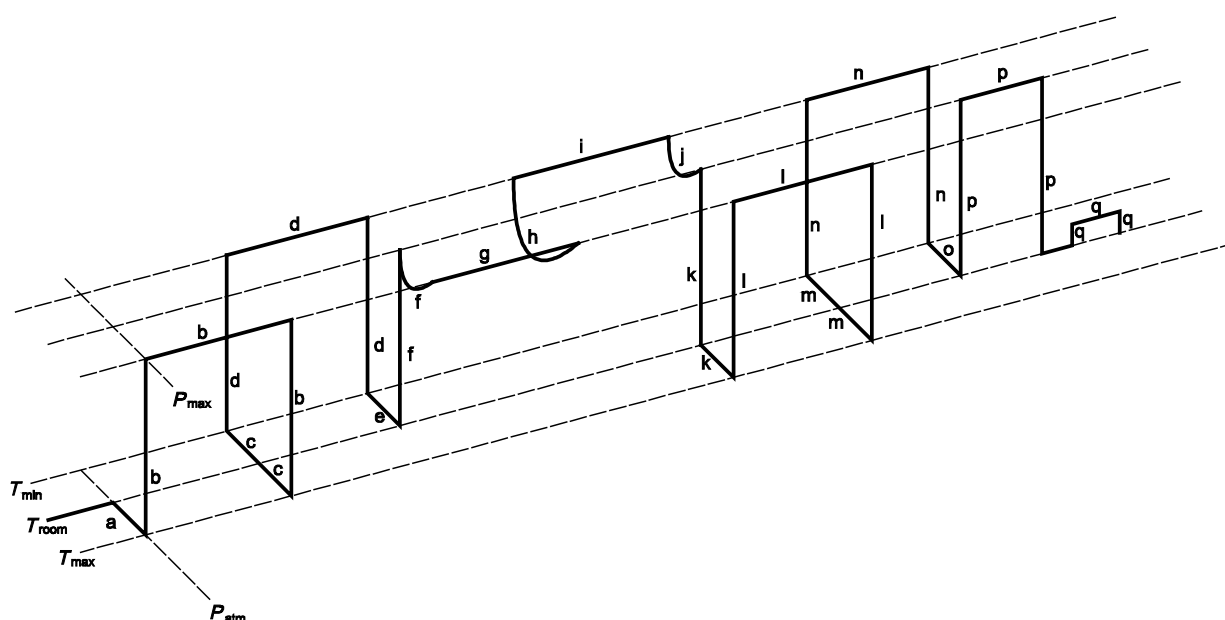
#### **F.1.11.3 Test procedure**

NOTE see Figure F.1.

Pressure shall be monitored and controlled during temperature change. The following procedure shall be followed. The item letters of the steps of the procedure correspond to the letters shown in Figure F.1.

- a) Start at room temperature with atmospheric pressure and raise temperature to the maximum.
- b) Apply test pressure, hold for a minimum period of 1 h, then release pressure.
- c) Lower temperature to the minimum.
- d) Apply test pressure, minimum hold period 1 h, then release pressure.
- e) Raise the temperature to room temperature.
- f) Apply the test pressure at room temperature and maintain at 50 % to 100 % of test pressure while raising temperature to the maximum.
- g) Hold for a period of 1 h minimum at test pressure.
- h) Reduce the temperature to the minimum while maintaining 50 % to 100 % of test pressure.
- i) Hold for a minimum period of 1 h at test pressure.

- j) Raise the temperature to room temperature while maintaining 50 % to 100 % of test pressure.
- k) Release the pressure, then raise the temperature to the maximum.
- l) Apply the test pressure, hold for a minimum period of 1 h, and then release the pressure.
- m) Reduce the temperature to the minimum.
- n) Apply the test pressure, hold for a minimum period of 1 h, and then release the pressure.
- o) Raise the temperature to room temperature.
- p) Apply the test pressure, hold for a minimum period of 1 h, and then release the pressure.
- q) Apply 5 % to 10 % of the test pressure, hold for a minimum period of 1 h, and then release the pressure.



NOTE Letters correspond to the steps in the preceding list.

**Figure F.1 — Test procedure**

## **F.1.12 Load and mechanical cycles**

Load testing and mechanical cycles shall be performed as specified in F.2 for the specific product being tested.

## **F.1.13 Testing of non-metallic seals**

### **F.1.13.1 Non-metallic seals**

Non-metallic seals that are exposed to fluids, either produced from or injected into a well, shall undergo the design validation procedure described in F.1.13.

### **F.1.13.2 Intent of procedure**

The intent of this procedure is to validate the performance of the seal for the standard test fluid rating as specified in F.1.13.4, not the performance of products containing the seal. The full-size seals shall be tested as specified in F.1 or F.2 to determine temperature and pressure performances.

### F.1.13.3 Temperature of record

The temperature of record shall be the stabilized temperature measured in contact with the fixture as specified in F.1.9.

### F.1.13.4 Testing medium

The testing medium shall be the standard test fluid specified in Table F.2 for the materials class rating.

### F.1.13.5 Thermochemical performance of seal materials

#### F.1.13.5.1 General

The fluid compatibility of the seal materials for the intended service shall be validated by a test demonstrating the response of the seal material to exposure to the standard test fluid, at or above the maximum rated temperature of the seal.

#### F.1.13.5.2 Immersion testing

A sample immersion test, comparing physical and mechanical properties prior to and after exposure to the standard test fluids, temperature and pressure as stated below, shall be performed. This test shall be in addition to the full-scale pressure and temperature testing of F.1 or F.2, as specified.

The following apply:

a) test fluid:

The standard test fluids for the material classes are listed in Table F.2. The non-metallic material being evaluated shall be totally immersed in the hydrocarbon liquid. A hydrocarbon liquid quantity equal to 60 % of the test vessel volume shall be charged in the test vessel. Water equal to 5 % of the test vessel volume shall also be charged in the test vessel. The hydrocarbon liquid shall be over-pressurized with the appropriate gas or gas mixture for the standard test fluid.

**Table F.2 — Standard test fluids for non-metallic seals**

Material class	Hydrocarbon liquid phase <sup>a</sup>	Gas phase
AA/BB	b	5 % vol. fraction CO <sub>2</sub> /95 % vol. fraction CH <sub>4</sub>
CC	b	80 % vol. fraction CO <sub>2</sub> /20 % vol. fraction CH <sub>4</sub>
DD/EE	b	10 % vol. fraction H <sub>2</sub> S/5 % vol. fraction CO <sub>2</sub> /85 % vol. fraction CH <sub>4</sub>
FF/HH	b	10 % vol. fraction H <sub>2</sub> S/80 % vol. fraction CO <sub>2</sub> /10 % vol. fraction CH <sub>4</sub>
<sup>a</sup> Water shall be added to the liquid phase.		
<sup>b</sup> Hydrocarbon liquid phase is selected at the manufacturer's discretion, which may include, but is not limited to, jet fuel, diesel, kerosene, etc.		

b) temperature:

The test temperature shall be either the maximum specified temperature rating for the temperature classification being tested (see F.1.9) or the maximum temperature at the seal location for the equipment at the maximum test temperature classification of the test product, as established by product testing and/or design analysis.

c) pressure:

The final test pressure, after heating to the test temperature, shall be 6,9 MPa ± 0,7 MPa (1 000 psig ± 100 psig).

d) exposure period:

The test exposure period shall be a minimum of 160 h; see F.1.10.

#### **F.1.13.5.3 Fixture testing**

Alternatively, the standard test fluid tests may be run at or above the maximum rated temperature and pressure with a reduced or full-size seal in fixtures or products that represent the nominal specified clearances and extrusion gaps specified on the manufactured part. At the completion of the exposure period, a room-temperature pressure test and low-pressure test shall be performed.

The following apply:

a) exposure test fluid:

The standard test fluids for the material classes are listed in Table F.2. The fixture shall be positioned so the seal is partially exposed to both the liquid and gas phases. A hydrocarbon liquid quantity equal to 60 % of the test fixture volume shall be charged in the test fixture. Water equal to 5 % of the test fixture volume shall also be charged in the test fixture. The hydrocarbon liquid shall be over-pressurized with the appropriate gas or gas mixture for the material class being tested.

b) temperature:

The test temperature shall be either the maximum specified temperature rating for the temperature classification being tested (see F.1.9) or the maximum temperature at the seal location for the equipment at the maximum test temperature classification of the test product, as established by product testing and/or design analysis.

c) pressure:

The final test pressure, after heating to the test temperature, shall be the rated working pressure of the seal.

d) exposure period:

The test exposure period shall be a minimum of 160 h (F.1.10).

e) room-temperature pressure test:

At the completion of the test exposure period, cool the test fixture and release the pressure. At a temperature of  $25 \pm 5$  °C ( $75 \pm 10$  °F) and no pressure in the test fixture, pressurize the test fixture using air, nitrogen, methane or other gases or mixture of gases to the maximum rated working pressure of the seal. Hold for a minimum of 1 h (F.1.10). At the end of the hold period, reduce the pressure to zero.

f) low-temperature pressure test:

Lower the temperature of the test fixture to the minimum specified temperature rating for the temperature classification being tested; see F.1.9. Pressurize the test fixture using air, nitrogen, methane or other gases or mixture of gases to the maximum rated working pressure of the seal. Hold for a minimum of 1 h (F.1.10). At the end of the hold period, reduce the pressure to zero and let the test fixture temperature return to room temperature.

#### **F.1.13.6 Acceptance criteria**

The following apply:

a) acceptance criteria:

The acceptance criteria for the standard test fluid compatibility of non-metallic seals exposed to sample immersion testing of F.1.13.5.2 shall be documented. The acceptance criteria for the non-metallic seals exposed to the fixture testing of F.1.13.5.3 shall be as follows:

- 1) 160 h exposure period: The pressure change observed/recorded on the pressure-measuring device during the exposure period (see F.1.10) shall be less than 5 % of the test pressure or 3,45 MPa (500 psi),

whichever is less. Fluid displacement for fixture leak detector (bubble-type indicator) shall be less than 100 cm<sup>3</sup>. No sustained bubbles shall be observed (20 cm<sup>3</sup>/h or more).

- 2) room-temperature pressure test: The pressure change observed/recorded on the pressure-measuring device during the hold period shall be less than 5 % of the test pressure or 3,45 MPa (500 psi), whichever is less. Fluid displacement for fixture leak detector (bubble-type indicator) shall be less than 20 cm<sup>3</sup>. No sustained bubbles shall be observed (20 cm<sup>3</sup>/h or more).
- 3) low-temperature test: The pressure change observed/recorded on the pressure-measuring device during the hold period shall be less than 5 % of the test pressure or 3,45 MPa (500 psi), whichever is less. Fluid displacement for fixture leak detector (bubble type indicator) shall be less than 20 cm<sup>3</sup>. No sustained bubbles shall be observed (20 cm<sup>3</sup>/h or more).

b) alternative testing acceptance:

A material that passes the immersion testing of F.1.13.5.2 is acceptable without running the fixture testing of F.1.13.5.3. A material that passes the fixture testing of F.1.13.5.3 is acceptable even if it fails the immersion testing of F.1.13.5.2. A material that fails the fixture testing of F.1.13.5.3 is not acceptable.

## **F.1.14 Scaling**

### **F.1.14.1 Scaling**

Scaling may be used to validate the members of a product family in accordance with the requirements and limitations described in F.1.14.

### **F.1.14.2 Product family**

A product family shall meet the following design requirements:

a) configuration:

The design principles of physical configuration and functional operation are the same.

b) design stress levels:

The design stress levels in relation to material mechanical properties are based on the same criteria.

### **F.1.14.3 Limitations of scaling**

#### **F.1.14.3.1 Design validation by pressure rating**

The test product may be used to validate products of the same family having equal or lower pressure ratings.

#### **F.1.14.3.2 Design validation by size**

Testing of one size of a product family shall validate products one nominal size larger and one nominal size smaller than the tested size. Testing of two sizes also validates all nominal sizes between the two sizes tested.

The following apply:

a) determination of choke nominal size:

The choke nominal size shall be defined as the size of the maximum orifice that can be used in that choke (orifice sizes smaller than the nominal size do not require testing). Choke nominal sizes are in 25 mm (1 in) increments.

b) determination of valve nominal size:

The valve nominal size shall be defined as the nominal size of the end connections, as defined in F.1.14.3.2 e). For valves of the same product family (as defined in F.1.14.2), 46 mm and 52 mm ( $1 \frac{13}{16}$  in and  $2 \frac{1}{16}$  in) sizes may be considered as one size for scaling purposes.

c) determination of other end-connector nominal sizes:

The nominal sizes of other end connectors shall be defined as the nominal size of the end connection as defined in F.1.14.3.2 e) 1).

d) determination of hanger and pack-off nominal sizes:

The nominal size of hangers and pack-offs that are sized by pipe ODs and wellhead IDs shall be defined by either the wellhead connection or the pipe. The manufacturer shall choose whether the size is determined by the connection or the pipe. The manufacturer shall be consistent in the practice of choosing sizes.

e) nominal sizes:

1) Nominal connector sizes shall be as given in Table F.3:

**Table F.3 — Nominal connector sizes — SI and USC**

Millimetres	(Inches)
46	$1 \frac{13}{16}$
52	$2 \frac{1}{16}$
65	$2 \frac{9}{16}$
78	$3 \frac{1}{16}$
79	$3 \frac{1}{8}$
103	$4 \frac{1}{16}$
105	$4 \frac{1}{8}$
130	$5 \frac{1}{8}$
179	$7 \frac{1}{16}$
228	9
279	11
346	$13 \frac{5}{8}$
425	$16 \frac{3}{4}$
476	$18 \frac{3}{4}$
527	$20 \frac{3}{4}$
540	$21 \frac{1}{4}$
679	$26 \frac{3}{4}$
762	30

- 2) Nominal pipe sizes shall be as given in Table F.4:

**Table F.4 — Nominal pipe sizes — SI and USC**

Millimetres	(Inches)
52,4	2 <sup>1</sup> / <sub>16</sub>
60,3	2 <sup>3</sup> / <sub>8</sub>
73,0	2 <sup>7</sup> / <sub>8</sub>
88,9	3 <sup>1</sup> / <sub>2</sub>
101,6	4
114,3	4 <sup>1</sup> / <sub>2</sub>
127,0	5
139,7	5 <sup>1</sup> / <sub>2</sub>
168,3	6 <sup>5</sup> / <sub>8</sub>
177,8	7
193,7	7 <sup>5</sup> / <sub>8</sub>
219,1	8 <sup>5</sup> / <sub>8</sub>
244,5	9 <sup>5</sup> / <sub>8</sub>
273,1	10 <sup>3</sup> / <sub>4</sub>
298,4	11 <sup>3</sup> / <sub>4</sub>
339,7	13 <sup>3</sup> / <sub>8</sub>
406,4	16
473,0	18 <sup>5</sup> / <sub>8</sub>
508,0	20

- f) determination of actuator nominal size:

Sizes shall be determined by the manufacturer.

#### **F.1.14.3.3 Design validation by temperature rating**

The temperature range validated by the test product shall validate all temperature classifications that fall entirely within that range.

#### **F.1.14.3.4 Design validation by standard test fluid rating for non-metallic seals**

The standard test fluid rating validated by the test product shall validate all products of the same product family and material properties as the test product. See Table F.5.

**Table F.5 — Scaling for non-metallic seals**

Material of products tested	Classes of products validated
AA/BB	AA, BB
CC	AA, BB, CC
DD/EE	AA, BB, DD, EE
FF/HH	AA through HH

### **F.1.14.3.5 Design validation by PSL**

Validation of equipment is independent of the PSL of the production equipment.

## **F.1.15 Documentation**

### **F.1.15.1 Design validation files**

The manufacturer shall maintain a file on each design validation.

### **F.1.15.2 Contents of validation files**

Validation files shall contain or reference the following information, if applicable:

- a) test number and revision level, or test procedure;
- b) complete identification of the product being tested;
- c) date of test completion;
- d) test results and post-test examination conclusions (see F.1.6.5);
- e) model numbers and other pertinent identifying data on all other sizes, rated pressures, temperature ranges and standard test fluid ratings of products of the same product family that are qualified by the validation of this particular product;
- f) class of seal designs (static, dynamic);
- g) all detailed dimensional drawings and material specifications applicable to the tested product, including seals and non-extrusion devices;
- h) sketch of test fixture, product and seal or sample; temperature and pressure measurement locations should be shown;
- i) actual sealing-surface dimensions;
- j) all test data specified in this annex, including actual test conditions (pressure, temperature, etc.) and observed leakages or other acceptance parameters;
- k) identification of testing media used;
- l) test equipment identification and calibration status;
- m) certification of manufacturer report, including the supplier of test seals, moulding dates, compound identifications and batch numbers for non-metallic materials;
- n) letter of compliance that the tested equipment is in accordance with the design requirements of this International Standard.

## **F.1.16 Test equipment calibration requirements**

### **F.1.16.1 General**

In F.1.16 are described the calibration requirements for equipment necessary to conduct the design validation tests described in this annex. Test equipment that requires calibration includes pressure-measuring equipment, load-measuring equipment, temperature-measuring equipment, torque-measuring equipment, elastomer physical and mechanical-property-measurement equipment, and any other equipment used to measure or record test conditions and results.

Except for specific requirements in F.1.16.2, the manufacturer's instructions shall provide all the requirements for the identification, control, calibration, adjustment, intervals between calibrations and accuracy of all the testing equipment to which this International Standard is applicable.

#### **F.1.16.2 Measuring and testing equipment**

Equipment for measuring dimensions shall be controlled and calibrated by the methods specified in this International Standard to maintain the accuracy required by the manufacturer's specification. Equipment for measuring dimensions for which this International Standard is not applicable shall be controlled and calibrated by the manufacturer's written specifications to maintain the accuracies required by this annex. Test pressure-measuring devices shall comply with the requirements of 7.2.

#### **F.1.16.3 Status**

When used for validation, equipment shall be calibrated in accordance with the requirements of the manufacturer and this International Standard.

### **F.2 Product-specific design validation**

#### **F.2.1 General**

##### **F.2.1.1 Design validation**

Procedures that are specific and unique to the product being tested are contained in F.2. The procedures shall be in addition to the procedures of F.1, unless otherwise specified in Annex F. There are two design validation procedures, corresponding to performance requirement levels PR1 and PR2.

##### **F.2.1.2 Acceptance criteria**

Unless noted otherwise, acceptance criteria for specific steps in F.2 shall be in accordance with F.1.

##### **F.2.1.3 Re-energization**

Any seal requiring re-energization during the test, except as specified in the product operating procedures, shall be retested.

##### **F.2.1.4 Objective evidence**

Objective evidence is defined as documented field experience, test data, technical publications, finite element analysis (FEA) or calculations that verify the performance requirements, as applicable.

##### **F.2.1.5 Actuated valves, chokes or other actuated products**

Valves, chokes or other products designed for actuators shall have the same design validation as the manually actuated products.

Design validation of a manual valve or choke shall validate an actuated valve or choke if the basic design is the same, provided that functional differences between manual and actuated designs are subjected to appropriate validation through fixture testing or product testing. These functional differences for consideration shall include, but not be limited to, the following:

- stem-seal design;
- stem size;
- stem movement (linear vs. rotary);

- bonnet design;
- relative speed of operation (hydraulic vs. pneumatic).

The manufacturer shall have documentation and/or validation to support the application of the actuated valve, choke or other product to the type of actuator, hydraulic or pneumatic.

#### **F.2.1.6 Bottom casing pack-off**

Bottom casing pack-offs are considered part of the hanger but may be tested separately.

### **F.2.2 Design validation for PR1 valves**

#### **F.2.2.1 General**

NOTE See Table F.6.

Acceptance criteria, unless noted otherwise for specific steps in F.2.2, shall be in accordance with F.1.

#### **F.2.2.2 Design validation procedure**

**Table F.6 — Design validation for valves**

Performance requirement level	PR1	PR2
Open/close cycling dynamic pressure test at room temperature	3 cycles	160 cycles as specified in F.2.3
Low-pressure seat test at room temperature	Objective evidence	1 h hold period at 5 % to 10 % of rated working pressure as specified in F.2.3
Open/close cycling dynamic pressure gas test at maximum and minimum temperatures	Objective evidence	20 cycles at each extreme as specified in F.2.3
Low-pressure seat test at maximum and minimum temperatures	Objective evidence	1 h hold period at 5 % to 10 % of rated working pressure as specified in F.2.3
Retained fluid compatibility	Objective evidence	As specified in F.1.13
Operating force or torque	As specified in F.2.2	As specified in F.2.2
Pressure/temperature cycling	Objective evidence	As specified in F.1.11

#### **F.2.2.2.1 Force or torque measurement**

The break-away and running torques or forces shall be measured. This is not applicable to check valves.

The following apply:

a) procedure:

The procedure shall be determined and documented by the manufacturer.

b) acceptance criteria:

The operating forces or torques shall be within the manufacturer's specifications.

**F.2.2.2.2 Dynamic test at room temperature****F.2.2.2.2.1 Procedure for gate and plug valves**

Gate and plug valves shall be tested as follows.

- a) Fill the downstream end of the valve with the test medium at 1 % or less of test pressure.
- b) Apply pressure equal to the rated working pressure against the upstream side of the gate or plug. All subsequent seat tests shall be in the same direction.
- c) Open the valve fully, starting against the full differential pressure. Pressure shall be maintained at a minimum of 50 % of the initial test pressure after the initial partial opening. The opening stroke may be interrupted to adjust the pressure within the above limits.
- d) Close the valve fully while pressure is maintained within the limits of the preceding step.
- e) Bleed the downstream pressure to 1 % or less of test pressure after the valve is fully closed.
- f) Repeat the above steps until a minimum of three open-and-close cycles have been carried out.

**F.2.2.2.2.2 Procedure for check valves**

Check valves shall be tested as follows.

- a) Apply pressure equal to the rated working pressure to the downstream side of the valve, while the upstream side is vented to atmosphere.
- b) Relieve the pressure to 1 % or less of test pressure and unseat the valve.
- c) Repeat F.2.2.2.2.2 a) and F.2.2.2.2.2 b) until a minimum of three pressure cycles have been carried out.

**F.2.2.2.3 Static pressure testing at room temperature****F.2.2.2.3.1 Body static pressure test**

Carry out the hydrostatic or gas testing, with the testing medium selected in accordance with F.1.7 or F.1.8

The static body test pressure shall be the rated working pressure of the valve. The body test shall consist of three steps:

- a) a primary pressure-holding period of 3 min;
- b) a reduction of pressure to zero;
- c) a secondary pressure-holding period of 15 min.

**F.2.2.2.3.2 Seat static pressure test**

Carry out the hydrostatic or gas testing, with the testing medium selected in accordance with F.1.7 or F.1.8.

Test valves intended for bidirectional installation in both directions for the first seat test specified in a) to c) as follows. Mark valves intended for single-direction installation accordingly, and test in the direction of intended installation. Testing of bidirectional valves may be conducted in one direction only for subsequent seat tests. The static seat test pressure shall be equal to the rated working pressure of the valve. The seat test shall consist of the following three steps:

- a) a primary pressure-holding period of 3 min;
- b) a reduction of pressure to zero;
- c) a secondary pressure-holding period of 15 min.

#### **F.2.2.2.4 Final force or torque measurement**

This shall be carried out in accordance with F.2.2.2.1.

### **F.2.3 Design validation for PR2 valves**

#### **F.2.3.1 General**

Acceptance criteria, unless noted otherwise for specific steps in subclause F.2.3, shall be in accordance with F.1.

NOTE See Table F.6.

#### **F.2.3.2 Seat tests**

Testing of bidirectional valves may be conducted in one direction only, provided that the same direction is used for all tests, unless otherwise specified.

#### **F.2.3.3 Design validation procedure**

##### **F.2.3.3.1 Force or torque measurement**

Carry out this test in accordance with F.2.2.2.1.

##### **F.2.3.3.2 Dynamic test at room temperature**

###### **F.2.3.3.2.1 Procedure for gate and plug valves**

Carry out this test in accordance with F.2.2.2.2.1, except that the minimum number of open-and-close cycles shall be 160.

###### **F.2.3.3.2.2 Procedure for check valves**

Carry out this test in accordance with F.2.2.2.2.2, except that the minimum number of pressure cycles shall be 160.

##### **F.2.3.3.3 Dynamic test at maximum rated temperature**

Carry out this test in accordance with F.2.2.2.2, except that the minimum number of open-and-close cycles shall be 20 and the test medium shall be gas.

##### **F.2.3.3.4 Gas body test at maximum rated temperature**

Carry out this test as follows.

- a) Gate and plug valves shall be in the partially open position during testing. Test check valves from the upstream side.
- b) Test pressure shall be the rated working pressure.
- c) The hold period shall be as specified in F.1.11.3 b), but do not release the pressure at the end of the hold period.

**F.2.3.3.5 Gas seat test at maximum rated temperature**

At the end of the hold period of F.2.3.3.4, close the valve. Maintain rated working pressure on the upstream side of the gate or plug and release it on the downstream side. Test check valves from the downstream side. There shall be one hold period of not less than 1 h duration. Then release the pressure.

**F.2.3.3.6 Low-pressure seat test at maximum rated temperature**

Subject the valves to a differential pressure of no less than 5 % and no more than 10 % of the rated working pressure. Apply the pressure on the upstream side of the gate or plug and release it on the downstream side for one hold period of a minimum of 1 h. For check valves, apply the low-pressure seat test pressure on the downstream end of the valve with the opposite end vented to the atmosphere.

**F.2.3.3.7 Dynamic test at minimum rated temperature**

A dynamic test at minimum rated temperature shall be performed as specified in F.2.2.2.2, except that the minimum number of open-and-close cycles shall be 20, and the test medium shall be gas.

**F.2.3.3.8 Gas body test at minimum rated temperature**

Carry out this test in accordance with F.2.3.3.4, except at minimum rated temperature.

**F.2.3.3.9 Gas seat test at minimum rated temperature**

Carry out this test in accordance with F.2.3.3.5, except at minimum rated temperature.

**F.2.3.3.10 Low-pressure seat test at minimum rated temperature**

Carry out this test in accordance with F.2.3.3.6, except at minimum rated temperature.

**F.2.3.3.11 Body pressure/temperature cycles**

Perform steps F.1.11.3 e) through F.1.11.3 o). Partially open gate and plug valves.

**F.2.3.3.12 Body pressure holding test at room temperature**

Perform step F.1.11.3 p), but do not release pressure. Partially open gate and plug valves.

**F.2.3.3.13 Gas seat test at room temperature**

At the end of the hold period mentioned later in this subclause, close the valve. Maintain rated working pressure on the upstream side of the gate or plug and release it on the downstream side. Test check valves from the downstream side. There shall be one pressure-holding period of not less than 15 min duration. Then, release the pressure.

**F.2.3.3.14 Body low-pressure holding test**

Perform step F.1.11.3 q). Partially open gate and plug valves.

**F.2.3.3.15 Low-pressure seat test at room temperature**

Subject valves to a differential pressure of no less than 5 % and no more than 10 % of the rated working pressure. Apply one hold period of a minimum of 1 h duration (in each direction, for bidirectional valves). For check valves, apply the low-pressure seat test pressure on the downstream end of the valve, with the opposite end vented to atmosphere.

**F.2.3.3.16 Final force or torque measurement**

Carry out this test in accordance with F.2.2.2.1.

## F.2.4 Design validation for PR1 actuators

NOTE See Table F.7.

Subject actuators, including electric actuators, to a functional test to demonstrate proper assembly and operation. The test medium for pneumatic actuators shall be a gas. Test medium for hydraulic actuators shall be a suitable hydraulic fluid. Perform the tests at room temperature.

The following test procedure is in lieu of the pressure/temperature test of F.1.11.

Pressure-test the actuator seals in two steps by applying a pressure of 20 % and of 100 % of the rated working pressure of the actuator. The minimum hold period for each pressure test shall be: 10 min at 20 % pressure and 5 min at 100 % pressure for pneumatic actuators and 3 min at each pressure test for hydraulic actuators. Repeat this actuator seal test a minimum of three times.

**Table F.7 — Design validation for actuators**

Performance requirement	PR1	PR2
Operating force or torque measurement	Objective evidence	Objective evidence
Actuator seal test at room temperature	3 cycles as specified in F.2.4	3 cycles as specified in F.2.5 a)
Dynamic open/close pressure cycling test at room temperature	Objective evidence	160 cycles as specified in F.2.5 b)
Dynamic open/close pressure cycling test at maximum temperature	Objective evidence	20 cycles as specified in F.2.5 c)
Dynamic open/close pressure cycling test at minimum temperature	Objective evidence	20 cycles as specified in F.2.5 d)
Pressure/temperature cycles	Not applicable	As specified in F.2.5 e)
Actuator fluid compatibility (retained fluid actuators only)	Objective evidence	As specified in F.1.13

## F.2.5 Design validation for PR2 actuators

NOTE See Table F.7.

Subject actuators, including electric actuators, to a functional test to demonstrate proper assembly and operation. Testing medium for pneumatic actuators shall be a gas. Testing medium for hydraulic actuators shall be a suitable hydraulic fluid. Test the actuator either on a valve/choke or on a fixture that simulates the opening/closing dynamic force profile of a valve/choke. A fixture test of a valve operator shall include the reduction in resisting force and resulting motion of the stem that occur when the valve is opened against differential pressure. If the bonnet assembly is part of the actuator, perform a validation of the stem seal and bonnet design to validate these design elements to the requirements for valves.

The following test procedure is in lieu of the pressure/temperature test of F.1.11.

a) actuator seal test at room temperature:

Pressure-test the actuator seals in two steps by applying a pressure of 20 % and of 100 % of the rated working pressure to the actuator. The minimum hold period for each test pressure shall be: 10 min at 20 % pressure and 5 min at 100 % pressure for pneumatic actuators and 3 min at each test pressure for hydraulic actuators. Repeat this actuator seal test a minimum of three times.

b) dynamic open/close pressure cycling test at room temperature:

Test the actuator for proper operation by cycling the actuator an equivalent of 160 open-close-open valve cycles. The acceptance criteria shall be within the manufacturer's specifications. The pressure applied shall be equal to the rated working pressure of the actuator.

- c) dynamic open/close pressure cycling test at maximum rated actuator temperature:

Test the actuator for proper operation by cycling the actuator an equivalent of 20 open-close-open valve cycles at the maximum rated temperature of the actuator. The acceptance criteria shall be within the manufacturer's specifications. The pressure applied shall be equal to the rated working pressure of the actuator.

- d) dynamic open/close pressure cycling test at minimum rated actuator temperature:

Test the actuator for proper operation by cycling the actuator an equivalent of 20 open-close-open valve cycles, at minimum rated temperature of the actuator. The acceptance criteria shall be within the manufacturer's specifications. The pressure applied shall be equal to the rated working pressure of the actuator.

- e) pressure/temperature cycles:

The pressure/temperature cycles shall be steps F.1.11.3 e) through F.1.11.3 q).

## **F.2.6 Design validation for PR1 chokes**

### **F.2.6.1 General**

Design validation of an adjustable choke also validates a positive choke that has the same body design and seat seal design.

NOTE See Table F.8.

### **F.2.6.2 Static pressure testing at room temperature**

#### **F.2.6.2.1 Body static pressure test**

Carry out the hydrostatic or gas testing, with the test medium selected in accordance with F.1.7 or F.1.8.

The static body test pressure shall be the rated working pressure of the choke. The body test shall consist of three steps:

- a) a primary pressure-holding period of 3 min;
- b) a reduction of pressure to zero;
- c) a secondary pressure-holding period of 15 min.

#### **F.2.6.2.2 Hydrostatic seat-to-body seal test**

Carry out the hydrostatic or gas testing, with the test medium selected in accordance with F.1.7 or F.1.8.

Carry out a hydrostatic seat-to-body seal test by applying rated working pressure. The seat-to-body seal test shall consist of the following three steps (a blind seat may be used for this test at the manufacturer's option):

- a) a primary pressure-holding period of 3 min;
- b) a reduction of pressure to zero;
- c) a secondary pressure-holding period of 15 min.

## F.2.7 Design validation for PR2 chokes

### F.2.7.1 General

Design validation of an adjustable choke also validates a positive choke which has the same body design and seat seal design. For testing of a positive choke, the dynamic test cycles (F.2.7.4, F.2.7.5 and F.2.7.7) are not required.

NOTE See Table F.8.

### F.2.7.2 Force or torque measurement

Measure the break-away and running torques.

The following apply:

a) procedure:

The procedure shall be determined and documented by the manufacturer.

b) acceptance criteria:

The operating forces or torque shall be within the manufacturer's specifications.

**Table F.8 — Design validation for chokes**

Performance requirement	PR1	PR2
Operating force or torque measurement	Objective evidence	As specified in F.2.7.2
Body static pressure test	As specified in F.2.6.2.1	Not applicable
Seat-to-body seal test at room temperature	1 cycle as specified in F.2.6.2.2	As specified in F.2.7.3
Dynamic open/close cycling pressure test at room temperature <sup>a</sup>	Objective evidence	160 cycles as specified in F.2.7.4
Dynamic open/close cycling pressure test at maximum temperature <sup>a</sup>	Objective evidence	20 cycles as specified in F.2.7.5
Gas body test at maximum rated temperature	Not applicable	As specified in F.2.7.6
Dynamic open/close cycling pressure test at minimum temperature <sup>a</sup>	Objective evidence	20 cycles as specified in F.2.7.7
Gas body test at minimum rated temperature	Not applicable	As specified in F.2.7.8
Body pressure/temperature cycling	Not applicable	As specified in F.2.7.9
Body pressure-holding test at room temperature	Objective evidence	As specified in F.2.7.10
Body low-pressure holding test	Not applicable	As specified in F.2.7.11
Second seat-to-body test at room temperature	Not applicable	As specified in F.2.7.12
Testing of non-metallic seals	Objective evidence	As specified in F.1.13
<sup>a</sup> Does not apply to a positive choke.		

### F.2.7.3 Hydrostatic seat-to-body seal test

Carry out the hydrostatic seat-to-body seal test at room temperature by applying rated working pressure and holding for a minimum of 1 h to confirm the integrity of the seat-to-body seal. A blind seat may be used for this test at the manufacturer's option. For an adjustable choke, a separate test or fixture test may be performed to confirm

the integrity of the seat-to-body seal, in accordance with F.2.7.3, F.2.7.9, F.2.7.10 and F.2.7.11. In this case, F.2.7.12 may be omitted.

#### **F.2.7.4 Dynamic open/close cycling pressure test at room temperature**

Apply rated working pressure and cycle the stem at rated working pressure a minimum 160 times open-close-open. The mating parts shall be free of all lubrication not specified in the manufacturer's part or assembly specifications or maintenance procedures. The acceptance criteria shall be within the manufacturer's written specifications. Adjust the internal pressure to compensate for expansion and contraction of the test fluid chamber.

#### **F.2.7.5 Dynamic open/close cycling pressure test at maximum rated temperature**

Perform a dynamic cycling test at the maximum rated temperature by repeating F.2.7.4, except as follows.

- a) The temperature shall be equal to the maximum temperature.
- b) The test medium shall be gas.
- c) Cycle the stem 20 times open to close and back to open.

#### **F.2.7.6 Gas body test at maximum rated temperature**

Perform a gas body test at maximum rated temperature as follows.

- a) The choke shall be in the partially open position during testing.
- b) Test pressure shall be the rated working pressure.
- c) One hold period of a minimum of 1 h duration shall be applied.

#### **F.2.7.7 Dynamic test at minimum rated temperature**

Perform a dynamic test at the minimum rated temperature by repeating F.2.7.5, except at the minimum rated temperature.

#### **F.2.7.8 Gas body test at minimum rated temperature**

Perform a gas body test at the minimum rated temperature as follows.

- a) The choke shall be in the partially open position during testing.
- b) Test pressure shall be the rated working pressure.
- c) One hold period of a minimum of 1 h duration shall be applied.

#### **F.2.7.9 Body pressure/temperature cycles**

Perform steps F.1.11.3 e) through F.1.11.3 o) with the seat open.

#### **F.2.7.10 Body pressure holding test at room temperature**

Perform step F.1.11.3 p) with the seat open, but do not release the pressure.

#### **F.2.7.11 Body low-pressure holding test**

Perform step F.1.11.3 q) with the seat open.

### F.2.7.12 Second seat-to-body seal test at room temperature

Perform a second hydrostatic seat-to-body seal test by applying rated working pressure at room temperature and holding for a minimum of 1 h to confirm the integrity of the seat-to-body seal after pressure/temperature cycle testing. A blind seat may be used for this test at the manufacturer's option.

## F.2.8 Design validation for PR1 casing-head housings, casing-head spools, tubing-head spools, cross-over connectors, and adapter and spacer spools

### F.2.8.1 General

NOTE See Table F.9.

#### a) deformation:

The deformation of casing-head housings, casing-head spools, and tubing-head spools due to hanger loading is outside the scope of this annex. Products shall be capable of sustaining rated loads without deformation to the extent that other required performance characteristics cannot be met.

#### b) penetrations:

Penetrations for lock screws, hanger pins and retainer screws are not addressed in performance testing of these members, but are addressed in F.2.28.

### F.2.8.2 Testing

Design validation is achieved through production hydrostatic pressure testing as required for the PSL to which the equipment is manufactured, in lieu of the procedure of F.1.11 (see 10.6.6).

**Table F.9 — Design validation for casing-head housings, casing-head spools, tubing-head spools, cross-over connectors and adapter and spacer spools**

PR level	PR1	PR2
Pressure	As specified in F.2.8.2	As specified in F.2.9.2
Thermal cycles	Objective evidence	Objective evidence
Penetrations	Objective evidence	As specified in F.2.29
Fluid compatibility	Objective evidence	Objective evidence

## F.2.9 Design validation for PR2 casing-head housings, casing-head spools, tubing-head spools, cross-over connectors and adapter and spacer spools

### F.2.9.1 General

NOTE See Table F.9.

#### a) deformation:

The deformation of casing-head housings, casing-head spools and tubing-head spools due to hanger loading is outside the scope of this annex. Products shall be capable of sustaining rated loads without deformation to the extent that other required performance characteristics cannot be met.

#### b) penetrations:

Penetrations for lock screws, hanger pins and retainer screws are not addressed in performance testing of these members, but are addressed in F.2.29.

### F.2.9.2 Testing

Design validation shall be in accordance with F.2.8.2.

### F.2.10 Design validation for PR1 group 1 slip hangers

NOTE See Table F.10.

The design validation of PR1 group 1 slip hangers shall be satisfied by objective evidence.

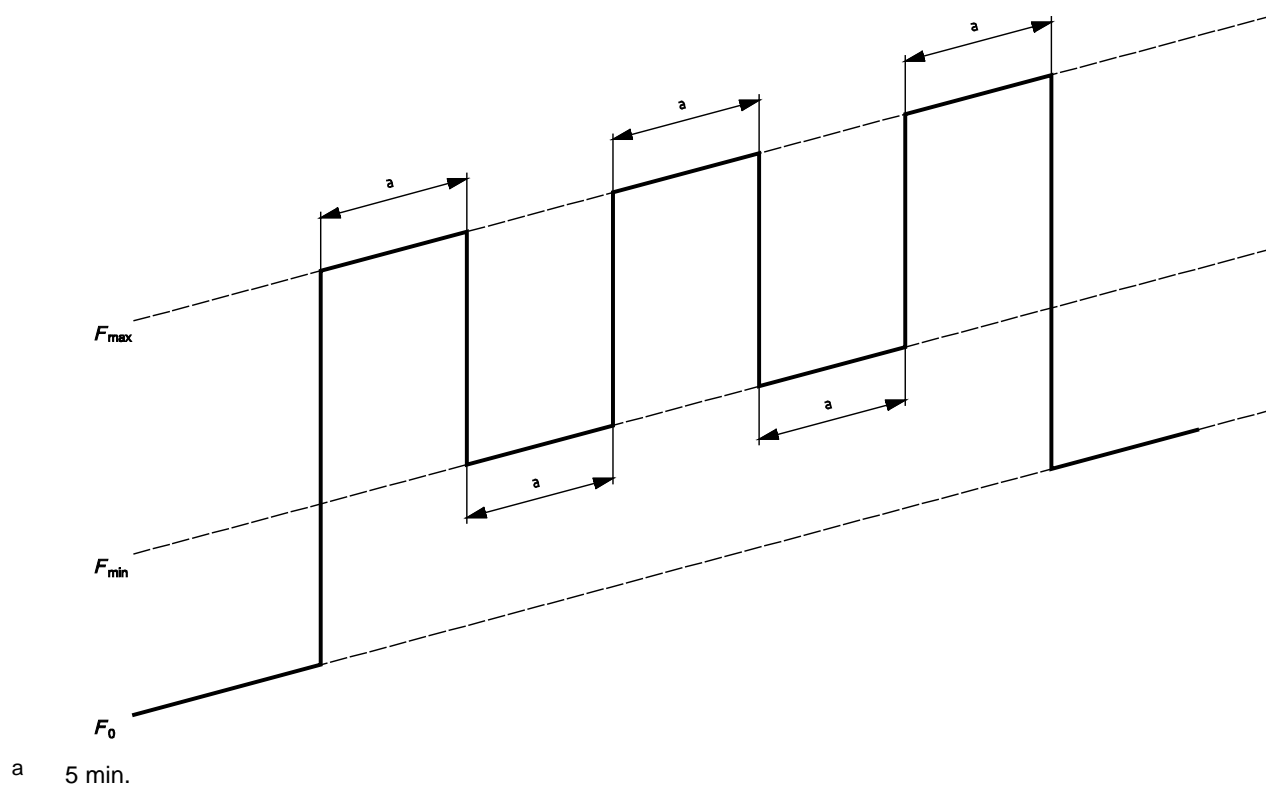
### F.2.11 Design validation for PR2 group 1 slip hangers

NOTE See Table F.10.

**Table F.10 — Design validation for group 1 slip hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.11

Load cycling capacity testing shall consist of 3 cycles at maximum rated load capacity to the minimum rated load capacity with 5 min minimum hold periods, as shown in Figure F.2. The pressure/temperature cycles of F.1.11 are not required.



**Figure F.2 — Load cycle testing for hangers**

### F.2.12 Design validation for PR1 group 2 slip hangers

NOTE See Table F.11.

**F.2.12.1 Load cycling**

Load cycling capacity shall be verified by objective evidence.

**F.2.12.2 Pressure cycle**

Perform one pressure cycle across the annular seal in one direction at room temperature with a hold period of 15 min.

**Table F.11 — Design validation for group 2 slip hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.13
Pressure seal(s)	1 cycle at room temperature	As specified in F.1.11
Fluid compatibility	Objective evidence	As specified in F.1.13

**F.2.13 Design validation for PR2 group 2 slip hangers**

NOTE See Table F.11.

**F.2.13.1 Load cycling**

The load cycle test in accordance with Figure F.2 shall be performed.

**F.2.13.2 Pressure/temperature testing with load**

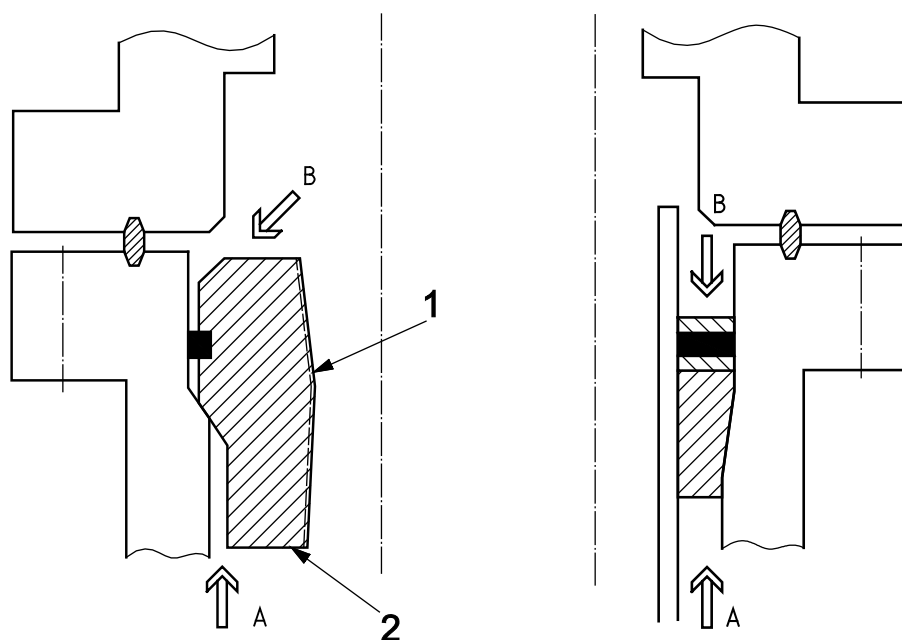
Cycle testing shall be performed in accordance with F.1.11 from either direction A or direction B (see Figure F.3). If the manufacturer's pressure rating at the maximum rated load is not equal to the maximum rated working pressure, repeat the test using the rated maximum working pressure of the hanger with the manufacturer's rated hanging load at that pressure.

**F.2.14 Design validation for PR1 group 3 slip hangers**

NOTE See Table F.12.

Validation testing is the same as for PR1 group 2 slip hangers with the addition of a separate test in the same manner but with the external pressure across the annular pack-off in a direction opposite to that identified in Figure F.3. Also, test the bottom casing pack-off from above in the same manner. Hydrostatically test the ring joint pressure area as identified in Figure F.4 at the rated working pressure at room temperature, one time for a 5 min minimum hold period.

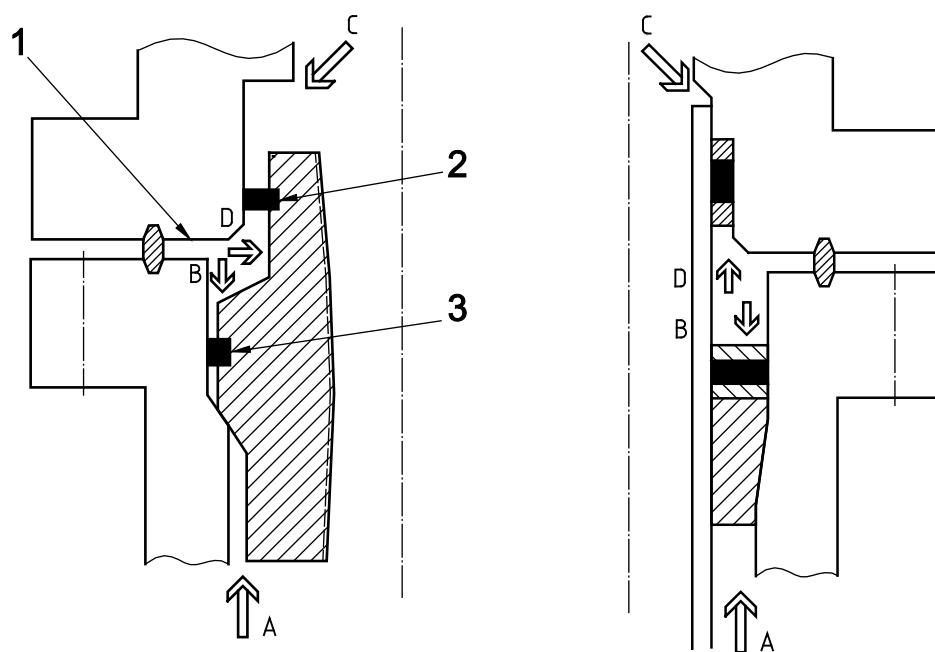
If the manufacturer's pressure rating from below is different from the pressure rating from above, test at the appropriate pressure for each direction.

**Key**

1 wellbore pressure area

2 annular pressure area

A, B Directions of pressure application (see text).

**Figure F.3 — Groups 2 and 3 hangers****Key**

1 ring-gasket pressure area

2 bottom casing pack-off

3 annular seal

A, B, C, D Directions of pressure application (see text).

**Figure F.4 — Group 3 hangers with cross-over seal**

### F.2.15 Design validation for PR2 group 3 slip hangers

NOTE See Table F.12.

Validation testing is the same as for PR2 group 2 slip-type hangers, with the addition of a separate test in the same manner but with external pressure across the annular pack-off in the other direction, as identified in Figure F.3. Also test the bottom casing pack-off from above in the same manner. Hydrostatically test the ring joint pressure area, as identified in Figure F.4, at the rated working pressure at room temperature, one time for a 5 min minimum hold period.

If the manufacturer's pressure rating from below is different from the pressure rating from above, carry out a test at the appropriate pressure for each direction. The bottom casing pack-off may be cycle-tested separately, as shown in Figure F.6, or concurrently with the pack-off, as shown in Figures F.7 or F.8.

**Table F.12 — Design validation for group 3 slip hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.15
Pressure from above seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.15
Thermal cycle	Objective evidence	As specified in F.1.11 and F.2.15
Fluid compatibility	Objective evidence	As specified in F.1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.15

### F.2.16 Design validation for PR1 group 4 slip hangers

NOTE See Table F.13.

Same as PR1 group 3 hangers. The design validation of PR1 group 4 slip hangers with respect to retention characteristics shall be satisfied by objective evidence.

### F.2.17 Design validation for PR2 group 4 slip hangers

NOTE See Table F.13.

Validation testing is the same as PR2 group 3 hangers, with an additional test of retention feature in accordance with Table F.13.

**Table F.13 — Design validation for group 4 slip hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.17
Pressure from above seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.17
Thermal cycle	Objective evidence	As specified in F.1.11 and F.2.17
Fluid compatibility	Objective evidence	As specified in F.1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.17
Retention feature test by annular pressure	Objective evidence	As specified in F.1.11 and F.2.17 with the hanger held in place by a retention feature with minimum rated tubular load and maximum annular pressure from below only

**F.2.18 Design validation for PR1 group 1 mandrel hangers**

NOTE See Table F.14.

Load cycling and pressure integrity shall be verified by objective evidence.

**F.2.19 Design validation for PR2 group 1 mandrel hangers**

NOTE See Table F.14.

**F.2.19.1 Internal pressure test**

Perform one internal pressure test at room temperature with a hold period of 15 min at rated working pressure. Documentation for the end-connection pressure rating or capability may be obtained from a thread manufacturer or an appropriate international industry standard if the wellhead product meets the dimensional (including the connection outside diameter) and material strength requirements of that standard. If the product does not meet the thread manufacturer's dimensional and material strength requirements, then test the threaded connection. The test may be performed in a fixture separate from the hanger.

**F.2.19.2 Load cycling**

Load-test the hanger by applying the rated capacity load as shown in Figure F.2. Load testing of the end connections is not required.

**Table F.14 — Design validation for group 1 mandrel hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.19
Internal pressure test	Objective evidence	As specified in F.2.19

**F.2.20 Design validation for PR1 group 2 mandrel hangers**

NOTE See Table F.15.

**F.2.20.1 Load cycling**

Load cycling capacity shall be verified by objective evidence.

**F.2.20.2 Pressure cycle**

Perform one pressure cycle across the annular pack-off in one direction at room temperature for a 15 min minimum hold period.

**Table F.15 — Design validation for group 2 mandrel hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.21
Pressure seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11
Thermal cycling seal(s)	Objective evidence	As specified in F.1.11
Fluid compatibility	Objective evidence	As specified in F.1.13
Internal pressure test	Objective evidence	As specified in F.2.21

## F.2.21 Design validation for PR2 group 2 mandrel hangers

NOTE See Table F.15.

### F.2.21.1 Load cycling

Perform the load cycle test specified in F.2.11.

### F.2.21.2 Internal pressure test

Internally pressure test the hangers as specified for PR2 group 1 mandrel hangers; see F.2.19.1.

## F.2.22 Design validation for PR1 group 3 mandrel hangers

NOTE See Table F.16.

### F.2.22.1 Downhole control line preparations

If downhole control line or electric cable preparations are included, they shall hold the rated working pressure and be subjected to the same testing requirements as the hanger.

**Table F.16 — Design validation for group 3 mandrel hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.23
Internal pressure tests	1 cycle at room temperature and rated pressure	As specified in F.2.23
Thermal cycling seal(s)	Objective evidence	As specified in F.1.11 and F.2.23
Fluid compatibility	Objective evidence	As specified in F.1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.23
Pressure from above seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.23

### F.2.22.2 Pressure cycle

Validation testing is the same as for PR1 group 2 mandrel type hangers, with the addition of a test at room temperature, one cycle for a 5 min minimum hold period, with the addition of a separate test in the same manner, but with external pressure from the opposite side of annular seal as identified in Figure F.3. For extended-neck hangers, see Figure F.4. Also, test the bottom casing pack-off in the same manner at room temperature, one cycle for a 5 min minimum hold period. Hydrostatically test the ring-gasket pressure area for extended-neck hangers at the rated working pressure at room temperature, once for a 5 min minimum hold period.

If the manufacturer's pressure rating from below is different from the pressure rating above, perform a test at the appropriate pressure for each direction.

## F.2.23 Design validation for PR2 group 3 mandrel hangers

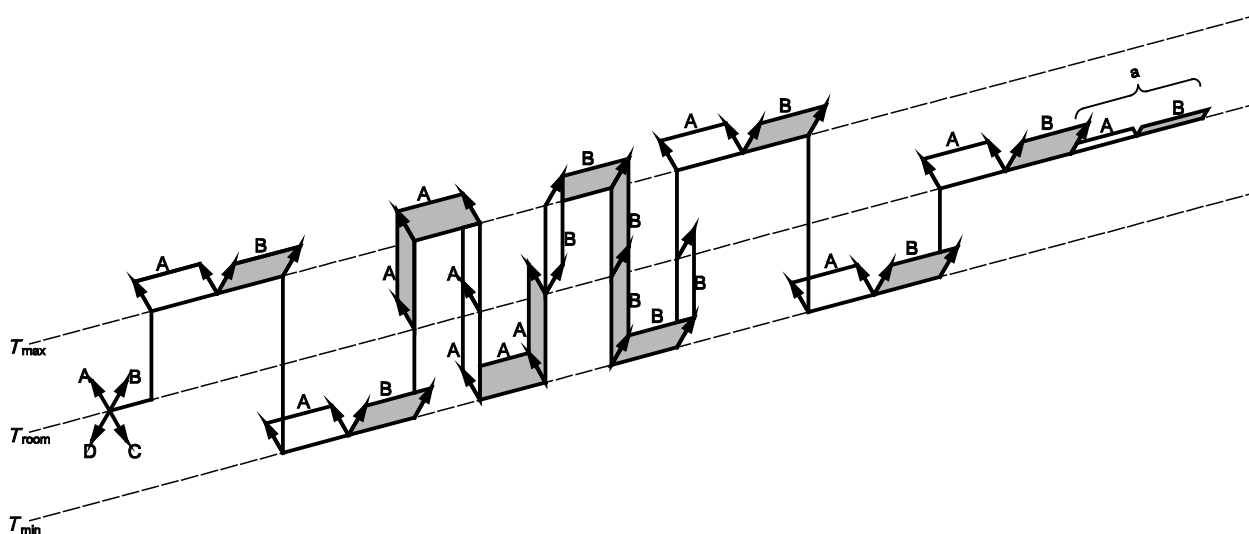
NOTE See Table F.16.

### F.2.23.1 Downhole control line

If downhole control-line or electric-cable preparations are included, they shall hold the rated working pressure and be subjected to the same testing requirements as the hanger.

### F.2.23.2 Pressure cycle

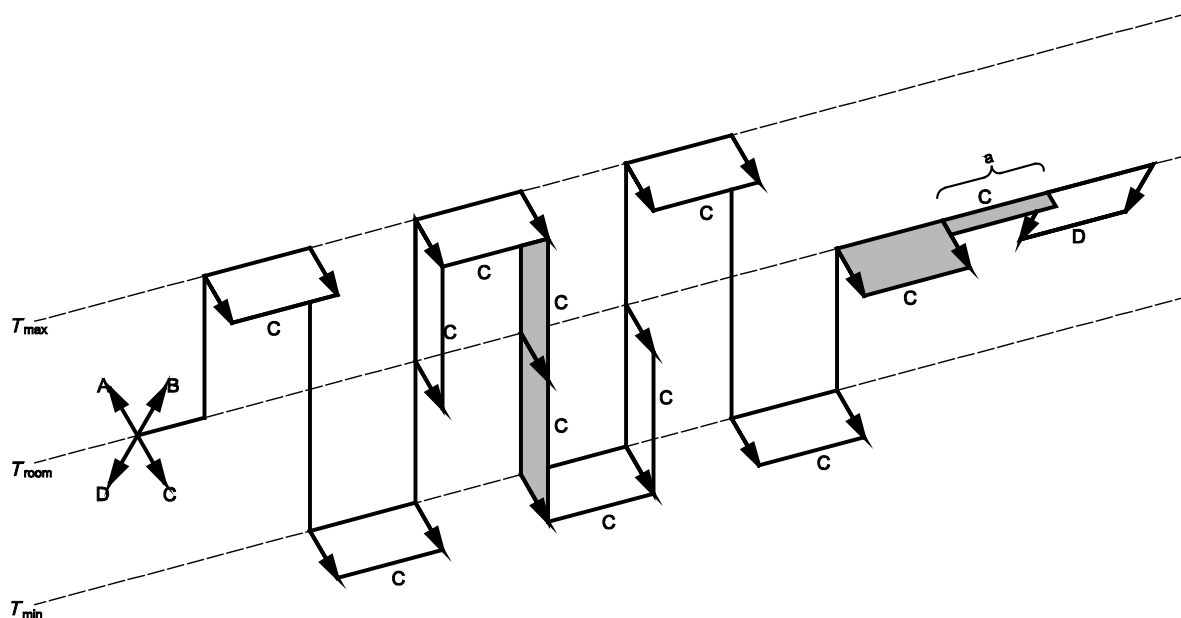
Validation testing is the same as for PR2 group 2 mandrel type hangers, with the addition of a separate test in the same manner, but with external pressure from the opposite side of the annular seal, as identified in Figure F.3. For extended-neck hangers, see Figure F.4. Also, test the bottom casing pack-off in the same manner from above. Hydrostatically test the ring-gasket pressure area for extended-neck hangers at the rated working pressure at room temperature, one time for a 5 min minimum hold period. Figures F.5, F.6, F.7 and F.8 show schematic representations of the pressure and temperature cycle test requirements.



a 5 % to 10 %.

NOTE Pressure directions A and B are shown in Figures F.3 and F.4.

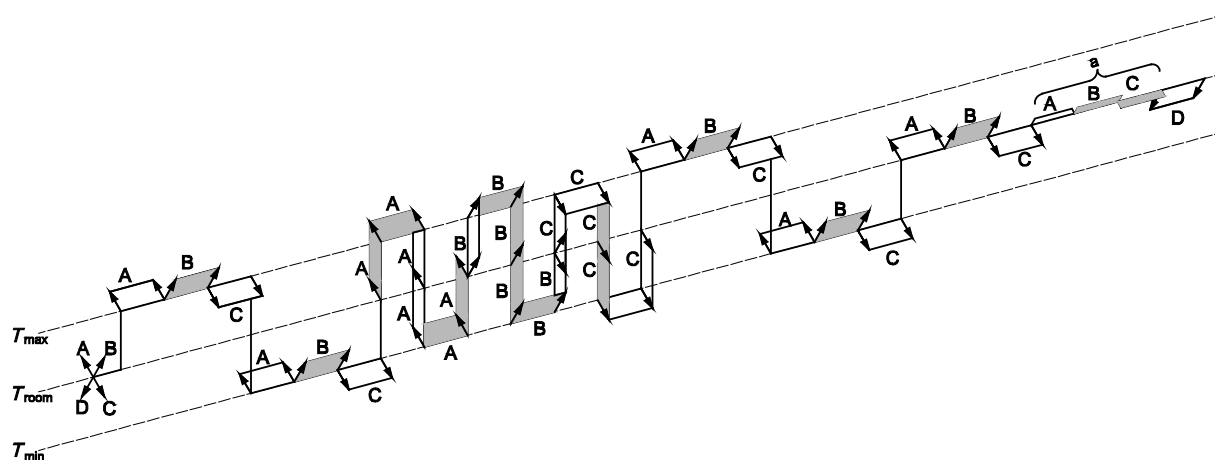
**Figure F.5 — Pressure/temperature cycles for group 3 slip and mandrel hangers without bottom casing pack-off**



a 5 % to 10 %.

NOTE Pressure directions C and D are shown in Figure F.4.

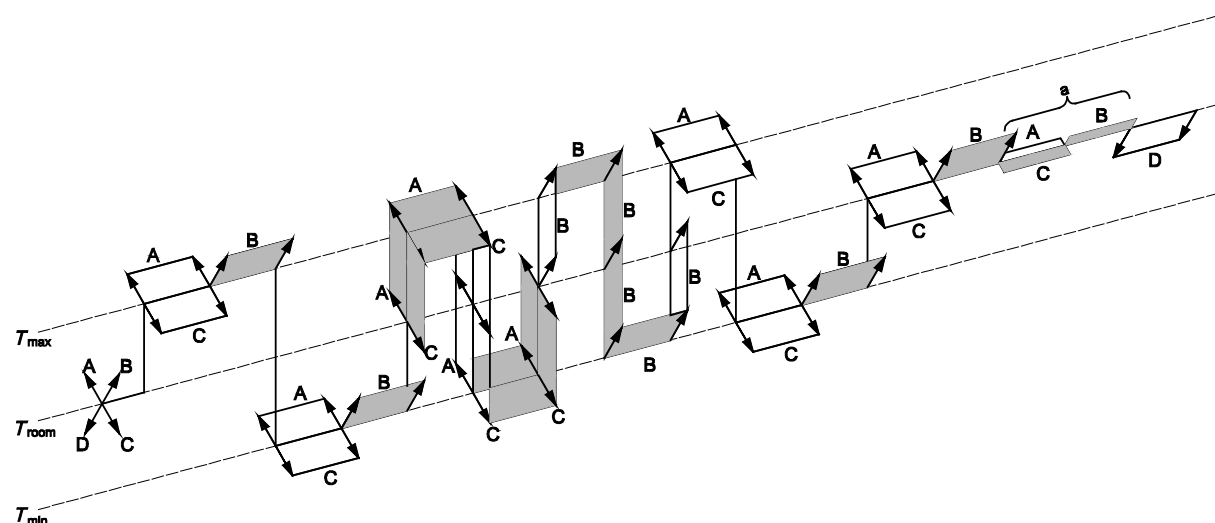
**Figure F.6 — Pressure/temperature cycles for group 3 slip and mandrel hangers with bottom casing pack-off tested separately**



a 5 % to 10 %.

NOTE Pressure directions A, B, C and D are shown in Figure F.4.

**Figure F.7 — Pressure/temperature cycles for group 3 slip and mandrel hangers with bottom casing pack-off tested concurrently**



a 5 % to 10 %.

NOTE Pressure directions A, B, C and D are shown in Figure F.4, with A and C tested together.

**Figure F.8 — Pressure/temperature cycles for group 3 slip and mandrel hangers with bottom casing pack-off tested concurrently**

### F.2.23.3 Internal pressure test

Internally pressure-test hangers as specified for PR2 group 1 mandrel hangers in F.2.19.1.

### F.2.23.4 Load cycling

Perform the load cycle test specified in F.2.11.

**F.2.24 Design validation for PR1 group 4 mandrel hangers**

NOTE See Table F.17.

Validation testing is the same as for PR1 group 3 hangers. Retention of the hanger shall be verified by objective evidence.

**F.2.25 Design validation for PR2 group 4 mandrel hangers**

NOTE See Table F.17.

**F.2.25.1 Pressure/temperature cycling**

Validation testing is the same as for PR2 group 3 hangers. Carry out three pressure/temperature cycles as specified in F.1.11 while the hanger is held in place by a retention feature.

**F.2.25.2 Internal pressure test**

Internally pressure-test hangers as specified for PR2 group 1 mandrel hangers in F.2.19.1.

**Table F.17 — Design validation for group 4 mandrel hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.25
Internal pressure test	1 cycle at room temperature and rated pressure	As specified in F.2.25
Thermal cycling seal(s)	Objective evidence	As specified in F.1.11 and F.2.25
Fluid compatibility	Objective evidence	As specified in F.1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.25
Pressure from above seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.25
Retention feature test by annular pressure	Objective evidence	As specified in F.1.11 and F.2.25 with the hanger held in place by a retention feature with minimum rated tubular load and maximum annular pressure from below only

**F.2.26 Design validation for PR1 group 5 mandrel hangers**

NOTE See Table F.18.

Validation testing is the same as for PR1 group 4 hangers, except for the test hanger retention feature with full blind annular pack-off load at room temperature with pressure from below. The preparations for back-pressure valves shall be satisfied by objective evidence.

**F.2.27 Design validation for PR2 group 5 mandrel hangers**

NOTE See Table F.18.

**F.2.27.1 Pressure/temperature cycling**

Validation testing is the same as for PR2 group 4 hangers, except for the test hanger retention feature with a full blind annular seal load as specified in F.1.11 with pressure from below. Independently pressure-test back-pressure valve preparation at room temperature to rated working pressure of the hanger, cycled from atmospheric to rated working pressure three times with 5 min minimum hold periods with the pressure applied against the lower end of the back-pressure valve preparation.

### F.2.27.2 Internal pressure test

Internally pressure-test hangers as specified for PR2 group 1 mandrel hangers in F.2.19.1.

**Table F.18 — Design validation for group 5 mandrel hangers**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.27
Internal pressure test	1 cycle at room temperature and rated pressure	As specified in F.2.27
Thermal cycling	Objective evidence	As specified in F.1.11 and F.2.27
Fluid compatibility	Objective evidence	As specified in F.1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.27
Pressure from above annular seal(s)	1 cycle at room temperature and rated pressure	As specified in F.1.11 and F.2.27
Retention feature test by full blind pressure	Objective evidence	As specified in F.1.11 and F.2.27 with the hanger held in place by a retention feature with minimum rated tubular load and maximum full blind pressure from below only
Back-pressure valve preparation test	Objective evidence	As specified in F.2.27

### F.2.28 Design validation for packing mechanisms for PR1 lock screws, alignment pins and retainer screws

NOTE See Table F.19.

The design validation of PR1 products shall be satisfied by objective evidence.

### F.2.29 Design validation for packing mechanisms for PR2 lock screws, alignment pins and retainer screws

NOTE See Table F.19.

Apply simulated maximum load at the manufacturer's recommended torque and then perform the pressure/temperature cycle test of F.1.11.

**Table F.19 — Design validation for packing mechanisms for lock screws, alignment pins and retainer screws**

PR level	PR1	PR2
Pressure and thermal cycling	Objective evidence	As specified in F.1.11
Operating force or torque	Objective evidence	Shall withstand manufacturer's rated force or torque as specified in F.2.29

### F.2.30 Design validation for PR1 group 1 tubing-head adapters

NOTE See Table F.20.

Pressure integrity shall be verified by objective evidence.

**Table F.20 — Design validation for group 1 tubing-head adapters**

PR level	PR1	PR2
Internal pressure integrity	Objective evidence	As specified in F.2.31

**F.2.31 Design validation for PR2 group 1 tubing-head adapters**

NOTE See Table F.20.

Design validation is achieved through production hydrostatic pressure testing as required for the PSL to which the equipment is manufactured, in lieu of the procedure of F.1.11; see 10.8.5.

**F.2.32 Design validation for PR1 group 2 tubing-head adapters**

NOTE See Table F.21.

**F.2.32.1 Load cycling**

Load cycling capacity shall be verified by objective evidence.

**F.2.32.2 Internal pressure test**

Design validation shall be in accordance with F.2.31.

**Table F.21 — Design validation for group 2 tubing-head adapters**

PR level	PR1	PR2
Load cycling	Objective evidence	As specified in F.2.33
Internal pressure test	As specified in F.2.8.2	As specified in F.2.33
Thermal cycling	Objective evidence	Objective evidence
Fluid compatibility	Objective evidence	Objective evidence

**F.2.33 Design validation for PR2 group 2 tubing-head adapters**

NOTE See Table F.21.

**F.2.33.1 Load cycling**

Perform the load cycle test as specified in F.2.11.

**F.2.33.2 Internal pressure test**

Perform the internal pressure test of the tubing head adaptor, including the end connections, as specified in F.2.31.

Perform one internal pressure test at room temperature with a hold period of 15 min at rated working pressure. Documentation for the end-connection pressure testing may be obtained from a thread manufacturer or appropriate international industry standard if the wellhead product meets the dimensional (including the connection outside diameter) and material strength requirements of that standard. If the product does not meet the thread manufacturer's dimensional and material strength requirements, then test the threaded connection. The test may be performed in a fixture separate from the hanger.

**F.2.34 Design validation for PR1 other end connectors**

NOTE See Table F.22.

PR1 connectors shall be verified by objective evidence.

**Table F.22 — Design validation for other end connectors**

PR level	PR1	PR2
Pressure and thermal cycles	Objective evidence	As specified in F.1.11
Bending moments	Objective evidence	Subject connector to manufacturer's rated load that produces the highest stress case for one cycle
Make-and-break	Objective evidence	Subject connector to manufacturer's rated make-and-break cycles (if applicable)
Fluid compatibility	Objective evidence	As specified in F.1.13

**F.2.35 Design validation for PR2 other end connectors**

NOTE See Table F.22.

**F.2.35.1 PR2 validation test**

Test the entire connector as specified in F.1.11.

**F.2.35.2 Make-and-break cycles**

Subject the connector to the manufacturer's rated make-and-break cycles independent of the test in F.2.35.1. Apply the working pressure to the connector for a 5 min hold period after each make-up of the connector.

**F.2.35.3 Bending moments**

Subject the connector to the manufacturer's rated load case for one cycle to the highest stress case determined for the connector, independent of the tests in F.2.35.1 and F.2.35.2.

**F.2.36 Design validation for PR1 fluid sampling devices**

NOTE See Table F.23.

PR1 fluid sampling devices shall be verified by objective evidence.

**Table F.23 — Performance validation for fluid sampling devices**

PR level	PR1	PR2
Pressure and temperature cycles	Objective evidence	As specified in F.1.11
Fluid compatibility	Objective evidence	As specified in F.1.13

**F.2.37 Design validation for PR2 fluid sampling devices**

NOTE See Table F.23.

Test the complete assembly as specified in F.1.11.

**F.2.38 Design validation for ring gaskets, bolting and other specified products**

Validation testing is not required for specified flanged or studded end and outlet connections, threaded end and outlet connections, studs and nuts, ring joint gaskets, bullplugs, tees and crosses, test and gauge connections, and other specified products that are completely specified (dimensions and materials) by this International Standard.

**F.2.39 Summary of product-specific design validation**

Table F.24 provides a summary of the product-specific cycle requirements.

**Table F.24 — Summary of product-specific design validation**

Component	Pressure cycling test <sup>a</sup> (Cycles)		Temperature cycling test <sup>a</sup> (Cycles)		Endurance cycling test <sup>a</sup> (Cycles)	
	PR1	PR2	PR1	PR2	PR1	PR2
Wellhead equipment						
Casing-head housings	Not required	3	Not required	3	Not required	3
Casing-head spools	Not required	3	Not required	3	Not required	3
Tubing-head spools	Not required	3	Not required	3	Not required	3
Cross-over spools	Not required	3	Not required	3	Not required	3
Multi-stage head housing & spools	Not required	3	Not required	3	Not required	3
Connectors and fittings						
Cross-over connectors	1	3	Not required	3	Not required	3
Tubing-head adapters	1	1	Not required	Not required	Not required	Not required
Top connectors	Not required	PMR <sup>b</sup>	Not required	PMR <sup>b</sup>	Not required	PMR <sup>b</sup>
Tees and crosses	Not required	3	Not required	3	Not required	Not required
Fluid sampling devices	Not required	3	Not required	3	Not required	Not required
Adapter and spacer spools	Not required	3	Not required	3	Not required	Not required
Casing and tubing hangers						
Mandrel hangers	1	3	Not required	3	Not required	3
Slip hangers	1	3	Not required	3	Not required	3
Valves and chokes						
Single valves	3	200	Not required	40	Not required	200
Multiple valves	3	200	Not required	40	Not required	200
Actuated valves	3	200	Not required	40	Not required	200
Valves prepared for actuators	3	200	Not required	40	Not required	200
Check valves	3	200	Not required	40	Not required	200
Chokes	1	200	Not required	40	Not required	200
SSV and USV	3	200	Not required	40	Not required	200
Back-pressure valves	Not required	PMR <sup>b</sup>	Not required	PMR <sup>b</sup>	Not required	PMR <sup>b</sup>
Other loose connectors						
Weld neck connectors	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Blind connectors	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Threaded connectors	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Adapter and spacer connectors	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Bullplugs and valve-removal plugs	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Other equipment						
Wear bushings	N/A	Not required	N/A	Not required	N/A	Not required
Actuators	3	200	Not required	40	Not required	200
Ring gaskets	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>
Running and testing tools	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>	N/A	PMR <sup>b</sup>

NOTE 1 Design validation testing is not required for specified designs or features that are completely specified (dimensions and material strength) in this International Standard.

NOTE 2 This table is for reference information only. All requirements are in the text and associated tables.

<sup>a</sup> Pressure cycles, temperature cycles, and endurance cycles are run as specified in the text and are not cumulative.

<sup>b</sup> As per manufacturer's rating (PMR).

## Annex G (informative)

### Design and rating of equipment for use at elevated temperatures

#### G.1 General

In accordance with 4.2.2.2, the design of equipment for operating temperatures above 121 °C (250 °F) shall take into consideration the effects of temperature on material strength. This annex provides two methods that may be used for the design and rating of equipment for use at elevated temperatures. The first is to derate the working pressure of the equipment at the elevated temperature to a pressure less than the room-temperature full-rated working pressure of the equipment. The second is to design the equipment for full-rated pressure at the elevated temperature.

**NOTE** Data on the performance of flanged end connections, as specified in this International Standard, at elevated temperatures are available in API TR 6AF1.

**CAUTION** — Annex G is not intended as a material selection guide for high-temperature use. Some alloys are embrittled after repeated or prolonged exposure to elevated temperatures. Care should be used in selection of alloys for these ratings. If plated or coated materials are used at temperatures greater than 180 °C (350 °F), the cracking potential can be increased.

#### G.2 Elevated temperature ratings

The temperature ratings given in Table G.1 may be used for equipment for service temperatures in excess of those covered by Clause 4.

**Table G.1 — Temperature ratings**

Classification	Operating temperature range	
	°C	°F
X	– 18 to 180	0 to 350
Y	– 18 to 345	0 to 650

#### G.3 Pressure-temperature derating

The rated working pressure of equipment may be derated for temperature ratings X and Y. Derated equipment shall be marked in accordance with G.4. The derated temperatures and pressures of Table G.2 may be used for equipment with 6B flanges. Alternative derated pressures may be used for other end connectors, or for flanges specified in this International Standard based on the data of API TR 6AF1.

**Table G.2 — Optional pressure-temperature ratings for 6B flanges**

Pressure rating for classes K to U	Derated pressure	
	Class X	Class Y
MPa (psi)	MPa (psi)	MPa (psi)
13,8 (2 000)	13,1 (1 905)	9,9 (1 430)
20,7 (3 000)	19,7 (2 860)	14,8 (2 145)
34,5 (5 000)	32,8 (4 765)	24,7 (3 575)
<b>NOTE</b> See Table G.1 for temperature ratings.		

## G.4 Marking of derated equipment

In addition to the marking requirements of Clause 8, equipment supplied for temperature classifications X and Y which is derated shall have the derated working pressure for the applicable maximum temperature marked on the equipment.

## G.5 Design of equipment for use at elevated temperature

### G.5.1 General

It has been demonstrated that some flanges specified in this International Standard are capable of being used at full working pressure at elevated temperatures. In addition, some other end connectors are capable of being used at full-rated pressure at elevated temperature. One purpose of this annex is to provide rules for the design of equipment for operation at full-rated working pressure at elevated temperature.

A second purpose of this annex is to provide rules for the design of derated equipment for use at elevated temperatures.

### G.5.2 Procedure

#### G.5.2.1 General

**G.5.2.1.1** Derated equipment may be designed in accordance with the rules of 4.3.3.2 (ASME method), extended to include high-temperature cases as follows.

There is no change to the rules of design for hydrostatic test conditions, since hydrostatic testing is carried out at room temperature.

**G.5.2.1.2** For the operating conditions that include rated pressure and loading at rated temperature, an  $S_m$  value may be used equal to two-thirds of a derated material yield strength,  $S_e$ , at rated temperature. Derated yield strength may be determined by one of the methods given in G.5.2.2 or G.5.2.3.

For non-standard materials, an  $S_m$  value may be used that is the lower of two-thirds of the elevated-temperature yield strength, one-half the minimum specified tensile strength, or 0,55 times the elevated-temperature tensile strength.

Elevated-temperature tensile strength shall be determined in the same manner as the elevated-temperature yield strength.

#### G.5.2.2 Testing at elevated temperature

##### G.5.2.2.1 QTC testing

$S_e$  at temperature shall be the minimum measured yield strength of the material tested at the rated temperature of the equipment. The room-temperature mechanical properties of the material shall equal or exceed the minimum requirements for the strength class of Table 6. The elevated-temperature tensile test(s) shall be performed on specimens removed from the same QTC used for room-temperature tensile testing. At least one elevated-temperature tensile test shall be performed at the rated temperature of the equipment, using the methods of ASTM E21 or equivalent methods.

If the elevated-temperature yield strength,  $E_{ty}$ , meets or exceeds the minimum specified room-temperature yield strength,  $S_{my}$ , of Table 6, then  $S_{my}$  may be used as  $S_e$  for the design. If the  $E_{ty}$  is less than the  $S_{my}$ , then a value no greater than  $E_{ty}$  shall be used as  $S_e$  for the design.

If the elevated-temperature test fails to meet the above requirements on the first attempt, two additional tensile tests may be performed in an effort to qualify the material. The results of each of these tests shall satisfy the required yield strength.

### G.5.2.2.2 Material grade qualification testing

$S_e$  at temperature shall be minimum yield strength of the material strength class of Table 6, reduced by the amount of derating of yield strength at the elevated temperature compared to the measured yield strength at room temperature.

Qualification testing shall be performed on a minimum of five heats of the material grade (same UNS alloy number or individual material composition and same heat-treat condition) for a particular strength class at elevated temperature and at room temperature. In addition, the room-temperature and elevated-temperature tensile specimens shall be obtained from the same QTC for a particular heat. The yield strength values,  $E_{ty}$  and  $R_{ty}$ , shall each be averaged for use in determining the amount of yield derating at a particular temperature.

The yield reduction ratio at temperature,  $Y_r$ , shall be calculated as given in Equation (G.1):

$$Y_r = \frac{E_{ty}}{R_{ty}} \quad (G.1)$$

where

$R_{ty}$  is the room-temperature yield strength (measured, 5 heats minimum);

$E_{ty}$  is the elevated-temperature yield strength (measured, 5 heats minimum).

The elevated-temperature yield strength,  $S_e$ , is then calculated as given in Equation (G.2):

$$S_e = Y_r S_y \quad (G.2)$$

where  $S_y$  is the minimum specified room-temperature yield strength for the material.

The elevated-temperature tensile data along with the room-temperature data for the material grade shall be contained in a material qualification file for each material grade and it is not necessary that this test be performed on a heat-lot basis.

### G.5.2.3 Reference sources

#### G.5.2.3.1 API TR 6AF1

The material may be derated using the derating factors,  $Y_r$ , shown in Table G.3, which, in part, are taken from API TR 6AF1, Table 1.

**Table G.3 — Optional material derating factors for elevated temperature**

Material	Derating factor $Y_r$	
	180 °C (350 °F)	345 °C (650 °F)
Carbon and low-alloy steels	0,85	0,75
Martensitic, ferritic and precipitation-hardened stainless steels	0,85	0,75
Austenitic and duplex stainless steels	0,80	0,73
Corrosion-resistant alloys (CRAs)	0,95	0,85
<b>CAUTION — This table does not constitute a recommendation of the use of any particular alloy at high temperature. Some materials are embrittled after repeated or prolonged exposure to elevated temperatures. Care should be taken when choosing a material for use at temperatures permitted by temperature classifications X and Y in Table G.1.</b>		

**G.5.2.3.2 ASME Boiler and Pressure Vessel Code**

$S_e$  can be found for some materials in ASME, BPVC:2004 with 2005 and 2006 addenda, Section II, Part D, Table Y-1.

**G.5.2.3.3 Other data**

The material may be derated using the derating factors,  $Y_r$ , shown in Table G.4, which are taken from a study conducted by the Association of Wellhead Equipment Manufacturers.

**Table G.4 — Optional material derating factors for elevated temperature**

Material	Derating factor $Y_r$			Comment
	149 °C (300 °F)	177 °C (350 °F)	204 °C (400 °F)	
25 Cr super duplex	0,81	0,78	0,73	(section size affects hardenability)
718 (as per API Spec 6A 718) (UNS N07718)	0,94	0,93	0,91	
925 (UNS N09925)	0,92	0,92	0,90	
AISI 4130	0,91	0,90	0,88	
AISI 8630	0,92	0,90	0,87	
2-1/4 Cr 1 Mo (UNS K21590)	0,92	0,91	0,89	
AISI 4140	0,92	0,90	0,88	
AISI 410 SS (UNS S41000)	0,91	0,90	0,88	
F6NM (UNS S42400)	0,92	0,91	0,88	
725/625 Plus (UNS N07725 and UNS N07716)	0,93	0,92	0,89	
<b>CAUTION — This table does not constitute a recommendation of the use of any particular alloy at high temperature. Some materials are embrittled after repeated or prolonged exposure to elevated temperatures. Care should be taken when choosing a material for use at temperatures permitted by temperature classifications X and Y in Table G.1.</b>				

## **Annex H**

### **(normative)**

## **Design and manufacture of surface wellhead running, retrieving and testing tools, clean-out tools and wear bushings**

### **H.1 General**

This annex addresses the design, materials selection, manufacture and testing of all tools and equipment for running, retrieving and testing of wellhead components, including wear bushings.

### **H.2 Design**

#### **H.2.1 General**

The equipment manufactured in accordance with this annex shall meet the design requirements of 4.3.5.

#### **H.2.2 Loads**

As a minimum, the following loads or combination of loads shall be considered when designing the running, retrieving, clean-out and testing tools:

- suspended loads, including overpull;
- bending loads;
- pressure;
- torsional loads, including the required make-up torque of shouldered connections;
- radial loads;
- environmental loads.

#### **H.2.3 End connections**

Tooljoints or rotary shouldered connections shall be in accordance with all requirements of API Spec 7:2001, sections 6 or 10. They shall be an integral part of the tool and not to be connected by welding. There shall be adequate space for elevator and rotary slips. The load capacity of the tool shall not be inferred by the choice of the end connection of the tool, and if this is the case, this should be documented. Attachments welded to tools are allowed if in accordance with 6.2. Threads shall be gauged in accordance with API Spec 7:2001, section 11.

Casing or tubing threads shall be in accordance with API Spec 5B or, in case of proprietary connections, according to licensed drawings, including provision for tonging and elevator space.

Torque-operated tools should preferably be threaded left-hand for make-up and right-hand for release to prevent inadvertently backing off of casing/tubing/drillpipe connections during operation/disconnection. Left-hand threads shall be clearly marked and can be required for tubing running tools for backing out of a permanent production packer.

## **H.2.4 Vertical bore**

If tools have a vertical bore in order to make circulation possible, the drift diameter of the bore should, as a minimum, be equal to the drift size for the specified tooljoint or, in case internal profiles are used, according to manufacturer's written drift specifications.

The wear bushings shall have an ID in accordance with Table 80\*.

## **H.2.5 Outside profile**

The outside profile of the tools shall be in accordance with the manufacturer's written specification. If possible, the outside profile should be designed to ensure alignment, if needed, and to minimize the risk of hanging up in blow-out preventer cavities. The OD and length of the connections shall, however, be in accordance with H.2.3.

## **H.2.6 Pressure rating**

The pressure rating of the tool shall, if applicable, be in accordance with the manufacturer's written specification.

# **H.3 Materials**

## **H.3.1 General**

All tools and parts thereof shall require a written material specification that shall define the following, along with accept/reject criteria:

- mechanical property requirements;
- material qualification;
- heat-treatment procedure, including cycle time and temperatures with tolerances;
- material composition with tolerances;
- NDE requirements;
- allowable melting practice(s);
- hot-working practice(s);
- cooling media when heat treating.

Running tools shall be fabricated from materials that meet the applicable property requirements as specified by the manufacturer.

## **H.3.2 Additional requirements**

### **H.3.2.1 General**

H.3.2 to H.3.4 apply only to major load-bearing tools, such as casing and tubing running tools, cup-type tester and seal assembly setting tools required to transmit torque that is higher than 50 % of the make-up torque of the tool.

### H.3.2.2 Heat treatment

Heat treatment shall be performed in accordance with the manufacturer's written specification. This specification shall contain all necessary information to perform the heat treatment of each selected material or part in order to obtain the required mechanical properties.

### H.3.2.3 Chemical composition

**H.3.2.3.1** Materials shall conform to the manufacturer's written specification.

**H.3.2.3.2** The manufacturer shall specify the nominal chemical composition, including the composition tolerances, of the material.

**H.3.2.3.3** The material composition shall be determined on a heat basis (or a remelt ingot basis for remelt grade materials) in accordance with an International Standard specified by the manufacturer.

### H.3.2.4 Material qualification

#### H.3.2.4.1 QTC

The QTC for a running tool shall be a full section prolongation. The prolongation may be heat-treated either attached or separated from the running tools it represents. The prolongation shall be sufficiently long to ensure that mechanical test specimens (see H.3.2.4.3) can be taken at least  $\frac{1}{4} T$  (where  $T$  is the heaviest cross-section of the prolongation) from the nearest heat-treated surface.

If a running tool is preheat-machined to different diameters, the prolongation shall be taken from the end having the largest diameter.

#### H.3.2.4.2 Qualification lot

The QTC shall represent identical running tools that are from the same heat and heat-treated together in the same furnace at the same time (heat per heat-treat-lot testing). An attached prolongation, if used, shall remain attached to a production running tool throughout heat treatment, except for re-tempering or re-ageing cycles when required.

#### H.3.2.4.3 Mechanical testing

A minimum of one tensile test and three Charpy V-notch tests shall be performed on each QTC. Full-size specimens shall be used. Testing shall be carried out in accordance with ISO 148 (all parts) or ASTM A370. Impact test temperature shall be no higher than the lowest anticipated service temperature.

The following apply.

- a) Test specimens shall be removed from the QTC such that the tensile specimen gauge length and the Charpy V-notch root are at least  $\frac{1}{4} T$  from the "as-heat-treated" ends of the QTC ( $T$  is the heaviest cross-section of the prolongation). The longitudinal axis of the tensile and Charpy specimens shall be taken within the centre  $\frac{1}{4} T$  envelope for solid QTCs or within 3 mm ( $\frac{1}{8}$  in) of the midwall for hollow QTCs.
- b) Hardness testing shall be carried out as specified by the manufacturer.

### H.3.3 Mechanical property requirements

In case the running tools are used to run casing or tubing, or are required to transmit high torque, or can be heavily loaded because of test pressures, the mechanical properties of the tool shall be as specified in Table H.1.

**Table H.1 — Mechanical properties of tools**

<b>Minimum 0,2 % offset yield strength</b> MPa (psi)	<b>Minimum elongation</b> %	<b>Brinell hardness</b> HBW	<b>Charpy V-notch minimum impact requirement</b>
690 (100 000)	13	260 to 321	42 J at – 20 °C (31 ft·lb at – 4 °F)

Lower-yield-strength materials may be used if it can be demonstrated that the running tool is at least as strong as the hanger. The material requirements for wear bushings shall comply with the manufacturer's written specification; however, the hardness should be between 241 HBW and 321 HBW. Impact testing is not required for wear bushing material. The ratio of yield strength to tensile strength shall not exceed 0,90.

### H.3.4 Coatings

The rotary connections of the tools shall be coated with an anti-galling agent.

## H.4 Testing

### H.4.1 Factory acceptance testing

All tools shall, as far as reasonably possible, be functionally tested and dimensionally inspected or gauged to confirm their correct operation prior to shipment from the manufacturer's facility. Tools with hydraulic operating systems shall have the hydraulic system tested in accordance with the manufacturer's written specification. This hydrostatic test shall consist of three steps:

- a primary pressure-holding period;
- a reduction of the pressure to zero (atmospheric pressure);
- a secondary pressure-holding period.

Each holding period shall not be less than 15 min; the timing shall not start until the external surfaces of the body members have been thoroughly dried, the test pressure has been reached and the equipment and the pressure-monitoring gauge have been isolated from the pressure source.

## H.5 Marking

All tools should be marked "ISO 10423" and also as indicated in ISO 10424-1:2004, 5.6, below the tooljoint tong space, as a minimum. Wear bushings shall be marked "ISO 10423" followed by the drift internal diameter, expressed in millimetres and inches. A unique serial number shall be die-fixed to each tool assembly, preferably in a milled recess.

## H.6 Quality control and record requirements

The quality control requirements shall be in accordance with documented requirements of the manufacturer and as indicated in 7.5.1 and 7.5.2.1 b). Product specification levels are not applicable to tools.

## H.7 Storing and shipping

In addition to the requirements of Clause 9, outside threads shall be protected by a proper storage compound and a metal pressed thread protector or equivalent.

## **Annex I**

### **(normative)**

## **Design validation procedures for surface safety valves and underwater safety valves**

### **I.1 General**

#### **I.1.1 Purpose**

Annex I provides requirements to

- a) validate that a valve designed and manufactured to satisfy the PR2 requirements of 10.5 may be used as a surface safety/underwater safety (SSV/USV) valve according to one or both of the following classes:
  - 1) Class I: This performance requirement level is intended for use on wells that do not exhibit the detrimental effects of sand erosion.
  - 2) Class II: This performance requirement level is intended for use if a substance such as sand can be expected to cause an SSV/USV valve failure.
- b) demonstrate that the design validation testing covered by this annex qualifies specific valve-bore sealing mechanisms that are manufactured in accordance with this International Standard for class II valves.

#### **I.1.2 Performance requirements**

To qualify a specific SSV/USV design for class I or II, the manufacturer shall test an SSV/USV of the same basic design and materials of construction, tested in accordance with the PR2 and PSL 2 requirements of this International Standard.

To qualify an SSV/USV for class I service, the valve shall pass the design validation test specified in I.3.

To qualify an SSV/USV for class II service, the valve shall pass the design validation test specified in I.4.

A valve qualified for class II also satisfies the requirements of class I.

#### **I.1.3 Design validation testing**

The design validation testing requirements in this annex are not represented as duplicating actual well conditions. Validation tests that have been completed in accordance with the validation testing requirements of API Spec 14D or API Spec 6AV1, during their validity, satisfy the requirements of this annex.

#### **I.1.4 Design validation test requirements**

A flanged nominal 2  $\frac{1}{16}$ , 52 mm 34,5 MPa (5 000 psi) rated working pressure SSV/USV valve shall be used for the qualifying test. The valve being tested shall be hydrostatically and functionally tested in accordance with 7.4.9 and meet the requirements of PR2 in accordance with 10.5.2. The successful completion of the test shall qualify all sizes and all pressure ratings of that manufacturer's SSV/USV of the same basic design and materials of construction for class I service. Any significant change in the design or materials of construction that can affect the SSV/USV valve-bore sealing mechanism shall require requalification by validation testing.

**NOTE** The requirements of I.1.4 are derived from API Spec 6AV1. However, API Spec 6AV1 also includes an additional requirement that all Class II valves of the same basic design and materials of construction be validated when a qualifying test is completed. It is intended that I.1.4 will be fully aligned with API Spec 6AV1 in the future.

### I.1.5 Documentation

The manufacturer is required to maintain a file on each test, including any retest that was required to qualify a particular SSV/USV design and materials of construction. As a minimum, this file shall contain sufficient documentation to satisfy F.1.15 and shall be retained for 10 years after a design has been discontinued.

### I.1.6 Test-equipment calibration requirement

Test-equipment calibration requirements shall satisfy the requirements of F.1.16.

Pressure-measuring devices shall meet the requirements of 7.2.2.

### I.1.7 Heat-sensitive lock-open devices

The manufacturer shall have data available to show that the heat-sensitive lock-open device has been sufficiently tested to ensure that it is capable of satisfying the design requirements of 10.20.2.5.

## I.2 General requirements for a class I or II for SSV/USV validation test facility

### I.2.1 General

The typical piping arrangement and test section detail of a test facility for class II SSV/USV design validation testing are shown in Figures I.2 and I.3.

### I.2.2 Design considerations

The following apply.

- a) The test facility shall be designed to permit the validation tests to be made as detailed in I.3 and I.4.
- b) The circulation piping shall be of sufficient working-pressure rating to withstand the circulation pressure. The test-section upstream isolation valve and the pressure-measuring devices, valves, and fittings between it and the SSV/USV valve being tested, shall be designed for a working pressure of at least that of the valve being tested. Components of lower pressure ratings shall be protected with appropriate pressure-relief valves.

### I.2.3 Apparatus — Circulation system components

**I.2.3.1 Freshwater tank**, with a minimum capacity of 1 m<sup>3</sup> and equipped with a low level pump shutdown control.

**I.2.3.2 Sand slurry tank and associated accessories**, consisting of a cylindrical, cone-bottom sand slurry tank with a minimum capacity of 1 m<sup>3</sup>, equipped with an agitation device as required to obtain proper slurry consistency.

Sample connections shall be provided in the tank and in the return line to the tank so that representative samples for sand content and viscosity analyses can be taken. High- and low-level shutdowns shall be provided in the tank to signal shutdown of the circulating pumps. Viscosity and sand content shall be determined in accordance with ISO 10414-1.

**I.2.3.3 Circulating pumps with drivers and controls**, for pumping the sand slurry and freshwater at the required flow rates and pressures.

At least one pump shall be provided with a variable-speed motor for circulation flow rate control. Each pump motor shall be provided with a non-resettable elapsed-time meter to monitor pumping duration.

**I.2.3.4 Circulation piping and controls**, installed in an arrangement similar to that shown in Figure I.2.

Block valves shall be provided as indicated in Figure I.3. The return piping to the sand slurry tank shall be installed in such a manner as to provide agitation to aid in preventing sand accumulation in the bottom of the tank. A choke or other suitable means for back-pressure control shall be installed between the circulation pumps and test section as shown in Figure I.3, and shall be used to control SSV/USV differential pressure to 2,8 MPa (400 psi) during the cycling test.

**I.2.3.5 Circulation flow meter**, covering a minimum flow rate of 0,3 m<sup>3</sup>/min (77 US gpm) and providing an output signal suitable for strip chart recording.

**I.2.3.6 Recording instruments**, provided to monitor the following data:

- circulation flow rate during all flow testing;
- SSV/USV valve upstream test pressure during valve seat leakage test;
- differential pressure across the SSV/USV valve being tested during closure test.

Recorders shall be of appropriate ranges and equipped with variable chart speeds to allow resolution of time-varying analogue signals. Other time-based recording technologies may be applied with appropriate documentation and when approved by qualified personnel.

### **I.3 Class I SSV/USV valve-design validation testing — Test procedure**

The following is a general procedure that is intended to show the limits and extent of the class I service SSV/USV design validation test.

- a) Install the SSV/USV in the test section of a fluid circulating system, as depicted in Figures I.2 and I.3.
- b) Seat-test the SSV/USV for pressure integrity at the rated working pressure using fresh water and at 13,8 MPa (2 000 psi) using nitrogen. No leakage shall be allowed after a 3 min stabilization period.
- c) Circulate water or other suitable fluid through the SSV/USV with the SSV/USV in a fully open position for a 50 h period. At the end of this period, repeat the SSV/USV seat test of I.3 b). No leakage shall be allowed after a 3 min stabilization period.
- d) Circulate water or other suitable fluid through the SSV/USV while cycling the SSV/USV from the fully open to the fully closed position. The differential pressure across the SSV/USV seat shall increase to approximately 2,8 MPa (400 psi) on each SSV/USV closure. Following 500 cycles of operation, repeat the SSV/USV seat test of I.3 b). No leakage shall be allowed after a 3 min stabilization period. During this phase of testing, perform the normal preventive maintenance procedures, if any are prescribed in the manufacturer's operating manual, except that no preventive maintenance shall be allowed during the last 100 cycles of operation in the test. The SSV/USV shall show no visible leakage during each holding period. Record the test pressure reading and the time at the beginning and end of the pressure-holding periods.

### **I.4 Class II SSV/USV design validation testing**

#### **I.4.1 General**

To qualify a specific SSV/USV design for class II, the manufacturer shall test an SSV/USV of the same basic design and materials of construction tested in accordance with the PR2 and PSL 2 requirements of this International Standard.

#### **I.4.2 SSV/USV valve-seat-leakage test procedure for class II SSV/USV services**

Carry out the following procedure and record results on the form given as Figure I.1.

- a) Step 1: Install SSV/USV in the test section.
- b) Step 2: Check SSV/USV for leakage with freshwater.
  - 1) Circulate freshwater at a minimum flow rate of 0,30 m<sup>3</sup>/min (77 US gpm) for at least 10 min with the SSV/USV fully open.
  - 2) Close SSV/USV by releasing actuator power.
  - 3) Close isolation valves upstream and downstream from SSV/USV.
  - 4) Open downstream liquid leak detection valve.
  - 5) Apply water pressure upstream of the SSV/USV at between 95 % and 105 % of the rated working pressure of the SSV/USV.
  - 6) After the pressure has stabilized for at least 3 min, check for SSV/USV valve-seat-leakage from the downstream leak-detection valve for a period of at least 5 min. No leakage is allowed.
- c) Step 3: Check SSV/USV for leakage with nitrogen pressure.
  - 1) Close upstream and downstream block valves.
  - 2) Bleed all pressure and drain water on both sides of the SSV/USV. (Open and close SSV/USV valve three times while draining water.)
  - 3) Close SSV/USV.
  - 4) With bleed valve open, immerse the end of a flexible tube connected thereto in a container of water.
  - 5) Apply nitrogen at 13,8 MPa  $\pm$  0,69 MPa (2 000 psi  $\pm$  100 psi) on the upstream side of the SSV/USV.
  - 6) After the pressure has stabilized for at least 3 min, check for valve seat leakage by observing for gas bubbles for a period of at least 5 min. No leakage is allowed.

### I.4.3 Sand slurry flow test procedure for class II SSV/USV services

Carry out the following procedure and record results using the form in Figure I.1.

Step 1: Circulate sand slurry at a minimum flow rate of 0,30 m<sup>3</sup>/min (77 US gpm) while bypassing the test section until the slurry viscosity and sand content stabilize with slurry agitator on.

Step 2: Determine the sand content of the slurry in accordance with ISO 10414-1. Adjust sand content of the circulating fluid to (2  $\pm$  0,5) % by adding 40 US to 60 US mesh sand or diluting mixture with fresh water.

Step 3: Determine viscosity of sand-slurry sample with Marsh funnel viscometer in accordance with ISO 10414-1. Adjust viscosity to  $\left(100^{+20}_{-10}\right)$  Pa  $\cdot$  s by adding viscosifier or diluting mixture with freshwater.

Step 4: If dilution or strengthening was necessary in step 3, return to step 1 of the procedure.

Step 5: Adjust flow rate to a minimum of 0,30 m<sup>3</sup>/min. Record flow rate, sand percentage and viscosity.

Step 6: Pump sand slurry through SSV/USV for 25 h  $\pm$  1 h.

Step 7: Check sand content and viscosity of the slurry as before in steps 2 and 3. Adjust as required.

Step 8: Pump sand slurry through SSV/USV for an additional 25 h  $\pm$  1 h at a minimum flow rate of 0,30 m<sup>3</sup>/min (77 US gpm).

Step 9: Check for leakage with fresh water using the procedure in I.4.2 b).

Step 10: Check for leakage with nitrogen using the procedure in I.4.2 c).

#### **I.4.4 Test for sand slurry flow while valve cycling during circulation for class II SSV/USV services**

Carry out the following procedure and record results using the form in Figure I.1.

Step 1: Circulate sand slurry at a minimum flow rate of 0,30 m<sup>3</sup>/min (77 US gpm) while bypassing the test section with slurry agitator on.

Step 2: See step 2 of I.4.3.

Step 3: See step 3 of I.4.3.

Step 4: See step 4 of I.4.3.

Step 5: See step 5 of I.4.3.

Step 6: Cycle SSV/USV valve from fully open to fully closed at a maximum rate of 7 cycles per minute.

Step 7: Adjust choke for equivalent upstream from SSV/USV valve to provide a differential pressure of 2,8 MPa (400 psi)  $\pm$  10 % across the SSV/USV valve when closed.

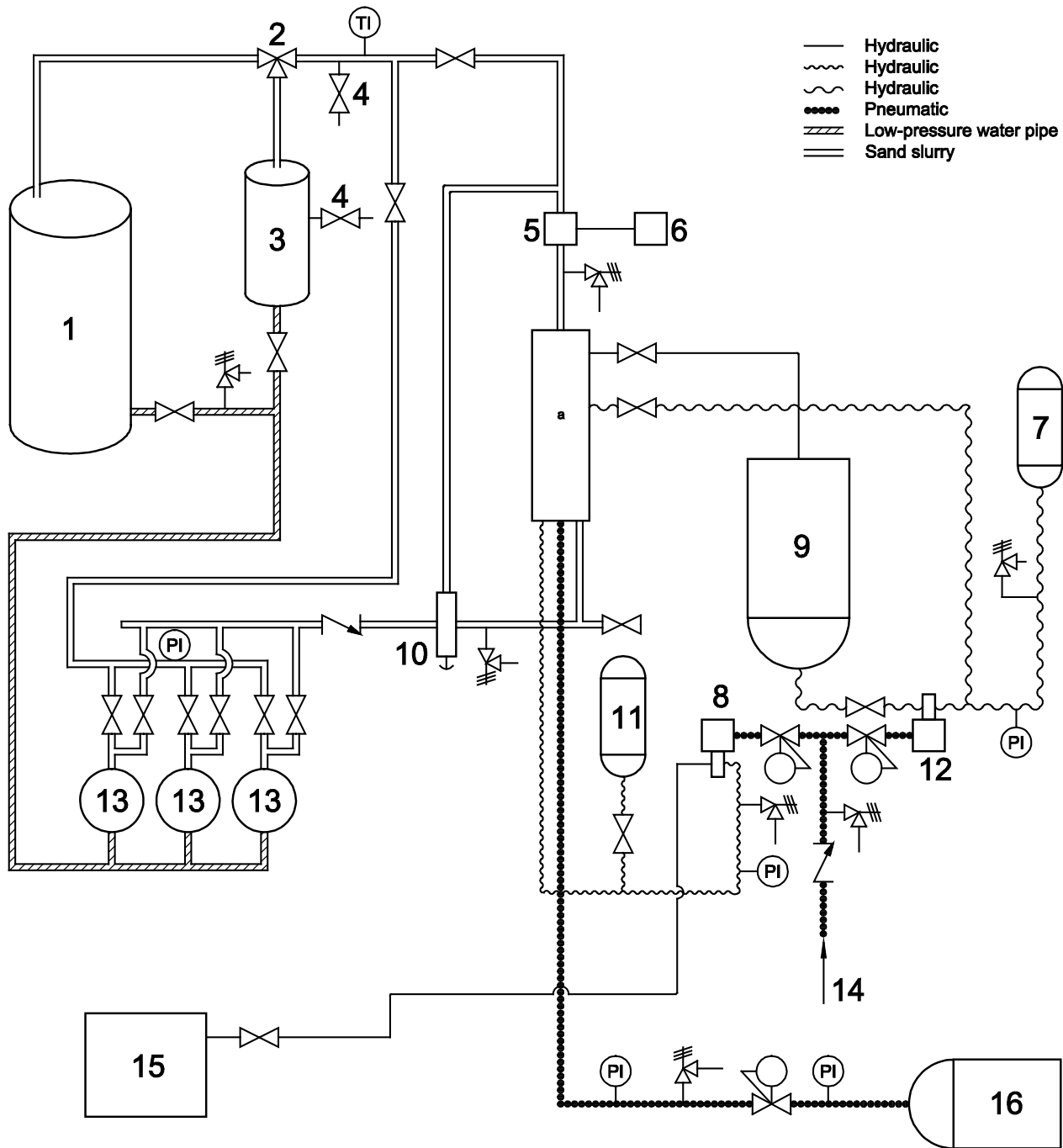
Step 8: Carry out 500  $^{+10}_0$  opening/closing cycles of the SSV/USV.

Step 9: See step 9 of I.4.3.

Step 10: See step 10 of I.4.3.

Example of a class II SSV/USV valve test form							
Test report number _____							
I. Tested SSV/USV valve and SSV/USV actuator design validation							
	Manufacturer	Manufacturer's contact	Model	Serial No.	Size	Working pressure	
SSV/USV valve		_____	_____	_____	_____	_____	
SSV/USV actuator		_____	_____	_____	_____	_____	
II. Initial SSV/USV valve seat leakage test (see I.4.1.)			Date	_____	Time	_____	
Test performed by _____							
1. Freshwater SSV/USV valve seat leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
2. Nitrogen leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
III. Sand slurry flow test (see I.4.2)			Date	_____	Time	_____	
Test performed by _____							
1. _____ rate of sand slurry circulation.							
2. _____ % by volume of the 40-60 mesh fraction sand in circulating sand slurry.							
3. _____ seconds. Viscosity determined by Marsh funnel viscometer.							
4. _____ slurry temperature.							
5. _____ hours of sand slurry circulation.							
6.a) Freshwater SSV/USV valve seat leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
6.b) Nitrogen leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
IV. Sand slurry flow test while opening and closing during circulation (see I.4.3)							
Date		_____	Time		_____		
Test performed by _____							
1. _____ rate of sand slurry circulation.							
2. _____ % by volume of the 40-60 mesh fraction sand in circulating sand slurry.							
3. _____ seconds. Viscosity determined by Marsh funnel viscometer.							
4. _____ slurry temperature.							
5. _____ differential pressure across SSV/USV valve when opened.							
6. _____ seconds, time for one complete cycle.							
7. _____ number of SSV/USV cycles.							
8.a) Freshwater SSV/USV valve seat leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
8.b) Nitrogen leakage test							
	Test pressure	_____	Leaked	Yes	_____	No	_____
9.a) Type and frequency of preventive maintenance. Describe in detail.							
_____							
_____							
9.b) Number of cycles completed at last preventive maintenance operation. _____							
V. Any testing problems or difficulties.							
_____							
_____							
_____							
SSV/USV qualified for class II sandy services (Yes, No) _____							
Date: _____							
Tested by _____							

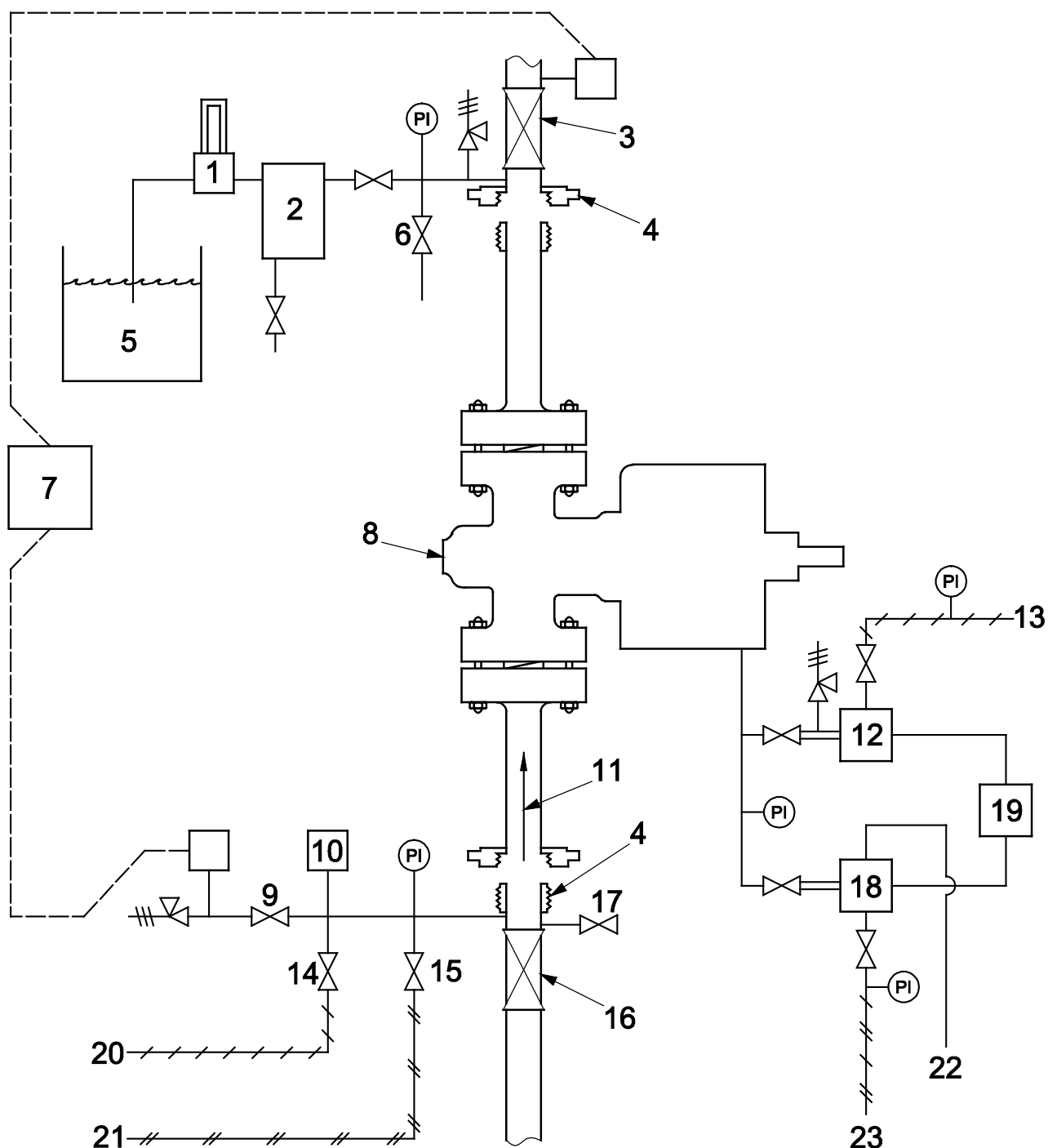
Figure I.1 — Example of a class II SSV/USV valve test form

**Key**

- |  |   |
|--|---|
| 1 water tank   | 9 hydraulic oil reservoir                                     |
| 2 two-position three-way diverter valve                      | 10 adjustable back-pressure control                           |
| 3 sand slurry tank   | 11 hydraulic pressure accumulator, high-pressure water supply |
| 4 sample connections for sand content and viscosity analyses | 12 hydraulic oil supply pump                                  |
| 5 flow meter   | 13 circulation pumps  |
| 6 flow recorder  | 14 air supply   |
| 7 hydraulic pressure accumulator, hydraulic oil supply       | 15 clean freshwater tank                                      |
| 8 high-pressure water supply pump                            | 16 nitrogen supply  |

<sup>a</sup> See Figure I.3, test section detail.

**Figure I.2 — Example of piping arrangement test facility for class II sandy service SSV/USV validation testing**



**Key**

- |  |  |
|--|--|
| 1 air flow meter                                   | 13 air supply  |
| 2 leaked nitrogen scrubber                         | 14 nitrogen pressure manifold valve                          |
| 3 downstream isolation valve                       | 15 high-pressure water manifold valve                        |
| 4 hammer union                                     | 16 upstream isolation valve                                  |
| 5 water  | 17 upstream bleed valve                                      |
| 6 downstream bleed valve                           | 18 three-way solenoid valve hydraulic oil supply             |
| 7 differential pressure transducer                 | 19 cyclic timer to control air and hydraulic solenoid valves |
| 8 SSV/USV  | 20 nitrogen supply   |
| 9 differential pressure transducer isolation valve | 21 high-pressure water supply                                |
| 10 upstream pressure transducer                    | 22 hydraulic oil return to reservoir                         |
| 11 flow of test fluid                              | 23 hydraulic oil supply                                      |
| 12 three-way solenoid valve air supply             |  |

**Figure I.3 — Example of SSV/USV validation test section detail**

## **Annex J**

### **(normative)**

## **Repair and remanufacture requirements**

### **J.1 General**

Annex J defines the requirements for repair and remanufacture of user/purchaser-owned wellhead and christmas tree equipment originally manufactured in accordance with this International Standard for continued service by the user/purchaser. This annex is not applicable to field repair, with or without the replacement of parts and modification of equipment, and is not applicable to repair or remanufacture of used or surplus equipment intended for resale.

This International Standard also provides requirements for repair and remanufacture of wellhead and christmas tree equipment originally manufactured in accordance with API Spec 6A, API Spec 14D and ASME SPPE 1.

### **J.2 Repair and remanufacture levels**

#### **J.2.1 General**

Repair and remanufacture levels (RL) provide the basis for defining and controlling repair and remanufacture of wellhead and christmas tree equipment during its life cycle. RL levels as defined in this annex include requirements consistent with sound industry practices for repair and remanufacture activities.

#### **J.2.2 RL levels**

RL levels are representative of the product specifications and, if applicable, product specification level (PSL) to which the equipment was originally manufactured. RL levels indicate the level of technical requirements associated with the repair or remanufacture of equipment and do not represent equipment suitability for specific service or performance requirements. Table J.1 summarizes the requirements of this annex to assist the customer and the repairer/remanufacturer in the selection of the appropriate RL level for equipment.

#### **J.2.3 Application of RL levels**

The original product specification and PSL levels shall be used to determine the RL levels to which equipment may be repaired or remanufactured as follows.

- a) Equipment identified as originally manufactured to API Spec 6A prior to introduction of PSL levels shall be repaired or remanufactured to RL 1.
- b) Equipment identified as originally manufactured to PSL 1 shall be repaired or remanufactured to RL 1.
- c) Equipment identified as originally manufactured to PSL 2 shall be repaired or remanufactured to RL 1 or RL 2.
- d) Equipment identified as originally manufactured to PSL 3 shall be repaired or remanufactured to RL 1, RL 2 or RL 3.
- e) Equipment identified as originally manufactured to PSL 4 shall be repaired or remanufactured to RL 1, RL 2, RL 3 or RL 4.
- f) Equipment identified as originally manufactured to API Spec 14D or ASME SPPE 1 shall be repaired or remanufactured to RL 2.

This annex is not applicable to the repair and remanufacture of equipment that cannot be identified as originally manufactured to any of the product specifications identified in Table J.1.

**Table J.1 — Summary of Annex J requirements**

Requirement	RL 1	RL 2	RL 3	RL 4
Corresponding PSL level	PSL 1	PSL 2	PSL 3/3G	PSL 4
Equipment identified as originally manufactured in accordance with API Spec 6A prior to introduction of PSL levels	x	—	—	—
Equipment identified as originally manufactured as PSL 1	x	—	—	—
Equipment identified as originally manufactured as PSL 2	x	x	—	—
Equipment identified as originally manufactured as API Spec 14 D, or ASME SPPE 1	—	x	—	—
Equipment identified as originally manufactured as PSL 3, or PSL 3G	x	x	x	—
Equipment identified as originally manufactured as PSL 4	x	x	x	x
Design status indeterminate	x	—	—	—
Design status acceptable	x	x	x	x
Design of product attributes and parts similar to the OPD <sup>a</sup> requirements	x	—	—	—
Design of product attributes and parts meet or exceed OPD requirements	—	x	x	x
Complete disassembly and cleaning	—	x	x	x
Visual examination	x <sup>b</sup>	x	x	x
Dimensional inspection of specified dimensions of this International Standard	x	x	x	x
Surface NDE for remanufactured parts	—	x	x	x <sup>c</sup>
Welding controlled to include material identification	x	x	x	x <sup>c</sup>
Visual weld examination for remanufactured parts	—	x	x	x <sup>c</sup>
Weld surface NDE for remanufactured parts	—	x	x	x <sup>c</sup>
Weld volumetric NDE for remanufactured parts	—	x	x	x <sup>c</sup>
Weld hardness test	—	—	x	x <sup>c</sup>
Hardness testing for sour service	x <sup>e</sup>	x <sup>e</sup>	x <sup>e</sup>	x <sup>e</sup>
Hardness testing to requirements of this International Standard	—	x <sup>e</sup>	x <sup>e</sup>	x <sup>e</sup>
Reassembly traceability	—	—	x	x
Hydrostatic body test	x <sup>f</sup>	x	x	x
Hydrostatic seat test	x	x	x	x
Extended seat test	—	—	x	x
Drift test	x	x	x	x
Gas test	—	—	x <sup>d</sup>	x
Certificate of conformance provided to customer	—	—	x	x
Assembly traceability and test records provided to customer	—	—	x	x
Complete quality control records provided to customer	—	—	—	x
<sup>a</sup> OPD indicates “original product definition”. <sup>b</sup> Examination required only to extent permitted by disassembly. <sup>c</sup> Welding is not permitted except for weld overlays. <sup>d</sup> Gas test for PSL 3G option only. <sup>e</sup> Applicable to body, bonnet, end and outlet connections and stems. <sup>f</sup> Hydrostatic test required only at working pressure.				

## **J.3 Design and performance requirements**

### **J.3.1 Performance requirements — General**

Replacement parts or remanufactured equipment and parts shall be designed to perform to requirements that meet or exceed the original equipment design. For RLs 1 to 4, designs shall be in accordance with the requirements of the corresponding PSLs and performance requirements (PR) as required by Clauses 4 and 10.

### **J.3.2 Design of product attributes and replacement parts**

Requirements for the design of replacement parts shall be as follows.

- a) Product attributes and replacement parts for RL 1 shall be in accordance with documented designs as required by Clauses 4 and 10, which are functionally and materially similar to the original product definition.
- b) Product attributes and replacement parts for RLs 2 to 4 shall be in accordance with documented designs as required by Clauses 4 and 10, which meet or exceed the original product definition.

### **J.3.3 Design of remanufactured parts**

Requirements for designs utilized in the process of remanufacturing equipment and parts are as follows.

- a) Remanufactured parts for RL 1 shall be in accordance with documented designs that are functionally and materially similar to the original product definition.
- b) Remanufactured parts for RLs 2 to 4 shall be in accordance with documented designs that meet or exceed the original product definition.

### **J.3.4 Design status**

Establishing the RL level for repair or remanufacture shall include the determination of the design status as defined by the original product definition based on equipment markings and records traceable to equipment markings. If this cannot be defined, equipment can be repaired/remanufactured only to RL 1.

Equipment designs established as no longer suitable for repair and remanufacture as a result of design changes, such as materials, processes, physical features or application, shall not be repaired or remanufactured according to this annex.

## **J.4 Materials**

Requirements for materials used to manufacture replacement parts shall conform to the corresponding PSL requirements and Clause 5. Replacement parts shall meet all applicable requirements of Clause 10 for this specification.

## **J.5 Repair and remanufacture**

### **J.5.1 Personnel**

Personnel performing repair and remanufacture operations described in this annex shall be qualified in accordance with written requirements of the repairer/remanufacturer, which include minimum training and qualification requirements.

### J.5.2 Equipment identification

Identification of equipment shall be determined through markings, or records traceable to markings, as follows:

- a) original manufacturer;
- b) size and working pressure;
- c) PSL, PR, temperature rating, material class/retained fluid rating/API Spec 14D service class and RL, as applicable;
- d) serial number and any other traceable information, as applicable;
- e) comments as to general condition;
- f) product design status.

The repairer/remanufacturer shall document this information, the RL level designated for repair or remanufacture of the equipment and the basis for determination of the RL level and, for RL 2 to RL 4, records traceable to the original product definition. Documentation shall be maintained as a record in accordance with the retention requirements identified in this International Standard.

### J.5.3 Repair of equipment

Repair of equipment shall not include remanufacturing of bodies, bonnets, end and outlet connections, stems and valve-bore sealing mechanisms.

Repair of equipment shall require the following.

- a) Disassembly and cleaning shall be performed in accordance with the repairer's/remanufacturer's documented requirements. Control features shall be included to segregate or identify components of each assembly to avoid mixing or mismatching of parts.
  - 1) For RL 2 to RL 4, complete disassembly is required.
  - 2) For RL 1, disassembly is required to the extent necessary to evaluate the equipment in accordance with the requirements of this annex and replace parts necessary to return the equipment to working condition.
- b) Visual examination shall be performed in accordance with documented specifications, which include acceptance criteria. Results of the examination shall be documented.
- c) All dimensions controlled by this International Standard shall be inspected. Results of the inspection shall be documented and retained.
- d) Hardness testing shall be performed in accordance with the requirements of this annex.
- e) Replacement or remanufacture of those parts necessary to return the equipment to working condition:
  - 1) Replacement parts shall be in accordance with the PSL level corresponding to the RL level to which the equipment is being repaired.
  - 2) Remanufacture of parts other than bodies, bonnets and end and outlet connections, stems and valve-bore sealing mechanisms shall be in accordance with the quality control requirements of the repairer/remanufacturer.

- f) Equipment shall be reassembled in accordance with documented specifications of the repairer/remanufacturer.
- g) Equipment shall be tested in accordance with the requirements of Clause 7 for the PSL level corresponding to the RL level to which the equipment is being repaired.

#### **J.5.4 Remanufacture of equipment**

Remanufacture of equipment includes remanufacturing of bodies, bonnets, end and outlet connections, stems and valve-bore sealing mechanisms. Remanufacturing of other parts necessary to return the equipment to working condition may also be performed.

Remanufacture of equipment shall require the following.

- a) Disassembly and cleaning shall be performed in accordance with the repairer's/remanufacturer's documented requirements. Control features shall be included to segregate or identify components of each assembly to avoid mixing or mismatching of parts.
  - 1) For RL 2 to RL 4, complete disassembly is required.
  - 2) For RL 1, disassembly is required to the extent necessary to evaluate the equipment in accordance with the requirements of this Annex J and replace parts necessary to return the equipment to working condition.
- b) Visual examination shall be performed in accordance with documented specifications, which include acceptance criteria. Results of the examination shall be documented.
- c) All dimensions controlled by this International Standard shall be inspected. Results of the inspection shall be documented and maintained.
- d) Hardness testing shall be performed in accordance with the requirements of this annex.
- e) Dimensional inspection and non-destructive examination of remanufactured parts shall be performed in accordance with the requirements of this annex. Results of inspections, tests and examinations shall be documented.
- f) Replacement or remanufacture of all parts that do not meet acceptance criteria:
  - 1) Replacement parts shall be in accordance with the PSL level corresponding to the RL level to which the equipment is being repaired.
  - 2) Remanufacture of parts shall be in accordance with the quality control requirements of this annex.
- g) Equipment shall be reassembled in accordance with documented specifications of the repairer/remanufacturer.
- h) Equipment shall be tested in accordance with the requirements of Clause 7 for the PSL level corresponding to the RL level to which the equipment is being repaired.

#### **J.6 Welding**

For RL 1 to RL 4, the material being welded shall be identified and welding shall be performed in accordance with the requirements of Clause 6 for the PSL level corresponding to the RL level to which the equipment is being repaired.

## J.7 Quality control

### J.7.1 General

Quality control Tables J.2 and J.3 are included in this annex to provide a matrix of requirements for specific parts and equipment.

### J.7.2 Personnel

Personnel performing quality control activities shall be qualified in accordance with the requirements of Clause 7.

### J.7.3 Measuring and testing equipment

Measuring and testing equipment shall be maintained and calibrated in accordance with the requirements of Clause 7.

### J.7.4 Bodies, bonnets and end and outlet connections, stems and mandrel hanger bodies (reused parts)

Table J.2 lists the quality control requirements for the reuse of parts for bodies, bonnets, end and outlet connections, as well as stems and mandrel hanger parts.

**Table J.2 — Quality control requirements for bodies, bonnets, end and outlet connections, stems and mandrel hanger bodies (reused parts)**

Requirement	Subclause reference			
	RL 1	RL 2	RL 3	RL 4
Hardness testing	J.7.4.1.1	J.7.4.1.1	J.7.4.3.1	J.7.4.3.1
Dimensional inspection	J.7.4.1.2	J.7.4.1.2	J.7.4.1.2	J.7.4.1.2
Traceability	—	—	J.7.4.3.3	J.7.4.3.3
Visual examination	J.7.4.1.3	J.7.4.2.3	J.7.4.2.3	J.7.4.2.3
Surface NDE	—	J.7.4.2.4	J.7.4.3.5	J.7.4.3.5
Weld NDE				
General	J.7.4.1.4	J.7.4.2.5	J.7.4.2.5	J.7.4.4.6 <sup>a</sup>
Visual examination	—	J.7.4.2.6	J.7.4.2.6	J.7.4.2.6 <sup>a</sup>
NDE surface	—	J.7.4.2.7	J.7.4.3.8	J.7.4.3.8 <sup>a</sup>
Repair welds	—	J.7.4.2.8	J.7.4.3.9	J.7.4.4.9 <sup>a</sup>
NDE volumetric	—	J.7.4.2.9	J.7.4.2.9	—
NDE hardness testing	—	—	J.7.4.3.11	—
<sup>a</sup> Welding is not permitted for RL 4 except for weld overlays and repairs to weld overlays.				

#### J.7.4.1 RL 1

##### J.7.4.1.1 Hardness testing

All parts being reused that are intended for sour service shall be hardness-tested in accordance with 7.4.1.5, using the methods specified in 7.4.2.1.3.

**J.7.4.1.2 Inspection of dimensions**

All dimensions controlled by this International Standard shall be inspected.

All dimensions affected by remanufacturing shall be inspected for conformity to documented design specifications.

**J.7.4.1.3 Visual examination**

All accessible areas shall be visually examined to the extent permitted by disassembly.

The repairer/remanufacturer shall perform visual examination in accordance with documented specifications that include acceptance criteria.

**J.7.4.1.4 Weld NDE**

Quality control requirements for welding shall be in accordance with Table 18.

**J.7.4.2 RL 2****J.7.4.2.1 Hardness testing**

Hardness testing requirements for RL 2 shall be identical to the requirements for RL 1.

**J.7.4.2.2 Inspection of dimensions**

Requirements for inspection of dimensions of RL 2 shall be identical to the requirements for RL 1.

**J.7.4.2.3 Visual examination**

Visual examination requirements for RL 2 shall be identical to the requirements for RL 1, with the addition that all accessible areas shall be examined.

**J.7.4.2.4 Surface NDE**

All accessible wetted surfaces and all accessible sealing surfaces affected by remanufacturing shall be examined in accordance with the requirements of 7.4.2.2.8 or 7.4.2.2.9.

**J.7.4.2.5 Weld NDE — General**

Quality control requirements for welding shall be in accordance with 7.4.2.2.10.

**J.7.4.2.6 Weld NDE — Visual**

All welds shall be examined visually in accordance with the requirements of 7.4.2.2.11.

**J.7.4.2.7 Weld NDE — Surface**

Weld-surface NDE shall be performed in accordance with the requirements of 7.4.2.2.12. Additionally, all accessible wetted and sealing surfaces shall be examined after final heat treatment and machining.

**J.7.4.2.8 Repair welds**

All repair welds shall be examined in accordance with the requirements of 7.4.2.2.13. Additionally, all accessible wetted and sealing surfaces shall be examined after final heat treatment and machining.

**J.7.4.2.9 Weld NDE — Volumetric**

All pressure-containing welds and all repair welds where the repair is greater than 25 % of the wall thickness or 25 mm (1 in), whichever is less, shall be examined in accordance with 7.4.2.2.14.

**J.7.4.3 RL 3****J.7.4.3.1 Hardness testing**

Hardness-testing requirements for RL 3 shall be identical to the requirements for RL 2 with the addition that all parts shall be hardness-tested at a minimum of one location specified by the repairer/remanufacturer. Acceptance criteria shall meet the requirements of 7.4.2.1.3 and 7.4.1.5. Acceptance criteria shall also meet the original product definition requirements if these exceed the requirements of this International Standard.

**J.7.4.3.2 Inspection of dimensions**

Requirements for inspection of dimensions of RL 3 shall be identical to the requirements for RL 1.

**J.7.4.3.3 Traceability**

Parts shall not be reused if the serial markings in accordance with 7.4.2.3.14 are no longer legible or otherwise traceable to the part.

**J.7.4.3.4 Visual examination**

Visual examination requirements for RL 3 shall be identical to the requirements for RL 2.

**J.7.4.3.5 Surface NDE**

Surface NDE requirements for RL 3 shall be identical to the requirements for RL 2 with the addition that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709.

**J.7.4.3.6 Weld NDE — General**

Quality control requirements for welding shall be identical to the requirements of RL 2.

**J.7.4.3.7 Weld NDE — Visual**

The requirements for visual examination of welds for RL 3 shall be identical to the requirements for RL 2.

**J.7.4.3.8 Weld NDE — Surface**

The requirements for NDE of weld surfaces for RL 3 shall be identical to the requirements for RL 2, except that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709. Additionally, all accessible surfaces shall be examined after final heat treatment and machining.

**J.7.4.3.9 Repair welds**

The requirements for examination of repair welds for RL 3 shall be identical to the requirements for RL 2 with the addition that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709. Additionally, all accessible surfaces shall be examined after final heat treatment and machining.

**J.7.4.3.10 Weld NDE — Volumetric**

The requirements for volumetric examination of welds for RL 3 shall be identical to the requirements for RL 2.

**J.7.4.3.11 Weld hardness testing**

The requirements for hardness testing of welds shall be in accordance with 7.4.2.3.13. Acceptance criteria shall meet the requirements of 7.4.2.1.3 and 7.4.1.5. Acceptance criteria shall also meet the original product definition requirements if these exceed the requirements of this International Standard.

**J.7.4.4 RL 4****J.7.4.4.1 Hardness testing**

The requirements for hardness testing for RL 4 shall be identical to the requirements for RL 3.

**J.7.4.4.2 Inspection of dimensions**

The requirements for inspection of dimensions for RL 4 shall be identical to the requirements for RL 1.

**J.7.4.4.3 Traceability**

Traceability requirements for RL 4 shall be identical to the requirements for RL 3.

**J.7.4.4.4 Visual examination**

The requirements for visual examination for RL 4 shall be identical to the requirements for RL 2.

**J.7.4.4.5 Surface NDE**

Surface NDE requirements for RL 4 shall be identical to the requirements for RL 3.

**J.7.4.4.6 Weld NDE — General**

Quality control requirements for welding shall be in accordance with 7.4.2.2.10. Welding other than weld overlays is not allowed.

**J.7.4.4.7 Weld NDE — Visual**

The requirements for visual examination of welds for RL 4 shall be identical to the requirements for RL 2.

**J.7.4.4.8 Weld NDE — Surface**

The requirements for NDE of weld surfaces for RL 4 shall be identical to the requirements for RL 3.

**J.7.4.4.9 Repair welds**

The following apply.

- a) The requirements for examination of repair welds for RL 4 shall be identical to the requirements for RL 3.
- b) Welding other than weld overlays or repair to weld overlays is not allowed.

**J.7.5 Stems (reused parts)**

The quality control requirements for stems are the same as bodies, bonnets and end and outlet connections. Table J.2 lists the quality control requirements for the reuse of stems.

## J.7.6 Valve-bore sealing mechanisms (reused parts)

Table J.3 lists the quality control requirements for the reuse of parts for valve-bore sealing mechanisms.

### J.7.6.1 RL 1

#### J.7.6.1.1 Inspection of dimensions

All dimensions affected by remanufacturing shall be inspected for conformity to documented design specifications.

#### J.7.6.1.2 Visual examination

The following apply.

- a) All accessible areas shall be visually examined to the extent permitted by disassembly.
- b) The repairer/remanufacturer shall perform visual examination in accordance with documented specifications that include acceptance criteria.

**Table J.3 — Quality control requirements for valve-bore sealing mechanisms (reused parts)**

Requirement	Subclause reference			
	RL 1	RL 2	RL 3	RL 4
Dimensional inspection	J.7.6.1.1	J.7.6.1.1	J.7.6.1.1	J.7.6.1.1
Traceability	—	—	J.7.6.3.2	J.7.6.3.2
Visual examination	J.7.6.1.2	J.7.6.2.2	J.7.6.2.2	J.7.6.2.2
Surface NDE	—	—	J.7.6.3.4	J.7.6.3.4
Weld NDE				
General	—	J.7.6.2.3	J.7.6.2.3	J.7.6.4.5 <sup>a</sup>
Visual examination	—	J.7.6.2.4	J.7.6.2.4	J.7.6.2.4 <sup>a</sup>
NDE surface	—	J.7.6.2.5	J.7.6.3.7	J.7.6.3.7 <sup>a</sup>
Repair welds	—	J.7.6.2.6	J.7.6.3.8	J.7.6.4.8 <sup>a</sup>
NDE hardness testing	—	—	J.7.6.3.9	—
<sup>a</sup> Welding is not permitted for RL 4 except for weld overlays and repairs to weld overlays.				

### J.7.6.2 RL 2

#### J.7.6.2.1 Inspection of dimensions

The requirements for inspection of dimensions for RL 2 shall be identical to the requirements for RL 1.

#### J.7.6.2.2 Visual examination

The requirements for visual examination for RL 2 shall be identical to the requirements for RL 1 with the addition that all accessible areas shall be examined.

#### J.7.6.2.3 Weld NDE — General

Quality control requirements for welding shall be in accordance with 7.4.2.2.10.

**J.7.6.2.4 Weld NDE — Visual**

All welds shall be examined visually in accordance with the requirements of 7.4.2.2.11.

**J.7.6.2.5 Weld NDE — Surface**

NDE of weld surfaces shall be performed in accordance with the requirements of 7.4.2.2.12.

**J.7.6.2.6 Repair welds**

All repair welds shall be examined in accordance with the requirements of 7.4.2.2.13. Additionally, all accessible wetted and sealing surfaces shall be examined after final heat treatment and machining.

**J.7.6.3 RL 3****J.7.6.3.1 Inspection of dimensions**

The requirements for inspection of dimensions for RL 3 shall be identical to the requirements for RL 1.

**J.7.6.3.2 Traceability**

Parts shall not be reused if the serialization markings in accordance with 7.4.2.3.14 are no longer legible or otherwise traceable to the part.

**J.7.6.3.3 Visual examination**

The requirements for visual examination of RL 3 shall be identical to the requirements for RL 2.

**J.7.6.3.4 Surface NDE**

All accessible wetted surfaces and all accessible sealing surfaces affected by remanufacturing shall be examined in accordance with the requirements of 7.4.2.2.8 or 7.4.2.2.9, except that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709.

**J.7.6.3.5 Weld NDE — General**

Quality control requirements for welding shall be in accordance with 7.4.2.2.10.

**J.7.6.3.6 Weld NDE — Visual**

The requirements for visual examination of welds for RL 3 shall be identical to the requirements for RL 2.

**J.7.6.3.7 Weld NDE — Surface**

The requirements for NDE of weld surfaces for RL 3 shall be identical to the requirements for RL 2, except that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709.

**J.7.6.3.8 Repair welds**

The requirements for examination of repair welds for RL 3 shall be identical to the requirements for RL 2, except that magnetic-particle examination shall use the wet fluorescent method in accordance with ASTM E709. Additionally, all accessible surfaces shall be examined after final heat treatment and machining.

### **J.7.6.3.9 Weld hardness testing**

The requirements for hardness testing of welds shall be in accordance with 7.4.2.3.13. Acceptance criteria shall meet the requirements of 7.4.2.1.3 and 7.4.1.5. Acceptance criteria shall also meet the original product definition requirements if these exceed the requirements of this International Standard.

### **J.7.6.4 RL 4**

#### **J.7.6.4.1 Inspection of dimensions**

The requirements for inspection of dimensions for RL 4 shall be identical to the requirements for RL 1.

#### **J.7.6.4.2 Traceability**

Traceability requirements for RL 4 shall be identical to the requirements for RL 3.

#### **J.7.6.4.3 Visual examination**

Visual examination requirements for RL 4 shall be identical to the requirements for RL 2.

#### **J.7.6.4.4 Surface NDE**

Surface NDE requirements for RL 4 shall be identical to the requirements for RL 3.

#### **J.7.6.4.5 Weld NDE — General**

The following apply.

- a) Quality control requirements for welding shall be in accordance with 7.4.2.2.10.
- b) Welding other than weld overlays is not allowed.

#### **J.7.6.4.6 Weld NDE — Visual**

The requirements for visual examination of welds for RL 4 shall be identical to the requirements for RL 2.

#### **J.7.6.4.7 Weld NDE — Surface**

The requirements for NDE of weld surfaces for RL 4 shall be identical to the requirements for RL 3.

#### **J.7.6.4.8 Repair welds to weld overlays**

The following apply.

- a) The requirements for examination of repair welds for RL 4 shall be identical to the requirements for RL 3.
- b) Welding other than weld overlays or repair to weld overlays is not allowed.

### **J.7.7 Tubing hanger mandrel bodies (reused parts)**

The quality control requirements for tubing hanger mandrel bodies are the same as for bodies, bonnets and end and outlet connections. Table J.2 lists the quality control requirements for the reuse of parts for tubing hanger mandrel bodies.

**J.7.8 Studs and nuts** (reused parts)

Studs and nuts which are intended for reuse shall be examined in accordance with the specified requirements of the repairer/remanufacturer.

**J.7.9 Non-metallic sealing materials** (reused parts)

Non-metallic seals that are intended for reuse shall be examined in accordance with the specified requirements of the repairer/remanufacturer.

**J.7.10 Assembled equipment**

The quality control requirements for assembled equipment shall be in accordance with Clause 7.

Assembled equipment shall be tested in accordance with 7.4.9 to the PSL level corresponding to the RL level to which the equipment is being repaired or remanufactured, as follows.

- a) RL 1 shall be tested according to the requirements of PSL 1, except that the minimum hydrostatic body test pressure shall be equal to the rated working pressure.
- b) RL 2 shall be tested according to the requirements of PSL 2.
- c) RL 3 shall be tested according to the requirements of PSL 3 or PSL 3G, as applicable, and specified by the user/purchaser.
- d) RL 4 shall be tested according to the requirements of PSL 4.

**J.7.11 Quality control records****J.7.11.1 Replacement part records**

The requirements for quality control records for replacement parts shall conform to Clause 7 for the numerical PSL level corresponding to the RL level to which the equipment is being repaired or remanufactured.

**J.7.11.2 Reused-part records**

The requirements for quality control records for reused parts shall conform to Clause 7 and 7.5 for the numerical PSL level corresponding to the RL level to which the equipment is being repaired or remanufactured, except that material test records are not required.

**J.7.11.3 Assembled equipment records**

The requirements for quality control records for assembled equipment shall conform to Clause 7 for the numerical PSL level corresponding to the RL level to which the equipment is being repaired or remanufactured.

**J.7.11.4 Records furnished to purchasers**

Quality control records that it is required to furnish to purchasers shall conform to Clause 7. Records shall be required in accordance with the requirements for the numerical PSL level corresponding to the RL level to which the equipment is being repaired or remanufactured.

For RL 3 and RL 4, the certificate of compliance shall state that the equipment was repaired or remanufactured in accordance with the requirements of this International Standard.

When requested by the user/purchaser, a certificate of conformance shall be furnished certifying that the equipment and all of its component parts meet the requirements of the original product definition. The certificate of conformance shall be traceable to documentation including, but not limited to, the documentation required by the original product definition. The documentation shall be retained by the repairer/remanufacturer as specified in Clause 7.

## **J.8 Equipment marking**

### **J.8.1 General**

Equipment repaired or remanufactured shall be marked in accordance with the requirements of this annex. These marking requirements are in addition to and do not replace the marking requirements of Clause 8, which are applicable to the repair or remanufacture. The original markings shall be retained on repaired or remanufactured equipment.

### **J.8.2 Metallic marking locations**

The locations of metallic marking for equipment that is repaired or remanufactured are shown in Clause 8.

### **J.8.3 Repair and remanufacture markings**

The following RL markings shall be placed in close proximity to PSL markings:

- a) "RMFR" for remanufacture or "RPR" for repair;
- b) repairer's/remanufacturer's name or mark;
- c) repair/remanufacture level (RL);
- d) date of repair or remanufacture (month and year).

## **J.9 Storing and shipping**

Storing and shipping shall be in accordance with the requirements of Clause 9.

## **Annex K**

(informative)

### **Recommended specifications for top connectors for christmas trees**

#### **K.1 General**

Annex K recommends dimensions and material strengths for top connectors, also known as christmas tree caps, for the most common sizes and pressure ratings. The dimensions and material specifications indicated allow for compliance with all other requirements for top connectors, as specified in this International Standard.

If this annex is applied, the following requirements shall be met.

#### **K.2 Materials**

Materials shall meet the requirements of 5.2 and have a minimum 0,2 % offset yield strength of 517 MPa (75 000 psi) and a maximum hardness of 237 HBW in order to be suitable for H<sub>2</sub>S service. The appropriate material selection shall be made in accordance with Table 3.

#### **K.3 Design**

The top connectors are designed for use in combinations of nominal size ranges and rated working pressure as shown in Tables K.1 and K.2 and Figure K.1.

Provisions on the collar other than those indicated in Figures K.1 and K.2 for transfer of make-up torque may be provided but are not specified in this International Standard.

#### **K.4 Top connector dimensions**

The threads shall conform to ASME B1.5 ACME screw threads, as specified in Table K.1.

Dimensions for top connectors shall conform to Tables K.1, K.2 and K.3; flanges shall conform to the appropriate tables and requirements of 10.1 and clamp hubs shall conform to ISO 13533.

The maximum bore for top connectors listed in Table K.2 is typically not large enough to pass a drift as specified in Table 30, and does not necessarily pass a back-pressure valve.

#### **K.5 Seal dimensions**

The dimensions and materials of the “O” ring seals of the caps are specified in Tables K.5, K.6 and K.7, and shall conform to SAE AS 568A.

## K.6 Bleeder connection dimensions

The dimensions of the bleeder connection shall conform to 4.4.4 or 10.11 depending on the pressure rating of the top connector.

## K.7 Quality control

The quality control requirements shall be in accordance with 10.19.6.

## K.8 Marking

Marking shall be as specified in Clause 8.

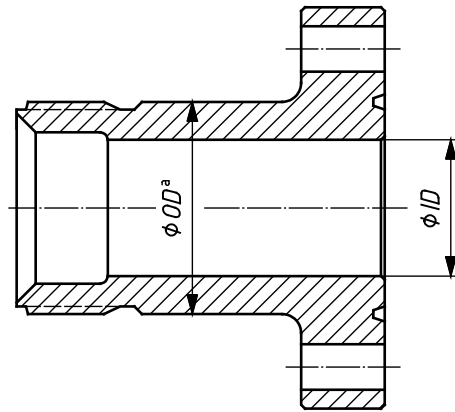
## K.9 Storing and shipping

Storing and shipping shall be as specified in Clause 9.

**Table K.1 — Standard top connector sizes**

Nominal size tree cap		Rated working pressure		Thread size	Seal bore diameter	
mm	(in)	MPa	(psi)	A <sup>a</sup> (in)	mm	(in)
65	2 <sup>9</sup> / <sub>16</sub>	103,5	(15 000)	5 <sup>3</sup> / <sub>4</sub> — 4THD Acme-2G	101,60	(4,000)
65	2 <sup>9</sup> / <sub>16</sub>	138,0	(20 000)	6 <sup>1</sup> / <sub>4</sub> — 4THD Acme-2G	101,60	(4,000)
76	3	34,5	(5 000)	5 <sup>3</sup> / <sub>4</sub> — 4THD Acme-2G	101,60	(4,000)
76	3	69,0	(10 000)	5 <sup>3</sup> / <sub>4</sub> — 4THD Acme-2G	101,60	(4,000)
76	3	103,5	(15 000)	7 <sup>1</sup> / <sub>2</sub> — 4THD Acme-2G	139,70	(5,500)
102	4	34,5	(5 000)	8 <sup>3</sup> / <sub>8</sub> — 4THD Acme-2G	133,35	(5,250)
102	4	69,0	(10 000)	8 <sup>3</sup> / <sub>8</sub> — 4THD Acme-2G	133,35	(5,250)
102	4	103,5	(15 000)	9 <sup>1</sup> / <sub>2</sub> — 4THD Acme-2G	158,75	(6,250)
127	5	34,5	(5 000)	9 — 4THD Acme-2G	171,45	(6,750)
127	5	69,0	(10 000)	9 — 4THD Acme-2G	171,45	(6,750)
127	5	103,5	(15 000)	12 <sup>1</sup> / <sub>4</sub> — 4THD Acme-2G	177,80	(7,000)
162	6 <sup>3</sup> / <sub>8</sub>	34,5	(5 000)	9 <sup>1</sup> / <sub>2</sub> — 4THD Acme-2G	203,20	(8,000)
162	6 <sup>3</sup> / <sub>8</sub>	69,0	(10 000)	11 <sup>1</sup> / <sub>2</sub> — 4THD Acme-2G	209,55	(8,250)

<sup>a</sup> See Figures K.1 and K.2.

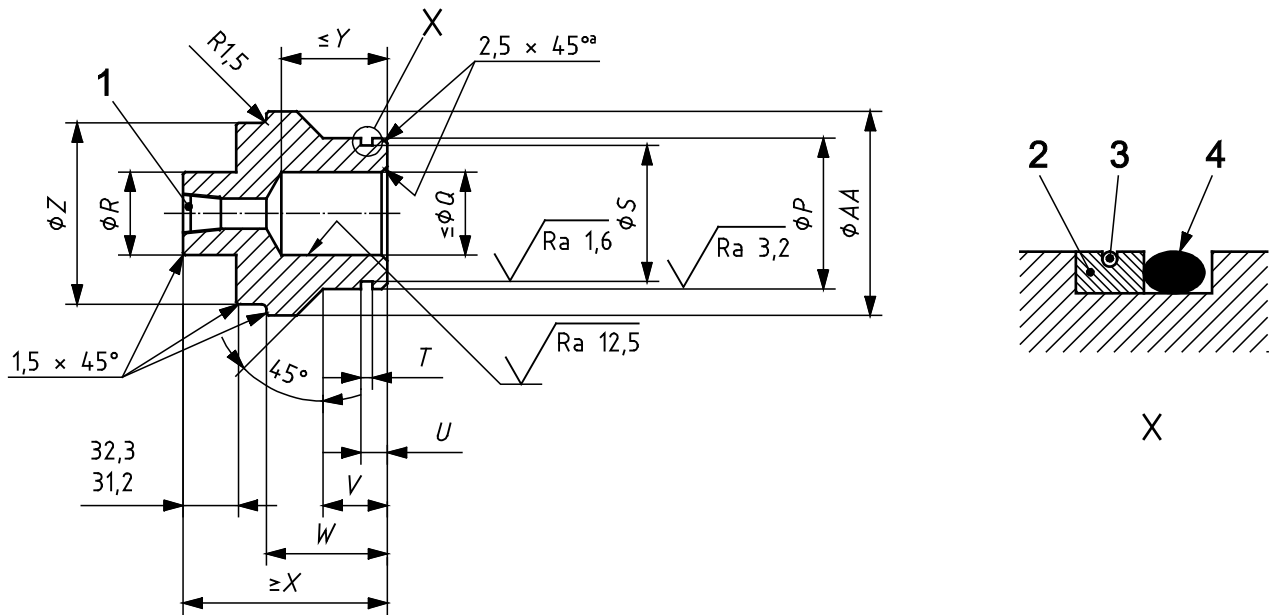
**Table K.2 — Top connector body, inside and outside diameter combinations**

<sup>a</sup> Boss.

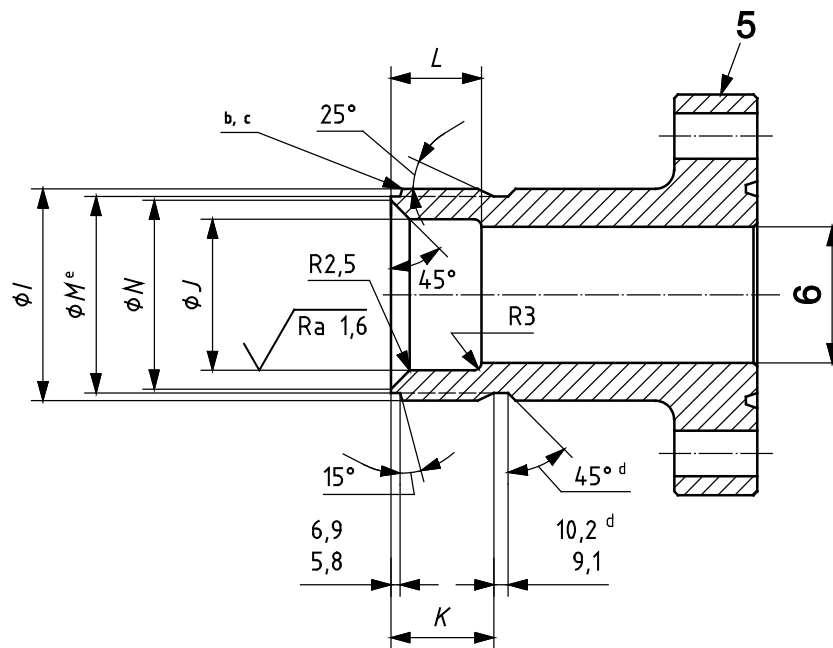
Nominal size tree cap		Rated working pressure		Maximum bore <sup>a</sup>		Minimum boss outside diameter	
mm	(in)	MPa	(psi)	mm	(in)	mm	(in)
65	2 9/16	103,5	15 000	66,6	2,62	109,0	4,29
65	2 9/16	138,0	20 000	66,6	2,62	144,5	5,69
76	3	34,5	5 000	76,7	3,02	94,5	3,72
76	3	69,0	10 000	76,7	3,02	104,6	4,12
76	3	103,5	15 000	76,7	3,02	126,7	4,99
102	4	34,5	5 000	102,1	4,02	125,7	4,95
102	4	69,0	10 000	102,1	4,02	139,2	5,48
102	4	103,5	15 000	102,1	4,02	166,4	6,55
127	5	34,5	5 000	127,5	5,02	157,0	6,18
127	5	69,0	10 000	127,5	5,02	174,0	6,85
127	5	103,5	15 000	127,5	5,02	212,1	8,35
162	6 3/8	34,5	5 000	162,6	6,4	200,2	7,88
162	6 3/8	69,0	10 000	162,6	6,4	221,7	8,73

<sup>a</sup> See Figures K.1 and K.2.

Dimensions in millimetres unless otherwise indicated  
Surface roughness in micrometres



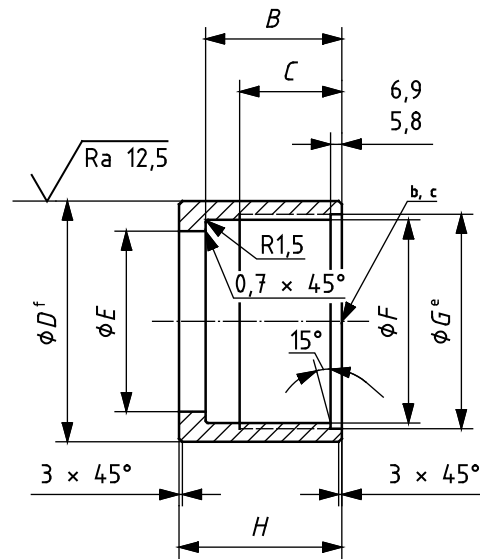
a) Blanking plug



b) Body

Figure K.1 — Top connector for Christmas tree  
(see Figure K.2 for USC units)

Dimensions in millimetres unless otherwise indicated  
Surface roughness in micrometres



c) Bonnet nut

#### Key

- 1 bleed port connection
  - 2 back-up ring (if used)
  - 3 O-ring (if back-up ring is used)
  - 4 main O-ring (if back-up ring is used)
  - 5 flange in accordance with 10.1
  - 6 ID in accordance with Table K.2 or with 10.1
- a Use  $1,5 \times 45^\circ$  for radial wall thickness less than 10,16 mm.
  - b A-4 thread  $29^\circ$  ACME 2G.
  - c Remove feather edge (see Table K.1).
  - d If applicable.
  - e Thread relief.
  - f Gripping grooves  $1,5 \pm 0,5$  wide  $\times$   $1,0 \pm 0,5$  deep  $\times$   $45^\circ$  walls. Typically, there are 36 grooves along entire length equally spaced around OD. Visually inspect grooves only.

Figure K.1 (continued)

**Table K.3 — Dimensions for top connectors**

(See Figure K.1 for location of dimensions.

See Table K.4 for USC units.)

Dimensions in millimetres

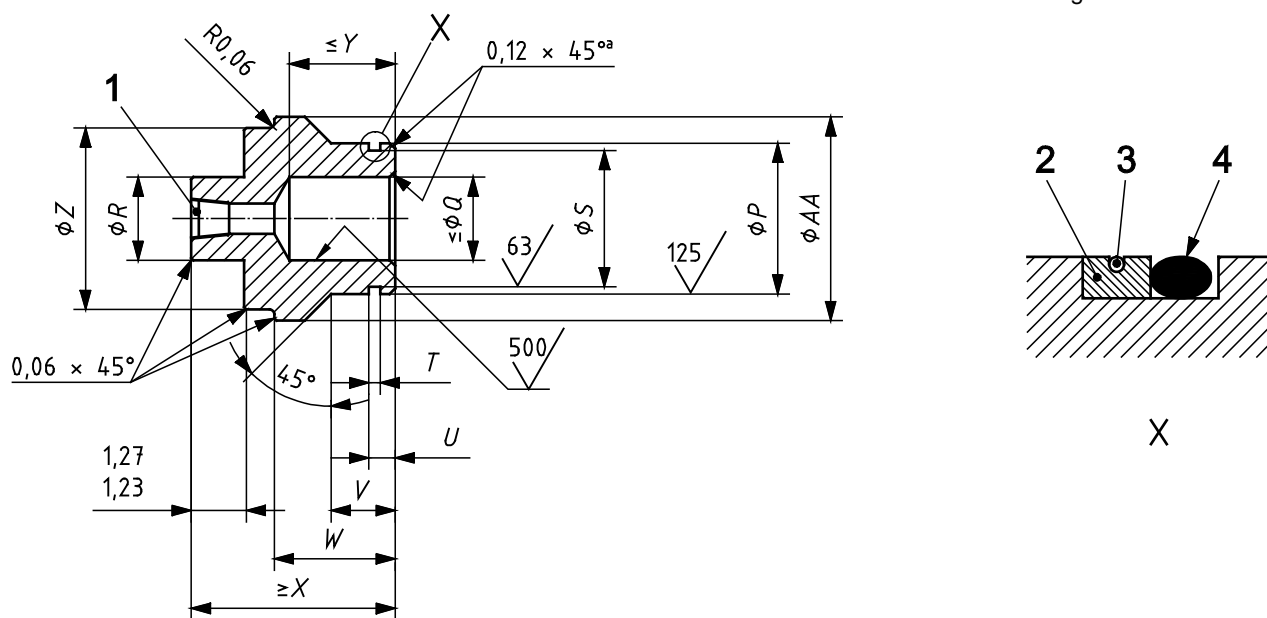
Dimensions	Nominal size							
	2 <sup>9</sup> / <sub>16</sub>	3	3	2 <sup>9</sup> / <sub>16</sub>	3	4	4	
	Rated working pressure MPa							
	103,5	34,5	69,0	138,0	103,5	34,5	69,0	
<i>B</i>	113,3/114,3			114,3/115,3	113,8/114,3	118,6/119,1		
<i>C</i>	88,9/91,9			91,9/92,5	88,9/89,4	92,2/92,7		
<i>D</i>	166,1/165,1			191,5/190,5	216,9/215,9	242,6/242,1		
<i>E</i>	115,6/116,1			134,6/135,1	155,2/155,7	182,1/182,6		
<i>F</i>	139,70/140,00			152,40/152,70	184,15/184,45	206,38/206,68		
<i>G</i>	147,57/148,08			160,27/160,78	192,02/192,53	214,25/214,76		
<i>H</i>	140,7/139,7			140,7/139,7	140,7/139,7	140,0/138,9		
<i>I</i>	146,05/145,72			158,75/158,42	190,50/190,17	212,73/212,39		
<i>J</i>	101,60/101,75			101,60/101,75	139,70/139,85	133,35/133,50		
<i>K</i>	86,9/85,9			82,8/81,8	91,4/90,4	95,8/94,7		
<i>L</i>	75,7/76,7			91,4/92,5	75,7/76,7	67,6/68,6		
<i>M</i>	137,52/137,01			150,16/149,68	181,81/181,31	203,96/203,45		
<i>N</i>	126,5/127,5			145,5/146,6	164,6/165,6	188,5/189,5		
<i>P</i>	101,50/101,35			101,50/101,35	139,60/139,45	133,25/133,10		
<i>Q</i>	66,5			66,5	91,7	102,1		
<i>R</i>	51,3/50,3			51,3/50,3	51,3/50,3	51,3/50,3		
<i>S</i>	92,35/92,20			92,35/92,20	130,45/130,30	121,46/121,31		
<i>T</i>	6,6/7,6			17,0/18,0	17,5/18,5	9,1/10,2		
<i>U</i>	18,5/19,6			34,5/35,6	34,5/35,6	18,5/19,6		
<i>V</i>	60,5/61,5			60,5/61,5	60,5/61,5	36,1/37,1		
<i>W</i>	106,2/105,2			114,8/113,8	106,2/105,2	97,0/96,0		
<i>X</i>	166,9			174,5	165,4	148,3		
<i>Y</i>	76,2			88,9	76,2	70,4		
<i>Z</i>	114,8/114,3			133,9/133,4	154,4/153,9	178,3/177,8		
<i>AA</i>	139,4/138,9			151,9/151,4	181,9/181,4	204,7/204,2		

Table K.3 (continued)

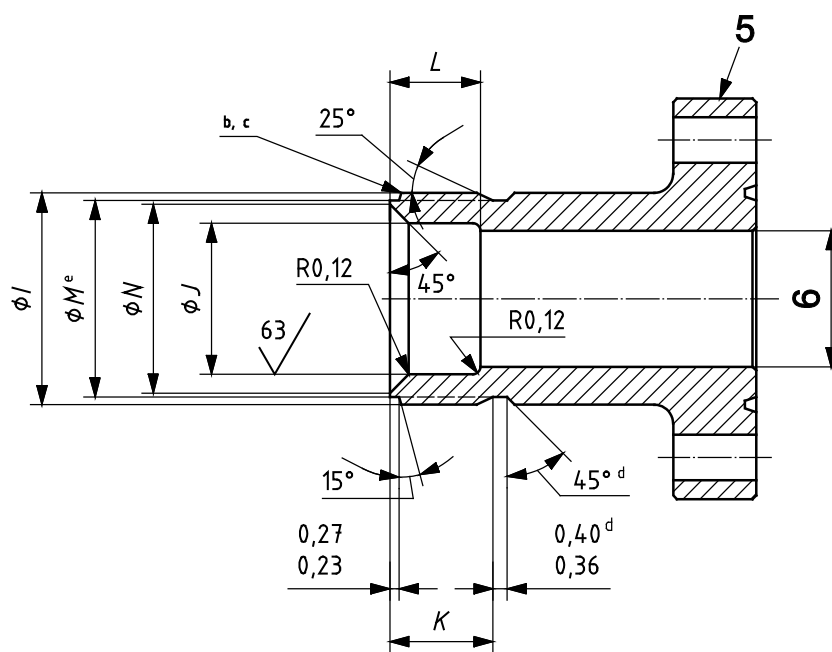
Dimensions in millimetres

Dimensions	Nominal size					
	4	5	5	5	6 <sup>3</sup> / <sub>8</sub>	6 <sup>3</sup> / <sub>8</sub>
	Rated working pressure MPa					
	103,5	34,5	69,0	103,5	34,5	69,0
<i>B</i>	116,8/117,3	113,8/114,3		177,8/178,3	113,8/114,3	153,4/153,9
<i>C</i>	101,6/102,1	101,6/102,1		136,7/137,2	101,6/102,1	123,7/125,2
<i>D</i>	277,9/276,9	267,7/266,7		369,3/368,3	267,7/266,7	331,2/330,2
<i>E</i>	209,6/210,1	200,9/201,4		261,4/261,9	217,2/217,7	253,2/253,7
<i>F</i>	234,95/235,25	222,25/222,55		304,80/305,10	234,95/235,25	285,75/286,05
<i>G</i>	242,82/243,33	230,12/230,63		312,67/313,18	242,82/243,33	293,62/294,13
<i>H</i>	140,7/139,7	140,7/139,7		222,8/221,7	140,7/139,7	186,2/185,2
<i>I</i>	241,30/240,97	228,60/228,27		311,15/310,82	241,30/240,97	292,10/291,77
<i>J</i>	158,75/158,90	171,45/171,60		177,80/177,95	203,20/203,35	209,55/209,70
<i>K</i>	82,3/81,3	100,6/99,6		118,6/117,6	102,1/101,1	117,9/116,8
<i>L</i>	88,9/89,9	72,6/73,7		111,3/112,3	68,6/69,6	94,7/95,8
<i>M</i>	234,44/233,93	219,81/219,30		302,11/301,60	232,46/231,95	283,11/282,60
<i>N</i>	218,2/219,2	202,7/203,7		289,1/290,1	228,1/229,1	272,5/273,6
<i>P</i>	158,65/158,50	171,35/171,20		177,70/177,55	203,10/202,95	209,45/209,30
<i>Q</i>	102,1	140,7		130,0	177,8	162,6
<i>R</i>	51,3/50,3	51,3/50,3		51,3/50,3	51,3/50,3	51,3/50,3
<i>S</i>	146,86/146,71	159,56/159,41		165,91/165,76	191,31/191,16	197,66/197,51
<i>T</i>	17,0/18,0	9,1/10,2		19,8/20,8	9,1/10,2	19,8/20,8
<i>U</i>	31,2/32,3	23,1/24,1		40,6/41,7	20,3/21,3	40,6/41,7
<i>V</i>	52,8/53,8	53,3/54,4		51,3/52,3	53,3/54,4	51,3/52,3
<i>W</i>	118,9/117,9	102,1/101,1		159,3/158,2	91,4/90,4	124,5/123,4
<i>X</i>	172,0	157,7		236,0	150,6	189,5
<i>Y</i>	83,8	95,0		114,3	53,3	96,5
<i>Z</i>	206,8/206,2	200,2/199,6		260,6/260,1	216,4/215,9	252,5/252,0
<i>AA</i>	233,4/232,9	220,7/220,2		303,5/303,0	233,9/233,4	284,2/283,7

Dimensions in inches unless otherwise indicated  
Surface roughness in micro-inches



**a) Blanking plug**



### b) Body

**Figure K.2 — Top connector for christmas tree — USC units**



**Table K.4 — Dimensions for top connectors — USC units**  
(See Figure K.2 for location of dimensions.)

Dimensions in inches

Dimensions	Nominal size					
	2 <sup>9</sup> / <sub>16</sub>	3	3	2 <sup>9</sup> / <sub>16</sub>	3	4
	Rated working pressure psi					
	15 000	5 000	10 000	20 000	15 000	5 000 10 000
<i>B</i>	4,46/4,50			4,50/4,54	4,48/4,50	4,67/4,69
<i>C</i>	3,50/3,62			3,62/3,64	3,50/3,52	3,63/3,65
<i>D</i>	6,54/6,50			7,54/7,50	8,54/8,50	9,55/9,53
<i>E</i>	4,55/4,57			5,30/5,32	6,11/6,13	7,17/7,19
<i>F</i>	5,500/5,512			6,000/6,012	7,250/7,262	8,125/8,137
<i>G</i>	5,810/5,830			6,310/6,330	7,560/7,580	8,435/8,455
<i>H</i>	5,54/5,50			5,54/5,50	5,54/5,50	5,51/5,47
<i>I</i>	5,750/5,737			6,250/6,237	7,500/7,487	8,375/8,362
<i>J</i>	4,000/4,006			4,000/4,006	5,500/5,506	5,250/5,256
<i>K</i>	3,42/3,38			3,26/3,22	3,60/3,56	3,77/3,73
<i>L</i>	2,98/3,02			3,60/3,64	2,98/3,02	2,66/2,70
<i>M</i>	5,414/5,394			5,912/5,893	7,158/7,138	8,030/8,010
<i>N</i>	4,98/5,02			5,73/5,77	6,48/6,52	7,42/7,46
<i>P</i>	3,996/3,990			3,996/3,990	5,496/5,490	5,246/5,240
<i>Q</i>	2,62			2,62	3,61	4,02
<i>R</i>	2,02/1,98			2,02/1,98	2,02/1,98	2,02/1,98
<i>S</i>	3,636/3,630			3,636/3,630	5,136/5,130	4,782/4,776
<i>T</i>	0,26/0,30			0,67/0,71	0,69/0,73	0,36/0,40
<i>U</i>	0,73/0,77			1,36/1,40	1,36/1,40	0,73/0,77
<i>V</i>	2,38/2,42			2,38/2,42	2,38/2,42	1,42/1,46
<i>W</i>	4,18/4,14			4,52/4,48	4,18/4,14	3,82/3,78
<i>X</i>	6,57			6,87	6,51	5,84
<i>Y</i>	3,00			3,50	3,00	2,77
<i>Z</i>	4,52/4,50			5,27/5,25	6,08/6,06	7,02/7,00
<i>AA</i>	5,49/5,47			5,98/5,96	7,16/7,14	8,06/8,04

Table K.4 (continued)

Dimensions in inches

Dimensions	Nominal size				
	4	5	5	5	6 <sup>3</sup> / <sub>8</sub>
	Rated working pressure psi				
	15 000	5 000	10 000	15 000	5 000
			10 000		10 000
<i>B</i>	4,60/4,62	4,48/4,50		7,00/7,02	4,48/4,50
<i>C</i>	4,00/4,02	4,00/4,02		5,38/5,40	4,00/4,02
<i>D</i>	10,94/10,90	10,54/10,50		14,54/14,50	10,54/10,50
<i>E</i>	8,25/8,27	7,91/7,93		10,29/10,31	8,55/8,57
<i>F</i>	9,250/9,262	8,750/8,762		12,000/12,012	9,250/9,262
<i>G</i>	9,560/9,580	9,060/9,080		12,310/12,330	9,56/9,58
<i>H</i>	5,54/5,50	5,54/5,50		8,77/8,73	5,54/5,50
<i>I</i>	9,500/9,487	9,000/8,987		12,250/12,237	9,500/9,487
<i>J</i>	6,250/6,256	6,750/6,756		7,000/7,006	8,000/8,006
<i>K</i>	3,24/3,20	3,96/3,92		4,67/4,63	4,02/3,98
<i>L</i>	3,50/3,54	2,86/2,90		4,38/4,42	2,70/2,74
<i>M</i>	9,230/9,210	8,654/8,634		11,894/11,874	9,152/9,132
<i>N</i>	8,59/8,63	7,98/8,02		11,38/11,42	8,98/9,02
<i>P</i>	6,246/6,240	6,746/6,740		6,996/6,990	7,996/7,990
<i>Q</i>	4,02	5,54		5,12	7,00
<i>R</i>	2,02/1,98	2,02/1,98		2,02/1,98	2,02/1,98
<i>S</i>	5,782/5,776	6,282/6,276		6,532/6,526	7,532/7,526
<i>T</i>	0,67/0,71	0,36/0,40		0,78/0,82	0,36/0,40
<i>U</i>	1,23/1,27	0,91/0,95		1,60/1,64	0,80/0,84
<i>V</i>	2,08/2,12	2,10/2,14		2,02/2,06	2,10/2,14
<i>W</i>	4,68/4,64	4,02/3,98		6,27/6,23	3,60/3,56
<i>X</i>	6,77	6,21		9,29	5,93
<i>Y</i>	3,30	3,74		4,50	2,10
<i>Z</i>	8,14/8,12	7,88/7,86		10,26/10,24	8,52/8,50
<i>AA</i>	9,19/9,17	8,69/8,67		11,95/11,93	9,21/9,19

**Table K.5 — Seals for top connector plugs for H<sub>2</sub>S service**

Nominal size (in)	Rated working pressure		Seals <sup>a</sup>	Back-up ring required <sup>b</sup>
	MPa	(psi)		
2 <sup>9</sup> / <sub>16</sub>	103,5	(15 000)	SAE AS 568-342-90 FKM	—
3	34,5	(5 000)	SAE AS 568-342-90 FKM	—
3	69,0	(10 000)	SAE AS 568-342-90 FKM	—
2 <sup>9</sup> / <sub>16</sub>	138,0	(20 000)	SAE AS 568-342-90 FKM SAE AS 568-153-80 FKM <sup>c</sup>	Yes
3	103,5	(15 000)	SAE AS 568-354-90 FKM SAE AS 568-159-80 FKM <sup>c</sup>	Yes
4	34,5	(5 000)	SAE AS 568-427-90 FKM	—
4	69,0	(10 000)	SAE AS 568-427-90 FKM	—
4	103,5	(15 000)	SAE AS 568-435-90 FKM SAE AS 568-161-80 FKM <sup>c</sup>	Yes
5	34,5	(5 000)	SAE AS 568-438-90 FKM	—
5	69,0	(10 000)	SAE AS 568-438-90 FKM	—
5	103,5	(15 000)	SAE AS 568-439-90 FKM SAE AS 568-166-80 FKM <sup>c</sup>	Yes
6 <sup>3</sup> / <sub>8</sub>	34,5	(5 000)	SAE AS 568-443-90 FKM	—
6 <sup>3</sup> / <sub>8</sub>	69,0	(10 000)	SAE AS 568-444-90 FKM SAE AS 568-168-80 FKM <sup>c</sup>	Yes
NOTE All O-rings specified are suitable for H <sub>2</sub> S service.				
<sup>a</sup> FKM according to ASTM D1418.				
<sup>b</sup> See Figure K.3 and Table K.6 for back-up ring details and dimensions.				
<sup>c</sup> The O-rings marked 80 (durometer) are used on the outside of a back-up ring.				

**Table K.6 — Back-up ring for O-ring seal**  
 (See Figure K.3 for location of dimensions;  
 see Table K.7 for USC units.)

Dimensions in millimetres

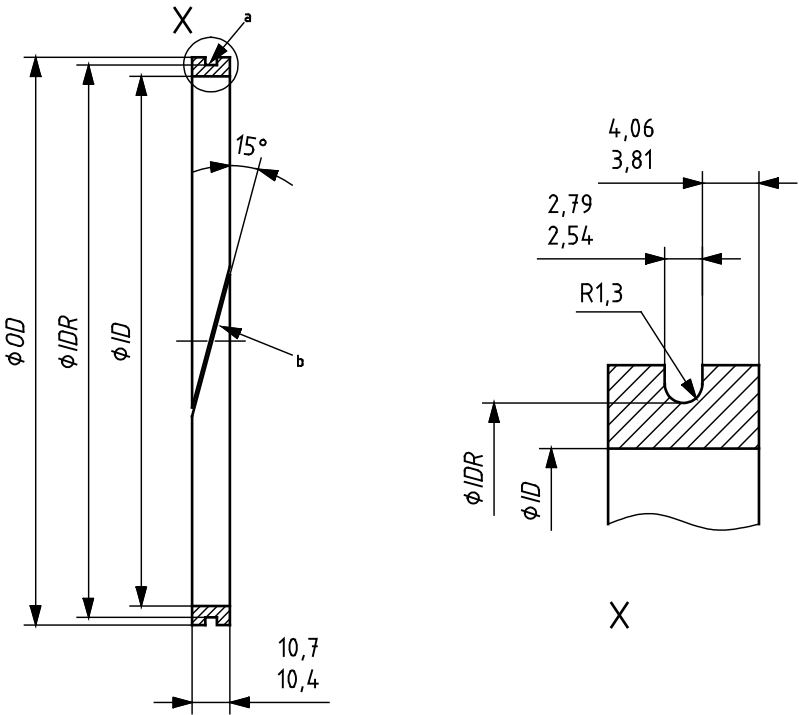
Nominal size		Rated working pressure	OD	IDR	ID
mm	(in)				
65	2 <sup>9</sup> / <sub>16</sub>	138,0	102,84 to 102,95	97,79 to 98,04	93,65 to 93,75
76	3	103,5	140,94 to 141,10	135,64 to 136,14	131,80 to 131,95
102	4	103,5	159,94 to 160,10	154,69 to 154,94	148,31 to 148,46
127	5	103,5	178,59 to 178,74	172,97 to 173,23	166,70 to 166,85
162	6 <sup>3</sup> / <sub>8</sub>	69,0	210,34 to 210,49	204,72 to 204,98	198,45 to 198,60

**Table K.7 — Back-up ring for O-ring seal — USC units**  
(See Figure K.4 for location of dimensions.)

Dimensions in inches

Nominal size		Rated working pressure			
mm	(in)	psi	OD	IDR	ID
65	2 <sup>9</sup> / <sub>16</sub>	20 000	4,049 to 4,053	3,85 to 3,86	3,687 to 3,691
76	3	15 000	5,549 to 5,555	5,34 to 5,36	5,189 to 5,195
102	4	15 000	6,297 to 6,303	6,09 to 6,10	5,839 to 5,845
127	5	15 000	7,031 to 7,037	6,81 to 6,82	6,563 to 6,569
162	6 <sup>3</sup> / <sub>8</sub>	10 000	8,281 to 8,287	8,06 to 8,07	7,813 to 7,819

Dimensions in millimetres unless otherwise indicated

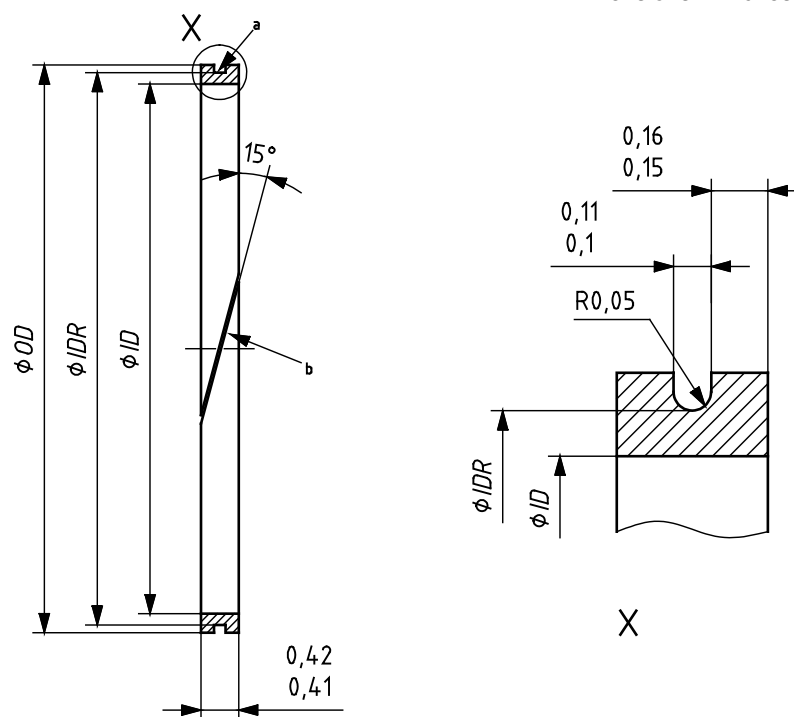


- a For O-ring size, see Table K.5.  
b Make 1 cut as shown 0,8 mm wide flush; steps not allowed.

NOTE Material is nylon. Prior to installation, soften by boiling in water for 4 h.

**Figure K.3 — Back-up ring for O-ring seal**  
(See Figure K.4 for USC units.)

Dimensions in inches unless otherwise indicated



a For O-ring size, see Table K.5.

b Make 1 cut as shown 0,03 in wide flush; steps not allowed.

NOTE Material is nylon. Prior to installation, soften by boiling in water for 4 h.

**Figure K.4 — Back-up ring for O-ring seal — USC units**

## **Annex L**

(normative)

### **Specifications for valve-removal preparations and valve-removal plugs**

#### **L.1 General**

This annex specifies the requirements for valve-removal preparations and valve-removal plugs.

#### **L.2 Design**

Internal pressure-relief check valves, internal threaded connections and other internal devices are permitted for valve-removal plugs, but are not specified in this International Standard.

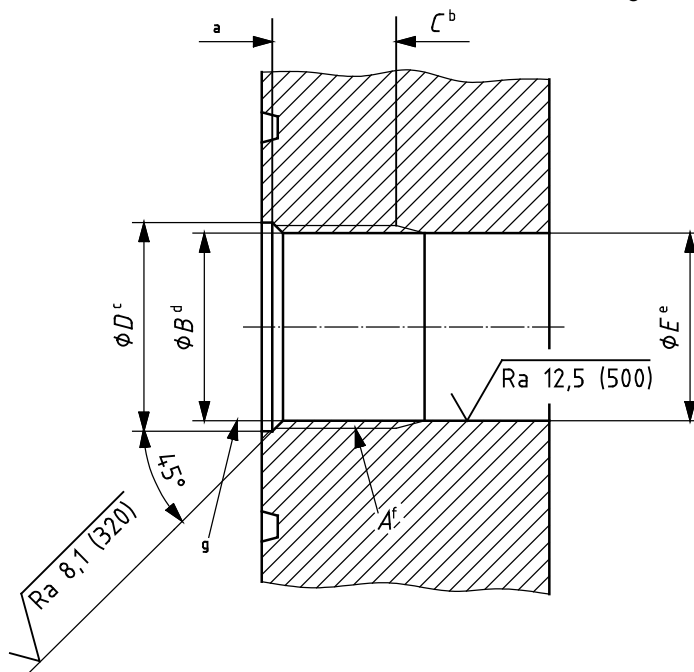
#### **L.3 Dimensions**

**L.3.1** Valve-removal preparation dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) working pressures shall be in accordance with Table L.1 and Figures L.1 and L.2. Included thread taper for all sizes shall be 1-in-16 on the diameter (reference  $1^{\circ} 47' 24''$  with the centreline). Tolerances on angles, unless otherwise noted, shall be  $\pm 0^{\circ} 30'$ .

**Table L.1 — Valve-removal preparation dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

SI units								
Dimensions in millimetres								
Nominal outlet size	Maximum working pressure	Nominal thread OD	Threads per inch	Thread type	Thread bore	Full thread length	Chamfer and counter-bore diameter	Straight bore
mm	MPa	<i>A</i> (in)	TPI (ref)		<i>B</i> ± 0,13	<i>C</i> (ref.)	<i>D</i> ± 0,8	<i>E</i> ± 0,4
46	69,0	1,660	11 1/2	Line-pipe	38,96	27,4	49,3	36,8
52	69,0	1,900	11 1/2	Sharp vee	45,03	38,4	55,6	42,2
65	69,0	2 3/8	11 1/2	Sharp vee	57,00	44,7	65,0	53,8
78 and 79	69,0	2 7/8	11 1/2	Sharp vee	69,65	55,9	77,7	65,7
103	69,0	3 1/2	11 1/2	Sharp vee	85,83	62,2	103,1	81,5
USC units								
Dimensions in inches								
Nominal outlet size	Maximum working pressure	Nominal thread OD	Threads per inch	Thread type	Thread bore	Full thread length	Chamfer and counter-bore diameter	Straight bore
in	psi	<i>A</i> in	TPI (ref)		<i>B</i> ± 0,005	<i>C</i> (ref.)	<i>D</i> ± 0,03	<i>E</i> ± 0,015
1 13/16	10 000	1,660	11 1/2	Line-pipe	1,532	1,08	1,94	1,449
2 1/16	10 000	1,900	11 1/2	Sharp vee	1,771	1,51	2,19	1,662
2 9/16	10 000	2 3/8	11 1/2	Sharp vee	2,242	1,76	2,56	2,117
3 1/16 and 3 1/8	10 000	2 7/8	11 1/2	Sharp vee	2,740	2,20	3,06	2,588
4 1/16	10 000	3 1/2	11 1/2	Sharp vee	3,377	2,45	4,06	3,209
NOTE See Figures L.1 and L.2 for location of dimensions.								

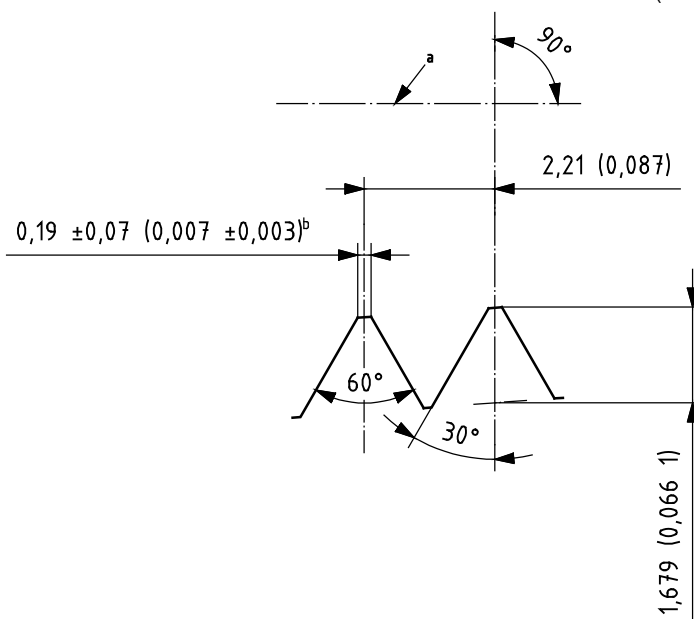
Surface roughness in micrometres (micro-inches)



- a Full thread.
- b Reference.
- c Diameter of counter-bore or chamfer.
- d Thread bore.
- e Standard bore.
- f Thread.
- g Thread bore taken at face of flange, gauge thread from bottom of chamfer, counter-bore is optional.

**Figure L.1 — Valve-removal preparation dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

Dimensions in millimetres (inches) unless otherwise indicated



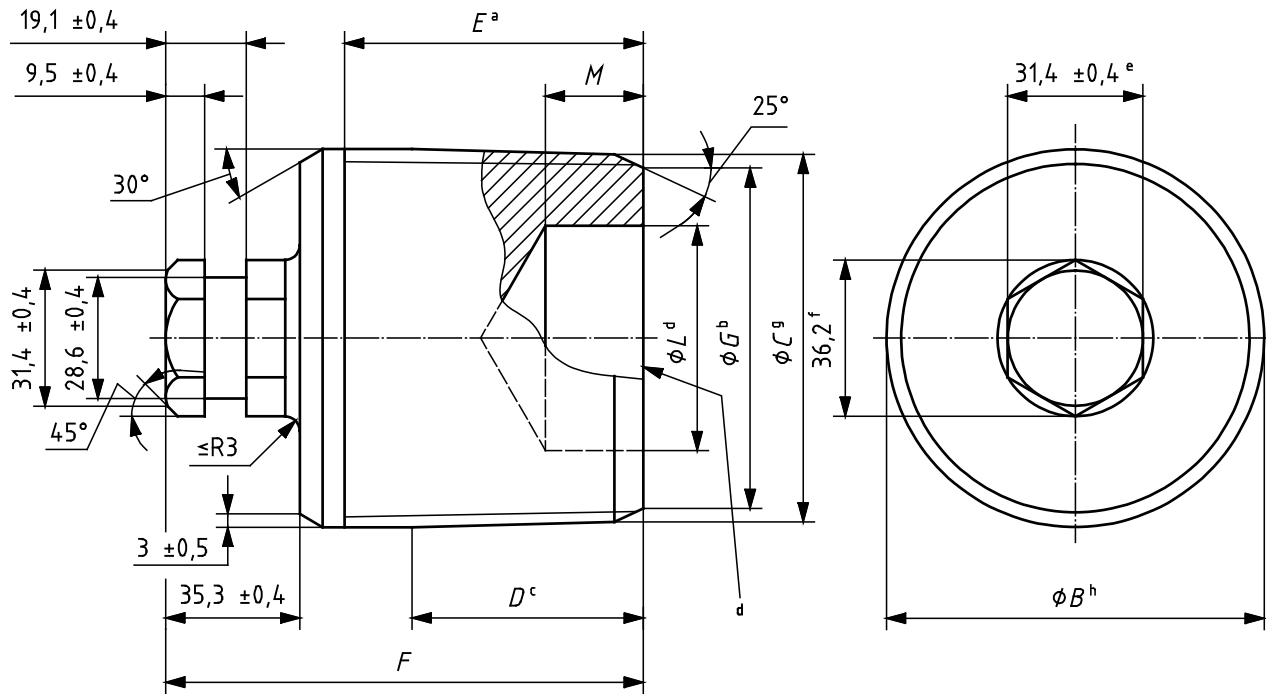
- a Bore centreline.
- b Crest width.

**Figure L.2 — Valve-removal preparation thread form dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

**Table L.2 — Valve-removal plug dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

SI units												
Dimensions in millimetres unless otherwise indicated												
Nominal outlet size	Maximum working pressure	Nominal thread OD	Threads per inch	Thread type	Diameter at large end	Diameter at small end	Length of taper	Length of full thread	Overall length of plug	Chamfer diameter	Counter-bore diameter	Counter-bore depth
mm	MPa	A (in)	TPI (ref.)		B ± 0,12	C ± 0,12	D (ref.)	E (ref.)	F ± 0,8	G ± 0,4	L ± 0,4	M ± 0,8
46	69,0	1,660	11 1/2	Line pipe	42,16	41,15	16,26	25,62	72,1	37,8	22,4	26,9
52	69,0	1,900	11 1/2	Sharp vee	48,26	46,59	26,70	34,93	80,3	43,2	25,4	26,9
65	69,0	2 3/8	11 1/2	Sharp vee	60,33	58,26	33,04	41,28	86,6	54,9	38,1	26,9
78 and 79	69,0	2 7/8	11 1/2	Sharp vee	73,03	70,26	44,18	52,39	97,5	66,9	44,5	41,4
103	69,0	3 1/2	11 1/2	Sharp vee	88,90	85,74	50,52	58,74	103,9	82,4	69,9	44,5
USC units												
Dimensions in inches unless otherwise indicated												
Nominal outlet size	Maximum working pressure	Nominal thread OD	Threads per inch	Thread type	Diameter at large end	Diameter at small end	Length of taper	Length of full thread	Overall length of plug	Chamfer diameter	Counter-bore diameter	Counter-bore depth
in	psi	A in	TPI (ref.)		B ± 0,005	C ± 0,005	D (ref.)	E (ref.)	F ± 0,03	G ± 0,015	L ± 0,015	M ± 0,03
1 13/16	10 000	1,660	11 1/2	Line pipe	1,660	1,620	0,640	1,009	2,84	1,488	0,88	1,06
2 1/16	10 000	1,900	11 1/2	Sharp vee	1,900	1,834	1,051	1,375	3,16	1,702	1,00	1,06
2 9/16	10 000	2 3/8	11 1/2	Sharp vee	2,375	2,294	1,301	1,625	3,41	2,162	1,50	1,06
3 1/16 and 3 1/8	10 000	2 7/8	11 1/2	Sharp vee	2,875	2,766	1,739	2,063	3,84	2,634	1,75	1,63
4 1/16	10 000	3 1/2	11 1/2	Sharp vee	3,500	3,376	1,989	2,313	4,09	3,244	2,75	1,75
NOTE See Figures L.3, L.4 (in USC units) and L.5 for location of dimensions and details.												

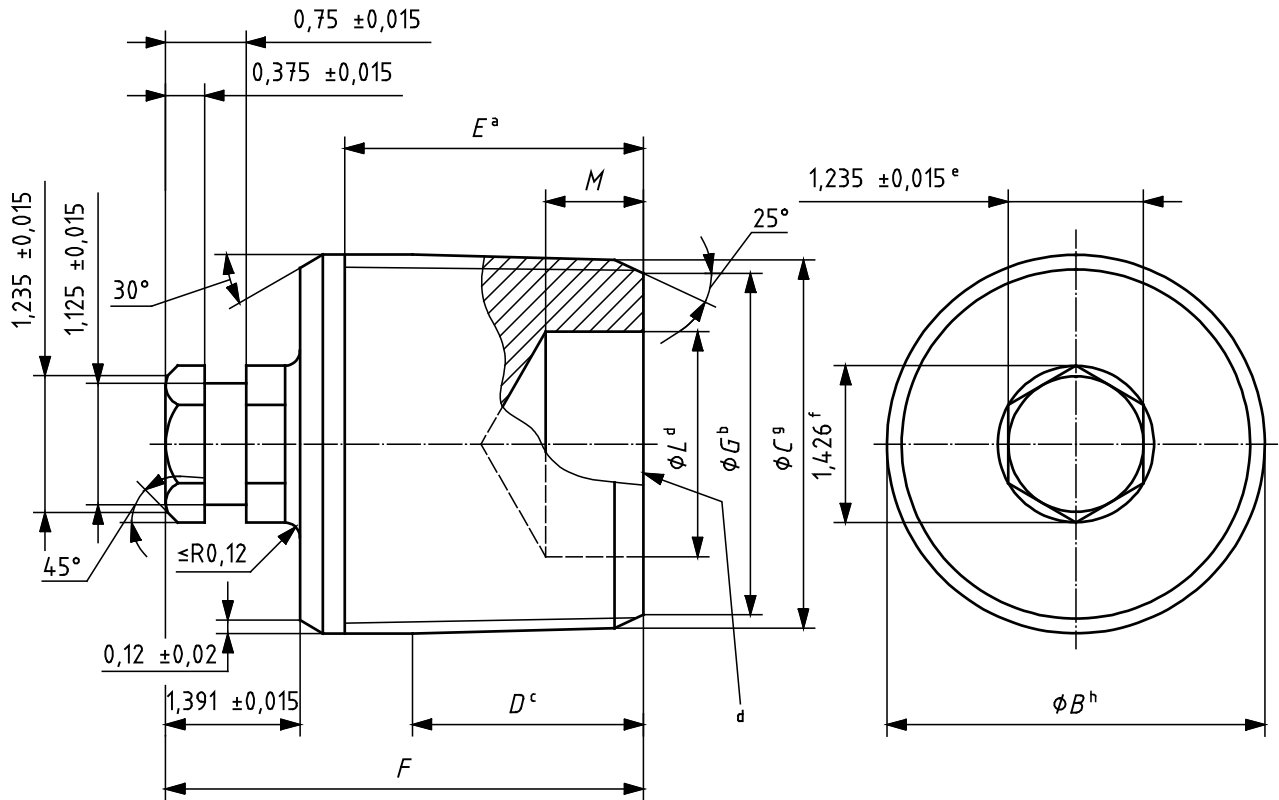
Dimensions in millimetres unless otherwise indicated



- a Total thread.
- b Chamfer at end.
- c End of taper.
- d Drill  $L$ ,  $M$  deep.
- e Across flats.
- f Across corners.
- g Diameter at face.
- h Equal to nominal diameter  $A$ .

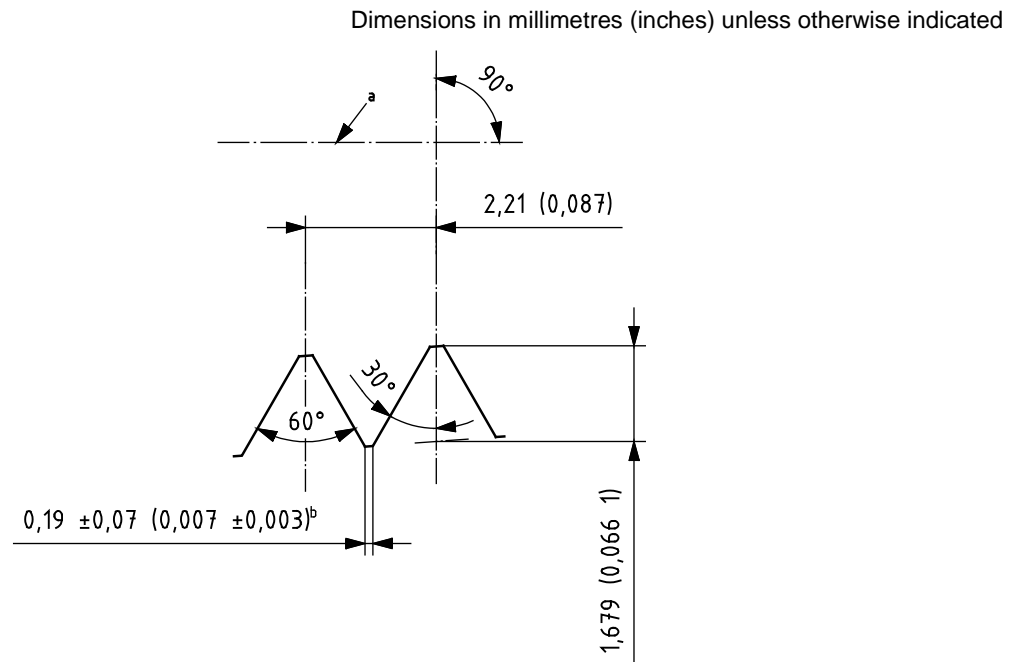
**Figure L.3 — Valve-removal plug dimensions for 13,8 MPa through 69,0 MPa rated working pressure**  
(see Figure L.4 for USC units)

Dimensions in inches unless otherwise indicated



- a Total thread.
- b Chamfer at end.
- c End of taper.
- d Drill  $L$ ,  $M$  deep.
- e Across flats.
- f Across corners.
- g Diameter at face.
- h Equal to nominal diameter  $A$ .

**Figure L.4 — Valve-removal plug dimensions for 2 000 psi through 10 000 psi rated working pressures — USC units**



**Figure L.5 — Valve-removal plug thread form dimensions (detail)  
for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

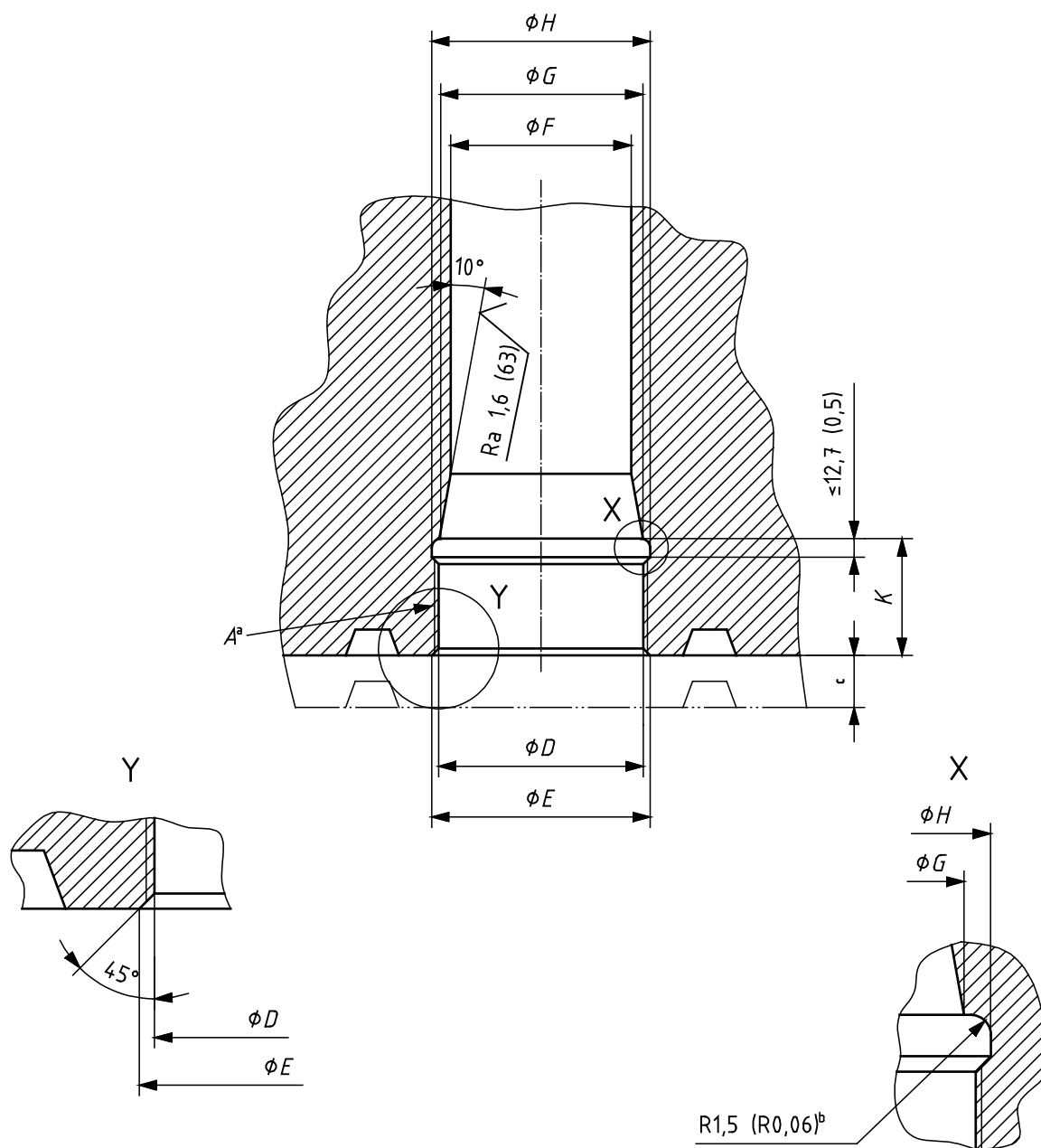
**L.3.3** Valve-removal preparation dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) working pressure shall be in accordance with Tables L.3 and L.4 and Figures L.6 and L.7. Tolerance on angles, unless otherwise noted, shall be  $\pm 0^\circ 30'$ .

**Table L.3 — Valve-removal preparation dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

SI units									
Dimensions in millimetres unless otherwise indicated									
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread minor diameter	Chamfer and counter-bore diameter	Straight through bore	Large diameter of taper	Thread relief diameter	Depth to taper
mm	MPa	A (in)	TPI (ref.)	D ± 0,10	E ± 0,4	F ± 0,13	G ± 0,05	H ± 0,4	K ± 0,4
46	138,0	1 ¾	6	42,01	46,4	37,47	41,28	46,2	39,70
52	138,0	2	6	48,36	52,7	43,82	47,63	53,0	39,70
65	138,0	2 ½	6	61,06	66,7	56,49	60,33	65,7	53,14
78	138,0	3	6	73,76	78,1	69,22	73,03	78,2	53,14
USC units									
Dimensions in inches unless otherwise indicated									
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread minor diameter	Chamfer and counter-bore diameter	Straight through bore	Large diameter of taper	Thread relief diameter	Depth to taper
in	psi	A in	TPI (ref.)	D ± 0,004	E ± 0,015	F ± 0,005	G ± 0,005	H ± 0,015	K ± 0,015
1 13/16	20 000	1 ¾	6	1,654	1,825	1,475	1,625	1,820	1,563
2 1/16	20 000	2	6	1,904	2,075	1,725	1,875	2,086	1,563
2 9/16	20 000	2 ½	6	2,404	2,625	2,224	2,375	2,585	2,092
3 1/16	20 000	3	6	2,904	3,075	2,725	2,875	3,080	2,092

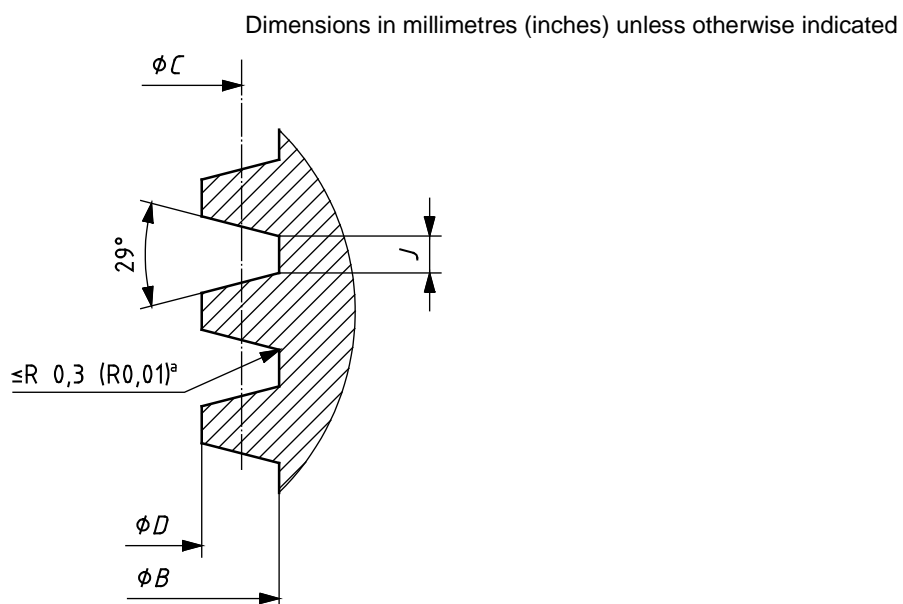
NOTE See Figure L.6 for location of dimensions.

Dimensions in millimetres (inches) unless otherwise indicated  
Surface roughness in micrometres (micro-inches)



- a Thread.
- b Typical.
- c Optional counter-bore 12,7 (0,50) deep max.

**Figure L.6 — Valve-removal preparation dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

**Key***B* major diameter*C* pitch diameter*D* minor diameter*J* reference<sup>a</sup> Typical.

**Figure L.7 — Valve-removal preparation thread form dimensions (6 TPI stub ACME thread 2G) for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

**Table L.4 — Valve-removal preparation thread form dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

SI units							
Dimensions in millimetres unless otherwise indicated							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread major diameter	Thread pitch diameter	Thread minor diameter	Width of thread at root
mm	MPa	<i>A</i> (in)	TPI (ref.)	<i>B</i> ± 0,25	<i>C</i> ± 0,25	<i>D</i> ± 0,10	<i>J</i> (ref.)
46	138,0	1 3/4	6	45,21	43,43	42,012	1,65
52	138,0	2	6	51,56	49,78	48,362	1,65
65	138,0	2 1/2	6	64,29	62,51	61,163	1,65
78	138,0	3	6	76,99	75,21	73,762	1,65
USC units							
Dimensions in inches unless otherwise indicated							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread major diameter	Thread pitch diameter	Thread minor diameter	Width of thread at root
in	psi	<i>A</i> in	TPI (ref.)	<i>B</i> ± 0,010	<i>C</i> ± 0,010	<i>D</i> ± 0,004	<i>J</i> (ref.)
1 13/16	20 000	1 3/4	6	1,780	1,710	1,654	0,065
2 1/16	20 000	2	6	2,030	1,960	1,904	0,065
2 9/16	20 000	2 1/2	6	2,531	2,461	2,408	0,065
3 1/16	20 000	3	6	3,031	2,961	2,904	0,065

NOTE See Figure L.7 for location of dimensions and USC units.

**Table L.5 — Valve-removal plug dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

SI units									
Dimensions in millimetres unless otherwise indicated									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Large taper diameter	Overall length	SAE AS 568A O-ring size No.	Chamfer diameter	Counter-bore diameter	Counter-bore depth
mm	MPa	<i>A</i> (in)	TPI (ref.)	<i>B</i> ± 0,25	<i>D</i> ± 0,8	<i>J</i>	<i>K</i> ± 0,8	<i>L</i> ± 0,4	<i>M</i> ± 0,4
46	138,0	1 3/4	6	40,64	95,3	126	38,1	N/A	N/A
52	138,0	2	6	46,99	95,3	130	44,5	N/A	N/A
65	138,0	2 1/2	6	59,66	106,4	138	59,2	23,8	15,9
78	138,0	3	6	72,36	106,4	146	72,1	28,6	15,9

USC units									
Dimensions in inches unless otherwise indicated									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Large taper diameter	Overall length	SAE AS 568A O-ring size No.	Chamfer diameter	Counter-bore diameter	Counter-bore depth
in	psi	<i>A</i> in	TPI (ref.)	<i>B</i> ± 0,010	<i>D</i> ± 0,03	<i>J</i>	<i>K</i> ± 0,03	<i>L</i> ± 0,015	<i>M</i> ± 0,015
1 13/16	20 000	1 3/4	6	1,600	3,75	126	1,50	N/A	N/A
2 1/16	20 000	2	6	1,850	3,75	130	1,75	N/A	N/A
2 9/16	20 000	2 1/2	6	2,349	4,19	138	2,33	0,938	0,625
3 1/16	20 000	3	6	2,849	4,19	146	2,84	1,125	0,625

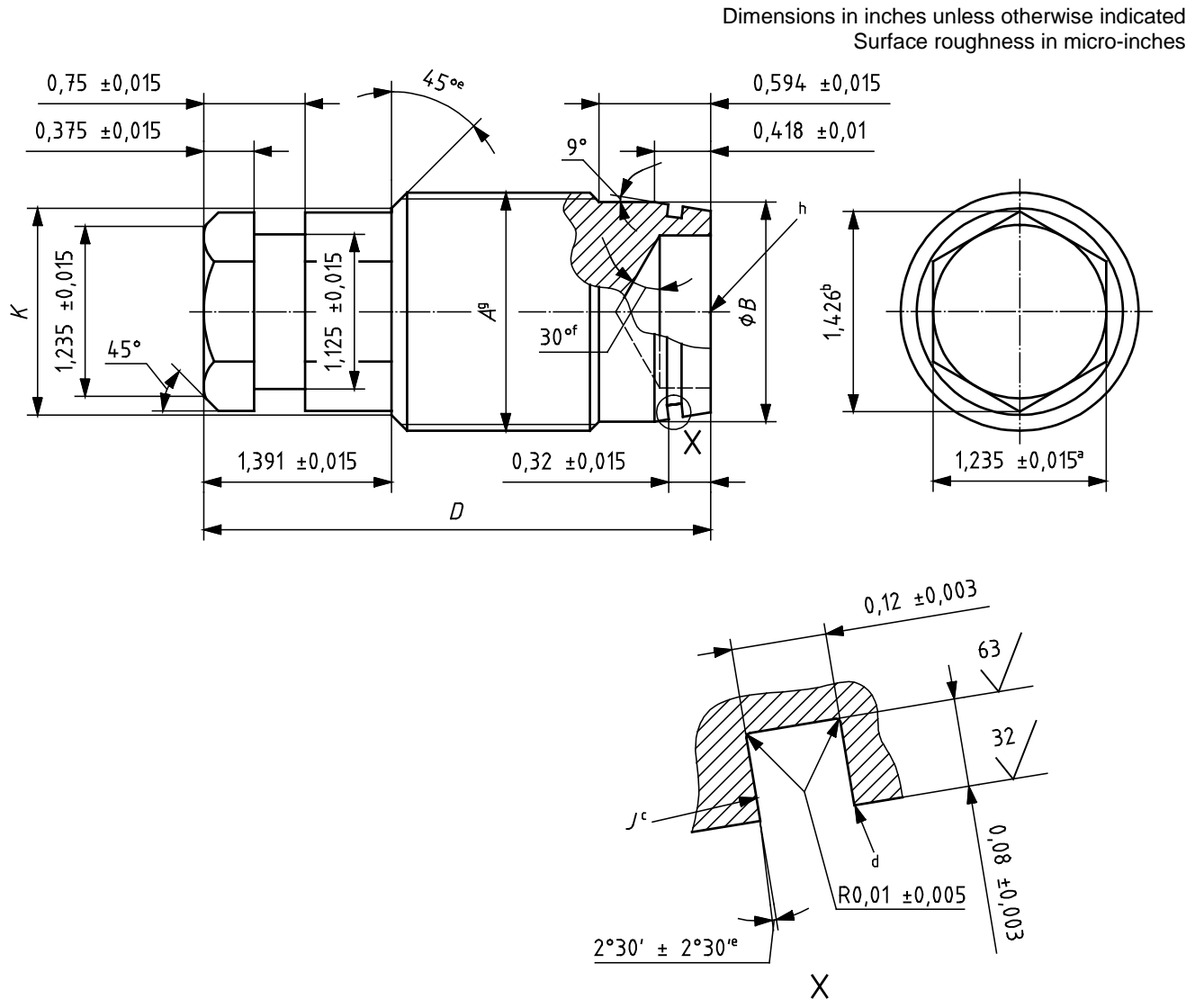
NOTE	For location of dimensions, see Figures L.8 (SI units) or L.9 (USC units).								
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The technical drawing illustrates a mechanical component with the following dimensions and features:

- Front View:** Shows overall dimensions including a total width of  $9,5 \pm 0,4$ , a central section width of  $19,1 \pm 0,4$ , and a right-side section width of  $15,1 \pm 0,4$ . The total height is  $K$ , with a base thickness of  $8,1 \pm 0,4$ . A vertical dimension of  $31,4 \pm 0,4$  is indicated on the left. A horizontal dimension of  $35,3 \pm 0,4$  spans from the left edge to the start of the rightmost section. A diagonal feature is labeled  $45^\circ_{oe}$ .
- Top View:** Shows a circular cross-section with an outer diameter of  $\phi B$  and an inner square-like feature with a side length of  $31,4 \pm 0,4^a$ . The distance from the center to the bottom edge is  $36,2^b$ .
- Detailed View (Bottom Right):** Focuses on a chamfered edge with a width of  $3,05 \pm 0,08$ . It specifies surface roughness values of  $Ra\ 1,6$  and  $Ra\ 0,8$ . A fillet radius is given as  $R0,25 \pm 0,12$ . The angle of the chamfer is  $2^\circ 30' \pm 2^\circ 30'^e$ . Other labels include  $J^c$ ,  $d$ , and  $2,03 \pm 0,08$ .

- a Across flats.
- b Across corners.
- c Install (SAE AS 568A O-ring size number).
- d Break corners approx. R0,12.
- e Typical.
- f Optional.
- g Thread.
- h Drill  $L$ ,  $M$  deep.

**Figure L.8 — Valve-removal plug dimensions for 103,5 MPa through 138,0 MPa rated working pressure**  
(See Figure L.9 for USC units.)



- a Across flats.
- b Across corners.
- c Install (SAE AS 568A O-ring size number).
- d Break corners approx. R0,005.
- e Typical.
- f Optional.
- g Thread.
- h Drill  $L$ ,  $M$  deep.

**Figure L.9 — Valve-removal plug dimensions for 15 000 psi through 20 000 psi rated working pressure — USC units**

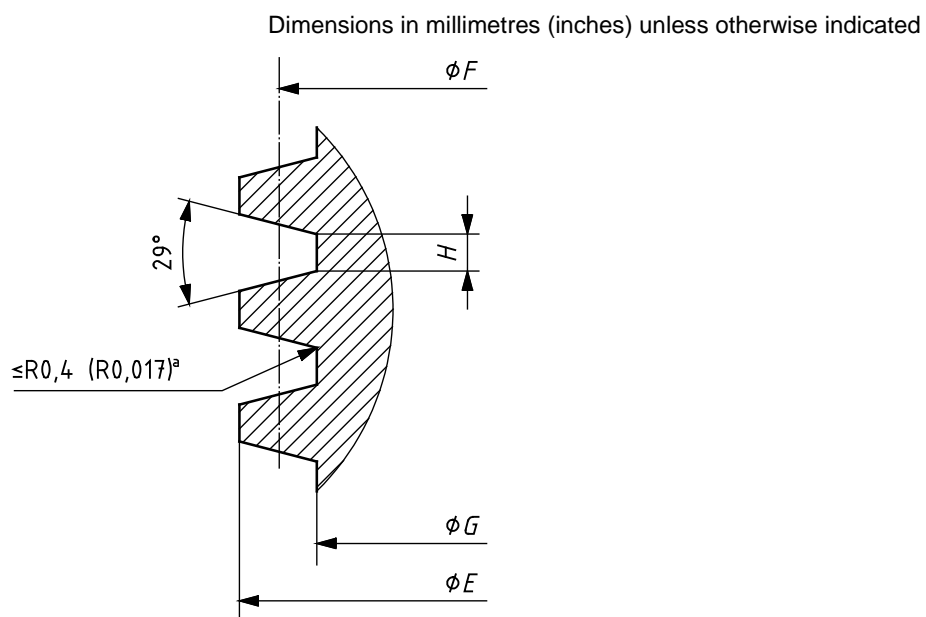
**Table L.6 — Valve-removal plug thread form dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

SI units							
Dimensions in millimetres unless otherwise indicated							
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread major diameter	Thread pitch diameter	Thread minor diameter	Width of thread at root
mm	MPa	A (in)	TPI (ref.)	E ± 0,10	F ± 0,3	G ± 0,3	H (ref.)
46	138,0	1 3/4	6	44,35	42,6	41,1	1,73
52	138,0	2	6	50,70	49,0	47,5	1,73
65	138,0	2 1/2	6	63,40	61,6	60,2	1,73
78	138,0	3	6	76,10	74,3	72,9	1,73

USC units							
Dimensions in inches unless otherwise indicated							
Nominal outlet size	Maximum working pressure	Nominal thread size	Threads per inch	Thread major diameter	Thread pitch diameter	Thread minor diameter	Width of thread at root
in	psi	A in	TPI (ref.)	E ± 0,004	F ± 0,010	G ± 0,010	H (ref.)
1 13/16	20 000	1 3/4	6	1,746	1,679	1,620	0,068
2 1/16	20 000	2	6	1,996	1,928	1,869	0,068
2 9/16	20 000	2 1/2	6	2,496	2,427	2,369	0,068
3 1/16	20 000	3	6	2,996	2,925	2,869	0,068

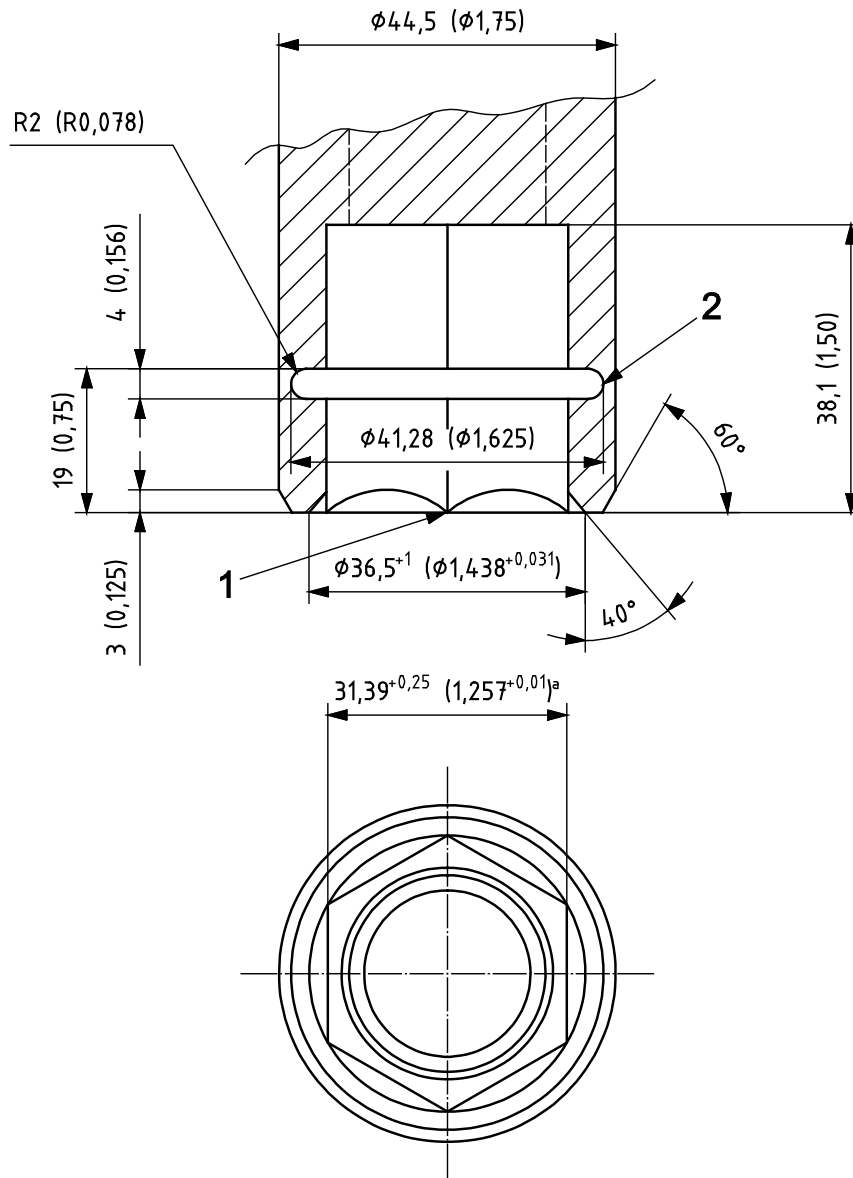
NOTE See Figure L.10 for location of dimensions.

**Key***E* major diameter*F* pitch diameter*G* minor diameter*H* reference<sup>a</sup> Typical.

**Figure L.10 — Valve-removal plug thread form dimensions (6 TPI stub ACME thread 2G)  
for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure**

**L.3.5** The running retrieval socket tool should be in accordance with Figure L.11.

Dimensions in millimetres (inches) unless otherwise indicated



**Key**

- 1 38,1 mm (1,5 in) deep hex
- 2 furnish O-ring AS 568A-219

<sup>a</sup> Across flats.

**Figure L.11 — Running and retrieving tool for valve removal plugs**

**L.4 Materials**

Valve-removal-plug body material shall, as a minimum, meet the requirements of 5.2, PSL 3, and 5.4, PSL 3. Material shall be in accordance with material designation 60K for 13,8 MPa (2 000 psi) to 69,0 MPa (10 000 psi) working pressure and 75K for 103,5 MPa (15 000 psi) to 138,0 MPa (20 000 psi) working pressure. Valve-removal plugs shall be material class DD, FF or HH. This International Standard is not applicable to valve removal plugs of less than material designation 60K.

## L.5 Quality control

Product specification levels are not applicable to valve removal plugs. The quality control requirements shall be in accordance with Table 38. Pressure testing is not required for valve-removal preparations and valve-removal plugs.

## L.6 Thread Gauging

### L.6.1 VR plugs and preparations

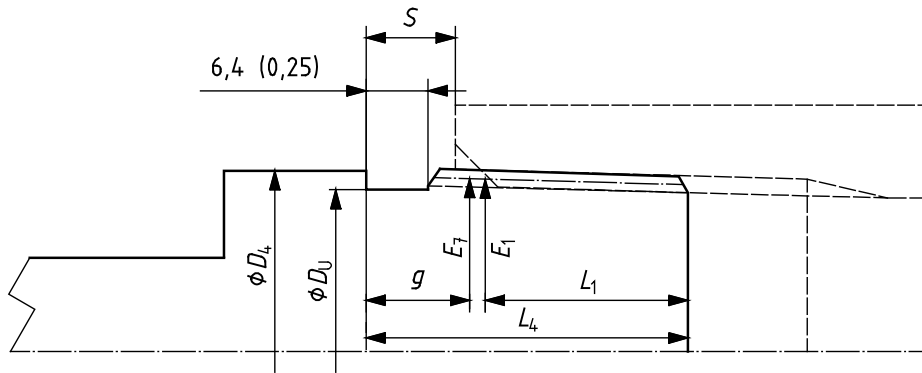
VR plug preparations may be inspected in accordance with Table L.7 and Figure L.12.

VR plugs may be inspected in accordance with Table L.8 and Figure L.13.

**Table L.7 — Valve-removal preparation gauging dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

SI units									
Dimensions in millimetres									
Nominal outlet size	Major diameter	Diameter of plug gauge groove	Threads per inch	Length: end of pipe to hand-tight plane	Pitch diameter at hand-tight plane	Total length: end of pipe to vanish point	Length: gauge point to vanish point	Pitch diameter at gauge point	Standoff
	$D_4$	$D_U$		$L_1$	$E_1$	$L_4$	$g$	$E_7$	$S$ $\pm 2,21$
46	42,2	37,1	11 1/2	10,670	40,2179	25,616	12,080	39,0916	10,419
52	48,3	43,1	11 1/2	20,589	46,2874	34,925	11,044	46,4929	9,667
65	60,3	55,4	11 1/2	26,507	58,3255	41,275	11,044	58,5579	11,417
78 and 79	73,0	68,1	11 1/2	36,927	70,9821	52,388	11,044	71,2579	12,090
103	88,9	83,8	11 1/2	43,277	86,8571	58,738	11,044	87,1329	7,328
USC units									
Dimensions in inches									
Nominal outlet size	Major diameter	Diameter of plug gauge groove	Threads per inch	Length: end of pipe to hand-tight plane	Pitch diameter at hand-tight plane	Total length: end of pipe to vanish point	Length: gauge point to vanish point	Pitch diameter at gauge point	Standoff
	$D_4$	$D_U$		$L_1$	$E_1$	$L_4$	$g$	$E_7$	$S$ $\pm 0,087$
1 <sup>13</sup> / <sub>16</sub>	1,660	1,46	11 1/2	0,4200	1,58338	1,0085	0,4756	1,59043	0,4102
2 <sup>1</sup> / <sub>16</sub>	1,900	1,70	11 1/2	0,8106	1,82234	1,3750	0,4348	1,83043	0,3806
2 <sup>9</sup> / <sub>16</sub>	2,375	2,18	11 1/2	1,0436	2,29628	1,6250	0,4348	2,30543	0,4495
3 <sup>1</sup> / <sub>16</sub> and 3 <sup>1</sup> / <sub>8</sub>	2,875	2,68	11 1/2	1,4538	2,79457	2,0625	0,4348	2,80543	0,4760
4 <sup>1</sup> / <sub>16</sub>	3,500	3,30	11 1/2	1,7038	3,41957	2,3125	0,4348	3,43043	0,2885
NOTE See Figure L.12 for location of dimensions.									

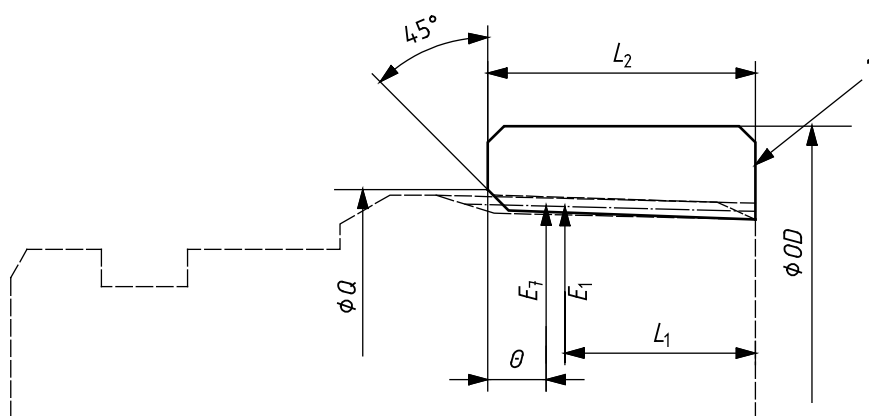
Dimensions in millimetres (inches)



**Figure L.12 — Valve-removal preparation gauge dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

**Table L.8 — Valve-removal plug gauging dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

SI units				
Dimensions in millimetres				
Nominal size	Ring gauge outside diameter	Ring gauge chamfer diameter	Ring gauge length	Face of ring gauge to plane of gauge point
	$OD$	$Q$	$L_2$	$\theta$
46	55,9	43,7	17,953	4,417
52	63,5	49,8	28,918	5,037
65	77,7	62,0	35,268	5,037
78 and 79	93,2	74,7	46,380	5,037
103	114,3	90,4	52,730	5,037
USC units				
Dimensions in inches				
Nominal size	Ring gauge outside diameter	Ring gauge chamfer diameter	Ring gauge length	Face of ring gauge to plane of gauge point
	$OD$	$Q$	$L_2$	$\theta$
1 $\frac{13}{16}$	2,20	1,72	0,7068	0,1739
2 $\frac{1}{16}$	2,50	1,96	1,1385	0,1983
2 $\frac{9}{16}$	3,06	2,44	1,3885	0,1983
3 $\frac{1}{16}$ and 3 $\frac{1}{8}$	3,67	2,94	1,8260	0,1983
4 $\frac{1}{16}$	4,50	3,56	2,0760	0,1983
NOTE 1 See Figure L.13 for location of dimensions.				
NOTE 2 See Table L.7 for $E_7$ , $E_1$ and $L_1$ .				

**Key**

1 gauge standoff with end of VR plug: flush  $\pm 1p$

NOTE "p" is defined as the distance from a point on a nominal thread form to a corresponding point on the next thread, measured parallel to the axis. This value can be calculated by dividing 1 mm by the number of threads per millimetre (1 in by the number of threads per inch).

**Figure L.13 — Valve-removal plug gauge dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure**

**L.6.2 HP VR plugs and preparations**

HP VR plugs shall be inspected in accordance with the manufacturer's documented specifications and procedures.

**L.7 Marking**

Valve-removal plugs shall be marked with "ISO 10423" followed by the nominal size and "VR" for 69,0 MPa (10 000 psi) working pressure or "HP VR" for 138,0 MPa (20 000 psi) working pressure and material class, as a minimum.

**L.8 Storing and shipping**

Valve-removal plugs shall be stored and shipped in accordance with Clause 9.

## **Annex M**

### **(informative)**

## **Qualification of heat-treating equipment**

### **M.1 General**

All heat treatment of parts, QTCs and TCs shall be performed with equipment meeting the requirements of this annex.

### **M.2 Temperature tolerance**

The temperature at any point in the working zone shall not vary by more than  $\pm 14\text{ }^{\circ}\text{C}$  ( $25\text{ }^{\circ}\text{F}$ ) from the furnace set-point temperature after the furnace working zone has been brought up to temperature. Furnaces which are used for tempering, ageing and/or stress-relieving shall not vary by more than  $\pm 8\text{ }^{\circ}\text{C}$  ( $15\text{ }^{\circ}\text{F}$ ) from the furnace set-point temperature after the furnace working zone has been brought up to temperature.

### **M.3 Furnace calibration**

#### **M.3.1 General**

Heat treatment of production parts shall be performed with heat-treating equipment that has been calibrated and surveyed.

#### **M.3.2 Records**

Records of furnace calibration and surveys shall be maintained for a period of not less than two years.

#### **M.3.3 Temperature survey method for calibration of batch-type furnaces**

A temperature survey within the furnace working zone(s) shall be performed on each furnace at the maximum and minimum temperatures for which each furnace is being used.

A minimum of nine thermocouple test locations shall be used for all furnaces having a working zone greater than  $0,3\text{ m}^3$  ( $10\text{ ft}^3$ ).

For each  $3,5\text{ m}^3$  ( $125\text{ ft}^3$ ) of furnace working zone surveyed, at least one thermocouple test location shall be used, up to a maximum of 40 thermocouples. See Figures M.1 and M.2 for examples of thermocouple locations.

For furnaces having a working zone less than  $0,3\text{ m}^3$  ( $10\text{ ft}^3$ ), the temperature survey may be made with a minimum of three thermocouples located either at the front, centre and rear, or at the top, centre and bottom of the furnace working zone.

After insertion of the temperature-sensing devices, readings shall be taken at least once every 3 min to determine when the temperature of the furnace working zone approaches the bottom of the temperature range being surveyed.

Once the furnace temperature has reached the set-point temperature, the temperature of all test locations shall be recorded at 2 min intervals, maximum, for at least 10 min. Then, readings shall be taken at 5 min intervals, maximum, for sufficient time (at least 30 min) to determine the recurrent temperature pattern of the furnace working zone.

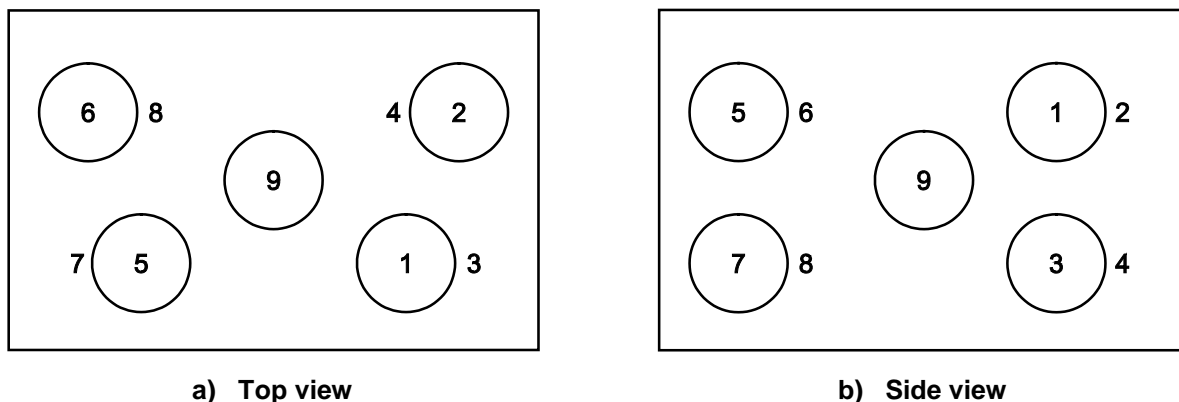
The scenarios in this annex are merely examples for illustration purposes only. Each company should develop its own approach. They are not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied for reliance on or any omissions from the information contained in this document.

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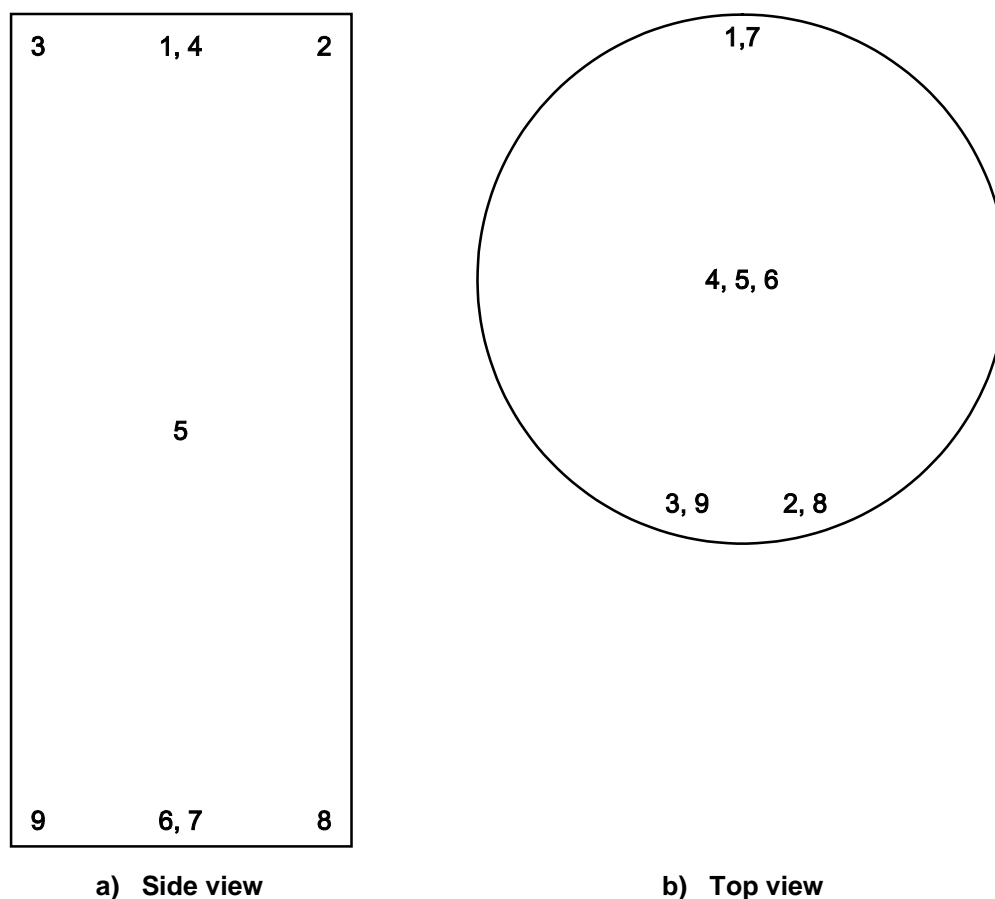
Where applicable, authorities having jurisdiction should be consulted.

Before the furnace set-point temperature is reached, none of the temperature readings shall exceed the set-point temperature by more than 14 °C (25 °F).

After the furnace control set-point temperature is reached, no temperature reading shall vary beyond the limits specified. The temperatures within each furnace shall be surveyed within one year prior to use of the furnace for heat treatment.



**Figure M.1 — Thermocouple locations — Rectangular furnace (working zone)**



**Figure M.2 — Thermocouple locations — Cylindrical furnace (working zone)**

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Where applicable, authorities having jurisdiction should be consulted.

When a furnace is repaired or rebuilt, a new temperature survey shall be carried out before the furnace is used for heat treatment.

### **M.3.4 Continuous-type furnaces method**

Furnaces used for continuous heat treatment shall be calibrated in accordance with procedures specified in SAE AMS-H-6875.

## **M.4 Instruments**

### **M.4.1 General**

Automatic controlling and recording instruments shall be used.

Thermocouples shall be located in the furnace working zone(s) and protected from furnace atmospheres by means of suitable protective devices.

### **M.4.2 Accuracy**

The controlling and recording instruments used for the heat-treatment processes shall be accurate to  $\pm 1\%$  of their full-scale range.

### **M.4.3 Calibration**

Temperature-controlling and -recording instruments shall be calibrated at least once every three months.

Equipment used to calibrate the production equipment shall be accurate to  $\pm 0,25\%$  of full-scale range.

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Where applicable, authorities having jurisdiction should be consulted.

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## Annex O (normative)

### API Regional Annex

#### O.1 Technical Modifications to ISO 10423:2009

API Committee on Standardization of Oilfield Equipment and Material/Subcommittee 6 has balloted and approved the following technical revisions for the National Adoption of ISO 10423.

<u>Clause/Subclause</u>	<u>Modification</u>
2	<p>Replace “For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.” with:</p> <p>“For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies, except that new editions may be used on issue and shall become mandatory 6 months from the date of the revision.”</p>
2	<p>Replace the normative reference “ASME Boiler and Pressure Vessel Code: 2004 with 2005 and 2006 addenda, Section V, <i>Nondestructive Examination</i>” with:</p> <p>“ASME Boiler and Pressure Vessel Code: Section V, <i>Nondestructive Examination</i>”</p>
2	<p>Replace the normative reference “ASME Boiler and Pressure Vessel Code: 2004 with 2005 and 2006 addenda, Section IX, <i>Welding and Brazing Qualifications</i>” with:</p> <p>“ASME Boiler and Pressure Vessel Code: Section IX, <i>Welding and Brazing Qualifications</i>”</p>
2	<p>Replace the normative reference “ASME Boiler and Pressure Vessel Code: 2004 with 2005 and 2006 addenda, Section VIII, Division 1, <i>Rules for Construction of Pressure Vessels</i>” with:</p> <p>“ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, <i>Rules for Construction of Pressure Vessels</i>”</p>
2	<p>Replace the normative reference “ASTM A703/A703M-08a” with:</p> <p>“ASTM A703/A703M, <i>Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts</i>”</p>
2	<p>Add the following normative references:</p> <p>“ASTM A609, <i>Specification for Ultrasonic Examination for Carbon and Low-Alloy Steel Castings</i></p> <p>ASTM E186, <i>Standard Reference Radiographs for Heavy-Walled (2 to 4½ in.) Steel Castings</i></p> <p>ASTM E280, <i>Standard Reference Radiographs for Heavy-Walled (4½ to 12 in.) Steel Castings</i></p> <p>ASTM E446, <i>Standard Reference Radiographs for Steel Castings Up to 2 in. in Thickness</i>”</p>

- 2 Add the following normative reference:  
“SAE AMS 2750, *Pyrometry*”
- 3.1 Add the following definitions:  
“**3.1.145**  
**full overlay equipment**  
equipment where all retained fluid-wetted surfaces are either weld overlaid or weld clad with a corrosion-resistant alloy or an austenitic stainless steel”  
  
“**3.1.146**  
**partial overlay equipment**  
equipment where some, but not all, retained fluid-wetted surfaces are either weld overlaid or weld clad with a corrosion-resistant alloy or an austenitic stainless steel to resist metal-loss corrosion”
- 4.3.1.1 Add the following note at the end of the clause:  
“NOTE Information on design analysis and load capacities of flanges specified in this International Standard can be found in API Technical Reports 6AF, 6AF1, and 6AF2.”
- 4.3.4 Replace “Bolting stresses, based on the root area of the thread, shall not exceed the limit given in Equation (9):” with:  
“Bolting stresses, based on the minimum cross-sectional area of the bolting, shall not exceed the limit given in Equation (9):”
- 5.3.5.2 b) Replace with:  
“b) test method:  
  
Perform tensile tests at room temperature in accordance with the procedures specified in ISO 6892-1 or ASTM A370.  
  
Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the manufacturer’s specified requirements. The 0,2% offset method shall be used for determination of the yield strength.”
- 5.4.3.1 b) Replace with:  
“b) PSL 2 and PSL 3 requirements:  
  
The requirements for PSL 2 and PSL 3 are identical to the requirements for PSL 1. In addition the manufacturer shall document foundry practices which establish limits for sand control, core-making, rigging, melting and heat treatment and NDE, to ensure repeatability in producing castings which meet the requirements of this International Standard.”
- 5.4.3.1 c) Replace with:  
“c) PSL 4 requirements:  
  
Wrought products shall be used.”
- 5.6.2 c) Replace the second bullet with:  
“— casting: size not required to exceed size shown in ASTM A703/A703M.”

Figure 3 c)

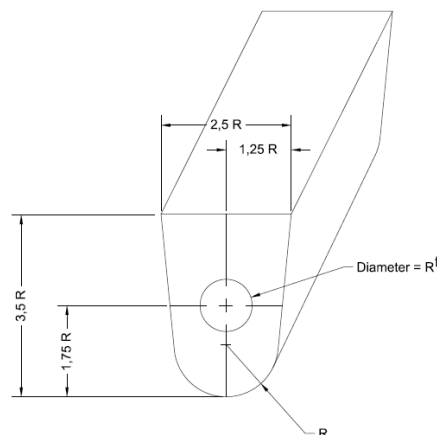
**c) Keel block configuration, ER equals 2,3R**

Figure 3, footnote f

Replace footnote f with:

“<sup>f</sup> This area is the centre core  $\frac{1}{4}T$  envelope for test specimen removal.”

5.6.4.1

Replace the fifth paragraph with:

“ASTM A370 standard-sized, 12,5 mm (0,500 in) diameter tensile specimens shall be used to qualify carbon, low-alloy and stainless steels, unless the physical configuration of the TC prevents their use. In this case, the sub-size specimens referenced in ASTM A370 may be used. Either standard 12,5 mm (0,500 in) or sub-size specimens (see ASTM A370) may be used to qualify CRA materials.”

5.7.4.1

Replace the sixth paragraph with:

“ASTM A370 standard-sized, 12,5 mm (0,500 in) diameter tensile specimens shall be used, unless the physical configuration of the QTC prevents their use. In this case, the sub-size specimens referenced in ASTM A370 may be used.”

6.2 a)

Replace with:

“a) welding procedure/performance:

Welding procedures and performance qualifications shall be in accordance with ASME BPVC: Section IX, Articles II and III.”

6.3.2.3 a)

Replace with:

“a) written procedure:

Welding shall be performed in accordance with welding procedure specifications (WPS), written and qualified in accordance with ASME, BPVC: Section IX, Article II. The WPS shall describe all the essential, nonessential and supplementary essential (if required; see ASME, BPVC: Section IX) variables.

The PQR shall record all essential and supplementary essential (if required) variables of the weld procedure used for the qualification test(s). Both the WPS and the PQR shall be maintained as records in accordance with the requirements of 7.5.”

6.3.2.3 b)

Replace with:

“b) base metal groupings:

The manufacturer may establish a P-number grouping for material(s) not listed in ASME, BPVC: Section IX.”

6.3.2.4 a)

Replace with:

“a) testing requirements:

Welders and welding operators shall be qualified in accordance with ASME, BPVC: Section IX, Article III.”

6.3.2.4 b)

Replace with:

“b) records:

Records of welder performance qualification (WPQ) tests shall be in accordance with ASME, BPVC: Section IX.”

6.3.3.2 a)

Replace with:

“a) base metal groupings:

Each base material that is not listed in an ASME, BPVC: Section IX, P-number or S-number grouping shall be specifically qualified by the manufacturer.”

6.5

Replace Section 6.5 in its entirety with the following:

## **6.5 Weld overlay for corrosion resistance and/or hard facing and other material surface property controls**

### **6.5.1 PSL 1**

#### **6.5.1.1 Corrosion Resistant overlay (including ring grooves and other corrosion resistant overlay)**

##### **6.5.1.1.1 General**

The provisions of 6.5.1.1 apply to use of corrosion-resistant weld overlay for bodies, bonnets, clamp hub end connectors, and end and outlet connectors (including ring grooves). These requirements do not apply to hard facing or to the weld overlay of valve-bore sealing mechanisms, choke trim or valve stems.

##### **6.5.1.1.2 Welding procedure/performance qualification**

Qualification shall be in accordance with ASME, BPVC:2004, Section IX, Articles II and III, for weld overlay.

The following apply:

a) chemical analysis:

Chemical analysis shall be performed on the weld metal in accordance with the requirements of ASME, BPVC, Section IX, at a location 3 mm (0,125 in) or less from the original base-metal surface. The chemical composition of the deposited weld metal at that location shall be as specified by the manufacturer or where applicable in this specification. For austenitic or 300 series stainless steels, the chemical composition shall be as given in Table 13.

**Table 13 — Chemical composition of austenitic or 300 series stainless steels**

Element	Composition % mass fraction
Nickel	8,0 min.
Chromium	16,0 min.
Carbon	0,08 max.

For other compositions that are required to conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2), the chemical analysis of the overlay shall conform to the specification limits of the corresponding approved material(s) of ISO 15156 (all parts) (NACE MR0175; see Clause 2)-.

For nickel-based alloy UNS N06625, the chemical composition shall meet one of the classes given in Table 15.

For all other compositions, the chemical analysis of the overlay shall conform to the specified limits of the manufacturer's written specification.

**Table 14—This table intentionally left blank****Table 15— Chemical composition of the nickel-based alloy UNS N06625**

Class	Element	Composition % mass fraction
Fe 5	Iron	5,0 max.
Fe 10	Iron	10,0 max.

b) mechanical properties

The base metal material shall retain the minimum mechanical property requirements after post-weld heat treatment. The manufacturer shall specify the methods to assure these required mechanical properties and record the results as part of the PQR.

If the overlay material is not considered as part of the manufacturer's or this International Standard's design criteria, a tensile test and an impact test of the overlay material are not required. Other than ring grooves, if the overlay material is considered as part of the manufacturer's design criteria or where dimensions for the product are specified in this International Standard, mechanical testing per clause 5 of the overlay material is required. If overlay material is only part of the manufacturer's design criteria, acceptance criteria for mechanical testing of the overlay material shall be as specified in clause 5, or as established by design analysis and specified by the manufacturer.

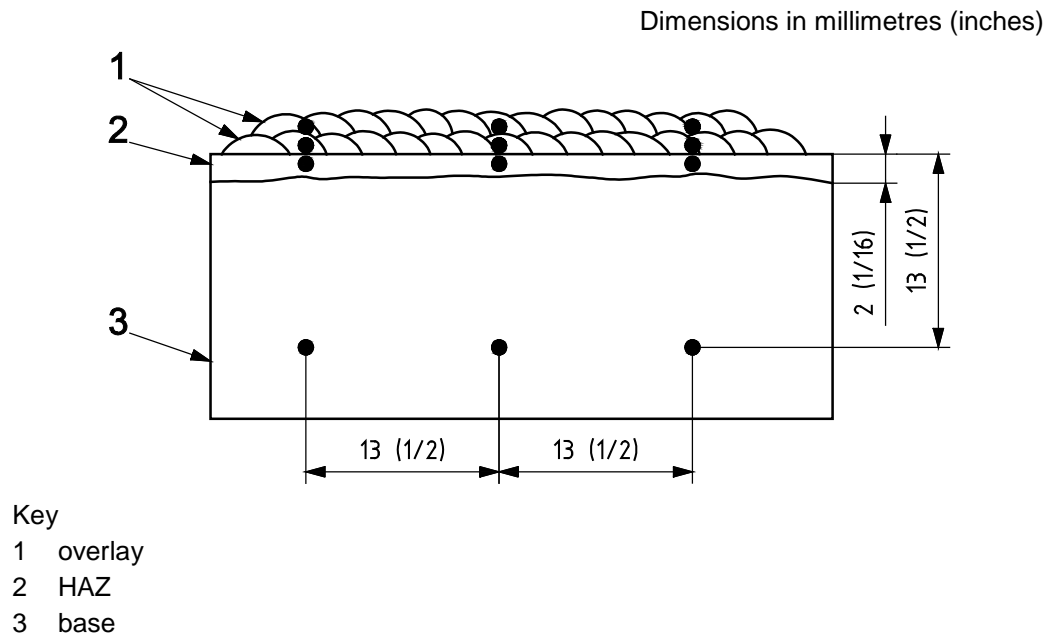
For ring grooves where weld preparations specified in table 52 are used, mechanical testing per clause 5 of the overlay material is not required. Other weld preps may be used but mechanical testing per clause 5 of the overlay material is required to demonstrate the mechanical properties of the deposited weld metal equal or exceed those of the base metal.

- c) weld conformance to ISO 15156 (all parts) (NACE MR0175; see Clause 2)

Welds for use in hydrogen sulfide service shall conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2). If the welding procedure is to be qualified for use on bodies, bonnets or flanges used for material classes DD, EE, FF or HH, hardness testing shall be carried out by the Rockwell method in accordance with ISO 6508 (all parts) or ASTM E18, or the Vickers 98 N method in accordance with ISO 6507 (all parts) or the Vickers 10 kgf method in accordance with ASTM E92. Hardness tests shall be performed at a minimum of three test locations in each of the base material, the heat-affected zone and in each layer of overlay up to a maximum of two layers. See Figure 6 for required hardness test locations.

- d) guided-bend tests:

Guided-bend tests and acceptance criteria shall be in accordance with ASME, BPVC, Section IX, to confirm weld overlay/base material bond integrity. Dimensions in millimetres (inches)



**Figure 6 M.— Hardness test locations for weld overlays**

#### **6.5.1.1.3 Base material conformance to ISO 15156 (all parts) (NACE MR0175; see Clause 2)**

Where the base material is required to meet ISO 15156 (all parts) (NACE MR0175; see Clause 2), the base material shall conform to ISO 15156 (all parts) (NACE MR0175; see Clause 2) after weld overlay and any subsequent heat treatments.

#### **6.5.1.2 Hard facing or other types of weld overlay**

The use of weld overlay for hard facing or for purposes other than those covered by 6.5.1.1 does not require a welding procedure/performance qualification. The manufacturer shall use a written procedure that provides controls for consistently meeting the manufacturer-specified material surface properties in the final machined condition.

### 6.5.1.3 Repair of weld overlays

Repairs of weld overlays, including associated base metal build-up using the overlay material, are acceptable only provided that

- a) the original applicable requirements (6.5.1.1) are adhered to;
- b) if the weld overlay material and/or base metal build-up for the weld overlay are considered part of the design criteria of the manufacturer or of the design criteria of this International Standard, those properties listed in the design criteria are met;
- c) weld overlay repairs and associated base metal build-up for use in hydrogen-sulfide service conform to the requirements of ISO 15156 (all parts) (NACE MR0175; see Clause 2). Weld repairs of the base metal that are not associated with the weld overlays are not allowed for PSL 4 equipment.

## 6.5.2 PSL 2 to PSL 4

### 6.5.2.1 General

The requirements for PSL 2 to PSL 4 shall be identical to the requirements for PSL 1, with the addition of the requirements given in 6.5.2.2 to 6.5.2.5.

### 6.5.2.2 Welding procedure/performance qualification

Qualification shall be in accordance with ASME, BPVC, Section IX, Articles II and III, for weld overlay, hard facing or other types of overlay, as applicable.

### 6.5.2.3 Mechanical properties

The base material shall retain the minimum mechanical property requirements after post-weld heat treatment.

The manufacturer shall specify the methods to assure these mechanical properties and record the results as part of the PQR.

### 6.5.2.4 Hardness testing for ring groove overlay

Hardness testing shall be performed in the weld metal as part of the procedure qualification testing. Test locations shall be within 3 mm (0,125 in) of the original base material. The average of three or more test results shall be equal to or greater than 83 HRB and recorded as part of the PQR.

### 6.5.2.5 Quality control requirements

The quality control requirements for weld metal overlays are shown in Table 18.

For the use of weld overlay for purposes other than those covered in 6.5.1.1, welding procedure/performance qualification requirements are not specified. The manufacturer shall use a written procedure that provides controls for consistently meeting the manufacturer-specified material surface properties in the final machined condition.

- 7.4.2.1.4 c) Replace the first sentence with:  
 “The end and outlet connection threads shall be in accordance with Tables 61 and B.61, API Spec 5B or ASME B1.1, ASME B1.2, and ASME B1.3, as applicable.”
- 7.4.2.1.5 b) Replace the last paragraph with:  
 “Visual examination of forgings and weld preps (when required by Table 18) shall be performed in accordance with manufacturer’s written specifications.”
- 7.4.2.1.5 c) 2) Replace with:  
 “2) for forgings and weld preps (when required by Table 18): in accordance with manufacturer’s written specifications.”
- 7.4.2.1.6 Replace the entire subclause with:  
**“7.4.2.1.6 Weld NDE — General**  
 If examination is required (see Table 18), for all weld types, the essential welding variables and equipment shall be monitored; welding activities shall be audited; and completed weldments [a minimum of 13 mm ( ½ in) of surrounding base metal and the entire accessible weld] shall be examined in accordance with the methods and acceptance criteria of Table 18.  
 The manufacturer’s written specification for corrosion-resistant weld overlay shall include a technique for measuring the specified overlay thickness.”
- 7.4.2.1.7 Add entirely new subclause:  
**“7.4.2.1.7 Weld overlay volumetric inspection**  
 Other testing requirements:  
 Measurement of overlay thickness, testing of bond integrity and volumetric examination shall be according to the manufacturer’s written specifications.  
 If the overlay is considered part of the manufacturer’s design criteria or of the design criteria of this International Standard, volumetric examinations shall be in accordance with the following:  
 a) sampling:  
 As far as practical, the entire volume of weld overlay plus the 3 mm (0.125 in) of adjacent base metal on all sides shall be examined using ultrasonic examination after heat treatment for mechanical properties and prior to machining operations that limit effective interpretation of the results of the examination.  
 NOTE This may require intermediate machining operation to meet surface finish requirements without limiting the effectiveness of results.  
 b) test methods:  
 — Weld overlay shall be examined using ultrasonic examination performed in accordance with the flat-bottom-hole procedures specified in ASTM A388/388M, except that the immersion method may be used, and ASTM E428.  
 — Calibration: The distance amplitude curve (DAC) shall be based on 3,2 mm ( ⅛ in) flat-bottom hole.

c) acceptance criteria:

- No single indication exceeding reference distance amplitude curve.
- No multiple indications exceeding 50 % of reference distance amplitude curve. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm ( $\frac{1}{2}$  in) of each other in any direction."

Table 17

Replace with:

**Table 17 — Quality control requirements for bodies, bonnets, end and outlet connections and clamp hub end connectors**

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3/3G	PSL 4
Tensile testing	7.4.2.1.1	7.4.2.2.1	7.4.2.2.1	7.4.2.2.1
Impact testing	7.4.2.1.2	7.4.2.2.2	7.4.2.3.2	7.4.2.4.2
Hardness testing	7.4.2.1.3	7.4.2.2.3	7.4.2.3.3	7.4.2.3.3
ISO 15156 (all parts) (NACE MR0175; see Clause 2)	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional inspection	7.4.2.1.4	7.4.2.1.4	7.4.2.3.4	7.4.2.3.4
Traceability	—	7.4.2.2.5	7.4.2.3.5	7.4.2.3.5
Chemical analysis	—	7.4.2.2.6	7.4.2.2.6	7.4.2.2.6
Visual examination	7.4.2.1.5	7.4.2.1.5 7.4.2.2.7	—	—
Surface NDE	—	7.4.2.2.8 7.4.2.2.9	7.4.2.3.8	7.4.2.3.8
Weld NDE				No welding permitted except for weld overlays (see 7.4.2.4.9)
General	7.4.2.1.6	7.4.2.1.6	7.4.2.1.6	
Serialization	—	—	7.4.2.3.14	7.4.2.3.14
Volumetric NDE	—	—	7.4.2.3.15	7.4.2.4.11

7.4.2.2.12 a)

Replace the sentence in the subclause with:

“100% of all pressure-containing fabrication welds and weld overlay shall be examined by either magnetic-particle (in the case of ferromagnetic materials) or liquid-penetrant (in the case of ferromagnetic or non-ferromagnetic materials) methods after all welding, post-weld heat treatment and machining operations.”

7.4.2.2.14 c)

Replace with:

“The following acceptance criteria apply:

- no type of crack, zone of incomplete fusion or penetration;
- no elongated slag inclusion that has a length equal to or greater than that given in Table 19;
- no group of slag inclusions in a line having an aggregated length greater than the weld thickness,  $T$ , in any total weld length of  $12T$ , except where the distance between successive inclusions exceeds six times the length of the longest inclusion;
- no rounded indication in excess of that specified in ASME BPVC: Section VIII, Division 1, Appendix 4.”

7.4.2.2.14 d)

Replace with:

“d) test method for ultrasonic examination:

Ultrasonic examinations shall be performed in accordance with procedures specified in ASME, BPVC: Section V, Subsection A, Article 4.”

7.4.2.3.15 b) 1)

Add the following after the first bullet:

“— castings: Ultrasonic examinations of castings shall be performed in accordance with the flat bottom hole procedures specified in ASTM A609 (except immersion method may be used) and ASTM E428.”

7.4.2.3.15 c) 1)

Replace the sentence in the subclause with:

“Radiographic examination of hot-worked parts or castings shall be performed in accordance with methods specified in 7.4.2.2.14.”

Table 18

Replace with the following:

**Table 18 — Quality control requirements for welding bodies, bonnets and end and outlet connections**

Weld type	Stages	PSL 1	PSL 2	PSL 3/PSL 3G	PSL 4
Pressure-containing	Preparation	-	-	7.4.2.1.5	No welding permitted
	Visual	-	-	-	
	Completion	-	-	-	
	Visual	-	7.4.2.2.11	7.4.2.2.11	
	Surface NDE	-	7.4.2.2.12	7.4.2.3.11	
	Volumetric NDE	-	7.4.2.2.14	7.4.2.3.12	
Non-pressure-containing	Hardness test	-	-	7.4.2.3.13	No welding permitted
	Preparation	-	-	7.4.2.1.5	
	Visual	-	-	-	
	Completion	-	-	-	
	Visual	-	7.4.2.2.11	7.4.2.2.11	
	Hardness test	-	-	7.4.2.3.13	
Pressure-containing repairs	Preparation	-	-	-	No welding permitted
	Surface NDE	-	7.4.2.2.13	7.4.2.2.13	
	Completion	-	-	-	
	Visual	-	7.4.2.2.11	7.4.2.2.11	
	Surface NDE	-	7.4.2.2.12	7.4.2.3.11	
	Volumetric NDE	-	7.4.2.2.14	7.4.2.3.12	
Weld metal overlay — partial overlay	Hardness test	-	-	7.4.2.3.13	
	Preparation	-	-	7.4.2.3.8	7.4.2.4.8
	Surface NDE	-	-	-	-
Weld metal overlay — full overlay	Completion	-	-	7.4.2.3.11	7.4.2.4.8
	Surface NDE	-	7.4.2.2.12	-	-
	Preparation	7.4.2.1.5	7.4.2.1.5	7.4.2.1.5	7.4.2.1.5
	Visual	7.4.2.2.11	7.4.2.2.11	7.4.2.2.11	7.4.2.2.11
	Completion	7.4.2.2.12	7.4.2.2.12	7.4.2.3.11	7.4.2.4.8
	Visual	-	-	7.4.2.1.7	7.4.2.1.7
	Surface NDE	-	-	-	-
	Volumetric NDE	-	-	-	-
NOTE “Preparation” refers to surface preparation, joint preparation, fit-up and preheat.					
“Completion” refers to after all welding, post-weld heat treat and machining, except for volumetric NDE which shall be done prior to machining that would limit effective interpretation of results.					

7.4.2.3.15 c) 2)

Add the following at the end of the subclause:

“— The following acceptance criteria apply to cast parts:

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4½ in.) Steel Castings*.

ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4½ to 12 in.) Steel Castings*.

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. in Thickness*.

7.4.2.3.15 c) 2)  
(continued)

Maximum defect classification as follows:

Type Defect	Maximum Defect Class
A	2
B	2
C	2 (all types)
D	none acceptable
E	none acceptable
F	none acceptable
G	none acceptable

7.4.10.1.2 c)

Replace the sentence in the subclause with:

“Acceptance criteria for critical dimensions shall be in accordance with the manufacturer’s specification. The end and outlet connection threads shall be in accordance with Table 61 and Table B.61, API Spec 5B or ASME B1.1, ASME B1.2 and ASME B1.3, as applicable.”

7.4.11

Replace the subclause title with:

**“7.4.11 Bullplugs, valve-removal plugs and back-pressure valves (see Table 38)”**

Table 39

Replace “ISO 10423” with “ISO 10423 and/or API 6A” in the first row.

8.1.1

Add the following at the end of the subclause:

“Manufacturers shall mark their equipment with ‘API 6A’ in addition to or in place of ‘ISO 10423’ in the location specified in this clause. As a minimum, equipment should be marked with US Customary Units.”

8.1.5

Replace the first sentence with:

“The thread type marking, in accordance with API 5CT/ISO 11960, shall be as follows:”

8.1.9 b)

Replace with:

“Clamp hub end connectors shall be marked ‘API 16A’ in addition to or in place of ‘ISO 13533’ following the size and pressure rating.”

8.2

Replace the second paragraph with:

“Wellhead outlets with valve removal preparations shall be marked near the outlet with ‘API 6A’ in addition to or in place of ‘ISO 10423’ followed by the nominal size and “VR” for 69,0 MPa (10 000 psi) working pressure or “HP VR” for 138,0 MPa (20 000 psi) working pressure.”

8.5 e)

Replace with:

“Mark the letter “V” after “API 6A” in addition to or in place of “ISO 10423”.”

8.5 f)

Replace the first sentence with:

“Safety valves meeting the requirements of 10.20 shall be marked with the letters “SSV” or “USV” following “API 6A” in addition to or in place of “ISO 10423”.”

8.10

Replace with:

“Valve-removal plugs shall be marked with “API 6A” in addition to or in place of “ISO 10423” followed by the nominal size and “VR” for 69,0 MPa (10 000 psi) working pressure or “HPVR” for 138,0 MPa (20 000 psi) working pressure, material class and manufacturer’s name or mark, as a minimum.”

- 8.11 Replace the first sentence with:  
 “Bullplugs shall be marked with “API 6A” in addition to or in place of “ISO 10423” followed by the nominal size, material class and manufacturer’s name or mark, as a minimum.”
- 8.12 Replace with:  
 “Back-pressure valves shall be marked with “API 6A” in addition to or in place of “ISO 10423” followed by the nominal size, working pressure, material class and manufacturer’s name or mark, as a minimum.”
- Table 49 Replace “tol.” column values for **Outside diameter of flange** with “±” the stated value.
- Table 50 Replace “tol.” column values for **Outside diameter of flange** with “±” the stated value.
- 10.3.3.5 a) Replace with:  
 “a) for ASTM A194 grades 2HM and 7M:  
 ASTM A194/A194M grades 2HM and 7M are acceptable for all flange sizes and rated working pressures.”

Table 62 Replace the last section of the table with:

Nuts							
ASTM spec. and grades, heavy	A194/A194M 2H, 2HM, 4, 7 or 7M	A194/A194M 2H, 2HM, 4, 7 or 7M	A194/A194M 2H, 2HM, 4, 7 or 7M	A194/A194M 2H, 2HM, 4, 7 or 7M	A194/A194M GR 2HM or 7M	A194/A194M GR 2HM or 7M	A194/A194M GR 2HM or 7M
Hardness as per ISO 15156 (all parts) (NACE MR0175; see Clause 2)	No	No	No	No	Yes	Yes	Yes
Charpy testing required	No	No	No	No	No	No	No

- 10.7.3.7 Replace with:  
 “Slip-type hangers and sealing systems to seal on casing or tubing shall be designed to accommodate the OD pipe tolerance as specified in API 5CT/ISO 11960.”
- 10.8.3.2 b) Replace the first sentence with:  
 “The upper connector of an independent adapter shall be flanged or studded, in accordance with 10.1, or threaded, in accordance with 10.2, or have an other-end connector in accordance with 10.18 or clamp hubend connectors in accordance with API 16A/ISO 13533 or swivel flanges in accordance with API 17D/ISO 13628-4.”
- 10.14.3.4 Replace the second sentence with:  
 “Restricted-area pack-offs to seal on casing or tubing shall be designed to accommodate the OD pipe tolerances as specified in API 5CT/ISO 11960.”
- 10.20.2.3 Replace the first and second bullets with:  
 “— USV valves may use end connections as specified in API 17D/ISO 13628-4.  
 — USVs may be of non-standard bores and/or face-to-face lengths. End connections shall meet all other requirements of this International Standard. Reduced-opening USV flow ports should be sized after consideration of through-flowline (TFL) operations, as specified in API 17C/ISO 13628-3.”

Figure A.9

Replace  
 “SSV/USV Valve  
 Performance test agency  
 (PR2 SSV/USV Valves)\_\_\_\_\_”  
 with:  
 “SSV/USV Valve  
 Performance test agency  
 (Class II SSV/USV valves)\_\_\_\_\_”

Table F.1

Replace Valves, gate and plug / Allowable leakage entry with:  
 “30 cm<sup>3</sup>/hr/25,4 mm of nominal bore size”

Table F.1

Replace Hangers / Allowable leakage entry with:  
 “10 cm<sup>3</sup>/hr/25,4 mm of nominal bore size”

Table G.4

Replace the header row with:

Material	Derating factor $Y_r$			Comment
	149 °C (300 °F)	177 °C (350 °F)	232 °C (450 °F)	

H.5

Replace with:  
 “All tools should be marked “API 6A” in addition to or in place of “ISO 10423” and also as indicated in API 7-1/ISO 10424-1:2004, 5.6, below the tool joint tong space, as a minimum. Wear bushings shall be marked “API 6A” and/or “ISO 10423” followed by the drift internal diameter, expressed in millimetres and inches. A unique serial number shall be die-fixed to each tool assembly, preferably in a milled recess.”

I.1.4

Replace the third sentence in the subclause with:  
 “The successful completion of the test shall qualify all sizes and all pressure ratings of that manufacturer’s SSV/USV of the same basic design and materials of construction for the intended class of service.  
 NOTE <deleted>”

I.2.3.1

Replace the entire subclause with:  
 “**I.2.3.1 Freshwater tank**, with a minimum capacity of 0,8 m<sup>3</sup> (5 bbl) and equipped with a low level pump shutdown control.”

I.2.3.2

Replace the first paragraph with:  
 “**I.2.3.2 Sand slurry tank and associated accessories**, consisting of a cylindrical, cone-bottom sand slurry tank with a minimum capacity of 0,8 m<sup>3</sup> (5 bbl), equipped with an agitation device as required to obtain proper slurry consistency.”

L.6.1

Add the following sentence to the beginning of the subclause:  
 “VR plugs and plug preparations shall be dimensionally inspected.”

- L.6.2                      Replace the sentence with:  
“HP VR plugs and plug preparations shall be dimensionally inspected. Inspection methods shall be in accordance with the manufacturer's documented procedures.”
- L.7                         Replace with:  
“Valve-removal plugs shall be marked with “API 6A” in addition to or in place of “ISO 10423” followed by the nominal size and “VR” for 69,0 MPa (10 000 psi) working pressure or “HP VR” for 138,0 MPa (20 000 psi) working pressure and material class, as a minimum.”
- M.3.3                     Replace the last paragraph with:  
“When a furnace is repaired or rebuilt, a new temperature survey shall be carried out before the furnace is used for heat treatment, subject to the following. Repairs that return the furnace to the condition it was in at the time of the last furnace survey and calibration or repairs that do not affect the temperature tolerance of the furnace shall not require a new temperature survey and calibration. The SAE AMS 2750 sections on furnace modifications and furnace repairs shall be used to determine whether a new furnace survey is required. All furnace repairs and modifications shall be documented and the responsible Quality Assurance organization shall make determination whether an additional furnace survey and calibration is required based on the repairs or modifications in accordance with AMS 2750.”

## **Annex P**

### **(informative)**

## **Use of the API Monogram by Licensees and Test Agency Licensing**

### **P.1 Scope**

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products in accordance with an API product specification.

API Monogram Program licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at <https://ncr.api.org>. API solicits information on new product that is found to be nonconforming with API-specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API-specified requirements.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API-specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, NW, Washington, DC 20005 or call 202-962-4791 or by email at [certification@api.org](mailto:certification@api.org).

### **P.2 References**

In addition to the referenced standards listed earlier in this document, this annex references the following standards:

API Specification Q1

API Specification 6AV1

For applicants and Licensees under the Monogram Program, the latest version of these documents shall be used at all times or by the effective implementation date (when specified on the document). All requirements, including those identified as "supplemental," identified therein are mandatory.

### **P.3 API Monogram Program: Licensee Responsibilities**

#### **P.3.1 Maintaining a License to Use the API Monogram**

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

- a) the quality management system requirements of API Q1;

- b) the API Monogram Program requirements of API Q1, Annex A;
- c) the requirements contained in the API product specification(s) for which the organization desires to be licensed;
- d) the requirements contained in the API Monogram Program License Agreement.

### **P.3.2 Monogrammed Product—Conformance with API Q1**

When an API-licensed organization is providing an API monogrammed product, conformance with API-specified requirements, described in API Q1, including Annex A, is required.

### **P.3.3 Application of the API Monogram**

Each Licensee shall control the application of the API Monogram in accordance with the following.

- a) Each Licensee shall develop and maintain an API Monogram marking procedure that documents the marking/monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's license number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g. 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.
- b) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the Licensee's API Monogram marking procedure if the product is subsequently found to be nonconforming with API-specified requirements. Products that do not conform to API-specified requirements shall not bear the API Monogram.
- c) The API Monogram shall be applied at the licensed facility, unless alternate arrangements are approved by the API Monogram. Only an API Licensee may apply the API Monogram and its license number to API monogramable products. For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Under the requirements for alternate API Monogram marking procedures, third-party API Monogram marking activities shall be licensed separately by the API Monogram Program. The current API requirements for Monogram marking are detailed in the API Policy Document, *Monogram Marking Requirements*, available on the API Monogram Program website at <http://www.api.org/certifications/monogram/documents/applications.cfm>.
- d) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee's API Monogram marking procedure.

### **P.3.4 Records**

Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

### **P.3.5 Quality Program Changes**

Any proposed change to the Licensee's quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

### **P.3.6 Use of the API Monogram in Advertising**

Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee's authorization (license number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

## **P.4 Marking Requirements for Products**

### **P.4.1 General**

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

### **P.4.2 Product Specification Identification**

Manufacturers shall mark equipment with the information identified in Section 8, as a minimum, including “API Spec 6A” in addition to or in place of “ISO 10423.”

### **P.4.3 Units**

Units are defined by the product specification. As a minimum, equipment should be marked with U.S. customary (USC) units. Use of dual units [metric (SI) units and USC units] is acceptable, when permitted by the document.

### **P.4.4 Nameplates**

Nameplates, when required, shall be made of a corrosion-resistant material and shall be located as indicated in Section 8. If the location is not identified, then P.3.3 a) shall apply.

The API Monogram shall be marked on the nameplate, in addition to the marking requirements of this specification.

### **P.4.5 License Number**

The API Monogram License number shall not be used unless it is marked in conjunction with the API Monogram.

### **P.4.6 Repaired or Remanufactured Equipment**

The API Monogram shall not be applied to any product that has been repaired or remanufactured, including those products that meet the requirements of Annex J of this specification.

## **P.5 API Monogram Program: API Responsibilities**

The API shall maintain records of reported problems encountered with API monogrammed products. Documented cases of nonconformity with API-specified requirements may be reason for an audit of the Licensee involved (also known as audit for “cause”).

Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.

## **P.6 Additional Requirements**

The requirements for Test Agency Licensing are given in API Specification 6AV1.

## Bibliography

- [1] ISO 13628-3, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 3: Through flowline (TFL) systems*
- [2] API Spec 5CT, *Specification for Casing and Tubing*
- [3] API Spec 6A, *Specification for Wellhead and Christmas Tree Equipment*
- [4] API TR 6AF, *Technical Report on Capabilities of API Flanges Under Combinations of Load*
- [5] API TR 6AF1, *Technical Report on Temperature Derating on API Flanges Under Combination of Loading*
- [6] API TR 6AF2, *Technical Report on Capabilities of API Integral Flanges Under Combination of Loading — Phase II*
- [7] API Spec 6FA, *Specification for Fire Test for Valves*
- [8] API Spec 14D, *Specification for Wellhead Surface Safety Valves and Underwater Safety Valves for Offshore Service*
- [9] ASME B16.34, *Valves-Flanged, Threaded, and Welding End*
- [10] ASME B18.2.2, *Square and Hex Nuts (Inch Series)*
- [11] ASME, Boiler And Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section II, *Materials*
- [12] ASME, Boiler And Pressure Vessel Code:2004 with 2005 and 2006 addenda, Section VIII, Division 3, *Alternative Rules for Construction of High Pressure Vessels*
- [13] ASME SPPE 1, *Quality Assurance and Certification of Safety and Pollution Prevention Equipment Used in Offshore Oil and Gas Operations<sup>8)</sup>*
- [14] ASTM E21, *Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials*
- [15] ASTM E110, *Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers*
- [16] API Spec 6A718, *Specification of Nickel Base Alloy 718 (UNS N07718) for Oil and Gas Drilling and Production Equipment*

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8) Out of print; included to deal with old equipment made to obsolete standards.

**Date of Issue:** August 2016

**Affected Publication:** API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*, Twentieth Edition, October 2010

## ERRATA 10

(including changes from Errata 1, January 2011; Errata 2, November 2011; Errata 3, June 2013; Errata 4, August 2013; Errata 5, November 2013; Errata 6, March 2014; Errata 7, December 2014; Errata 8, February 2016; and Errata 9 [correction], June 2016)

**ERRATA 8** published in June 2016 should have been published as **ERRATA 9**; the PDF version of the **ERRATA 8**, June 2016 document has been updated to **ERRATA 9**.

**ERRATA 8, February 2016, and ERRATA 9, June 2016, Page 91, Table 33 and Table 34, change:**

*text*

*to*

*test*

*Page vii, Table of Contents, change:*

Annex O (informative) API Regional Annex

*to*

Annex O (normative) API Regional Annex

*Page 67, Table 17, change:*

Impact Testing	7.4.2.1.2	7.4.2.1.2	7.4.2.1.2	7.4.2.1.2
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*to*

Impact Testing	7.4.2.1.2	7.4.2.2.2	7.4.2.3.2	7.4.2.4.2
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*Page 69, 7.4.2.2.12 a), change to read:*

100% of all pressure-containing fabrication welds and weld overlay shall be examined by either magnetic-particle (in the case of ferromagnetic materials) or liquid-penetrant (in the case of **ferromagnetic or** non-ferromagnetic materials) methods after all welding, post-weld heat treatment and machining operations.

*Page 87, Table 30, insert the following footnote at the end of the table:*

Note: Due to SI unit conversion methods noted in Annex B, the drift dimensions in millimeters may have interference if used for drifting equipment manufactured to USC bore sizes, measured in inches. It is recommended that the units of measure used for the drift diameter  $D_1$  be consistent with the units used for manufacturing equipment to be drift tested.

Page 89, **7.4.9.4.5**, change:

The following apply:

to

**For PSL 2 and PSL 3G, the following apply:**

Page 91, **Table 33**, change:

Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	—	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
	seat	—	—	7.4.9.5.6	7.4.9.5.6	7.4.9.5.6

to

Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	<b>7.4.9.4.5</b>	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	<b>7.4.9.5.4</b>	7.4.9.5.4
	seat	—	—	7.4.9.5.6	—	7.4.9.5.6

Page 91, **Table 34**, change:

Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	—	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	7.4.9.5.4	7.4.9.5.4
	seat	—	—	7.4.9.5.6	7.4.9.5.6	7.4.9.5.6

to

Hydrostatic test	body	7.4.9.3.3	7.4.9.3.3	—	—	—
	seat	7.4.9.3.5	7.4.9.4.5	—	<b>7.4.9.4.5</b>	—
Hydrostatic test (extended)	body	—	—	7.4.9.5.4	<b>7.4.9.5.4</b>	7.4.9.5.4
	seat	—	—	7.4.9.5.6	—	7.4.9.5.6

Page 96, **7.4.10.1.2 c)**, change the reference in the second sentence from:

Table 48 and Table B.48

to

Table 61 and Table B.61

Page 102, change title from:

**7.4.11 Bullplugs, valve-removal plugs and back-pressure valves** (see Table 26)

to

**7.4.11 Bullplugs, valve-removal plugs and back-pressure valves** (see Table **38**)

Page 121, **Table 49**:

Change “tol.” column values for **Outside diameter of flange** to be “±” the stated value.

Page 124, **Table 50**:

Change “tol.” column values for **Outside diameter of flange** to be “±” the stated value.

Page 162, **Table 63** (continued), line R 57, change the **Width of Flat of Octagonal Ring (C)** value from:

7,79

to

7,75

Page 198, **Table 87** (continued):

The first two columns, for **13,8 MPa**, **20,7 MPa**, and **34,5 MPa**, should read as follows:

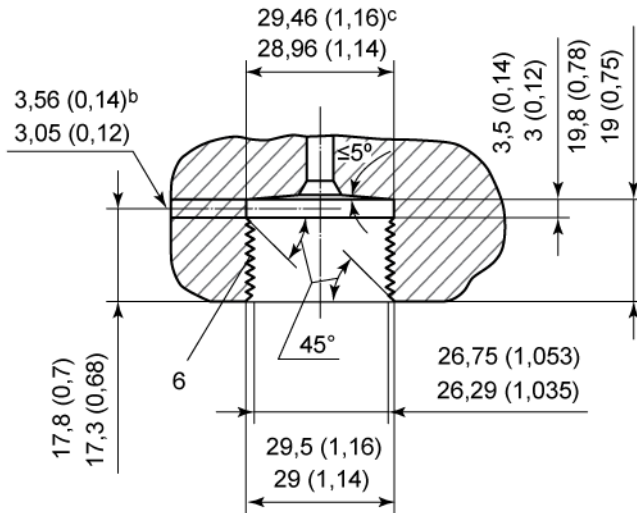
Nominal size and bore	
Vertical $B_V$ +0,8 0	Outlet $B_0$ +0,8 0
<b>13,8 MPa</b>	
52	52
65	52
65	65
79	52
79	65
79	79
103	52
103	65
103	79
103	103
<b>20,7 MPa</b>	
79	52
79	65
79	79
103	52
103	65
103	79
103	103
<b>34,5 MPa</b>	
52	52
65	52
65	65
79	52
79	65
79	79
103	52
103	65
103	79
103	103
130	52
130	65
130	79
130	103
130	130

Page 200, **Table 88** (continued):

The first two columns, for **13,8 MPa**, **20,7 MPa**, and **34,5 MPa**, should read as follows:

Nominal size and bore	
Vertical $B_V$ +0,8 0	Outlet $B_O$ +0,8 0
<b>13,8 MPa</b>	
52	52
65	52
65	65
79	52
79	65
79	79
103	52
103	65
103	79
103	103
<b>20,7 MPa</b>	
79	52
79	65
79	79
103	52
103	65
103	79
103	103
<b>34,5 MPa</b>	
52	52
65	52
65	65
79	52
79	65
79	79
103	52
103	65
103	79
103	103
130	52
130	65
130	79
130	103
130	130

Page 202, **Figure 19 d)**, replace with the following:



d) Female preparation

Key

- 1 collar
- 2 gland
- 3 plug
- 4 male by male
- 5 coupling
- 6 1 1/8 - 12 UNF-2B

- a Minimum depth perfect female thread.
- b Drill for vent optional but recommended.
- c 15,7 (0,62) minimum thread length or undercut to thread relief as an option.

Page 218, **Section 10.19.9**, delete the following:

“and shall be equipped with a bleeder plug”

Page 272, **Table B.55** (continued), change:

10 000 psi										
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,13	8,81	7,19	3,19	0,38

to

10 000 psi										
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,12	8,81	7,19	3,19	0,38

Page 277, **Table B.57** (continued), change:

10 000 psi										
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,13	8,81	7,19	3,19	0,38

to

10 000 psi										
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,12	8,81	7,19	3,19	0,38

Page 319, **Table F.1**, *change* Valves, gate and plug / Allowable leakage to:

30 cm<sup>3</sup>/hr/25,4 mm of nominal bore size

Page 319, **Table F.1**, *change* Hangers / Allowable leakage to:

10 cm<sup>3</sup>/hr/25,4 mm of nominal bore size

Page 355, **Table G.4**, *remove the following row*:

ASTM A453/453M Gr660 (UNS S66286)	0,99	0,95	0,97
--------------------------------------	------	------	------

Page 383, **Section K.9**, *delete the second sentence*:

“Top connectors shall be shipped with a bleeder plug.”

Page 393, **Table K.5**, fifth row, **Seals** column, *replace*:

SAE AS 568-436-90 FKM

*with*

SAE AS 568-435-90 FKM



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