Specification for Wellhead and Christmas Tree Equipment

ANSI/API Specification 6A
Nineteenth Edition, July 2004

ISO 10423:2003, (Modified) Petroleum and natural gas industries—Drilling and production equipment—Wellhead and Christmas tree equipment

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This American National Standard is under the jurisdiction of the API Subcommittee on Valves and Wellhead Equipment (API C1/SC6). This standard is a modified adoption of the English version of ISO 10423:2003. ISO 10423 was prepared by Technical Committee ISO/TC 67, Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries, SC 4, Drilling and production equipment which was based on the prior API Specification 6A, 17th Edition.

In this American National Standard certain technical modifications have been made. These technical modifications from the ISO Standard have not been incorporated directly into this API adopt-back version.

The modifications have been noted with an arrow (➔) adjacent to the clause, table, figure, etc. that has been modified.

A complete list of modifications can be found in Annex O—API Regional Annex. Informative Annex N—API Monogram and Test Agency Licensing is also included giving guidance for the users.

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ISO 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 third edition cancels and replaces the second edition (ISO 10423:2001), of which it constitutes a minor revision. Details of the differences between this third edition and the second edition may be obtained, upon request, from ISO/TC 67/SC 4.

Introduction

This International Standard is based on API Spec 6A, seventeenth edition, February 1996, its errata and supplement, and API Spec 6AV1, first edition, February 1996.

The contents of API Spec 14D (upon which ISO 10433 was based) and API Recommended Practice 14H (upon which ISO 10419 was based) have been incorporated in API Spec 6A, seventeenth edition.

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 which are marked with an asterisk are repeated in Annex B in US Customary units with the same table number as in the main body but with the prefix B. In figures where dimensions are only given in inches, the values of surface roughness have been indicated in accordance with US draughting conventions. See also Annex M for listings of tables and figures.

Users of this International Standard should be aware that further or differing requirements may 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 may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should 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;

— hubs;

— pressure boundary penetrations;

— ring gaskets;

— running and testing tools (in Annex H);

— wear bushings (in Annex H).

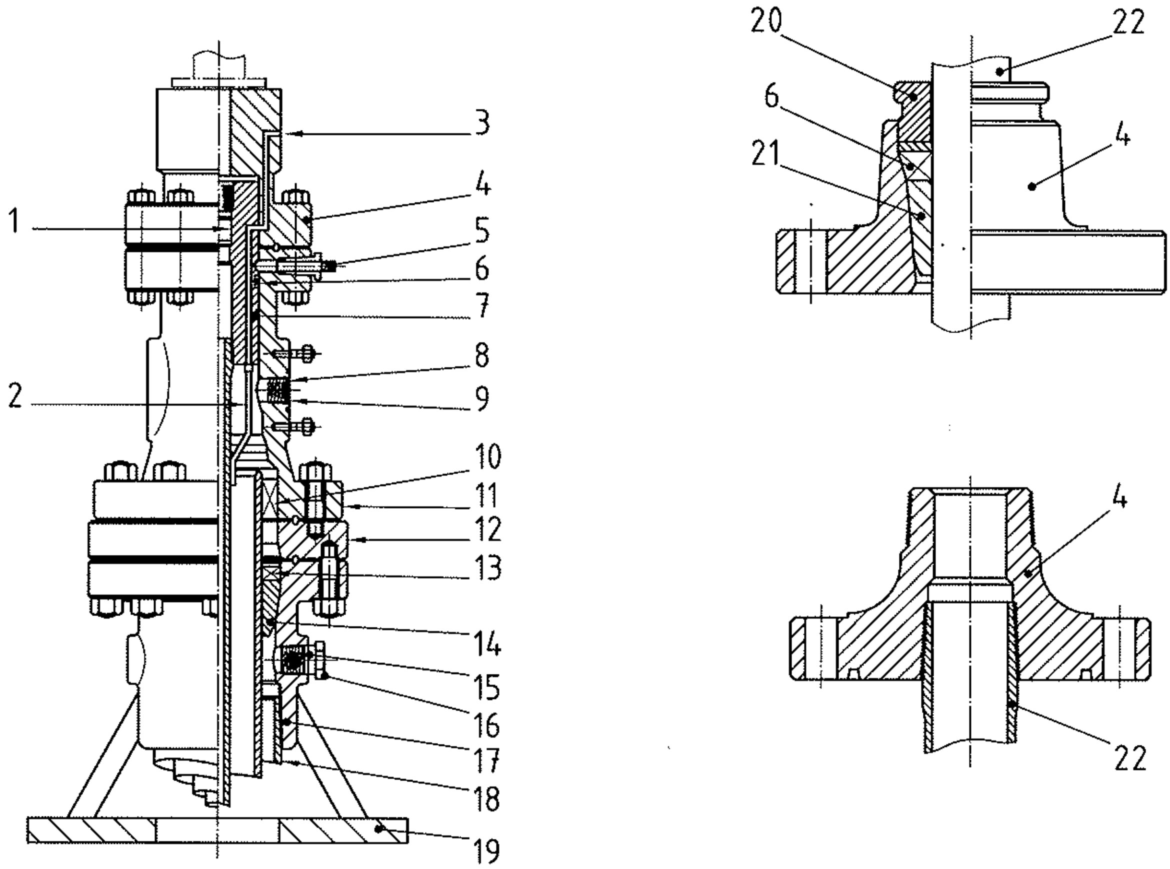
The nomenclature used in this International Standard for typical equipment is shown in Figure 1 and Figure 2. All parts whose physical dimensions conform to the metric tables incorporated into the body of this International Standard or to the US Customary units tables in Annex B are acceptable (see Introduction).

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 (PSL)

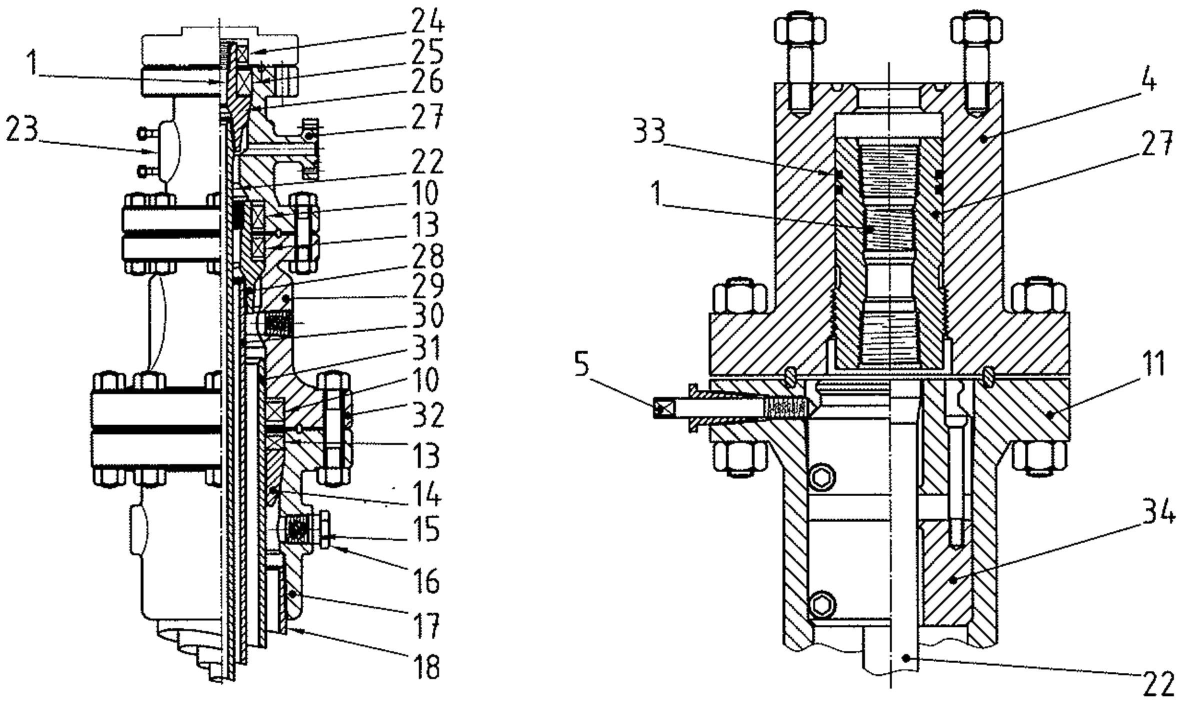
This International Standard establishes requirements for five product specification levels. These five PSL designations define different levels of technical quality requirements. Annex A provides guidelines (not requirements) for selecting an acceptable PSL.



Key

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

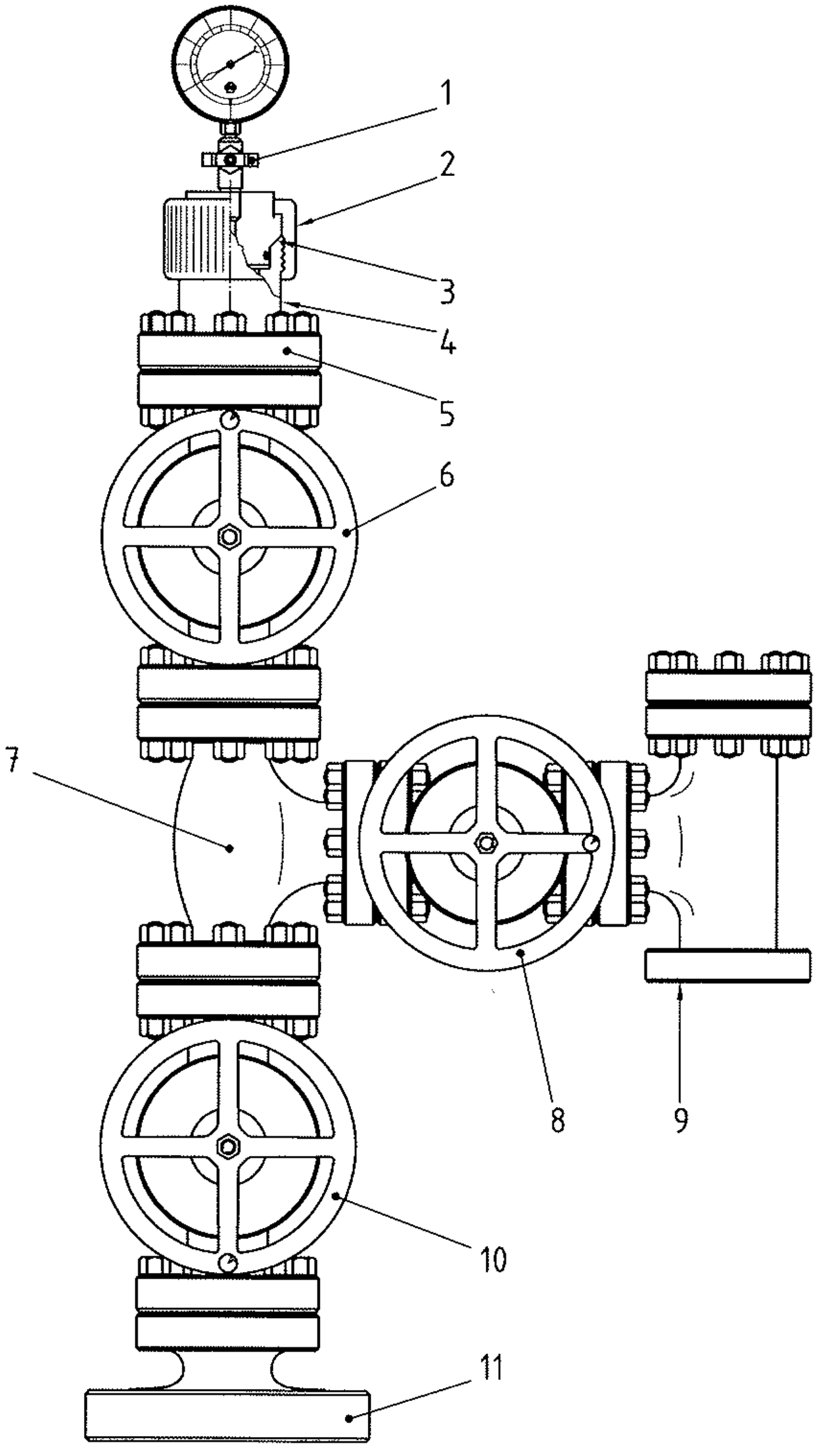
Figure 1 — Typical wellhead assembly nomenclature



Key

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

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



Key

1 gauge valve	7 tee
2 bonnet nut	8 wing valve
3 blanking plug	9 choke
4 body	10 master valve
5 top connector	11 tubing head adapter
6 swab or crown valve	

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

ISO 10422:1993, *Petroleum and natural gas industries — Threading, gauging, and thread inspection of casing, tubing and line pipe threads — Specification*

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 and line pipe*

API [1] Spec 7:1997, *Specification for rotary drill stem elements*

API RP 14F, *Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum production facilities for unclassified and class 1, division 1 and division 2 locations*

ASME [2] B1.1, *Unified inch screw threads*

ASME B1.2, *Gages and gaging for unified inch screw threads*

ASME B1.20.1, *Pipe threads, general purpose (inch)*

ASME Boiler and Pressure Vessel Code:1998, Section V, *Non destructive examination*

ASME Boiler and Pressure Vessel Code:1998, Section VIII, Division 1, *Rules for construction of pressure vessels*

ASME Boiler and Pressure Vessel Code:1998, Section VIII, Division 2, *Alternative rules for construction of pressure vessels*

ASME Boiler and Pressure Vessel Code:1998, Section IX, *Welding and brazing qualifications*

ASNT [3] SNT-TC-1A, *Personnel qualifications and certification in non destructive testing*

ASTM [4] A 193/A 193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service*

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

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

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

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

ASTM A 194/A 194M, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A 320/A 320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service*

ASTM A 370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A 388/A 388M, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings*

ASTM A 453/A 453 M, *Standard Specification for High-Temperature Bolting Materials, With Expansion Coefficients Comparable to Austenitic Stainless Steels*

ASTM A 703/A 703M:1999, *Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts*

ASTM D 395, *Standard Test Methods for Rubber Property — Compression Set*

ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*

ASTM D 471, *Standard Test Method for Rubber Property — Effect of Liquids*

ASTM D 1414, *Standard Test Methods for Rubber O-Rings*

ASTM D 1415, *Standard Test Method for Rubber Property — International Hardness*

ASTM D 1418, *Standard Practice for Rubber and Rubber Latices — Nomenclature*

ASTM D 2240, *Standard Test Method for Rubber Property — Durometer Hardness*

ASTM E 10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E 18, *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*

ASTM E 92, *Standard Test Method for Vickers Hardness of Metallic Materials*

ASTM E 94, *Standard Guide for Radiographic Examination*

ASTM E 140, *Standard Hardness Conversion Tables for Metals — Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness and Scleroscope Hardness*

ASTM E 165, *Standard Test Method for Liquid Penetrant Examination*

ASTM E 428, *Standard Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Examination*

ASTM E 709, *Standard Guide for Magnetic Particle Examination*

ASTM E 747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*

EN [5] 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

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

MSS[6] SP-55, *Quality standard for steel castings for valves, flanges and fittings and other piping components, visual method for evaluation of surface irregularities*

NACE[7] MR 0175:1999, *Standard material requirements — Sulfide stress cracking resistant metallic materials for oilfield equipment*

SAE[8] 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 which can be viewed, for purposes of non-destructive examination, 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

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 packoff
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

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

7) NACE, P.O. Box 218340, Houston, TX 77218, USA.

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

3.1.8
body
any portion of wellhead and christmas tree equipment between end connections, with or without internal parts, which contains well-bore pressure

3.1.9
bolting closure
threaded fastener used to assemble well-bore pressure-containing parts or join end or outlet connections

EXAMPLES Studs, nuts, bolts and capscrews.

3.1.10
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

3.1.11
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

3.1.12
bonnet
pressure-containing closure for a body, other than an end or outlet connection

3.1.13
bottom casing packoff
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

3.1.14
bullplug
pressure-containing closure for a female threaded end or outlet connection, which may have an internal counter bore and/or test port

3.1.15
calibration
comparison and adjustment to a standard of known accuracy

3.1.16
carbon steel
alloy of carbon and iron containing a maximum of 2 % carbon (mass fraction), 1,65 % manganese (mass fraction), and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminium)

3.1.17
casing
pipe run from the surface and intended to line the walls of a drilled hole

3.1.18
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

3.1.19
slip-type casing hanger
mechanism used to support a casing string in a casing head by gripping the pipe with wedge-type members

3.1.20
casing head housing
equipment attached to the uppermost end of the surface casing which serves to suspend and seal a casing string

3.1.21
casing head spool
equipment attached to another casing head which serves to suspend and seal a secondary casing string

3.1.22
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.

3.1.23
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 flowrate

3.1.26
choke trim
pressure-controlling choke component, including choke beans, used to control or regulate the flow of fluids

NOTE One-piece stems, and that segment of multi-piece stems that passes through the pressure boundary, are pressure-containing components.

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
conformance
compliance with specified requirements

3.1.29
loose connector
connector, as-manufactured, not intended to be made integral with another piece of wellhead and christmas tree equipment

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

3.1.30
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)

3.1.31
corrosion-resistant ring grooves
ring grooves lined with metal resistant to metal-loss corrosion

NOTE This metal is either a CRA or an austenitic stainless steel.

3.1.32
cross
pressure-containing fitting with a minimum of four openings

3.1.33
cross-over connector
adapter with a restricted-area sealing means and with a top-connection pressure rating above that of the lower connection

3.1.34
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

3.1.35
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.

3.1.36
date of manufacture
date of manufacturer's final acceptance of finished equipment

3.1.37
date of repair/remanufacture
date of repairer's/remanufacturer's final acceptance of finished equipment

3.1.38
dynamic seal
seal in which motion exists relative to the sealing surface after installation

3.1.39
end connection
outlet connection
integral male or female thread; 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
fit
geometric relationship between parts

NOTE This includes the tolerance criteria used during the design of a part and its mating part.

3.1.43
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

3.1.43.1
blind flange
flange with no centre bore, used to close off completely a flanged end or outlet connection

3.1.43.2
loose flange
flange, as-manufactured, 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.

3.1.43.3
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

3.1.43.4
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

3.1.44
forging, noun
shaped metal part formed by the forging method

3.1.45
forge, verb
deform metal plastically into desired shapes with compressive force

NOTE Forging is usually a hot process. Use of dies is optional.

3.1.46
form
essential shape of a product including all its component parts

3.1.47
function
operation of a product during service

3.1.48
gauge and test port connection
hole drilled and tapped into wellhead and christmas tree equipment through which internal pressure may be measured or through which pressure may be applied to test the sealing mechanisms

3.1.49
hanger mandrel
portion of a casing or tubing hanger which is attached by a threaded connection to the tubular string and forms the upper end of that tubular string

3.1.50
heat-affected zone
HAZ
portion of the base metal which has not been melted, but whose mechanical properties or microstructure has been altered by the heat of welding or cutting

3.1.51
heat
cast lot
material originating from a final melt

NOTE For remelted alloys, a heat is the raw material originating from a single remelted ingot.

3.1.52
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

3.1.53
heat treat lot
⟨batch furnaces⟩ material placed on loading or carry devices and moved as a batch through one heat treat cycle

3.1.54
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

3.1.55
heat treatment
heat treating
alternating steps of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties

3.1.56
hold period
period of time that the product is subjected to pressure and isolated from the pressure source

3.1.57
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.

3.1.58
hot-work
deform metal plastically at a temperature above the recrystallization temperature

3.1.59
hub
protruding rim with an external angled shoulder and a sealing mechanism used to join pressure-containing equipment

3.1.60
job lot traceability
ability for parts to be traced as originating from a job lot which identifies the included heat(s)

3.1.61
linear indication
surface NDE indication whose length is equal to or greater than three times its width

3.1.62
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

3.1.63
low-alloy steel
steel containing less than 5 % (mass fraction) total alloying elements, but more than that specified for carbon steel

NOTE Steels with less than 11 % chromium (mass fraction) are included in this category.

3.1.64
make-and-break, verb
connect and disconnect a connection

3.1.65
manufacturing operation
activity involving, but not limited to, the machining, welding, heat treating or other processes utilized to produce a finished product

3.1.66
material performance basis
capabilities which must be demonstrated, as a minimum, for material to satisfy the criteria of this International Standard

3.1.67
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.

3.1.68
objective evidence
documented field experience, test data, publications, finite element analysis or calculations that verify performance characteristics, as applicable

3.1.69
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.

3.1.70
post-weld heat treatment
any heat treatment subsequent to welding, including stress relief

3.1.71
pressure-boundary penetration
device which penetrates directly into or communicates with the wellbore 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.

3.1.72
pressure-containing part
part whose failure to function as intended would result in a release of retained fluid to the atmosphere

EXAMPLES Bodies, bonnets and stems.

3.1.73
pressure-controlling part
part intended to control or regulate the movement of pressurized fluids

EXAMPLES Valve bore sealing mechanisms, choke trim and hangers.

3.1.74
pressure integrity
structural and leak-resistant capability of a product to contain applied pressure

3.1.75
pressure vessel quality
metallic material specified for pressure-containing or pressure-controlling parts conforming to the applicable product specification level requirement

3.1.76
primary equipment
pieces of equipment that cannot normally be isolated from well fluid or well pressure

3.1.77
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

3.1.78
rated working pressure
maximum internal pressure that the equipment is designed to contain and/or control

NOTE Working pressure is not to be confused with test pressure.

3.1.79
records
retrievable information

3.1.80
relevant indication
surface 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.

EXAMPLES Magnetic permeability variations, non-metallic stringers.

3.1.81
remanufacture
activity involving disassembly, reassembly and testing of wellhead and christmas tree equipment, with or without the replacement of parts, where machining, welding, heat treating or other manufacturing operations are employed

NOTE Remanufacture does not include the replacement of bodies.

3.1.82
repair
activity involving disassembly, reassembly and testing of wellhead and christmas tree equipment with or without the replacement of parts

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

3.1.83
repair level
level to which equipment will be repaired or remanufactured in compliance with this International Standard

3.1.84
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

3.1.85
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

3.1.86
restricted-area sealing means
restricted-area pack-off
packoff 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 which encloses a pressure-containment area smaller than the adjacent ring gasket or connector seal.

3.1.87
retained fluid
actual fluid produced by a well or injected into a well

3.1.88
room temperature
any temperature between 4 °C and 50 °C (40 °F and 120 °F)

3.1.89
rounded indication
surface NDE indication which is circular or elliptical, having a length less than 3 times its width

3.1.90
running tool
tool used to run, retrieve, position or connect wellhead equipment remotely from the drill floor

3.1.91
secondary equipment
piece of equipment that can normally be isolated from the well fluid or well pressure

3.1.92
serialization
assignment of a unique code to individual parts and/or pieces of equipment to maintain records

3.1.93
spacer
pressure-containing piece of equipment used to connect and provide separation between other pieces of equipment

3.1.94
specified material
material meeting a particular performance requirement(s) as specified by a manufacturer or industry standard

3.1.95
stainless steel
steel containing more than 11 % chromium (mass fraction) to render the steel corrosion-resistant

NOTE Other elements may be added to secure special properties.

3.1.96
static seal
seal in which no motion exists relative to sealing surfaces after installation

3.1.97
stress-corrosion cracking
cracking which results from a combination of corrosion and stress

3.1.98
stress relief
controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses after welding

3.1.99
studded-flange connection
flanged end or outlet connection in which thread-anchored studs screwed into tapped holes replace the holes for bolt studs

3.1.100
substantive change
change identified by the manufacturer which affects the performance of the product in the intended service

3.1.101
sulfide-stress cracking
cracking of metallic materials due to exposure to fluid containing hydrogen sulfide

3.1.102
surface safety valve
SSV
automatic wellhead valve assembly which 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.

3.1.103
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

3.1.104
SSV valve
USV valve
portion of the SSV/USV which contains the wellstream and shuts off flow when closed

3.1.105
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.

3.1.106
test tool
tool used to run into the wellhead in order to perform a pressure test

3.1.107
top connector
bottom hole test adapter
uppermost fitting of a christmas tree which allows full-bore access to the christmas tree

3.1.108
thread protector
cap or insert used to protect threads and seals during handling, transportation and storage

3.1.109
tubing
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.

3.1.110
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

3.1.111
tubing head adapter
equipment which adapts the uppermost connection of a tubing head to the lowermost valve of the christmas tree

3.1.112
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

3.1.113
underwater safety valve
USV
automatic valve assembly (installed at an underwater wellhead location) which will close upon loss of power supply

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

3.1.114
valve-bore sealing mechanism
internal valve parts which close off the flow through the valve bore

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

3.1.115
check valve
valve that permits fluid to flow freely in one direction and contains a mechanism to automatically prevent flow in the other direction

3.1.116
full-bore valve
valve whose closure mechanism has the same bore dimension as the valve body

3.1.117
gate valve
valve assembly with a gate operating within the body, 90° to the conduit, to effect a closure

3.1.118
master valve
lowermost valve on the vertical bore of the christmas tree

NOTE It is used to completely shut in the well.

3.1.119
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.

3.1.120
reduced-opening valve
valve with either a regular or Venturi-type opening, either circular or non-circular, through the closure mechanism

3.1.121
swab valve
crown valve
uppermost valve on the vertical bore of the christmas tree above the flowline outlet

3.1.122
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

3.1.123
wing valve
valve located on the christmas tree, but not in the vertical run, which can be used to shut off well flow

3.1.124
valve-removal plug
threaded plug which can be installed in the wellhead to enable gate valve removal under pressure

3.1.125
visual examination
examination of parts and equipment for visible defects in material and workmanship

3.1.126
volumetric non-destructive examination
volumetric NDE
examination for internal material defects by methods such as radiography and/or ultrasonic testing

3.1.127
wear bushing
retrievable cylindrical device which protects the internal surfaces of wellhead equipment and the top of the last casing suspended

3.1.128
fabrication weld
weld joining two or more parts

3.1.129
non-pressure-containing weld
weld whose absence does not reduce the pressure-containing integrity of the part

3.1.130
pressure-containing weld
weld whose absence reduces the pressure-containing integrity of the part

3.1.131
weld groove
area between two metals to be joined that has been prepared to receive weld-filler metal

3.1.132
weld joint
fitting together of components in order to facilitate joining by welding

3.1.133
welding
fusion of materials, with or without the addition of filler materials

3.1.134
wellhead
all permanent equipment between the uppermost portion of the surface casing and the tubing head adapter connection

3.1.135
wetted surface
any surface which has contact with pressurized well fluid, either by design or because of internal seal leakage

3.1.136
wrought products
products shaped by means of forging or hot isostatic pressing

3.1.137
wrought structure
structure that contains no cast dendritic elements

3.1.138
yield strength
stress level, measured at room temperature, at which material plastically deforms and will not return to its original dimensions when the load is released

NOTE All yield strengths specified in this International Standard are the 0,2 % yield offset strength in accordance with ASTM A 370.

3.2 Abbreviated terms

For the purposes of this International Standard, 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
OEM	original equipment manufacturer
PQR	procedure qualification record
PR	performance requirement
PSL	product specification level
QTC	qualification test coupon
r.m.s.	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 this clause and 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 include load capability, cycles, and operating force or torque. There are two performance requirement levels: PR1 and PR2. Valves operating as safety valves 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:

MPa	(psi)
13,8	2 000
20,7	3 000
34,5	5 000
69,0	10 000
103,5	15 000
138,0	20 000

4.2.1.2 Threaded equipment limitations

Equipment designed with internal 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 shall also be considered, such as pressure rating changes in cross-over connectors and pressurizing with temporary test plugs. 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	Size OD	Rated working pressure	
	in	mm	MPa	(psi)
Line-pipe/NPT	$^1/_2$	21,3	69,0	10 000
(nominal sizes)	$^3/_4$ to 2	26,7 to 60,3	34,5	5 000
	$2^1/_2$ to 6	73,0 to 168,3	20,7	3 000
Tubing, non-upset, and external upset round thread	1,050 to $4^1/_2$	26,7 to 114,3	34,5	5 000
Casing	$4^1/_2$ to $10^3/_4$	114,3 to 273,1	34,5	5 000
(8 round, buttress,	$11^3/_4$ to $13^3/_8$	298,5 to 339,7	20,7	3 000
and extreme line)	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.

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 would experience in service. Design for high temperature rating, e.g. X and Y, 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 the ultimate responsibility of the user. In making these selections, the user should consider the temperature the equipment would 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
P	− 29	82	− 20	180
R	Room temperature		Room temperature	
S	− 18	66	0	150
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, which meet requirements set forth in Table 3. Table 3 does not define either the present or the future wellhead environment, but provides material classes for increasing levels of severity of service conditions and relative corrosivity.

Provided the mechanical properties can be met, stainless steels may be used in place of carbon and low-alloy steels and corrosion-resistant alloys may be used in place of stainless steels.

4.2.3.2 Material classes

Choosing material classes is the ultimate responsibility of the user. In making these selections, the user should consider the various environmental factors and production variables listed in Annex A.

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 [a]	Carbon or low-alloy steel [b]	Carbon or low-alloy steel [b]
EE — Sour service [a]	Carbon or low-alloy steel [b]	Stainless steel [b]
FF — Sour service [a]	Stainless steel [b]	Stainless steel [b]
HH — Sour service [a]	CRAs [b]	CRAs [b]

[a] As defined by NACE MR 0175.
[b] In compliance with NACE MR 0175.

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 Hub and outlet end connections

Design of end and outlet 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 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 as in 4.2. The manufacturer shall specify methods to be used in design which are consistent with accepted engineering practices.

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 following methods. Standard materials are those materials whose properties meet or exceed the requirements of Table 5.

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 specified minimum yield strength in excess of 517 MPa (75 000 psi) that do not meet the ductility requirements of Table 5 for standard 75K materials.

In the event 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 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 as described in ASME, Section VIII, Division 2, Appendix 4, may be used for design calculations for pressure-containing equipment. Design-allowable stresses shall be limited by the following criteria:

$$S_T = 0{,}83 S_Y \text{ and } S_m = 2\frac{S_Y}{3}$$

where

S_m is the design stress intensity at rated working pressure;

S_T is the maximum allowable general primary membrane stress intensity at hydrostatic test pressure;

S_Y is the material-specified minimum yield strength.

4.3.3.3 Theory of constant energy of distortion

The theory of constant energy of distortion, 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 International Standard. 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:

$$S_E = S_Y$$

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, 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

a) 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.

b) 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.

c) 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.

d) 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

a) 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 50 microstrain (0,005 %) (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.

b) 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.

c) 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.

d) 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 the value H which will, by the formula, justify 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.

e) Resulting rating

Compute the maximum allowable working pressure p for parts tested under this subclause by one of the following equations.

If the average yield strength is determined in accordance with 4.3.3.5.2:

$$p = 0{,}5H\,(S_Y/S_A)$$

If the actual average yield strength is not determined by test specimens:

$p = 0{,}4H$

where

H is the hydrostatic test pressure at which this test was stopped, in accordance with 4.3.3.5.3 b);

S_Y is the material-specified minimum yield strength;

S_A is the actual average yield strength from test specimens.

4.3.3.6 Non-standard materials design requirements

The design methodology as described in ASME, Section VIII, Division 2, Appendix 4, shall be used for design and calculations for pressure-containing equipment utilizing non-standard materials. Design allowable stresses shall be limited by the following criteria:

S_T = the smaller of $^5/_6\, S_Y$ or $^2/_3\, R_{m,\ min.}$

S_m = the smaller of $^2/_3\, S_Y$ or $^1/_2\, R_{m,\ min.}$

S_S = the smaller of $2\, S_Y$ or $R_{m,\ min.}$

where

S_m is the design stress intensity at rated working pressure;

S_S is the maximum combined primary and secondary stress intensity;

S_T is the maximum allowable general primary membrane stress intensity at hydrostatic test pressure;

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

S_Y is the material-specified minimum yield strength.

4.3.4 Closure bolting

The maximum allowable tensile stress 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 following limit:

$S_A = 0{,}83\, S_Y$

where

S_A is the maximum allowable tensile stress;

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 to be used in design which 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 following tolerances shall apply:

Metric		Inch	
Dimension	**Tolerance** mm	**Dimension**	**Tolerance** in
x	± 0,5	x,x	± 0,02
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

a) Hole alignment

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

b) 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 which 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 leaktight seal at the hydrostatic test pressure of the equipment in which they are installed.

4.4.4.2 Test and gauge connection ports

a) 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 ($^1/_2$ in) nominal size. High-pressure connections as described in 4.4.4.2 b) may also be used.

b) 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 upon which the design is to be based. Design documentation media shall be clear, legible, reproducible and retrievable. Design documentation shall be retained for 5 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 verification

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

5 Materials — General requirements

5.1 General

This clause describes the material performance, processing and compositional requirements for bodies, bonnets, end and outlet connections, hub end connectors, hangers, back-pressure valves, bullplugs, valve-removal plugs, 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 this clause 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 this clause 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, back-pressure valves, bullplugs and valve-removal plugs 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;
- NDE requirements.

b) for PSL 2 to PSL 4:

The requirements for PSL 2 to PSL 4 are identical to the requirements for PSL 1. In addition:

- 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) — ASTM D 1418;
- physical property requirements;
- material qualification (shall meet the equipment class requirement);
- storage and age-control requirements.

5.3 Mandrel tubing and casing hangers

5.3.1 Material

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

a) PSL 1 requirements:

- tensile testing;
- hardness testing.

b) PSL 2 to PSL 4 requirements:

The requirements for PSL 2 to PSL 4 are identical to the requirements for PSL 1. In addition:

- impact requirements.

5.3.2 Processing

5.3.2.1 Casting practices

a) PSL 1 requirements

All castings used for hanger mandrels shall meet applicable requirements of Clause 5 and Clause 7.

b) PSL 2 requirements

The requirements for PSL 2 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, heat treatment and NDE to ensure repeatability in providing castings which 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

a) PSL 1 requirements

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

b) PSL 2 to PSL 4 requirements

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

5.3.2.3 Melting practices

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 the requirements for PSL 1 to PSL 3. In addition 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.

5.3.3.2 Temperatures

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 the requirements for PSL 1 to PSL 3. In addition 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-base alloys, nickel-copper alloys and nickel-base alloys. For components which 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 this subclause 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) from any external or internal surface.

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

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 for material to be qualified 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

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 ASTM A 370.

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

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 ASTM A 370 using the Charpy V-notch technique.

In order to qualify a material for 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 (removed from typically 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, end and outlet connections

5.4.1 Material

a) Tensile property requirements

All bodies, bonnets, end and outlet connections shall be fabricated from standard or non-standard materials as specified in Table 4. Standard materials shall meet the applicable properties shown in Table 5. Non-standard material shall conform to the manufacturer's written specification. The specification shall include minimum requirements for tensile strength, yield strength, elongation, reduction of area, toughness and hardness applicable for the specific alloy. All non-standard materials shall exceed a 75K minimum yield strength and meet a minimum of 15 % elongation and 20 % reduction of area.

b) Impact toughness requirements

Impact toughness shall conform to the requirements of Table 6.

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 7. Sub-size specimens shall not be used for PSL 4.

Table 4 — Standard material applications for bodies, bonnets and end and outlet connections

Part	Pressure ratings MPa (psi)					
	13,8 (2 000)	20,7 (3 000)	34,5 (5 000)	69,0 (10 000)	103,5 (15 000)	138,0 (20 000)
	Material designation					
Body,[a] bonnet	36K, 45K 60K, 75K NS[b]	36K, 45K 60K, 75K NS	36K, 45K 60K, 75K NS	36K, 45K 60K, 75K NS	45K, 60K 75K, NS	60K, 75K NS
Integral end connection						
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[c]	c	c	c	c	c	c
Loose connectors						
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

a If end connections are of the material designation indicated, welding is in accordance with Clause 6 and design is in accordance with Clause 4.

b NS indicates non-standard materials as defined in 4.3.3 and 5.4.1 a).

c As specified by manufacturer.

Table 5 — Standard material property requirements for bodies, bonnets and end and outlet connections

Material designation	**0,2 % 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 6 — Charpy V-notch impact requirements (10 mm × 10 mm)

Temperature		Minimum average impact value Transverse direction J (ft·lbf)		
Temperature classification	**Test temperature** °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)
P	– 29 (– 20)	—	20 (15)	20 (15)
R	– 18 (0)	—	—	20 (15)
S	– 18 (0)	—	—	20 (15)
T	– 18 (0)	—	—	20 (15)
U	– 18 (0)	—	—	20 (15)
V	– 18 (0)	—	—	20 (15)

Table 7 — Adjustment factors for sub-size impact specimens (PSL 1 to PSL 3)

Specimen dimension	Adjustment factor
10 mm × 7,5 mm	0,833
10 mm × 5,0 mm	0,667
10 mm × 2,5 mm	0,333

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 TC or QTC as applicable.

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.

5.4.2.2 PSL 1 tensile testing

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 ASTM A 370.

Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the applicable requirements of Table 5.

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

a) Test specimens

Tensile test specimens shall be removed from a QTC as described in 5.7.

b) Test method

Perform tensile tests at room temperature in accordance with the procedures specified in ASTM A 370.

Perform a minimum of one tensile test. The results of the tensile test(s) shall satisfy the applicable requirements of Table 5.

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

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 ASTM A 370 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 6. 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.

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 6 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 27 J (20 ft-lbf) minimum average value.

5.4.3 Processing

5.4.3.1 Casting practices

a) PSL 1 requirements

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

b) PSL 2 requirements

The requirements for PSL 2 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.

c) PSL 3 and PSL 4 requirements

Wrought products shall be used.

5.4.3.2 Hot-working practices

a) PSL 1 requirements

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

b) PSL 2 to PSL 4 requirements

The requirements for PSL 2 to PSL 4 are identical to the requirements for PSL 1. In addition the manufacturer shall document hot working practices.

5.4.3.3 Melting practices

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 the requirements for PSL 1 to PSL 3. In addition 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.

5.4.4.2 Temperatures

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 also apply. 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-base alloy, nickel-copper alloys and nickel-base alloys. For components which 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 this subclause 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)

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.

a) The manufacturer shall specify the nominal chemical composition, including composition tolerances, of 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

Tables 8 and 9 list element limits (% mass fraction) for carbon, low-alloy and martensitic stainless steels (other than precipitation-hardening types) required to manufacture bodies, bonnets and end outlet connections. If the composition is specified by reference to a recognized industry standard, those elements specified as residual/trace elements need not be reported, provided the residual/trace element limits of the industry standard are within the limits of this International Standard. Table 8 and Table 9 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 8 — Steel composition limits for bodies, bonnets and end and outlet connections materials (% mass fraction) (PSL 2 to PSL 4)

Alloying element	Carbon and low-alloy steels composition limits	Martensitic stainless steels composition limits	45K material for welding neck flanges composition limits [a]
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	(See Table 9)	(See Table 9)	0,05 max.
Sulfur	(See Table 9)	(See Table 9)	0,05 max.
Nickel	1,00 max.	4,50 max.	NA
Chromium	2,75 max.	11,0–14,0	NA
Molybdenum	1,50 max.	1,00 max.	NA
Vanadium	0,30 max.	NA	NA

[a] 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 %.

Table 9 — Phosphorus and sulfur concentration limits (% mass fraction) (PSL 2 to PSL 4)

	PSL 2	PSL 3 and PSL 4
Phosphorus	0,040 max.	0,025 max.
Sulfur	0,040 max.	0,025 max.

5.4.5.3 Tolerance ranges

Table 10 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 8.

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 Table 10. These tolerances only apply to the materials covered in Table 8.

Table 10 — Alloying element maximum tolerance range requirements (% mass fraction) (PSL 3 and PSL 4)

Elements	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

These values are the total allowable variation in any one element and shall not exceed the maximum specified in Table 8.

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

a) Tensile testing

None specified.

b) Impact testing

None specified.

c) Hardness requirements

The maximum hardness shall be as follows:

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.

5.5.3 Processing

5.5.3.1 Melting, casting and hot working

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

a) Equipment qualification

All heat-treating of parts and QTCs shall be performed with equipment meeting the requirements specified by the manufacturer.

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 (TC)

5.6.1 General

The properties exhibited by the TC 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 may 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 only permitted to qualify production parts having the same or smaller ER. The TC shall only qualify 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 only qualify production parts having identical size and shape. The TC shall only qualify material and parts produced from the same heat and heat-treat lot.

5.6.2 Equivalent round (ER)

a) Selection

The size of a TC for a part shall be determined using the following ER methods.

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 T equal to the thickness of the thickest flange of that part. ER determination for these parts shall be in accordance with the methods for complex shaped parts.

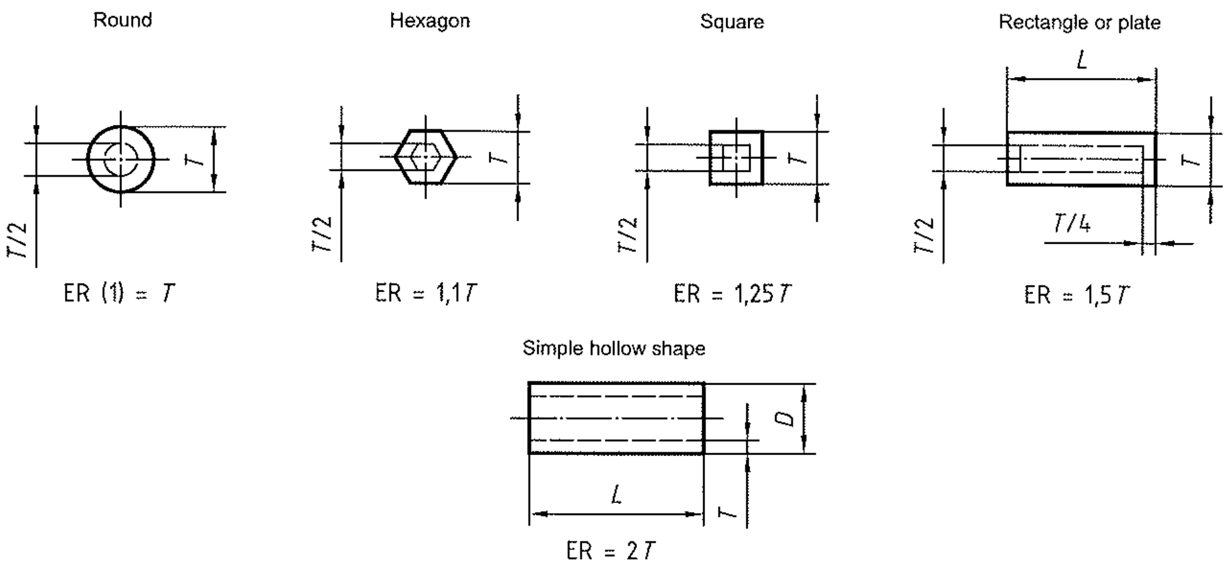
c) Size requirements

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

1) Forging: size not required to exceed 63 mm ($2^1/_2$ in) ER.

2) Casting: size not required to exceed size shown in ASTM A 703, Figure 1.

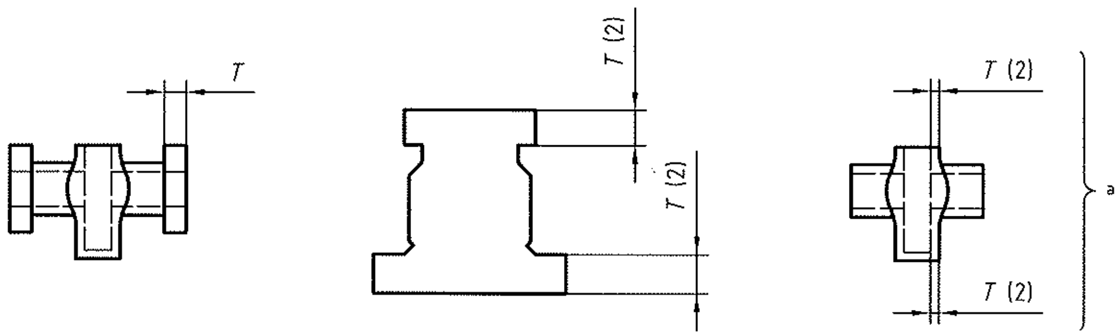
NOTE At the option of the manufacturer, the ER of the TC can meet ASME, Section VIII, Division 2, AM-201 and AM-202 in place of the above requirements.



When L is less than T, consider section as a plate of L thickness. Area inside dashed lines is 1/4 T envelope for test specimen removal.

When L is less than D, consider as a plate of T thickness.

a) Simple geometric equivalent rounds (ER) sections/shapes having length L



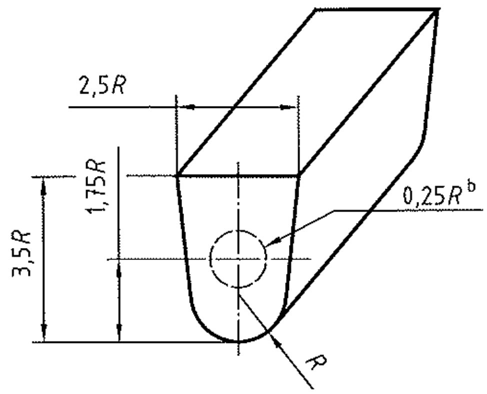
When all internal and external surfaces during heat treatment are within 13 mm (1/2 in) of the final surfaces, ER = 11/4 T. When all internal and external surfaces during heat treatment are not within 13 mm (1/2 in) of the final surfaces, then ER = 2 T. On multiflanged components, T shall be the thickness of the thickest flange.

Where T is the thickness when the component is heat-treated as in T(2), use the larger of the two indicated dimensions.

[a] Bodies with screwed and open ends.

b) General flanged bodies for complex-shaped wellhead components

Figure 3 — Equivalent round models



b Envelope for test specimen removal.

c) Keel block configuration, ER = 2,3*R*

Figure 3 — Equivalent round models *(continued)*

5.6.3 Processing

5.6.3.1 Melting, casting and hot working

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 which 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 which has been and 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 hot-working ratios on the TC which 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

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 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 $^1/_4 T$ envelope for a solid TC or within 3 mm ($^1/_8$ 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), the test specimens need not 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 $^1/_4 T$ 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 size 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 A 370 may be used. Either standard 12,7 mm (0,500 in) or standard sub-size specimens (see ASTM A 370) may be used to qualify CRA materials.

Standard size impact specimens 10 mm × 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 $^1/_4 T$ 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 ASTM E 10 or ASTM E 18.

5.7 Qualification test coupons (QTC)

5.7.1 General

The properties exhibited by the QTC 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 may not always correspond with 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 only qualify production parts having the same or smaller ER. The QTC shall only qualify 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 only qualify production parts having identical size and shape. The QTC shall only qualify material and parts produced from the same heat and heat-treat lot.

5.7.2 Equivalent round (ER)

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 T equal to the thickness of the thickest flange of that part. 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 ($2^1/_2$ in) ER.

   2) Casting: size not required to exceed size shown in ASTM A 703.

b) For PSL 3 and PSL 4

Size not required to exceed 125 mm (5 in) ER.

NOTE At the option of the manufacturer, the ER of the QTC can meet ASME 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

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 may not qualify material from the same primary melt which 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 which has been and 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 hot-working ratios on the QTC which 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

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 be not lower than 14 °C (25 °F) below that of the QTC. The upper limit shall be not higher than 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, the test specimens need not 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-size 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-sized specimens referenced in ASTM A 370 may be used.

Standard-size impact specimens 10 mm × 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 $^{1}/_{4}T$ 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 ASTM E 10 or ASTM E 18.

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.

"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 this subclause is given in this International Standard, the manufacturer shall specify the methods necessary to qualify and test materials.

5.10 Bullplugs and valve-removal plugs

Material requirements for bullplugs and valve-removal plugs shall, as a minimum, be the same as those specified for PSL 3 bodies, bonnets, end and outlet connections (see 5.4).

5.11 Back-pressure valves

Material requirements for back-pressure valves shall, as a minimum, be the same as those specified for PSL 3 tubing hangers (see 5.3).

5.12 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 NACE MR 0175.

5.13 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.

5.14 Hub-end connectors

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

6 Welding — General requirements

6.1 General

Requirements are established in four groups as follows:

a) Non-pressure-containing weldments other than weld overlays: PSL 1 to PSL 3.

b) Pressure-containing fabrication weldments for bodies, bonnets, and 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, and end and outlet connections, bullplugs, valve-removal plugs and back-pressue 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)

a) Welding procedure/performance

Welding procedures and performance qualifications shall be in accordance with ASME, Section IX, Articles II and III.

b) Application

Welding shall be performed in accordance with qualified procedures by qualified welding personnel. Weld joint types and sizes shall meet the manufacturer's design requirements.

c) Quality control requirements

Welding and completed welds shall meet the requirements of Table 12.

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 groove designs.

6.3.2.2 Materials

a) Welding consumables

Welding consumables shall conform to American Welding Society 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

a) Written procedure

Welding shall be performed in accordance with welding procedure specifications (WPS) written and qualified in accordance with ASME, Section IX, Article II. The WPS shall describe all the essential, non-essential and supplementary essential (if required: see ASME, 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, 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 according to 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 conformance with NACE MR 0175.

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 ASTM E 18, Rockwell method; or ASTM E 92, Vickers 10-kg method. Results shall be converted to Rockwell C, as applicable, in accordance with ASTM E 140.

e) Hardness testing (optional)

Minimum mechanical properties: for the purpose 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 hardness less than shown 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 ASTM A 370 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 ASTM A 370.

6.3.2.4 Welder performance qualification

a) Testing requirements

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

b) Records

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

6.3.2.5 Welding requirements

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

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 verify 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 also apply for PSL 2, in addition to the requirements given in 6.3.3.2 to 6.3.3.4.

6.3.3.2 Welding procedure qualification

a) Base metal groupings

Each base material which is not listed in an ASME, 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, one set of three test specimens each shall be removed from the weld metal and base material HAZ. At least one face of each specimen shall be within $^1/_4T$ from 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:

1) weld metal specimens (3 each): 100 % weld metal;

2) 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 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 also apply for PSL 3, in addition to 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, ± 14 °C (± 25 °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 to be 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 ASTM E 18 or the Vickers 10-kg method in accordance with ASTM E 92.

a) Rockwell method

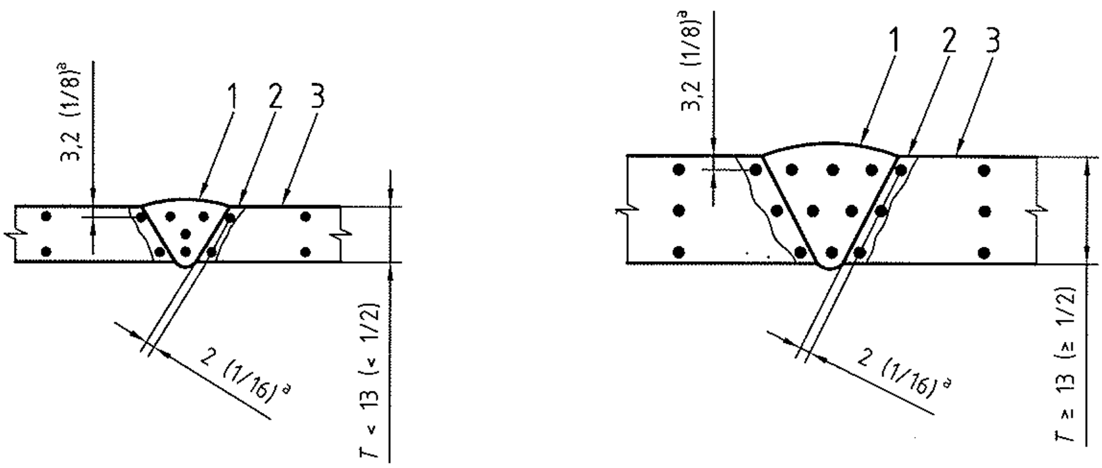
Test locations shall be as shown in Figure 4.

For a weld cross-section thickness less than 13 mm ($^1/_2$ in), four hardness tests each shall be made in 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 each shall be made in 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 each within 3 mm ($^1/_8$ in) from top and bottom of the weld.

Dimensions in millimetres (inches)



Key

1 weld

2 HAZ

3 base

a Typical.

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

b) Vickers 10-kg method

Test locations shall be as shown in Figure 5.

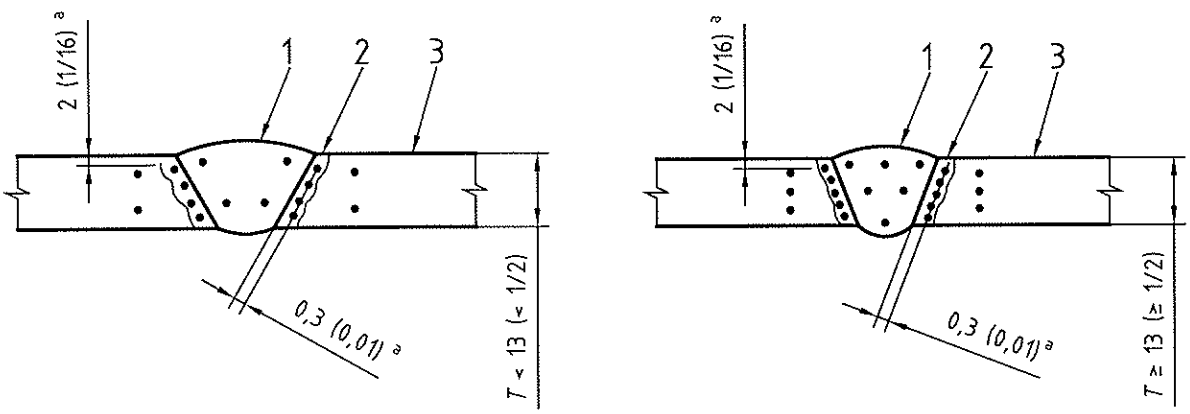
For a weld cross-section thickness less than 13 mm ($^1/_2$ in), four hardness tests each shall be made in the base material(s) and the weld.

For a weld cross-section thickness equal to or greater than 13 mm ($^1/_2$ in), six hardness tests each shall be made in 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 verify 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) and shall be shortened based on the recorded history. Written records shall document the calibration date, procedure used, accuracy, frequency and results.

Dimensions in millimetres (inches)



Key

1 weld

2 HAZ

3 base

a 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 12.

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

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 toughness, 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 is not 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 also apply for PSL 2 and PSL 3, in addition to the following requirements for bolt hole, tapped hole, and machined blind hole repair.

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 macroetched to verify complete fusion. One surface of each of the four matching segments shall be macroetched. 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 the 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 this International Standard as shown in Table 12.

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

This subclause applies 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, Section IX, Articles II and III for weld overlay.

a) Chemical analysis

Chemical analysis shall be performed on the weld metal in accordance with the requirements of ASME, Section IX at a location of 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 austentic or 300 series stainless steels, the chemical composition shall be:

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 NACE MR 0175.

6.5.1.1.3 Application

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 39.

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

This subclause applies to use of corrosion-resistant weld overlay for bodies, bonnets, 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, Section IX, Articles II and III for weld overlay.

a) Chemical analysis

Chemical analysis shall be performed of the weld metal in accordance with the requirements of ASME, 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:

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

For nickel-base alloy UNS N06625, the chemical composition shall meet one of the following classes:

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

For other compositions which must conform to the requirements of NACE MR 0175, the chemical analysis of the overlay shall conform to the specification limits of the corresponding NACE-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 NACE MR 0175

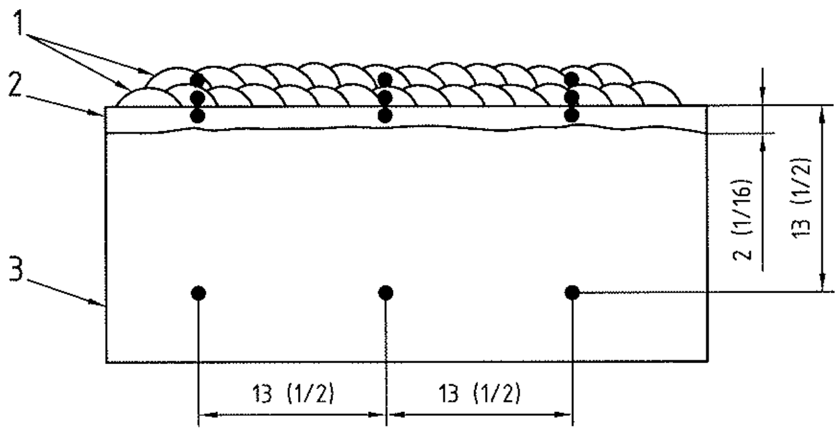
Welds for use in hydrogen sulfide service shall conform to the requirements of NACE MR 0175.

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 ASTM E 18 or the Vickers 10-kg method in accordance with ASTM E 92. Hardness tests shall be performed at a minimum of three test locations each: in the base material, in 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, Section IX, to verify weld overlay/base material bond integrity.

Dimensions in millimetres (inches)



Key
1 overlay
2 HAZ
3 base

Figure 6 — Hardness test locations for weld overlays

6.5.1.2.3 Base material conformance to NACE MR 0175

The base material shall conform to NACE MR 0175 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 only acceptable 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 NACE MR 0175. 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, in addition to 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, 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 12.

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

This clause 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 ± 0,5 % of full-scale range.

7.2.2.2 Calibration procedure

Pressure-measuring devices shall be periodically recalibrated with a master pressure-measuring device or a dead-weight tester at 25 %, 50 % and 75 % of full scale.

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 3 months until recorded calibration history can be established by the manufacturer and new longer intervals (3 months maximum increment) established.

7.3 Quality control personnel qualifications

7.3.1 Non-destructive examination (NDE) personnel

Personnel performing NDE shall be qualified in accordance with requirements specified in EN 473 or ASNT SNT-TC-1A.

7.3.2 Visual examination personnel

Personnel performing visual examinations shall have an annual eye examination in accordance with 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 personnel performing other quality control activities directly affecting material and product quality shall be qualified in accordance with manufacturer's documented requirements.

7.4 Quality control requirements

7.4.1 General

7.4.1.1 Quality control tables

Tables have been included in this subclause that 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 and casing hangers; bodies, bonnet, end and outlet connections; ring gaskets; bullplugs and valve-removal plugs; back-pressure valves; pressure-boundary penetrations; wear bushings; 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 to be used in H_2S service shall be hardness-tested individually to verify that the NACE MR 0175 hardness values have been satisfied (except for ring gaskets which may be sampled in accordance with 7.4.6.2). 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 hub end connectors (see Table 11)

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 (for temperature classifications K and L)

Impact testing shall be in accordance with 5.4.2.4.

7.4.2.1.3 Hardness testing

a) Sampling

   Loose connectors do not require hardness testing.

   For bodies, bonnets, end and outlet connections and 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, Level II, 4.0 AQL.

   For bodies, bonnets, end and outlet connections and 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 ASTM E 10 or ASTM E 18.

   Hardness conversion to other measurement units shall be in accordance with ASTM E 140.

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 hub ends have different material designations, each part shall be tested.

c) Acceptance criteria

Parts shall exhibit the following minimum 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:

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:

$$HBW_{\mathrm{c}} = \frac{R_{\mathrm{m,\,min.}}}{\bar{R}_{\mathrm{m,\,QTC}}}\left(\overline{HBW}_{\mathrm{QTC}}\right)$$

where

$HBW_{\mathrm{c,\,min.}}$ is the minimum acceptable Brinell hardness for the part after the final heat-treatment cycle (including stress-relieving cycles);

$R_{\mathrm{m,\,min.}}$ is the minimum acceptable ultimate tensile strength for the applicable material designation;

$\bar{R}_{\mathrm{m,\,QTC}}$ is the average ultimate tensile strength determined from the QTC tensile tests;

$\overline{HBW}_{\mathrm{QTC}}$ is the average of the Brinell hardness values observed among all tests performed on the QTC.

7.4.2.1.4 Dimensional verification

a) Sampling

Sampling shall be in accordance with ISO 2859-1, Level II, 1.5 AQL. End and outlet connection threads shall all be gauged.

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

These shall be in accordance with ISO 10422 or ASME B1.1 and ASME B1.2 as applicable.

The manufacturer shall specify and verify critical dimensions.

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

7.4.2.1.5 Visual examination

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) Castings: in accordance with MSS SP-55.

   — Type 1: none acceptable;

   — Types 2 through 12: A and B.

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

7.4.2.1.6 Weld NDE — General

If examination is required (see Table 12), 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 ($^1/_2$ in) of surrounding base metal and the entire accessible weld] shall be examined in accordance with the methods and acceptance criteria of this subclause.

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 11 — Quality control requirements for bodies, bonnets, end and outlet connections and hub end connectors — Subclause reference

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	7.4.2.3.2
Hardness testing	7.4.2.1.3	7.4.2.2.3	7.4.2.3.3	7.4.2.3.3
NACE MR 0175	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional verification	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 all parts shall be tested.

7.4.2.2.4 Dimensional verification

Dimensional verification 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

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

a) Sampling

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

b) Test method

All ferromagnetic materials shall be examined in accordance with procedures specified in ASTM E 709. Prods are not permitted on well-fluid surfaces or sealing surfaces.

If indications are deemed to be non-relevant, they shall be examined by liquid-penetrant surface NDE methods, or removed and reinspected, to prove 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^2 (6 in^2) 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

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 E 165.

c) Acceptance criteria

The following acceptance criteria apply:

— no relevant linear indications;

— 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 indications 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

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

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 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 indications;

— 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).

c) Test method/acceptance — Liquid-penetrant examination

Liquid-penetrant examination shall be performed as described in 7.4.2.2.9 with additional acceptance criteria as follows:

— 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).

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.

Table 12 — 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	—	a, b and (c or d)	a, b, (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	—	a, b and (f or g)	a, b, e 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	a, b	a, b	a, b, i	a, b, i

a Visual examination.

b Penetrant testing inspection for non-ferromagnetic materials and magnetic particle testing for ferromagnetic material.

c Radiation (radiography or imaging) examination.

d Ultrasonic examination.

e Hardness test (weld).

f Ultrasonic examination only if weld is greater than 25 % of wall thickness, or 25 mm (1 in), whichever is less.

g Radiation (radiography or imaging) examination only if weld 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.

h Penetrant or magnetic particle as applicable for material defects only.

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.

NOTE Preparation = Surface preparation, joint preparation, fit-up and preheat.
Completion = After all welding, post-weld heat treat and machining.

7.4.2.2.14 Weld NDE — Volumetric

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. 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 E 94, to a minimum equivalent sensitivity of 2 %.

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 will result in a minimum equivalent sensitivity of 2 %. Wire-type image quality indicators are acceptable for use in accordance with ASTM E 747.

c) Acceptance criteria — Radiographic examination

The following acceptance criteria apply:

— no type of crack, zone of incomplete fusion or penetration;

— no elongated slag inclusion which has a length equal to or greater than the following:

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 indications in excess of that specified in ASME, Section VIII, Division 1, Appendix 4.

d) Test method — Ultrasonic examination

Ultrasonic examinations shall be performed in accordance with procedures specified in ASME, Section V, Article 5.

e) Acceptance criteria — Ultrasonic examination

The following acceptance criteria apply:

— no indication whose signal amplitude exceeds that of the reference level;

— no linear indications interpreted as cracks, incomplete joint penetration or incomplete fusion;

— no slag indications with amplitudes exceeding the reference level whose length exceeds the following:

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)

where 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 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 verification

Dimensional verification requirements for PSL 3 shall be identical to the requirements for PSL 1. Additionally, verification 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 12).

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, except 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^2 (10 in^2), 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

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 ASTM E 10 or in ASTM E 18.

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

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) Test method

— Hot-worked parts: Ultrasonic examination of hot-worked parts shall be performed in accordance with the flat-bottom-hole procedures specified in ASTM A 388 (except immersion method may be used) and ASTM E 428.

— Calibration: Distance amplitude curve (DAC) shall be based on 1,6 mm ($^1/_{16}$ in) flat-bottom hole for metal thicknesses through 38 mm ($1^1/_2$ in), on 3,2 mm ($^1/_8$ in) flat-bottom hole for metal thicknesses from 38 mm ($1^1/_2$ 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) Acceptance criteria

The following acceptance criteria apply:

— no single indications 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 indications with length greater than:

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 indications in a line that have an aggregate length greater than T in a length of 12T.

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 verification

Dimensional verification 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 except:

a) Acceptance criteria — Ultrasonic examination

Same acceptance criteria as for PSL 3. Additionally, 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 — Radiographic examination of hot-worked parts:

- 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).

7.4.3 Stems (PSL 1 to PSL 4)

7.4.3.1 Quality control requirements, methods and acceptance criteria

Table 13 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)

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 which cannot be examined axially using the straight-beam technique shall be examined using the angle-beam technique.

c) Calibration

Distance amplitude curve (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 13 — 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 NACE MR 0175	7.4.2.1.3 7.4.1.5	7.4.2.2.3 7.4.1.5	7.4.2.3.3 7.4.1.5	7.4.2.3.3 7.4.1.5
Dimensional verification	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 General Visual examination NDE surface Repair welds NDE volumetric NDE hardness testing	 7.4.2.1.6 — — — — —	 7.4.2.1.6 7.4.2.2.11 7.4.2.2.12 7.4.2.2.13 7.4.2.2.14 —	 7.4.2.1.6 7.4.2.2.11 7.4.2.3.11 7.4.2.2.13 7.4.2.3.12 7.4.2.3.13	No welding permitted except for weld overlays (see 7.4.2.4.9)
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 2 to PSL 4)

Table 14 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 material properties shall conform to the requirements of 5.1 and 5.2 and volumetric NDE is not required.

Table 14 — 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	—	—	7.4.2.3.3	7.4.2.3.3
NACE MR 0175	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional verification	—	—	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				No welding permitted except for weld overlays (see 7.4.2.4.9)
General	—	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	
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 (PSL 1 to PSL 4) (see Table 15)

7.4.6.1 Dimensional verification

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.

Table 15 — Quality control requirements for ring joint gaskets

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Dimensional verification	7.4.6.1	7.4.6.1	7.4.6.1	7.4.6.1
Hardness testing	7.4.6.2	7.4.6.2	7.4.6.2	7.4.6.2
NACE MR 0175	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Surface finish	7.4.6.3	7.4.6.3	7.4.6.3	7.4.6.3

7.4.6.2 Hardness testing

a) Sampling

As a minimum, sampling shall be performed on completed gaskets in accordance with ISO 2859-1, Level II, 1.5 AQL.

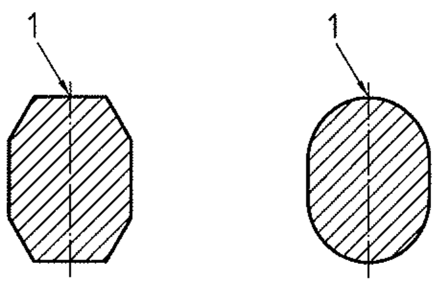
b) Test method

A minimum of one hardness test shall be performed in accordance with procedures specified in ASTM E 18. The location of the hardness test shall be in accordance with Figure 7.

c) Acceptance criteria

The acceptance criteria shall be as follows:

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.



a) Octagonal b) Oval

Key

1 hardness test location

Figure 7 — Ring gasket hardness test location

7.4.6.3 Surface finish

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 follows:

Gasket type	*Ra* µm	RMS (µin)
R	1,6	(63)
RX	1,6	(63)
BX	0,8	(32)

7.4.7 Studs and nuts (PSL 1 to PSL 4) (see Table 16)

7.4.7.1 General

The requirements for studs and nuts apply only to those used to connect end and outlet flanges and studded connections specified in 10.1. Quality control shall be performed in conformance with Table 16 and the following requirements. (Other studs and nuts shall meet the design requirements of 4.3.4 and the manufacturer's specifications.)

Table 16 — Quality control requirements for studs and nuts

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Tensile testing	7.4.7.2	7.4.7.2	7.4.7.2	7.4.7.2
Impact testing	7.4.7.3	7.4.7.3	7.4.7.3	7.4.7.3
Dimensional verification	7.4.7.4	7.4.7.4	7.4.7.4	7.4.7.4
Hardness testing	7.4.7.5	7.4.7.5	7.4.7.5	7.4.7.5
NACE MR 0175	7.4.7.5	7.4.7.5	7.4.7.5	7.4.7.5
Chemical analysis	7.4.7.6	7.4.7.6	7.4.7.6	7.4.7.6

7.4.7.2 Tensile testing

Tensile testing requirements shall be performed in accordance with procedures specified in ASTM A 193, ASTM A 194, ASTM A 320 or ASTM A 453 as appropriate, except that yield strength shall meet or exceed the minimum values shown in Table 49.

7.4.7.3 Impact testing

Impact testing shall be performed on studs and nuts as required by Table 49.

7.4.7.4 Dimensional verification

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

a) Specimens

Specimens shall be in accordance with the applicable ASTM specification.

b) Sampling

Sampling shall be in accordance with the applicable ASTM specification. Additionally, ASTM A 453, Grade 660 bolting and other CRA bolting material shall be individually hardness-tested.

c) Test method

Hardness testing shall be performed in accordance with ASTM E 18 and ASTM A 370.

d) Acceptance criteria

The acceptance criteria for exposed bolting shall be in accordance with NACE MR 0175. Hardness testing is not required on NACE MR 0175, 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 sealing material (PSL 1 to PSL 4) (see Table 17)

7.4.8.1 PSL 1

7.4.8.1.1 Dimensional verification

a) Sampling

Sampling shall be performed on non-metallic seals in accordance with ISO 2859-1, 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 17 — Quality control requirements for non-metallic sealing materials

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Dimensional verification	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	9.6

7.4.8.1.2 Visual examination

a) Sampling

Sampling shall be performed in accordance with ISO 2859-1, 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

a) Sampling

Sampling shall be performed in accordance with ISO 2859-1, 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 D 2240 or ASTM D 1415.

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 verification

Dimensional verification 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 verification

Dimensional verification 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. Additionally, the following documentation shall be included:

a) batch number;

b) cure/mold date;

c) shelf-life expiration date.

7.4.8.3.5 Storage and age control

The storage of non-metallic sealing materials shall conform to the requirements of 9.6.

7.4.8.4 PSL 4

7.4.8.4.1 Dimensional verification

Dimensional verification 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. Additionally, the following documentation shall be included.

a) Supplier/manufacturer 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 following:

Data	Documentation in accordance with
Hardness testing	ASTM D 1414 and ASTM D 2240
Tensile testing	ASTM D 412 and ASTM D 1414
Elongation	ASTM D 412 and ASTM D 1414
Compression set	ASTM D 395 and ASTM D 1414
Modulus	ASTM D 412 and ASTM D 1414
Fluid immersion	ASTM D 471 and ASTM D 1414

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 sealing material 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 20, 21, 22, 23 and 24 provide a matrix of quality control requirements and product specification levels for assembled equipment. The requirements are outlined according to product specification level.

The hydrostatic body test shall be performed first. The drift test shall be performed after the valve 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) PSL 1

None required.

b) 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) PSL 1 and PSL 2

None required.

b) PSL 3 and PSL 4

A report identifying the body, bonnet, stem, end and out 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

a) Test method

Pass a drift mandrel as described in Table 18 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 (see Table 18)

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 — Individual equipment

a) Test method

Subject assembled equipment 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 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:

— the primary pressure-holding period;

— the reduction of the pressure to zero;

— the secondary pressure-holding period.

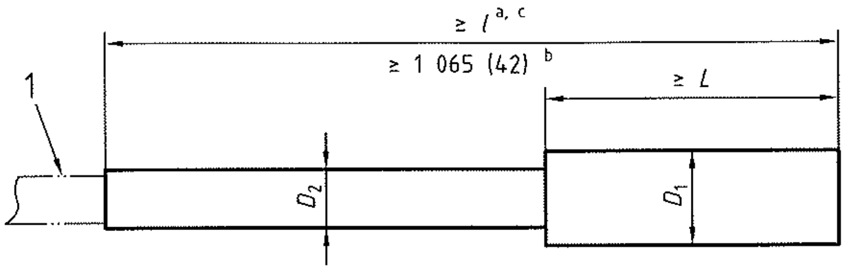
Conduct tests prior to the addition of body-filler grease. Lubrication applied during assembly is acceptable.

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.

Determine the hydrostatic body test pressure by the rated working pressure of the equipment. Hydrostatic test pressures shall be as given in Table 19.

Table 18 — Drift diameter for individual valves and christmas trees

Dimensions in millimetres (inches)



Key

1 handle

a Minimum length for individual valves only.

b Minimum length for christmas trees.

c Valve end to end dimension.

Nominal flange size		**Nominal bore size**		L min.		D_1 + 0,68 mm (+ 0,027 in)		D_2 + 0,7 mm (+ 0,027 in)	
mm	(in)	mm	(in)	mm	(in)	mm	(in)	mm	(in)
46	($1^{13}/_{16}$)	46	(1,81)	76	(3,00)	45,20	(1,78)	38,6	(1,52)
52	($2^{1}/_{16}$)	46	(1,81)	76	(3,00)	45,20	(1,78)	38,6	(1,52)
52	($2^{1}/_{16}$)	52	(2,06)	76	(3,00)	51,60	(2,03)	48,3	(1,90)
65	($2^{9}/_{16}$)	65	(2,56)	76	(3,00)	64,30	(2,53)	59,7	(2,35)
78	($3^{1}/_{16}$)	78	(3,06)	78	(3,06)	77,00	(3,03)	73,2	(2,88)
79	($3^{1}/_{8}$)	79	(3,12)	79	(3,12)	78,60	(3,09)	73,2	(2,88)
103	($4^{1}/_{16}$)	103	(4,06)	103	(4,06)	102,40	(4,03)	97,3	(3,83)
130	($5^{1}/_{8}$)	130	(5,12)	130	(5,12)	129,40	(5,09)	126,2	(4,97)
179	($7^{1}/_{16}$)	152	(6,00)	152	(6,00)	151,60	(5,97)	148,3	(5,85)
179	($7^{1}/_{16}$)	156	(6,12)	156	(6,12)	154,80	(6,09)	151,6	(5,97)
179	($7^{1}/_{16}$)	162	(6,38)	162	(6,38)	161,00	(6,34)	158,0	(6,22)
179	($7^{1}/_{16}$)	168	(6,62)	168	(6,62)	167,50	(6,59)	164,3	(6,47)
179	($7^{1}/_{16}$)	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)

Table 19 — 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 ($13^5/_8$) and smaller		425 ($16^3/_4$) and larger				114,3 to 273,1 ($4^1/_2$ to $10^3/_4$)		298,5 to 339,7 ($11^3/_4$ to $13^3/_8$)		406,5 to 508,0 (16 to 20)	
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 packoff of the lower connection. The lower connection shall be tested below the restricted area packoff to a level based on its pressure rating.

For chokes having an inlet connection of 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 trees assembled entirely with previously hydrostatically tested equipment, other than loose connectors, need only be tested to rated working pressure.

7.4.9.3.5 Hydrostatic seat test — Valves

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 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 — Individual equipment

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

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 — 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

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.

7.4.9.5.4 Hydrostatic body test (extended) — Individual equipment

Hydrostatic body test requirements for PSL 3 shall be identical to the requirements for PSL 1. Additionally, this hydrostatic body test requires the secondary pressure holding period to be extended 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. Additionally, this hydrostatic body test requires the secondary pressure holding period to be extended to a minimum of 15 min.

Table 20 — 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	—	—	—
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 [a]	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)

[a] Optional.

Table 21 — 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 [a]	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)

[a] Optional.

Table 22 — 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	—	—	—
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
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 23 — 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 24 — 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. Additionally, 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 — Individual equipment

In addition to a hydrostatic body test (extended) for individual equipment (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, or in place of, a hydrostatic seat test (extended) for valves (in accordance with 7.4.9.5.6), 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) ± 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) 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 — individual equipment (see 7.4.9.5.7) and the gas seat test for valves (see 7.4.9.5.8).

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) — Individual equipment

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 — Individual equipment

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 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

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 completed 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 % of 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) 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

a) Test method

Gas-test the back seat or other means provided for repacking. Conduct the test at ambient temperaturesusing 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) (see Table 25)

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 verification

a) Sampling

All suspension, lift and back-pressure valve threads shall be gauged.

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 verify ACME and other parallel thread profiles, in accordance with the manufacturer's specifications.

c) Acceptance criteria

Acceptance criteria shall be in accordance with the applicable specification.

Table 25 — Quality control requirements for casing and tubing hanger mandrels

Parameter	Subclause reference			
	PSL 1	PSL 2	PSL 3	PSL 4
Tensile testing [a]	7.4.10.1.1	7.4.10.2.1	7.4.10.2.1	7.4.10.2.1
Impact testing [a]	—	7.4.10.2.2	7.4.10.2.2	7.4.10.4.2
Hardness testing [a]	7.4.10.1.3	7.4.10.1.3	7.4.10.3.4	7.4.10.3.4
NACE MR 0175	7.4.1.5	7.4.1.5	7.4.1.5	7.4.1.5
Dimensional verification	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 [a]	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

[a] Acceptance criteria shall be as required by 5.1, 5.2 and 5.3, as applicable.

7.4.10.1.3 Hardness testing

a) Sampling

Each part shall be hardness tested.

b) Test method

Perform hardness testing in accordance with procedures specified in ASTM E 10 or ASTM E 18. 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

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

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.

— Type 1: none acceptable.

— 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 verification

Dimensional verification 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 verification

Dimensional verification requirements for PSL 3 shall be identical to the requirements for PSL 1. Additionally, verification 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, except 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

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 ASTM E 10 or procedures specified in ASTM E 18.

Perform at least one hardness test in both 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 verification

Dimensional verification 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 except:

a) Acceptance criteria — Ultrasonic

Same acceptance criteria as PSL 3. Additionally, 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 — Radiographic

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 26)

7.4.11.1 General

Cast iron shall not be used. Weld repair is not allowed.

7.4.11.2 Tensile testing

Tensile testing shall be in accordance with 5.4.2.3.

7.4.11.3 Impact testing

Impact testing shall be in accordance with 5.4.2.4.

7.4.11.4 Hardness testing

Hardness testing shall be in accordance with 7.4.2.1.3.

7.4.11.5 Dimensional verification

Dimensional verification shall be in accordance with 7.4.2.1.4. In addition, all threads 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

Back-pressure valves shall be hydrostatically tested to the rated working pressure. Acceptance criteria shall be in accordance with 7.4.9.3.3.

Table 26 — Quality control requirements for bullplugs, valve-removal plugs and back-pressure valves

Test	Body	Valve sealing mechanism (back-pressure valves)	Assembly (back-pressure valves)
Tensile testing [a]	7.4.11.2	—	—
Impact testing [b]	7.4.11.3	—	—
Hardness testing [c]	7.4.11.4	—	—
NACE MR 0175	7.4.1.5	7.4.1.5	—
Dimensional verification	7.4.11.5	—	—
Traceability	7.4.11.6	—	—
Chemical analysis [d]	7.4.11.7	—	—
Visual examination	7.4.11.8	—	—
Hydrostatic test	—	—	7.4.11.9

[a] Acceptance criteria in accordance with 5.4.2.3.

[b] Acceptance criteria in accordance with 5.4.2.4.

[c] Hardness testing is not required for those materials that have no hardness restriction specified by NACE MR 0175 or are not heat treated to obtain a minimum specified strength level.

[d] 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 NACE records requirements

Records required to substantiate conformance of material classes DD, EE, FF and HH equipment to NACE MR 0175 requirements shall be in addition to those described in 7.5.2 unless the records required by this International Standard also satisfy the NACE MR 0175 requirements.

7.5.1.3 Records control

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 to be maintained by manufacturer

7.5.2.1 Body, bonnet, end and outlet connections, stem, valve-bore sealing mechanism, mandrel tubing and casing hanger records

a) 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) 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) 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) Dimensional verification records (those activities required by 7.4.2.3.4).

d) 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.

Heat treatment records are not required.

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 shall be required in accordance with 7.4.8.

7.5.2.5 Bullplugs, valve-removal plugs and back-pressure valves

Material test records:

— chemical analysis;

— tensile test;

— impact test;

— hardness test.

7.5.2.6 Assembled equipment records

a) PSL 1

No records are required.

b) PSL 2

Assembled-equipment pressure test records:

— actual test pressure;

— holding period duration.

c) 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) Additionally, the following gas-test records are required for equipment designated PSL 3G:

— actual test pressures;

— actual holding period durations.

d) 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

a) PSL 1 and PSL 2

No records are required.

b) PSL 3 and PSL 4

Surface NDE records are required.

7.5.3 Records to 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 and casing hanger and back-pressure valve records

a) PSL 1 to PSL 3

No records are required.

b) 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) PSL 1 to PSL 3

No records are required.

b) PSL 4

Certification of compliance stating that non-metallic seals conform to PSL 4 of this International Standard.

7.5.3.6 Assembled equipment records

a) PSL 1 and PSL 2

No records are required.

b) 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) PSL 3G and PSL 4

All records/certifications of PSL 3 are also required for PSL 3G and PSL 4. Additionally, gas-test records shall 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 27. Marking shall contain the designation ISO 10423, the temperature rating, 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 27, 28, 29, 30, 31, 32, 33 and 34. 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): XL;

— tubing (non-upset): NU;

— tubing (external-upset): EU.

8.1.6 Size marking

The marking of size 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 27 — 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 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 (4.1)	Nameplate and/or body	—	Nameplate and/or body	OD of connector	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

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

a) Other end connectors shall be marked with "OEC" following the size or pressure rating.

b) 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 27 and 28. The bore size shall be preceded by the word "Bore".

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 27 and 29. 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 which can be installed upside down shall have the word "DOWN" on the end which will face 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 27 and 30.

8.4.2 Marking of slip hangers

Any hanger which can be installed upside down shall have the word "DOWN" on the end which will face 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 27 and 30.

Table 28 — 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 29 — Additional marking for connectors and fittings

Marking	Location
Packoff casing size	Nameplate or body, and bottom connector OD
Minimum vertical bore	Nameplate or body, and each connector OD

Table 30 — 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 27 and 31.

a) Additional marking for multiple valves

Multiple valves shall be designated by the nominal bore sizes in decreasing sizes (e.g. $3\ ^{1}/_{16} \times 2\ ^{1}/_{16}$, $2\ ^{9}/_{16} \times 2\ ^{9}/_{16}$). 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 32, 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".

Table 31 — 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 [a] (multiple-bore valves only)	Connector OD (see Tables 60* and 61*)	—

[a] See also 10.5.4.2.2.

Table 32 — 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 27. 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 27. Marking of the temperature rating, 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 34.

8.7.3 Ring gaskets

Ring gaskets shall be marked as specified in Table 33. Ring gasket material shall be identified by the following marks:

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 33 — 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 conformance with ASTM A 193, ASTM A 320, or ASTM A 453, 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 conformance with ASTM A 194.

8.8.3 Impact test marking

If the impact test temperature is different from that specified by the ASTM specification, the actual test temperature in degrees Celsius (or degrees Fahrenheit) shall be metal-stamped directly under the grade as required by the ASTM specification. The impact test temperatures 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 34.

Table 34 — 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 which will not become fluid and run at a temperature 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

a) PSL 1 and PSL 2

Age control procedures and the protection of non-metallic sealing materials shall be documented by the manufacturer.

b) PSL 3 and PSL 4

The manufacturer's written specified requirements for non-metallic sealing materials 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 35.

Table 35 — Rated working pressures and size ranges of flanges

Rated working pressure	Flange size range		
	Type 6B	Type 6BX	Dual segmented
MPa (psi)	mm (in)	mm (in)	mm (in)
13,8 (2 000)	52 to 540 (2 $^{1}/_{16}$ to 21 $^{1}/_{4}$)	680 to 762 (26 $^{3}/_{4}$ to 30)	—
20,7 (3 000)	52 to 527 (2 $^{1}/_{16}$ to 20 $^{3}/_{4}$)	680 to 762 (26 $^{3}/_{4}$ to 30)	—
34,5 (5 000)	52 to 279 (2 $^{1}/_{16}$ to 11)	346 to 540 (13 $^{5}/_{8}$ to 21 $^{1}/_{4}$)	35 to 103 × 108 (1 $^{3}/_{8}$ to 4 $^{1}/_{16}$ × 4 $^{1}/_{4}$)
69,0 (10 000)	—	46 to 540 (1 $^{13}/_{16}$ to 21 $^{1}/_{4}$)	—
103,5 (15 000)	—	46 to 476 (1 $^{13}/_{16}$ to 18 $^{3}/_{4}$)	—
138,0 (20 000)	—	46 to 346 (1 $^{13}/_{16}$ to 13 $^{5}/_{8}$)	—

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.

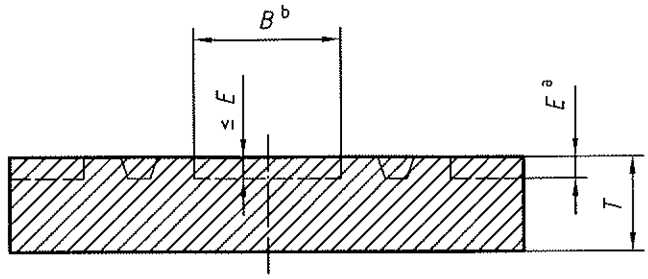
10.1.2.2.2 Dimensions

a) Standard dimensions

Dimensions for type 6B integral, threaded, and welding neck flanges shall conform to Table 36*, Table 37* and Table 38*.

NOTE The data in tables marked with an asterisk are repeated in US Customary 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 36*, 37* and 38* for dimensions B and T and for dimensions not shown. For E dimensions, see Tables 50* and 51*.

NOTE 2 Raised face and/or counter-bore are optional.

a Optional.
b Counter-bore.

Figure 8 — Type 6B blind flanges

Dimensions for ring grooves shall conform to Table 50* or Table 51*.

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 36*, 37* and 38*.

c) Threaded flanges

Threads shall conform to the requirements of 4.2.1.2.

d) Welding neck flanges

1) Bore diameter and wall thickness: The bore diameter J_L shall not exceed the values shown in Tables 36*, 37* and 38*. 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 US Customary 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, Type 6B welding neck flanges are not intended to be welded to equipment specified in this International Standard. Their purpose is to bolt to another 6B flange and provide a transition to be 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 36*, 37* or 38*.

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 39*. 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 may 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

a) Standard dimensions

Dimensions for 6BX integral flanges shall conform to Table 40* or 41*, as applicable.

Dimensions for 6BX welding neck flanges shall conform to Table 42* or 43*, as applicable.

NOTE These flanges are not available in all the same pressure ratings and sizes as the integral flanges.

Dimensions for 6BX blind and test flanges shall conform to Table 44*, 45* or 46*, as applicable.

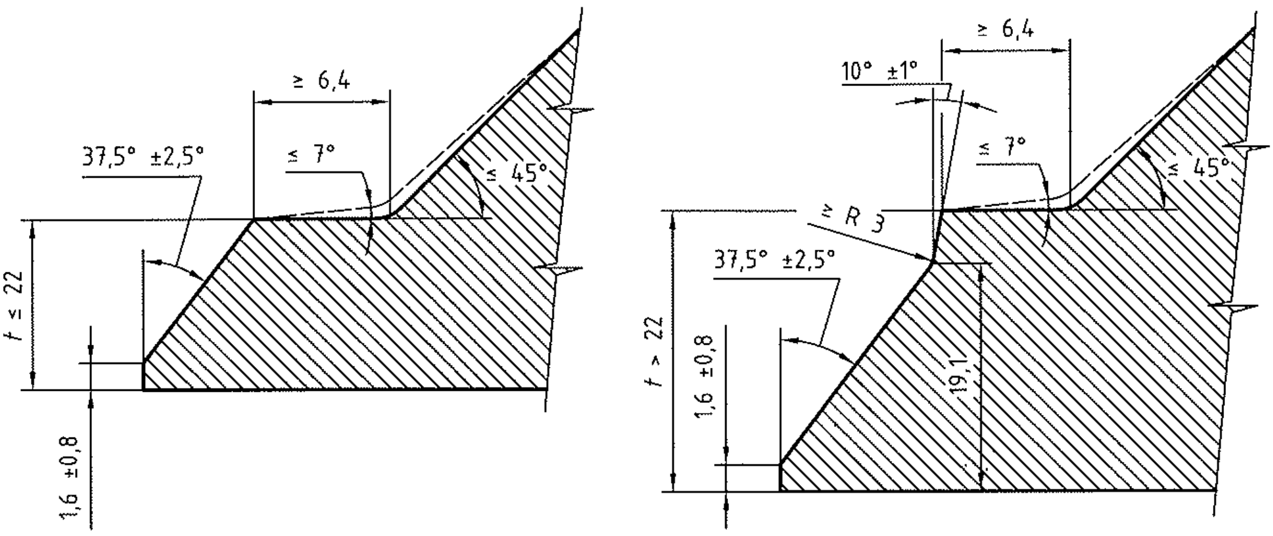
b) Integral flange exceptions

Type 6BX 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 of the tables.

c) Welding neck flanges

Dimensions for the weld end preparation shall conform to Figure 9 (see Figure B.9 for US Customary units).

Dimensions in millimetres



a) For neck thickness $t \leqslant 22$ mm

b) For neck thickness $t > 22$ mm

Figure 9 — Weld end preparation for type 6B and 6BX weld neck flanges
(see Annex B for US Customary units)

10.1.2.3.3 Flange face

The flange face on the ring joint side shall be raised except for studded 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°. 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 40* through 45*, 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 application of the overlay, preparation of the ring grooves shall conform to Table 39*. 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° surfaces on ring grooves shall have a surface finish no rougher than 0,8 µm Ra (32 µin 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 47*. Ring groove dimensions shall conform to Table 51*.

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 47*.

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_2S 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 furnished under this clause do not require a hydrostatic test prior to final acceptance.

10.1.5 Marking

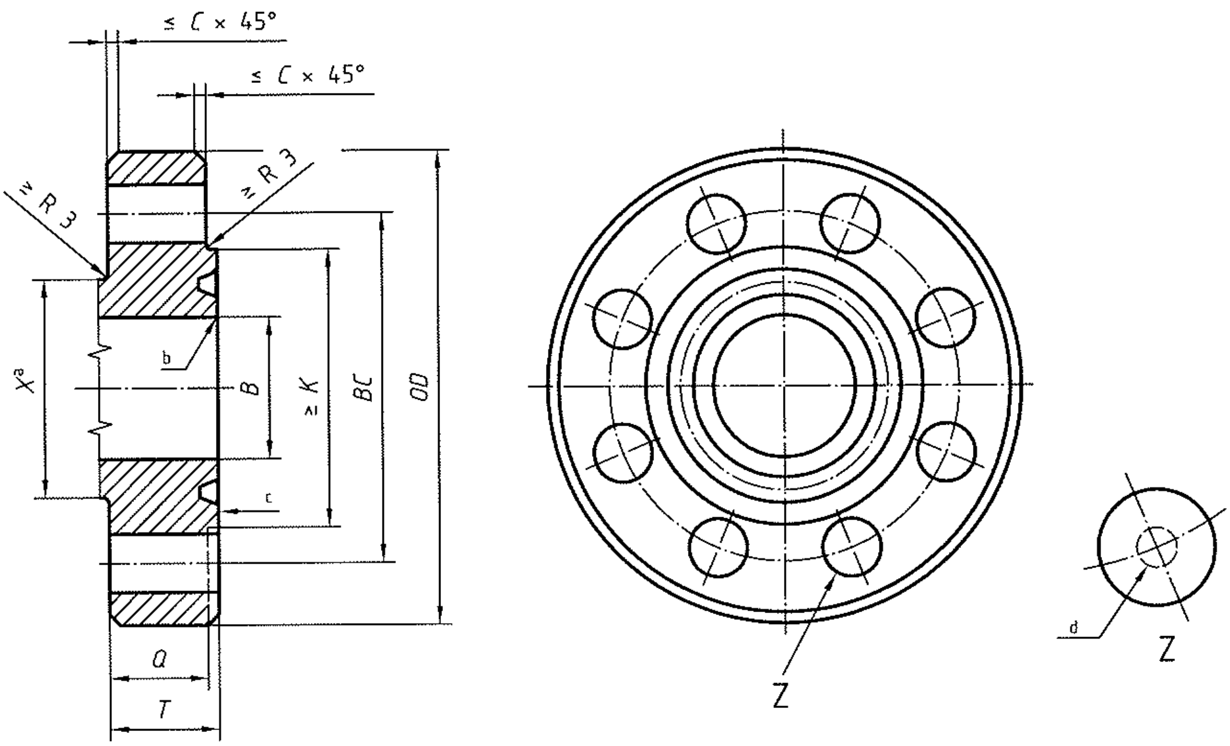
Flanges shall be marked to conform with Clause 8.

10.1.6 Storing and shipping

All flanges shall be stored and shipped in accordance with Clause 9.

Table 36 — Type 6B flanges for 13,8 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

[a] Reference dimension.

[b] Break sharp corners.

[c] Top.

[d] Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

a) Flange section integral flange

Dimensions in millimetres

(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**
(in)	mm	B	OD	tol.	C	K	T $^{+3}_{0}$	Q	X
2 1/16	52	53,2	165	2	3	108	33,4	25,4	84
2 9/16	65	65,9	190	2	3	127	36,6	28,6	100
3 1/8	79	81,8	210	2	3	146	39,7	31,8	117
4 1/16	103	108,7	275	2	3	175	46,1	38,1	152
5 1/8	130	131,0	330	2	3	210	52,4	44,5	189
7 1/16	178	181,8	355	3	6	241	55,6	47,6	222
9	228	229,4	420	3	6	302	63,5	55,6	273
11	279	280,2	510	3	6	356	71,5	63,5	343
13 5/8	346	346,9	560	3	6	413	74,7	66,7	400
16 3/4	425	426,2	685	3	6	508	84,2	76,2	495
21 1/4	540	540,5	815	3	6	635	98,5	88,9	610

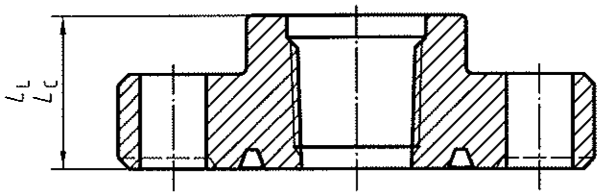
Table 36 *(continued)*

Dimensions in millimetres

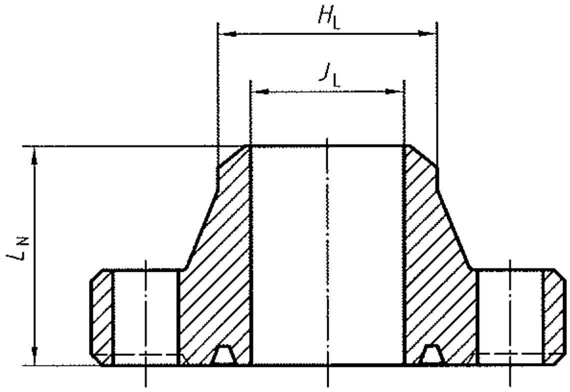
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		**Bolting dimensions**						
		Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
(in)	mm	BC		(in)		tol. [e]	L_{ssb}	R or RX
2 $^1/_{16}$	52	127,0	8	$^5/_8$	20	+ 2	115	23
2 $^9/_{16}$	65	149,2	8	$^3/_4$	23	+ 2	125	26
3 $^1/_8$	79	168,3	8	$^3/_4$	23	+ 2	135	31
4 $^1/_{16}$	103	215,9	8	$^7/_8$	26	+ 2	150	37
5 $^1/_8$	130	266,7	8	1	29	+ 2	170	41
7 $^1/_{16}$	178	292,1	12	1	29	+ 2	180	45
9	228	349,3	12	1 $^1/_8$	32	+ 2	205	49
11	279	431,8	16	1 $^1/_4$	35	+ 2	220	53
13 $^5/_8$	346	489,0	20	1 $^1/_4$	35	+ 2	230	57
16 $^3/_4$	425	603,2	20	1 $^1/_2$	42	+ 2,5	260	65
21 $^1/_4$	540	723,9	24	1 $^5/_8$	45	+ 2,5	300	73

[e] Minimum bolt hole tolerance is − 0,5 mm.

Table 36 *(continued)*



b) Threaded flange



c) Welding neck linepipe flange

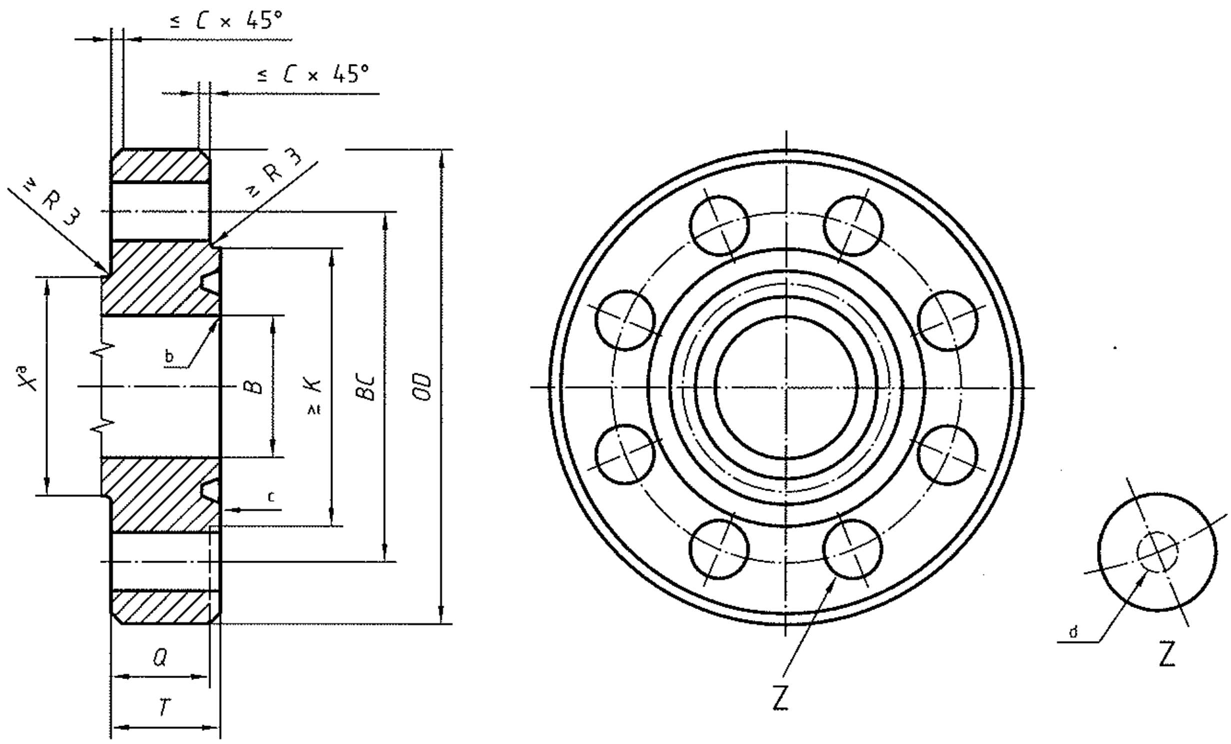
Dimensions in millimetres

(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**
(in)	mm	L_L	L_C	$L_N \pm 1{,}5$	H_L	tol.[f]	J_L
2 $^1/_{16}$	52	45	—	81	60,3	+2,4	53,3
2 $^9/_{16}$	65	50	—	88	73,0	+2,4	63,5
3 $^1/_8$	78	54	—	91	88,9	+2,4	78,7
4 $^1/_{16}$	103	62	89	110	114,3	+2,4	103,1
5 $^1/_8$	130	69	102	122	141,3	+2,4	122,9
7 $^1/_{16}$	178	75	115	126	168,3	+4	147,1
9	228	85	127	141	219,1	+4	199,1
11	279	94	134	160	273,0	+4	248,4
13 $^5/_8$	346	100	100	—	—	—	—
16 $^3/_4$	425	115	115	—	—	—	—
21 $^1/_4$	540	137	137	—	—	—	—

[f] Minimum tolerance for this dimension is – 0,8.

Table 37 — Type 6B flanges for 20,7 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

[a] Reference dimension.

[b] Break sharp corners.

[c] Top.

[d] Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

a) Flange section integral flange

Dimensions in millimetres

(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
(in)	mm	B	OD	tol.	C	K	T $^{+3}_{0}$	Q	X
2 1/16	52	53,2	215	2	3	124	46,1	38,1	104,8
2 9/16	65	65,9	245	2	3	137	49,3	41,3	123,8
3 1/8	79	81,8	240	2	3	156	46,1	38,1	127,0
4 1/16	103	108,7	290	2	3	181	52,4	44,4	158,8
5 1/8	130	131,0	350	2	3	216	58,8	50,8	190,5
7 1/16	179	181,8	380	3	6	241	63,5	55,6	235,0
9	228	229,4	470	3	6	308	71,5	63,5	298,5
11	279	280,2	545	3	6	362	77,8	69,9	368,3
13 5/8	346	346,9	610	3	6	419	87,4	79,4	419,1
16 3/4	425	426,2	705	3	6	524	100,1	88,9	508,0
20 3/4	527	527,8	855	3	6	648	120,7	108,0	622,3

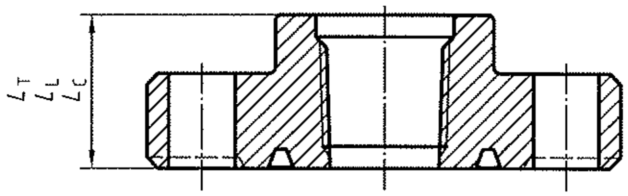
Table 37 *(continued)*

Dimensions in millimetres

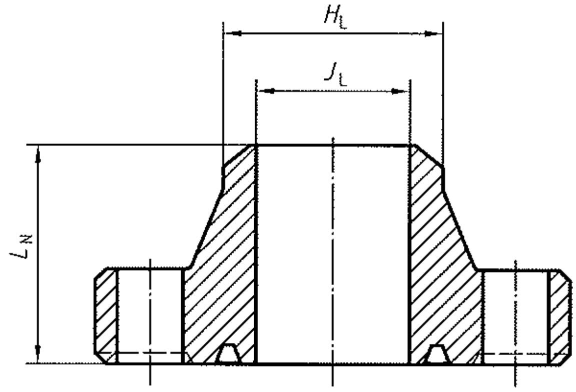
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		**Bolting dimensions**						
		Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
(in)	mm	BC		(in)		tol. [e]	L_{ssb}	R or RX
2 $^{1}/_{16}$	52	165,1	8	$^{7}/_{8}$	26	+ 2	150	24
2 $^{9}/_{16}$	65	190,5	8	1	29	+ 2	165	27
3 $^{1}/_{8}$	79	190,5	8	$^{7}/_{8}$	26	+ 2	150	31
4 $^{1}/_{16}$	103	235,0	8	1 $^{1}/_{8}$	32	+ 2	180	37
5 $^{1}/_{8}$	130	279,4	8	1 $^{1}/_{4}$	35	+ 2	195	41
7 $^{1}/_{16}$	179	317,5	12	1 $^{1}/_{8}$	32	+ 2	205	45
9	228	393,7	12	1 $^{3}/_{8}$	39	+ 2	230	49
11	279	469,9	16	1 $^{3}/_{8}$	39	+ 2	240	53
13 $^{5}/_{8}$	346	533,4	20	1 $^{3}/_{8}$	39	+ 2	260	57
16 $^{3}/_{4}$	425	616,0	20	1 $^{5}/_{8}$	45	+ 2,5	300	66
20 $^{3}/_{4}$	527	749,3	20	2	54	+ 2,5	370	74

[e] Minimum bolt hole tolerance is – 0,5 mm.

Table 37 *(continued)*



b) Threaded flange



c) Welding neck linepipe flange

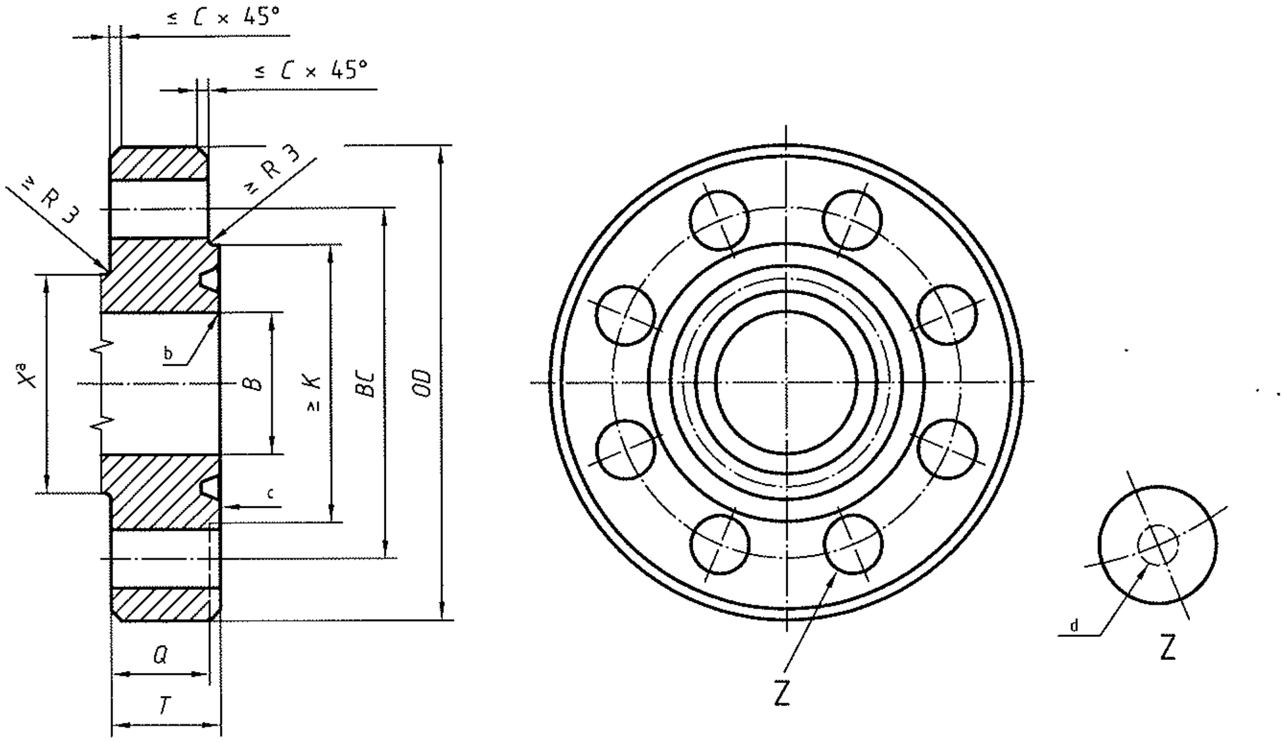
Dimensions in millimetres

(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**
(in)	mm	L_L	L_C	L_T	$L_N \pm 1,6$	H_L	tol.[f]	J_L
2 $^1/_{16}$	52	65,1	—	65,1	109,6	60,3	+ 2,4	50,0
2 $^9/_{16}$	65	71,4	—	71,4	112,7	73,0	+ 2,4	59,7
3 $^1/_8$	79	61,9	—	74,7	109,5	88,9	+ 2,4	74,4
4 $^1/_{16}$	103	77,8	88,9	88,9	122,2	114,3	+ 2,4	98,0
5 $^1/_8$	130	87,3	101,6	—	134,9	141,3	+ 2,4	122,9
7 $^1/_{16}$	179	93,7	114,3	—	147,6	168,3	+ 4,1	147,1
9	228	109,5	127,0	—	169,9	219,1	+ 4,1	189,7
11	279	115,9	133,4	—	192,1	273,0	+ 4,1	237,2
13 $^5/_8$	346	125,4	125,4	—	—	—	—	—
16 $^3/_4$	425	128,6	144,6	—	—	—	—	—
20 $^3/_4$	527	171,4	171,5	—	—	—	—	—

[f] Minimum tolerance for this dimension is – 0,8.

Table 38 — Type 6B flanges for 34,5 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

[a] Reference dimension.

[b] Break sharp corners.

[c] Top.

[d] Bolt hole centreline located within 0,8 mm of theoretical BC and equal spacing.

a) Flange section integral flange

Dimensions in millimetres

(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
(in)	mm	B	OD	tol.	C	K	T $^{+3}_{0}$	Q	X
2 1/16	52	53,2	215	± 2	3	124	46,1	38,1	104,8
2 9/16	65	65,9	245	± 2	3	137	49,3	41,3	123,8
3 1/8	79	81,8	265	± 2	3	168	55,6	47,7	133,3
4 1/16	103	108,7	310	± 2	3	194	62,0	54,0	161,9
5 1/8	130	131,0	375	± 2	3	229	81,0	73,1	196,8
7 1/16	178	181,8	395	± 3	6	248	92,1	82,6	228,6
9	228	229,4	485	± 3	6	318	103,2	92,1	292,1
11	279	280,2	585	± 3	6	371	119,1	108,0	368,3

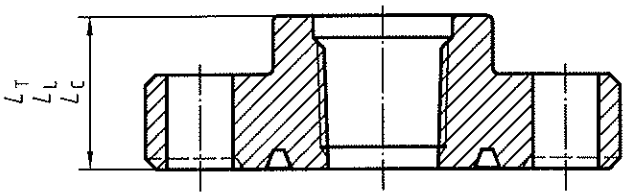
Table 38 *(continued)*

Dimensions in millimetres

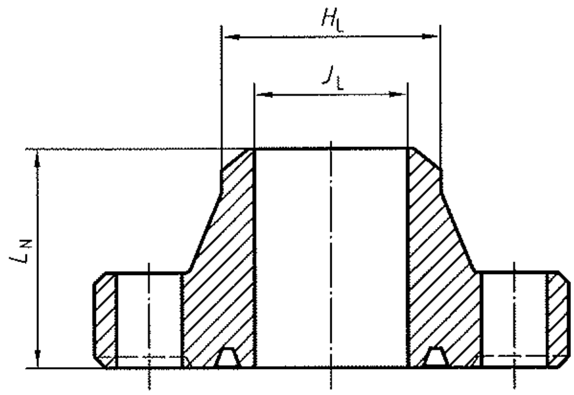
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nominal size and bore of flange		**Bolting dimensions**						
		Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
(in)	mm	*BC*		(in)		tol. [e]	L_{ssb}	R or RX
2 1/16	52	165,1	8	7/8	26	+ 2	150	24
2 9/16	65	190,5	8	1	29	+ 2	165	27
3 1/8	79	203,2	8	1 1/8	32	+ 2	185	35
4 1/16	103	241,3	8	1 1/4	35	+ 2	205	39
5 1/8	130	292,1	8	1 1/2	42	+ 2,5	255	44
7 1/16	178	317,5	12	1 3/8	39	+ 2	275	46
9	228	393,7	12	1 5/8	45	+ 2,5	305	50
11	279	482,6	12	1 7/8	51	+ 2,5	350	54

[e] Minimum bolt hole tolerance is – 0,5 mm.

Table 38 *(continued)*



b) Threaded flange



c) Welding neck linepipe flange

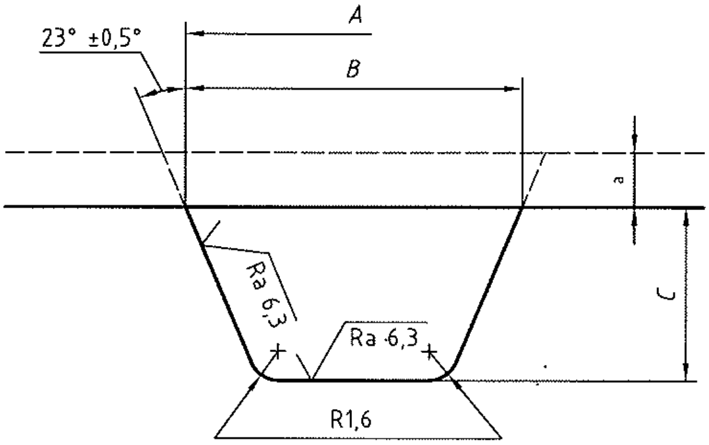
Dimensions in millimetres

(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**
(in)	mm	L_L	L_C	L_T	$L_N \pm 1{,}6$	H_L	tol.[f]	J_L
2 $^1/_{16}$	52	65,1	—	65,1	109,5	60,3	+ 2,3	43,7
2 $^9/_{16}$	65	71,4	—	71,4	112,7	73,0	+ 2,3	54,9
3 $^1/_8$	79	81,0	—	81,0	125,4	88,9	+ 2,3	67,5
4 $^1/_{16}$	103	98,4	98,4	98,4	131,8	114,3	+ 2,3	88,1
5 $^1/_8$	130	112,7	112,7	—	163,5	141,3	+ 2,3	110,3
7 $^1/_{16}$	178	128,6	128,6	—	181,0	168,3	+ 4	132,6
9	228	154,0	154,0	—	223,8	219,1	+ 4	173,8
11	279	169,9	169,9	—	265,1	273,1	+ 4	216,7

[f] Minimum tolerance for this dimension is – 0,8.

Table 39 — Rough machining detail for corrosion-resistant ring groove
(see Annex B for US Customary units)

Dimensions in millimetres
Surface roughness in micrometres



[a] Allow 3 mm or greater for final machining of weld overlay.

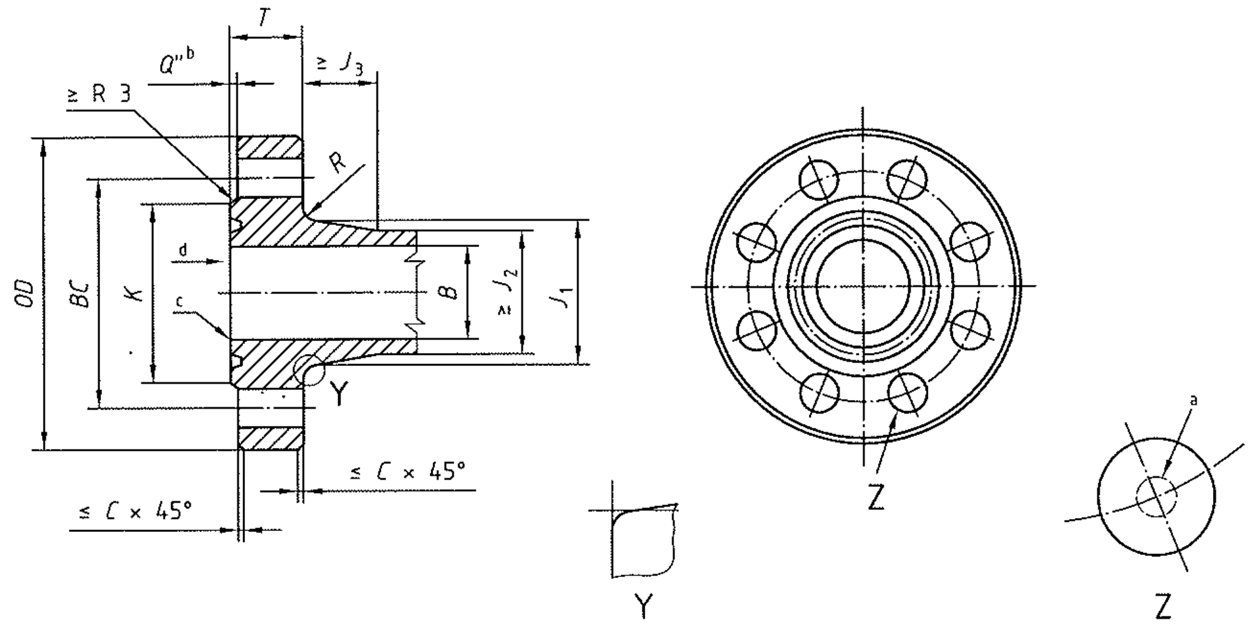
Dimensions in millimetres

Ring number	Outside diameter of groove A $^{+0,8}_{0}$	Width of groove B $^{+0,8}_{0}$	Depth of groove C $^{+0,8}_{0}$	Ring number	Outside diameter of groove A $^{+0,8}_{0}$	Width of groove B $^{+0,8}_{0}$	Depth of groove C $^{+0,8}_{0}$
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 [b]	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 [b]	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 [b]	59,9	12,7	7,6
R 37	169,4	19,1	11,4	R 205 [b]	71,1	12,7	10,7
R 39	182,1	19,1	11,4	R 210 [b]	106,7	16,8	9,9
				R 215 [b]	150,4	19,1	11,4

[b] See 10.1.2.4.5.

Table 40 — 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 US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

[a] Bolt hole centreline located within 0,8 mm of theoretical BC and equal spacing.

[b] $Q''_{max.} = E$ (Table 52);
$Q''_{min.}$ = 3 mm;
Q'' may be omitted on studded flanges.

[c] Break sharp corners.

[d] Top.

Table 40 *(continued)*

Dimensions in millimetres

(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**
(in)	mm	B	OD	tol.	C	K	T	J_1	J_2
						± 1,6	$^{+3}_{0}$	$^{0}_{-3}$	
		13,8 MPa							
26 $^3/_4$	680	680,2	1 040	± 3	6	805	126,3	835,8	743,0
30	762	762,8	1 120	± 3	6	908	134,2	931,9	833,0
		20,7 MPa							
26 $^3/_4$	680	680,2	1 100	± 3	6	832	161,2	870,0	776,3
30	762	762,8	1 185	± 3	6	922	167,1	970,0	871,1
		34,5 MPa							
13 $^5/_8$	346	346,9	675	± 3	6	457	112,8	481,0	423,9
16 $^3/_4$	425	426,2	770	± 3	6	535	130,2	555,6	527,1
18 $^3/_4$	476	477,0	905	± 3	6	627	165,9	674,7	598,5
21 $^1/_4$	540	540,5	990	± 3	6	702	181,0	758,8	679,5
		69,0 MPa							
1 $^{13}/_{16}$	46	46,8	185	± 2	3	105	42,1	88,9	65,1
2 $^1/_{16}$	52	53,2	200	± 2	3	111	44,1	100,0	74,7
2 $^9/_{16}$	65	65,9	230	± 2	3	132	51,2	120,7	92,1
3 $^1/_{16}$	78	78,6	270	± 2	3	152	58,4	142,1	110,2
4 $^1/_{16}$	103	104,0	315	± 2	3	185	70,3	182,6	146,1
5 $^1/_8$	130	131,0	360	± 2	3	221	79,4	223,8	182,6
7 $^1/_{16}$	179	180,2	480	± 3	6	302	103,2	301,6	254,0
9	228	229,4	550	± 3	6	359	123,9	374,7	327,1
11	279	280,2	655	± 3	6	429	141,3	450,9	400,1
13 $^5/_8$	346	346,9	770	± 3	6	518	168,3	552,5	495,3
16 $^3/_4$	425	426,2	870	± 3	6	576	168,3	655,6	601,7
18 $^3/_4$	476	477,0	1 040	± 3	6	697	223,1	752,5	674,7
21 $^1/_4$	540	540,5	1 145	± 3	6	781	241,3	847,7	762,0

Table 40 *(continued)*

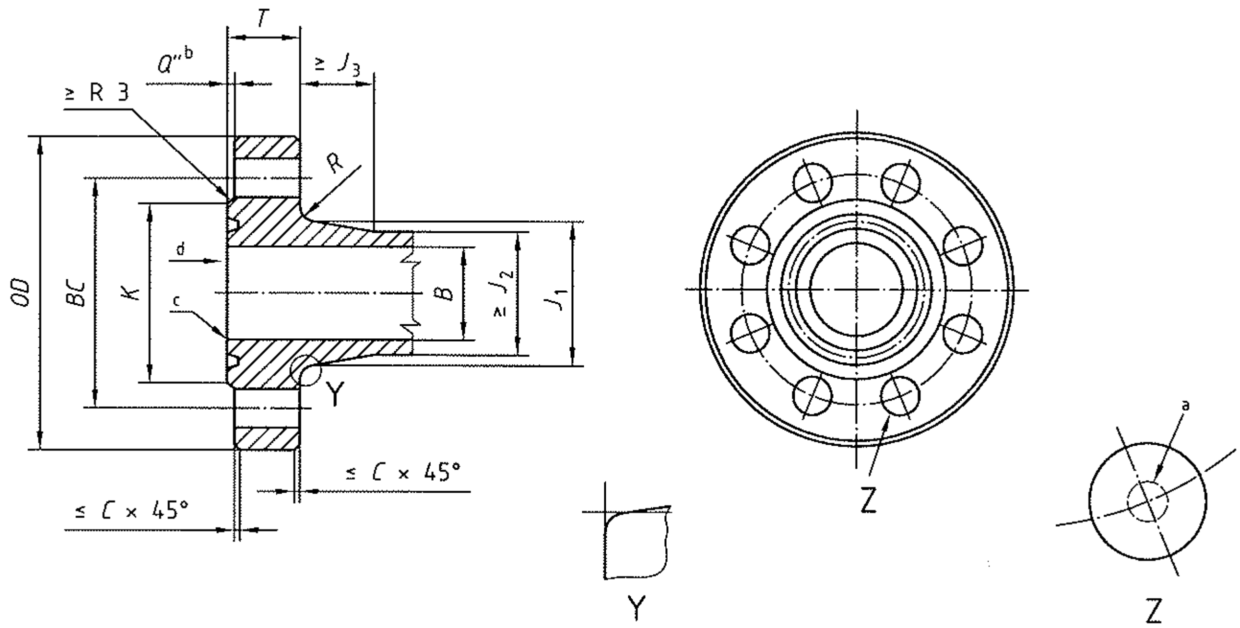
Dimensions in millimetres

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
(in)	mm	J_3	R	BC		(in)		tol. [e]	L_{ssb}	BX
		13,8 MPa								
26 $^3/_4$	680	185,7	16	952,5	20	1 $^3/_4$	48	+ 2,5	350	167
30	762	196,9	16	1 039,8	32	1 $^5/_8$	45	+ 2,5	360	303
		20,7 MPa								
26 $^3/_4$	680	185,7	16	1 000,1	24	2	54	+ 2,5	430	168
30	762	196,9	16	1 090,6	32	1 $^7/_8$	51	+ 2,5	450	303
		34,5 MPa								
13 $^5/_8$	346	114,3	16	590,6	16	1 $^5/_8$	45	+ 2,5	315	160
16 $^3/_4$	425	76,2	19	676,3	16	1 $^7/_8$	51	+ 2,5	370	162
18 $^3/_4$	476	152,4	16	803,3	20	2	54	+ 2,5	445	163
21 $^1/_4$	540	165,1	18	885,8	24	2	54	+ 2,5	480	165
		69,0 MPa								
1 $^{13}/_{16}$	46	48,5	10	146,1	8	$^3/_4$	23	+ 2	125	151
2 $^1/_{16}$	52	51,6	10	158,8	8	$^3/_4$	23	+ 2	130	152
2 $^9/_{16}$	65	57,2	10	184,2	8	$^7/_8$	26	+ 2	150	153
3 $^1/_{16}$	78	63,5	10	215,9	8	1	29	+ 2	170	154
4 $^1/_{16}$	103	73,1	10	258,8	8	1 $^1/_8$	32	+ 2	205	155
5 $^1/_8$	130	81,0	10	300,0	12	1 $^1/_8$	32	+ 2	220	169
7 $^1/_{16}$	179	95,3	16	403,2	12	1 $^1/_2$	42	+ 2,5	285	156
9	228	93,7	16	476,3	16	1 $^1/_2$	42	+ 2,5	330	157
11	279	103,2	16	565,2	16	1 $^3/_4$	48	+ 2,5	380	158
13 $^5/_8$	346	114,3	16	673,1	20	1 $^7/_8$	51	+ 2,5	440	159
16 $^3/_4$	425	76,2	19	776,3	24	1 $^7/_8$	51	+ 2,5	445	162
18 $^3/_4$	476	155,6	16	925,5	24	2 $^1/_4$	61	+ 2,5	570	164
21 $^1/_4$	540	165,1	21	1 022,4	24	2 $^1/_2$	67	+ 2,5	620	166

[e] Minimum bolt hole tolerance is – 0,5.

Table 41 — Type 6BX integral flanges for 103,5 MPa and 138,0 MPa rated working pressures
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

[a] Bolt hole centreline located within 0,8 mm of theoretical BC and equal spacing.

[b] $Q''_{max.} = E$ (Table 52);
$Q''_{min.} = 3$ mm;
Q'' may be omitted on studded flanges.

[c] Break sharp corners.

[d] Top.

Table 41 *(continued)*

Dimensions in millimetres

(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**
(in)	mm	*B*	*OD*	tol.	*C*	*K*	*T*	J_1	J_2
						± 1,6	$^{+3}_{0}$	$^{0}_{-3}$	
		103,5 MPa							
1 $^{13}/_{16}$	46	46,8	210	± 2	3	106	45,3	97,6	71,4
2 $^{1}/_{16}$	52	53,2	220	± 2	3	114	50,8	111,1	82,5
2 $^{9}/_{16}$	65	65,9	255	± 2	3	133	57,2	128,6	100,0
3 $^{1}/_{16}$	78	78,6	290	± 2	3	154	64,3	154,0	122,2
4 $^{1}/_{16}$	103	104,0	360	± 2	3	194	78,6	195,3	158,7
5 $^{1}/_{8}$	130	131,0	420	± 2	3	225	98,5	244,5	200,0
7 $^{1}/_{16}$	179	180,2	505	± 3	6	305	119,1	325,4	276,2
9	228	229,4	650	± 3	6	381	146,1	431,8	349,2
11	279	280,2	815	± 3	6	454	187,4	584,2	427,0
13 $^{5}/_{8}$	346	346,9	885	± 3	6	541	204,8	595,3	528,6
18 $^{3}/_{4}$	476	477,0	1 160	± 3	6	722	255,6	812,8	730,2
		138,0 MPa							
1 $^{13}/_{16}$	46	46,8	255	± 2	3	117	63,5	133,4	109,5
2 $^{1}/_{16}$	52	53,2	285	± 2	3	132	71,5	154,0	127,0
2 $^{9}/_{16}$	65	65,9	325	± 2	3	151	79,4	173,0	144,5
3 $^{1}/_{16}$	78	78,6	355	± 2	3	171	85,8	192,1	160,3
4 $^{1}/_{16}$	103	104,0	445	± 2	3	219	106,4	242,9	206,4
7 $^{1}/_{16}$	179	180,2	655	± 3	6	352	165,1	385,8	338,1
9	228	229,4	805	± 3	6	441	204,8	481,0	428,6
11	279	280,2	885	± 3	6	505	223,9	566,7	508,0
13 $^{5}/_{8}$	346	346,9	1 160	± 3	6	614	292,1	693,7	628,6

Table 41 *(continued)*

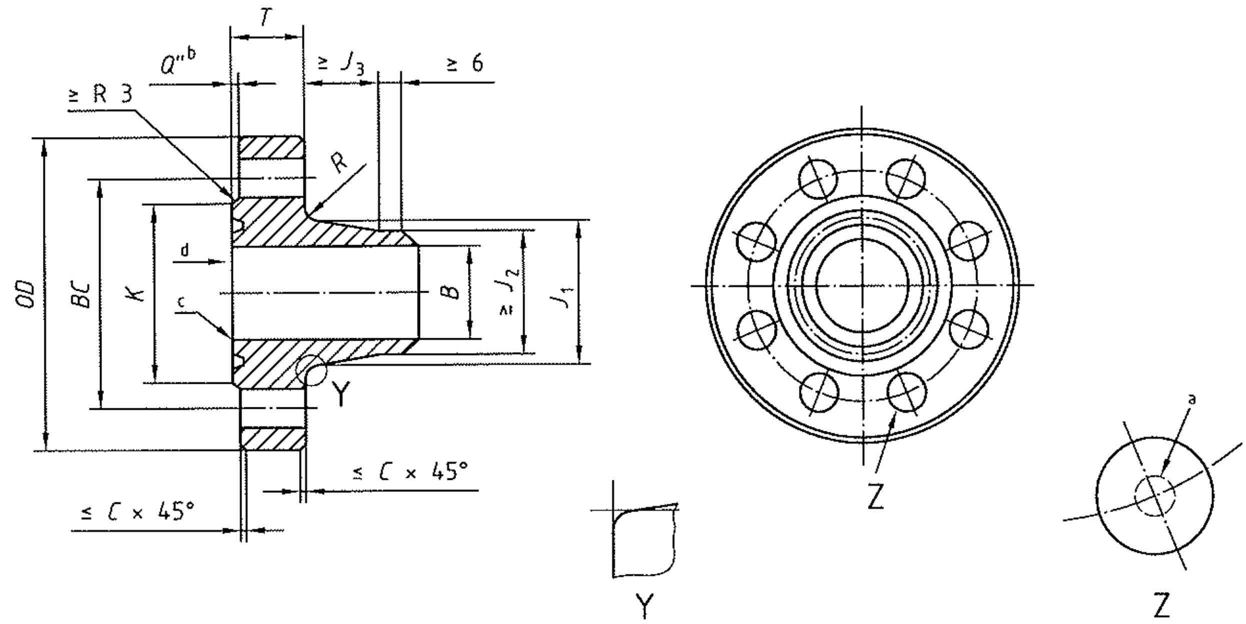
Dimensions in millimetres

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
(in)	mm	J_3	R	BC		(in)		tol.[e]	L_{ssb}	BX
		103,5 MPa								
1 $^{13}/_{16}$	46	47,6	10	160,3	8	$^{7}/_{8}$	26	+ 2	140	151
2 $^{1}/_{16}$	52	54,0	10	174,6	8	$^{7}/_{8}$	26	+ 2	150	152
2 $^{9}/_{16}$	65	57,1	10	200,0	8	1	29	+ 2	170	153
3 $^{1}/_{16}$	78	63,5	10	230,2	8	1 $^{1}/_{8}$	32	+ 2	190	154
4 $^{1}/_{16}$	103	73,0	10	290,5	8	1 $^{3}/_{8}$	39	+ 2	235	155
5 $^{1}/_{8}$	130	81,8	16	342,9	12	1 $^{1}/_{2}$	42	+ 2,5	290	169
7 $^{1}/_{16}$	179	92,1	16	428,6	16	1 $^{1}/_{2}$	42	+ 2,5	325	156
9	228	123,8	16	552,4	16	1 $^{7}/_{8}$	51	+ 2,5	400	157
11	279	235,7	16	711,2	20	2	54	+ 2,5	490	158
13 $^{5}/_{8}$	346	114,3	25	771,5	20	2 $^{1}/_{4}$	61	+ 2,5	540	159
18 $^{3}/_{4}$	476	155,6	25	1 016,0	20	3	80	+ 3	680	164
		138,0 MPa								
1 $^{13}/_{16}$	46	49,2	10	203,2	8	1	29	+ 2	190	151
2 $^{1}/_{16}$	52	52,4	10	230,2	8	1 $^{1}/_{8}$	32	+ 2	210	152
2 $^{9}/_{16}$	65	58,7	10	261,9	8	1 $^{1}/_{4}$	35	+ 2	235	153
3 $^{1}/_{16}$	78	63,5	10	287,3	8	1 $^{3}/_{8}$	39	+ 2	255	154
4 $^{1}/_{16}$	103	73,0	10	357,2	8	1 $^{3}/_{4}$	48	+ 2,5	310	155
7 $^{1}/_{16}$	179	96,8	16	554,0	16	2	54	+ 2,5	445	156
9	228	107,9	25	685,8	16	2 $^{1}/_{2}$	67	+ 2,5	570	157
11	279	103,2	25	749,3	16	2 $^{3}/_{4}$	74	+ 2,5	605	158
13 $^{5}/_{8}$	346	133,3	25	1 016,0	20	3	80	+ 3	760	159

[e] Minimum bolt hole tolerance is – 0,5.

Table 42 — Type 6BX welding neck flanges for 69,0 MPa and 103,5 MPa rated working pressures
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

a Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

b $Q''_{max.} = E$ (Table 52);
$Q''_{min.} = 3$ mm.

c Break sharp corners.

d Top.

Table 42 *(continued)*

Dimensions in millimetres

(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**
(in)	mm	B	OD	tol.	C	K ± 1,6	T $^{+3}_{0}$	J_1 $^{0}_{-3}$	J_2
		69,0 MPa							
1 13/16	46	46,8	185	± 2	3	105	42,1	88,9	65,1
2 1/16	52	53,2	200	± 2	3	111	44,1	100,0	74,6
2 9/16	65	65,9	230	± 2	3	132	51,2	120,7	92,1
3 1/16	78	78,6	270	± 2	3	152	58,4	142,1	110,3
4 1/16	103	104,0	315	± 2	3	185	70,3	182,6	146,1
5 1/8	130	131,0	360	± 2	3	221	79,4	223,8	182,6
7 1/16	179	180,2	480	± 3	6	302	103,2	301,6	254,0
9	228	229,4	550	± 3	6	359	123,9	374,7	327,1
11	279	280,2	655	± 3	6	429	141,3	450,9	400,1
13 5/8	346	346,9	770	± 3	6	518	168,3	552,5	495,3
16 3/4	425	426,2	870	± 3	6	576	168,3	655,6	601,7
		103,5 MPa							
1 13/16	46	46,8	210	± 2	3	106	45,3	97,6	71,4
2 1/16	52	53,2	220	± 2	3	114	50,8	111,1	82,6
2 9/16	65	65,9	255	± 2	3	133	57,2	128,6	100,0
3 1/16	78	78,6	290	± 2	3	154	64,3	154,0	122,2
4 1/16	103	104,0	360	± 2	3	194	78,6	195,3	158,8
5 1/8	130	131,0	420	± 2	3	225	98,5	244,5	200,0
7 1/16	179	180,2	505	± 3	6	305	119,1	325,4	276,2

Table 42 *(continued)*

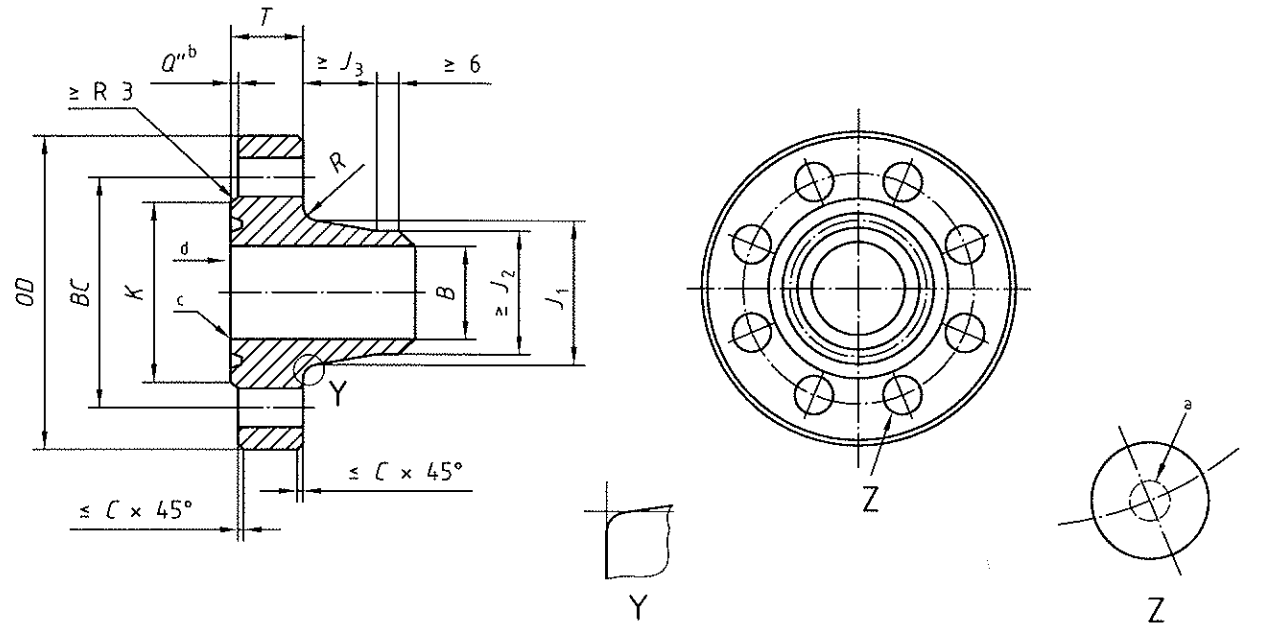
Dimensions in millimetres

(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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
(in)	mm	J_3	R	BC		(in)		tol.[e]	L_{ssb}	BX
		69,0 MPa								
1 13/16	46	48,4	10	146,0	8	3/4	23	+ 2	125	151
2 1/16	52	51,6	10	158,8	8	3/4	23	+ 2	135	152
2 9/16	65	57,2	10	184,2	8	7/8	26	+ 2	150	153
3 1/16	78	63,5	10	215,9	8	1	29	+ 2	170	154
4 1/16	103	73,0	10	258,8	8	1 1/8	32	+ 2	205	155
5 1/8	130	81,0	10	300,0	12	1 1/8	32	+ 2	220	169
7 1/16	179	95,2	16	403,2	12	1 1/2	42	+ 2,5	285	156
9	228	93,7	16	476,3	16	1 1/2	42	+ 2,5	330	157
11	279	103,2	16	565,2	16	1 3/4	48	+ 2,5	380	158
13 5/8	346	114,3	16	673,1	20	1 7/8	51	+ 2,5	440	159
16 3/4	425	76,2	19	776,3	24	1 7/8	51	+ 2,5	445	162
		103,5 MPa								
1 13/16	46	47,6	10	160,3	8	7/8	26	+ 2	140	151
2 1/16	52	54,0	10	174,6	8	7/8	26	+ 2	150	152
2 9/16	65	57,2	10	200,0	8	1	29	+ 2	170	153
3 1/16	78	63,5	10	230,2	8	1 1/8	32	+ 2	190	154
4 1/16	103	73,0	10	290,5	8	1 3/8	39	+ 2	235	155
5 1/8	130	81,8	16	342,9	12	1 1/2	42	+ 2,5	290	169
7 1/16	179	92,1	16	428,6	16	1 1/2	42	+ 2,5	325	156

[e] Minimum bolt hole tolerance is – 0,5.

Table 43 — Type 6BX welding neck flanges for 138,0 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

a Bolt hole centreline located within 0,8 mm of theoretical BC and equal spacing.

b $Q''_{max.} = E$ (Table 52);
$Q''_{min.}$ = 3 mm.

c Break sharp corners.

d Top.

Dimensions in millimetres

(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
(in)	mm	B	OD	tol.	C	K ± 1,6	T $^{+3}_{0}$	J_1 $^{0}_{-3}$	J_2	J_3	R
1 $^{13}/_{16}$	46	46,8	255	± 2	3	117	63,5	133,4	109,5	49,2	10
2 $^{1}/_{16}$	52	53,2	285	± 2	3	132	71,5	154,0	127,0	52,4	10
2 $^{9}/_{16}$	65	65,9	325	± 2	3	151	79,4	173,0	144,5	58,7	10
3 $^{1}/_{16}$	78	78,6	355	± 2	3	171	85,8	192,1	160,3	63,5	10
4 $^{1}/_{16}$	103	104,0	445	± 2	3	219	106,4	242,9	206,4	73,0	10
7 $^{1}/_{16}$	179	180,2	655	± 3	6	352	165,1	385,8	338,1	96,8	16

Table 43 *(continued)*

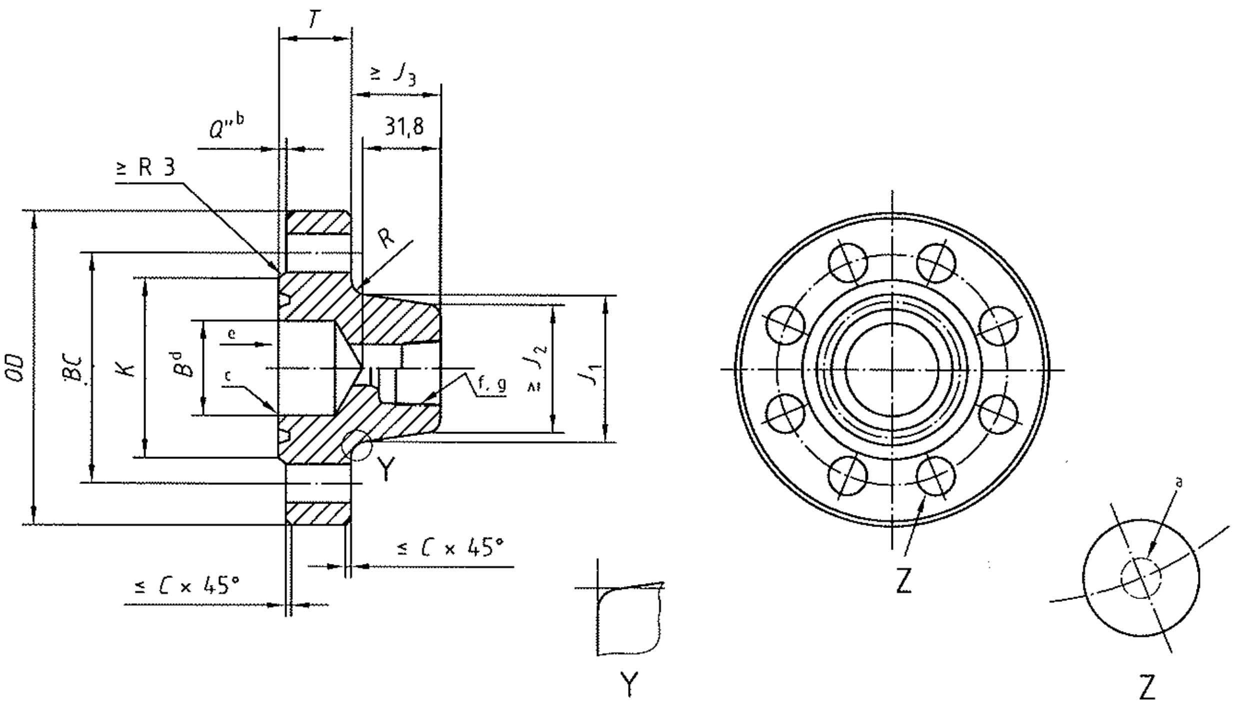
Dimensions in millimetres

(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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
(in)	mm	*BC*		(in)		tol. [e]	L_{ssb}	BX
1 $^{13}/_{16}$	46	203,2	8	1	29	+ 2	190	151
2 $^{1}/_{16}$	52	230,2	8	1 $^{1}/_{8}$	32	+ 2	210	152
2 $^{9}/_{16}$	65	261,9	8	1 $^{1}/_{4}$	35	+ 2	235	153
3 $^{1}/_{16}$	78	287,3	8	1 $^{3}/_{8}$	39	+ 2	255	154
4 $^{1}/_{16}$	103	357,2	8	1 $^{3}/_{4}$	48	+ 2,5	310	155
7 $^{1}/_{16}$	179	554,0	16	2	54	+ 2,5	445	156

[e] Minimum bolt hole tolerance is – 0,5.

Table 44 — Type 6BX blind and test flanges for 69,0 MPa and 103,5 MPa rated working pressures
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

a Bolt hole centreline located within 0,8 mm of theoretical BC and equal spacing.

b $Q''_{max.} = E$ (Table 52);
$Q''_{min.}$ = 3 mm.

c Break sharp corners.

d This bore optional.

e Top.

f Test connection. See Figure 22.

g $^1/_2$ inch linepipe or NPT threads (maximum 69,0 MPa working pressure).

Table 44 *(continued)*

Dimensions in millimetres

(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
(in)	mm	*B*	*OD*	tol.	*C*	*K* $\pm 1{,}6$	*T* $^{+3}_{0}$	J_1 $^{0}_{-3}$	J_2	J_3	*R*
		69,0 MPa									
1 13/16	46	46,8	185	± 2	3	105	42,1	88,9	65,1	48,4	10
2 1/16	52	53,2	200	± 2	3	111	44,1	100,0	74,6	51,6	10
2 9/16	65	65,9	230	± 2	3	132	51,3	120,6	92,1	57,1	10
3 1/16	78	78,6	270	± 2	3	152	58,4	142,1	110,3	63,5	10
4 1/16	103	104,0	315	± 2	3	185	70,3	182,6	146,0	73,0	10
5 1/8	130	131,0	360	± 2	3	221	79,4	223,8	182,6	81,0	10
		103,5 MPa									
1 13/16	46	46,8	210	± 2	3	106	45,3	97,6	71,4	47,6	10
2 1/16	52	53,2	220	± 2	3	114	50,8	111,1	82,6	54,0	10
2 9/16	65	65,9	255	± 2	3	133	57,2	128,6	100,0	57,1	10
3 1/16	78	78,6	290	± 2	3	154	64,3	154,0	122,2	63,5	10
4 1/16	103	104,0	360	± 2	3	194	78,6	195,3	158,8	73,0	10

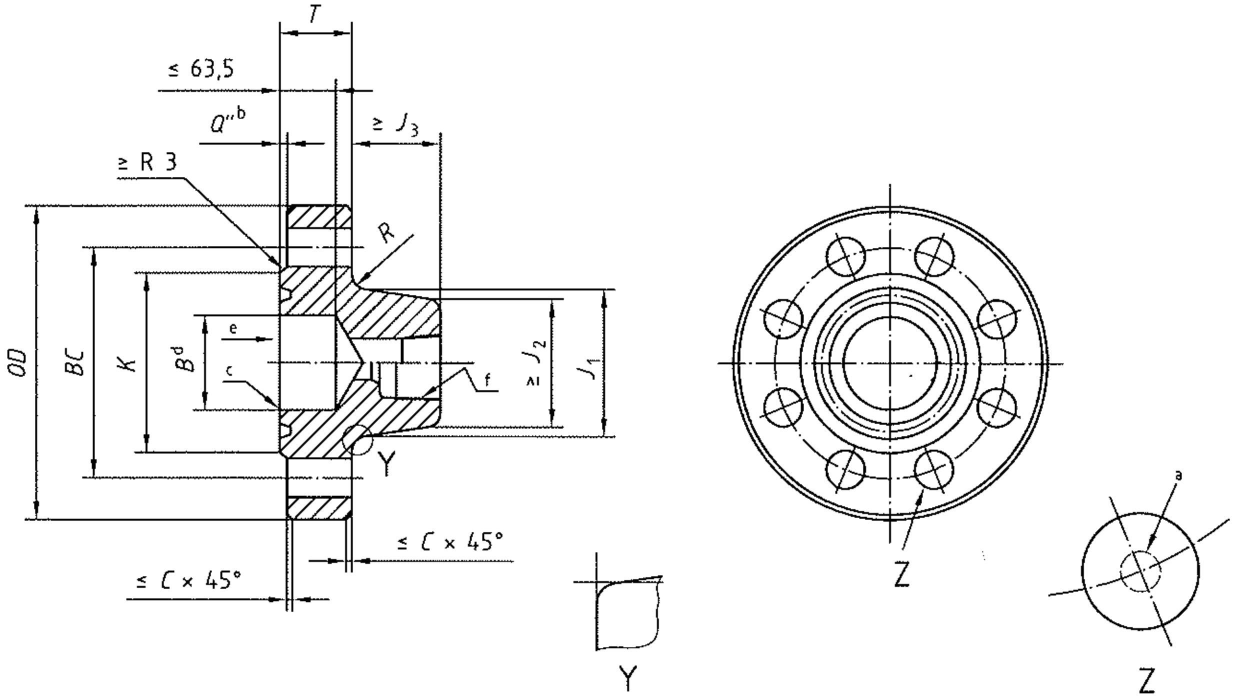
Dimensions in millimetres

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
(in)	mm	*BC*		(in)		tol.[h]	L_{ssb}	BX
		69,0 MPa						
1 13/16	46	146,0	8	3/4	23	+ 2	125	151
2 1/16	52	158,8	8	3/4	23	+ 2	135	152
2 9/16	65	184,2	8	7/8	26	+ 2	150	153
3 1/16	78	215,9	8	1	29	+ 2	170	154
4 1/16	103	258,8	8	1 1/8	32	+ 2	205	155
5 1/8	130	300,0	12	1 1/8	32	+ 2	220	169
		103,5 MPa						
1 13/16	46	160,3	8	7/8	26	+ 2	140	151
2 1/16	52	174,6	8	7/8	26	+ 2	150	152
2 9/16	65	200,0	8	1	29	+ 2	170	153
3 1/16	78	230,2	8	1 1/8	32	+ 2	190	154
4 1/16	103	290,5	8	1 3/8	39	+ 2	235	155

[h] Minimum bolt hole tolerance is – 0,5.

Table 45 — Type 6BX blind and test flanges for 103,5 MPa and 138,0 MPa rated working pressures
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

a Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

b $Q''_{max.} = E$ (Table 52);
$Q''_{min.}$ = 3 mm.

c Break sharp corners.

d This bore optional.

e Top.

f Test connection. See Figure 22.

Table 45 *(continued)*

Dimensions in millimetres

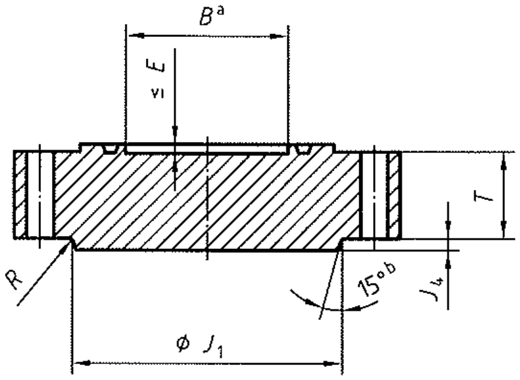
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange		Basic flange dimensions									
		Maximum bore	Outside diameter of flange		Maximum chamfer	Diameter of raised face	Total thickness of flange	Large diameter of hub	Small diameter of hub	Length of hub	Radius of hub
(in)	mm	*B*	*OD*	tol.	*C*	*K* ± 1,6	*T* $^{+3}_{0}$	J_1 $^{0}_{-3}$	J_2	J_3	*R*
		103,5 MPa									
5 $^1/_8$	130	131	420	± 2	3	225	98,5	244,5	200,0	81,8	16
		138,0 MPa									
1 $^{13}/_{16}$	46	46,8	255	± 2	3	117	63,5	133,4	109,5	49,2	10
2 $^1/_{16}$	52	53,2	285	± 2	3	132	71,4	154,0	127,0	52,4	10
2 $^9/_{16}$	65	65,9	325	± 2	3	151	79,4	173,0	144,5	58,7	10
3 $^1/_{16}$	78	78,6	355	± 2	3	171	85,7	192,1	160,3	63,5	10
4 $^1/_{16}$	103	104,0	445	± 2	3	219	106,4	242,9	206,4	73,0	10

Dimensions in millimetres

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
(in)	mm	*BC*		(in)		tol.[9]	L_{ssb}	BX
		103,5 MPa						
5 $^1/_8$	130	342,9	12	1 $^1/_2$	42	+ 2,5	290	169
		138,0 MPa						
1 $^{13}/_{16}$	46	203,2	8	1	29	+ 2	190	151
2 $^1/_{16}$	52	230,2	8	1 $^1/_8$	32	+ 2	210	152
2 $^9/_{16}$	65	261,9	8	1 $^1/_4$	35	+ 2	235	153
3 $^1/_{16}$	78	287,3	8	1 $^3/_8$	39	+ 2	255	154
4 $^1/_{16}$	103	357,2	8	1 $^3/_4$	48	+ 2,5	310	155

[9] Minimum bolt hole tolerance is – 0,5.

Table 46 — 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 US Customary units)



[a] Counterbore.

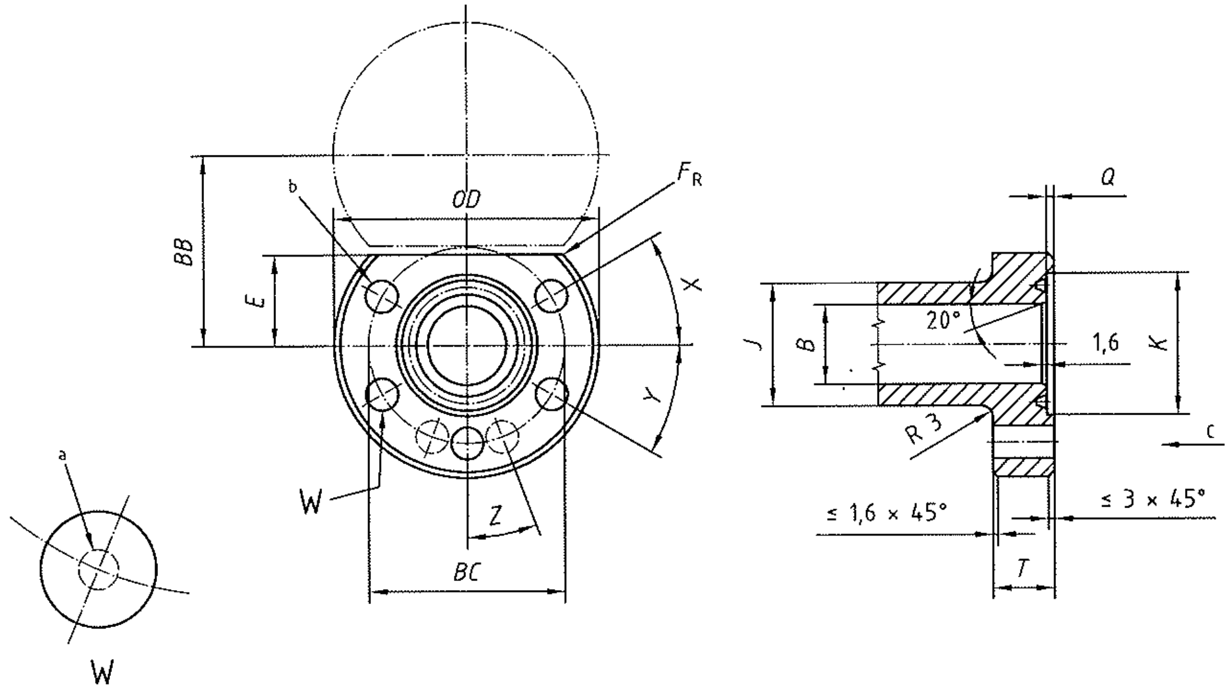
[b] Maximum slope.

Dimensions in millimetres

Nominal size of flange		Flange thickness	Hub diameter	Counter-bore depth	Added hub thickness
B (in)	mm	*T*	J_1	*E*	J_4
		13,8 MPa			
26 3/4	680	126,3	835,8	21,4	9,7
30	762	134,2	931,9	23,0	17,5
		20,7 MPa			
26 3/4	680	161,2	870,0	21,4	0
30	762	167,1	970,0	23,0	12,7
		34,5 MPa			
13 5/8	346	112,8	481,1	14,3	23,9
16 3/4	425	130,2	555,8	8,3	17,5
18 3/4	476	165,9	674,7	18,3	19,1
21 1/4	540	181,0	758,8	19,1	22,4
		69,0 MPa			
5 1/8	130	79,4	223,8	9,5	6,4
7 1/16	179	103,2	301,8	11,1	9,7
9	228	123,9	374,7	12,7	9,7
11	279	141,3	450,9	14,3	14,2
13 5/8	346	168,3	552,5	15,9	17,5
16 3/4	425	168,3	655,6	8,3	30,2
18 3/4	476	223,1	752,3	18,3	25,4
21 1/4	540	241,3	847,9	19,1	31,8
		103,5 MPa			
5 1/8	130	98,5	244,5	9,5	6,4
7 1/16	179	119,1	325,4	11,1	7,9
9	228	146,1	431,8	12,7	14,2
11	279	187,4	584,2	14,3	12,7
13 5/8	346	204,8	595,3	15,9	17,5
18 3/4	476	255,6	812,8	18,3	35,1
		138,0 MPa			
7 1/16	179	165,1	385,8	11,1	7,9
9	228	204,8	481,1	12,7	6,4
11	279	223,9	566,7	14,3	12,7
13 5/8	346	292,1	693,7	15,9	14,2
NOTE	For dimensions not listed, see Tables 40 to 45 as applicable.				

Table 47 — Dimensions for 34,5 MPa rated working pressure segmented flanges for dual completion
(see Annex B for US Customary units)

Dimensions in millimetres



NOTE Ring groove to be concentric with bore within 0,25 total indicator runout.

a Bolt hole centreline located within 0,8 mm of theoretical *BC* and equal spacing.

b Bolt holes: *L*, *M*.

c Top.

Dimensions in millimetres

(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 counterbore	Depth of counterbore	Ring number
(in)	mm	B	OD	tol.	T $^{+3}_{0}$	E −0,5	F_R	J	tol.	K	Q +0,25	RX
1 3/8	35	35,3	130	± 2	39,7	29,5	6	56,4	−0,5	52,4	2,77	201
1 13/16	46	46,4	155	± 2	52,4	34,9	3	69,8	−0,5	66,7	1,83	205
2 1/16	52	53,2	165	± 2	54,0	44,4	3	77,0	−0,8	79,4	3,68	20
2 9/16	65	65,9	215	± 2	63,5	56,4	3	93,7	−0,8	101,6	3,68	210
3 1/8	78	80,2	230	± 2	69,9	63,5	3	114,3	−0,8	115,9	3,30	25
4 1/16	103	104,0	270	± 2	69,9	74,6	25	133,4	−0,8	144,5	5,33	215
4 1/16 × 4 1/4	103 × 108	108,7	270	± 2	69,9	74,6	25	133,4	−0,8	144,5	5,33	215

Table 47 *(continued)*

Dimensions in millimetres

(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
(in)	mm	*BC*	*L*	tol.[d]	*M*	*X*	*Y*	*Z*	(in)			*BB*
1 3/8	35	98,4	16	+ 2	5	13	38,5	—	1/2	70	115	—
1 13/16	46	117,5	20	+ 2	5	16	37	—	5/8	90	145	70,64
2 1/16	52	130,2	23	+ 2	5	19	35,5	—	3/4	95	150	90,09
2 9/16	65	161,9	29	+ 2	5	21	34,5	—	1	120	185	114,30
3 1/8	78	179,4	29	+ 2	5	23	33,5	—	1	125	195	128,19
4 1/16	103	206,4	32	+ 2	6	28.5	19	23,5	1 1/8	135	210	—
4 1/16 × 4 1/4	103 × 108	206,4	32	+ 2	6	28.5	19	23,5	1 1/8	135	210	—

[d] Minimum bolt hole tolerance is – 0,5.

10.2 Threaded end and outlet connections

10.2.1 General

The requirements for loose and integral equipment end and outlet connections, including tubing and casing hangers apply only to those, which are threaded according to ISO 10422. 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 ISO 10422 or ASME B1.20.1 if applicable [see 10.2.2.3].

a) Thread lengths

The length of internal threads shall not be less than the effective thread length $L2$ of the external thread as specified in the figure belonging to Table 48* and as stipulated in ISO 10422.

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 ISO 10422 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 ISO 10422, 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 48* and Figure 10. Internal threads, furnished with a counter-bore, should conform to the counter-bore dimensions specified in Table 48* 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 ISO 10422.

10.2.2.4 Thread alignment

Threads shall align with the axis of the end connection within a tolerance of ± 5,0 mm/m (± 0,06 in/ft) or 0,3° of projected axis.

10.2.2.5 End/outlet coupling diameter

The outlet coupling diameter shall be of sufficient diameter to provide structural integrity of the threaded part at rated pressure. This diameter shall not be less than the tabulated joint or coupling diameter for the specified thread.

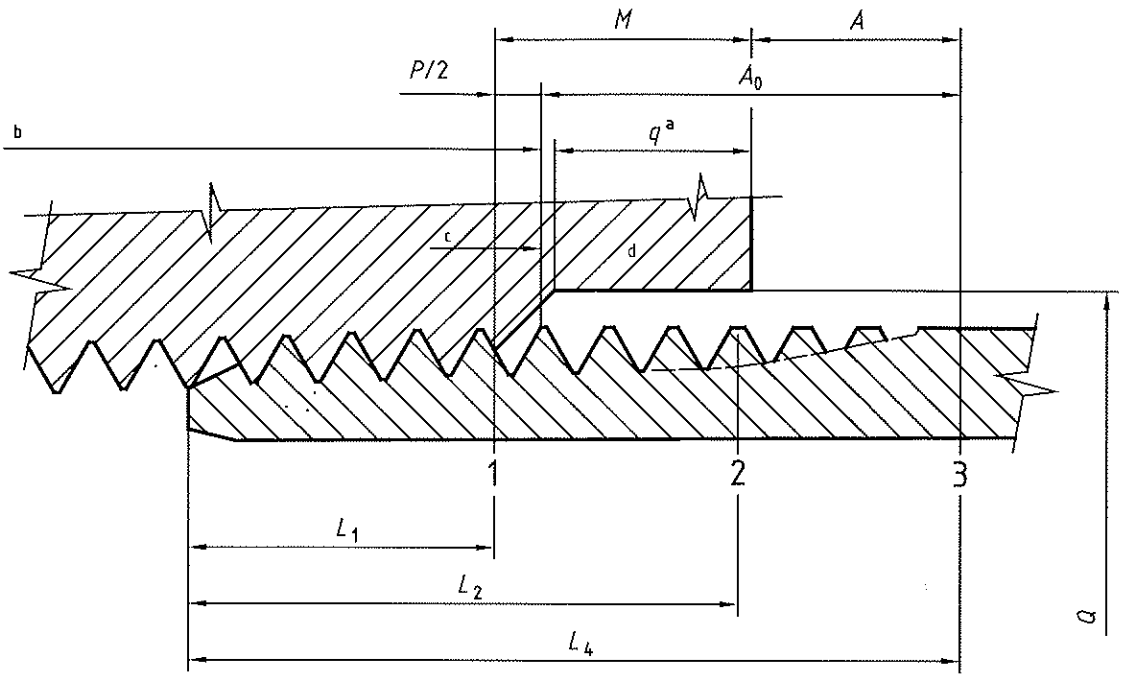
10.2.3 Testing (gauging)

Thread gauges shall comply with the requirements for working gauges as stipulated in 4.2 through 4.6 of ISO 10422:1993. 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 ISO 10422, use gauging practices as specified in ISO 10422.

10.2.4 Marking

Threaded connectors shall be marked to conform with Clause 8.

Table 48 — Pipe thread counter-bore and stand-off dimensions (see ISO 10422 for dimensions L_1, L_2 and L_4)
(see Annex B for US Customary units)



Key

1 plane of handtight engagement
2 plane of effective thread length
3 plane of vanish point

[a] Reference dimension.
[b] Internal thread length.
[c] Without counter-bore.
[d] With counter-bore.

Table 48 *(continued)*

Dimensions in millimetres

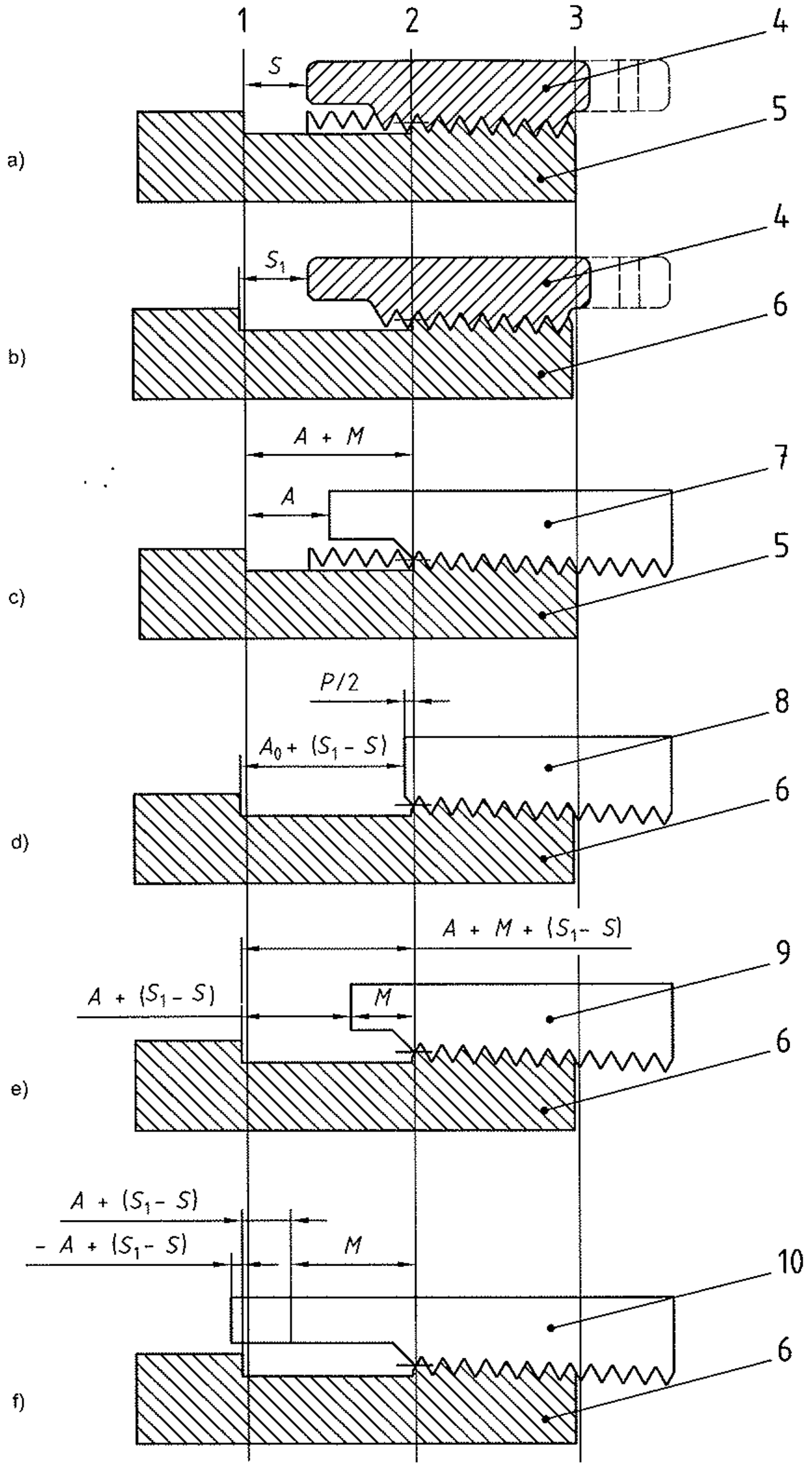
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Hand-tight standoff			Counter-bore	
Nominal thread size (in)	Length: plane of vanish point to hand-tight plane $A + M$	Thread without counter-bore A_0	Thread with shallow counter-bore A	Length: face of counter-bore to hand-tight plane M	Diameter Q	Depth q
	Line-pipe threads					
$^1/_8$	5,40	4,93	1,01	4,38	11,9	3,3
$^1/_4$	10,02	9,32	5,45	4,57	15,2	3,3
$^3/_8$	9,16	8,45	4,55	4,61	18,8	3,3
$^1/_2$	11,72	10,82	3,45	8,28	23,6	6,4
$^3/_4$	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 $^1/_4$	14,95	13,84	6,48	8,47	44,5	6,4
1 $^1/_2$	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 $^1/_2$	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 $^1/_2$	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 48 *(continued)*

Dimensions in millimetres

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Hand-tight standoff			Counter-bore	
Nominal thread size	Length: plane of vanish point to hand-tight plane	Thread without counter-bore	Thread with shallow counter-bore	Length: face of counter-bore to hand-tight plane	Diameter	Depth
(in)	$A + M$	A_0	A	M	Q	q
	Long and short casing threads					
4 1/2	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 1/2	27,41	25,82	15,00	12,40	143,0	9,7
6 5/8	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 5/8	29,11	27,52	16,72	12,39	196,9	9,7
8 5/8	29,11	27,52	16,72	12,39	222,3	9,7
9 5/8	29,11	27,52	16,72	12,39	247,7	9,7
10 3/4 [e]	29,11	27,52	16,65	12,46	276,4	9,7
11 3/4 [e]	29,11	27,52	16,65	12,46	301,8	9,7
13 3/8 [e]	29,11	27,52	15,95	13,15	344,4	9,7
16 [e]	29,11	27,52	15,89	13,22	411,2	9,7
20 [e]	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 3/8	16,41	15,14	7,69	8,72	63,5	6,4
2 7/8	16,41	15,14	4,51	11,90	76,2	9,7
3 1/2	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 1/2	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 3/8	19,91	18,33	10,87	9,04	69,1	6,4
2 7/8	19,91	18,33	7,69	12,22	81,8	9,7
3 1/2	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 1/2	19,91	18,33	7,65	12,27	124,0	9,7

[e] Short casing threads only (long casing threads not covered).

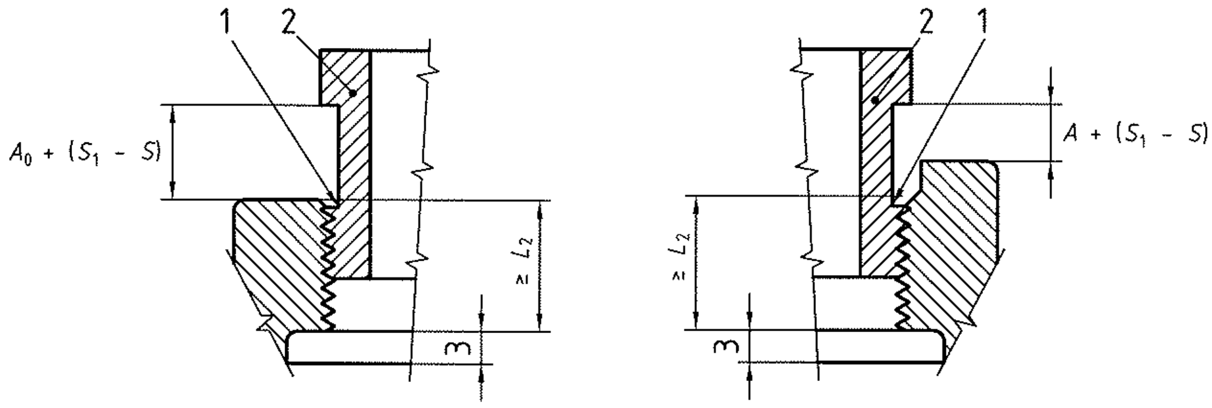


NOTE See ISO 10422 for dimensions of L_1, L_2, L_4, S and S_1.

Key

1 plane of vanish point
2 plane of hand-tight engagement
3 plane of end of pipe
4 certified reference master ring gauge
5 certified reference master plug gauge
6 working plug gauge
7 product thread
8 product thread without counter-bore
9 product thread with shallow counter-bore
10 product thread with deep counter-bore

Figure 10 — Gauging practice for line-pipe, casing and tubing internal threads, hand-tight assembly



a) Without counter-bore

b) With shallow counter-bore

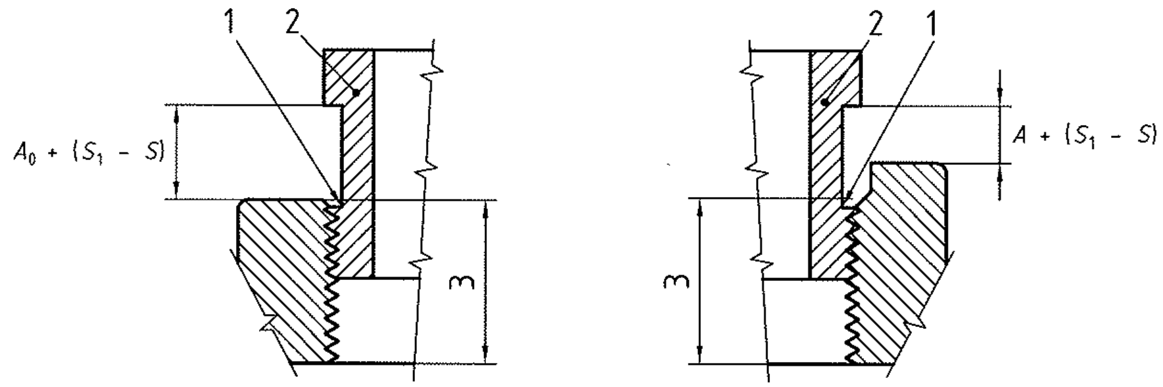
Key

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



a) Without counter-bore

b) With shallow counter-bore

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 49. Studs and nuts shall meet the requirements of the applicable ASTM specification, unless otherwise noted. Dimensions and thread pitch shall be in accordance with ASTM A 193 for studs and ASTM A 194 for nuts. The mechanical properties specified in Table 49 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 49. Alternate materials may be used provided the mechanical properties meet the requirements shown in Table 49.

a) Yield strength

Yield strength shall meet or exceed the minimums shown in Table 49.

b) Size limitations

The material size limitations specified in ASTM A 320 for Grade L7M may be exceeded if the material requirements are met.

10.3.3.2 NACE exposed bolting

a) ASTM A 453 Grade 660

ASTM A 453 Grade 660 solution-treated and aged-hardened is acceptable at a hardness of HRC 35 and lower, and a minimum 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.

b) CRA materials

Other CRA materials may be used provided they satisfy the minimum mechanical requirements of ASTM A 453 Grade 660 bolting except the maximum hardness shall meet NACE MR 0175 requirements.

NOTE Some materials may be susceptible to environmentally assisted cracking.

Bolting used with insulated flanges in sour service shall satisfy 10.3.3.3 (see NACE MR 0175, section 6).

10.3.3.3 NACE exposed bolting (low strength)

a) ASTM A 193 Grade B7M

ASTM A 193 Grade B7M is acceptable at a minimum yield strength of 550 MPa (80 000 psi) for the flanges listed in Table 49 for NACE MR 0175 exposed bolting (low strength) only.

b) ASTM A 320 Grade L7M

ASTM A 320 Grade L7M is acceptable at a minimum yield strength of 550 MPa (80 000 psi) for the flanges listed in Table 49 for NACE MR 0175 exposed bolting (low strength) only.

10.3.3.4 NACE non-exposed bolting

a) ASTM A 193 Grade B7

ASTM A 193 Grade B7 is acceptable for non-exposed service for the flanges listed in Table 49 for NACE MR 0175 non-exposed bolting only.

b) ASTM A 320 Grade L7 or L43

ASTM A 320 Grade L7 or L43 is acceptable for non-exposed service for the flanges listed in Table 49 for NACE MR 0175 non-exposed bolting only.

10.3.3.5 NACE nuts

a) ASTM A 194 Grade 2HM

ASTM A 194 Grade 2HM is acceptable for all flange sizes and rated working pressures.

b) NACE exposed bolting

ASTM A 453 Grade 660 or CRA nuts may be used with NACE exposed bolting only if provisions are made to prevent galling.

Table 49 — 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**
NACE MR 0175	N.A.	N.A.	Non-exposed	Non-exposed	Exposed (Low strength)		Exposed
Size and rated working pressure	All	All	All	All	All 13,8 and 20,7 MPa flgs 34,5 MPa flgs < $13\,^{5}/_{8}$ 69,0 MPa flgs < $4\,^{1}/_{16}$ 103,5 MPa flgs for $1\,^{13}/_{16}$ and $5\,^{1}/_{8}$ only All 138,0 MPa flgs		All
Bolting							
ASTM spec. grades and materials	A 193 GR B7	A 320 GR L7 OR L43	A 193 GR B7	A 320 GR L7 OR L43	A 193 GR B7M	A 320 GR L7M	A 453 GR 660 CRA
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)
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 per NACE MR 0175	No	No	No	No	Yes	Yes	Yes
Charpy testing required	No	Yes	No	Yes	No	Yes	No
Nuts							
ASTM spec. and grades, heavy	A 194 2H, 2HM, 4 or 7	A 194 2H, 2HM, 4 or 7	A 194 2H, 2HM, 4 or 7	A 194 2H, 2HM, 4 or 7	A 194 GR 2HM	A 194 GR 2HM	A 194 GR 2HM
Hardness per NACE MR 0175	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 and RX gaskets shall be used on 6B flanges. Only BX gaskets shall be used with 6BX flanges. RX and BX gaskets provide a pressure-energized seal but are not interchangeable.

10.4.2 Design

10.4.2.1 Dimensions

Ring gaskets shall conform to the dimensions and tolerances specified in Tables 50*, 51* and 52* 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

a) Surface finish

All 23° surfaces on R and RX gaskets shall have a surface finish no rougher than 1,6 μm *Ra* (63 μin RMS).

b) RX pressure-passage hole

Certain size RX gaskets shall have one pressure-passage hole drilled through their height as shown in Table 51*.

10.4.2.3 BX gaskets

a) Surface finish

All 23° surfaces on BX gaskets shall have a surface finish no rougher than 0,8 μm *Ra* (32 μin RMS).

b) Pressure-passage hole

Each BX gasket shall have one pressure-passage hole drilled through its height as shown in Table 52*.

10.4.2.4 Re-use of gaskets

Ring gaskets have a limited amount of positive interference which assures the gaskets will be coined into sealing relationship in the grooves. These gaskets shall not be re-used.

10.4.3 Materials

a) Gasket material

Gasket material shall conform to Clause 5.

b) Coatings and platings

Coatings and platings may be employed to aid seal engagement while minimizing galling, and to extend shelf life. Coating and plating thicknesses shall be 0,013 mm (0,000 5 in) maximum.

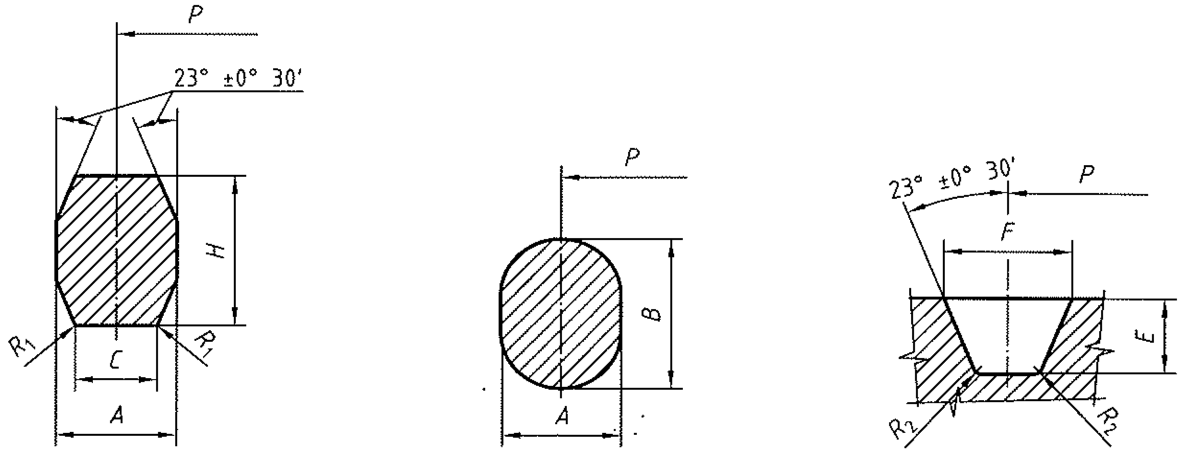
10.4.4 Marking

Gaskets shall be marked to conform with Clause 8.

10.4.5 Storing and shipping

Gaskets shall be stored and shipped in accordance with Clause 9.

Table 50 — Type R ring gaskets (see Annex B for US Customary units)



a) Octagonal b) Oval c) Groove

Dimensions in millimetres

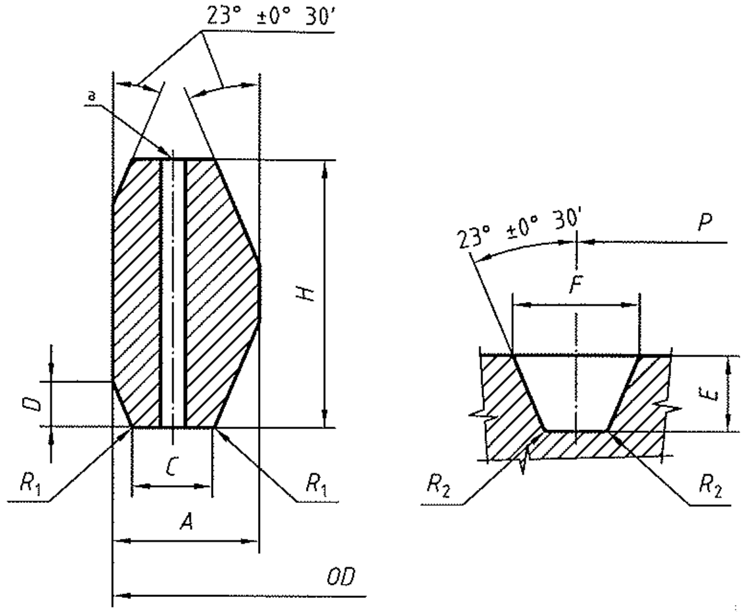
Ring number	Pitch diameter of ring (groove)	Width of ring	Height of ring oval	Height of ring octagonal	Width of flat of octagonal ring	Radius in octagonal ring	Depth of groove	Width of groove	Radius in groove	Approx. distance between made-up flanges
	P	A	B	H	C	R_1	E	F	R_2	S
	± 0,18 (± 0,13)	± 0,20	± 0,5	± 0,5	± 0,2	± 0,5	$^{+0,5}_{0}$	± 0,20	max.	
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
R 57	381,00	11,13	17,5	15,9	7,79	1,5	7,9	11,91	0,8	4,8

Table 50 *(continued)*

Dimensions in millimetres

Ring number	Pitch diameter of ring (groove)	Width of ring	Height of ring oval	Height of ring octagonal	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	A	B	H	C	R_1	E	F	R_2	S
	± 0,18 (± 0,13)	± 0,20	± 0,5	± 0,5	± 0,2	± 0,5	$^{+0,5}_{0}$	± 0,20	max.	
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

Table 51 — Type RX pressure-energized ring gaskets (see Annex B for US Customary units)

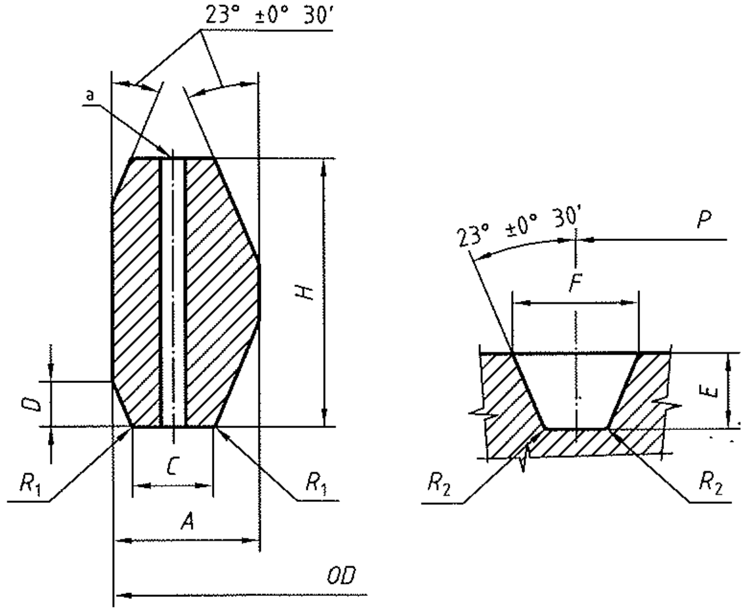


a The pressure-passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. Centreline of hole shall be located at midpoint of dimension C. Hole diameter shall be 1,5 mm for rings RX-82 through RX-85, 2,4 mm for rings RX-86 and RX-87, and 3,0 mm for rings RX-88 through RX-91.

Dimensions in millimetres

Ring number	Pitch diameter of ring and 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	OD	A [d]	C	D	H [d]	R_1	E	F	R_2	S
	± 0,13	$^{+0,5}_{0}$	$^{+0,20}_{0}$	$^{+0,15}_{0}$	$^{0}_{-0,8}$	$^{+0,2}_{0}$	± 0,5	$^{+0,5}_{0}$	± 0,20	max.	
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	18,5
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 51 *(continued)*



[a] The pressure-passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. Centreline of hole shall be located at midpoint of dimension *C*. 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 ring and 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	OD	A [d]	C	D	H [d]	R_1	E	F	R_2	S
	$\pm 0{,}13$	$^{+0{,}5}_{0}$	$^{+0{,}20}_{0}$	$^{+0{,}15}_{0}$	$^{0}_{-0{,}8}$	$^{+0{,}2}_{0}$	$\pm 0{,}5$	$^{+0{,}5}_{0}$	$\pm 0{,}20$	max.	
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 [b]	11,30	0,5 [c]	4,1	5,56	0,8	—
RX 205	57,15	62,31	5,56	3,05	1,83 [b]	11,10	0,5 [c]	4,1	5,56	0,5	—
RX 210	88,90	97,64	9,53	5,41	3,18 [b]	19,05	0,8 [c]	6,4	9,53	0,8	—
RX 215	130,18	140,89	11,91	5,33	4,24 [b]	25,40	1,5 [c]	7,9	11,91	0,8	—

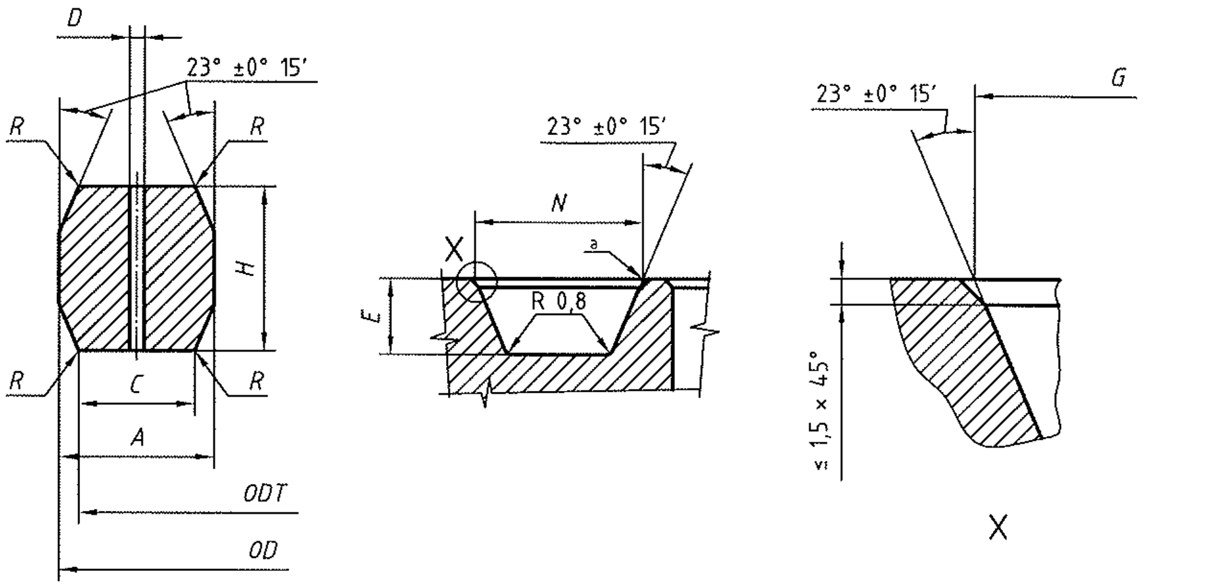
[b] Tolerance on these dimensions is $^{0}_{-0{,}38}$.

[c] Tolerance on these dimensions is $^{+0{,}5}_{0}$.

[d] 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.

Table 52 — Type BX pressure-energized ring gaskets (see Annex B for US Customary units)

Dimensions in millimetres



Radius R shall be 8 % to 12 % of the gasket height H. One pressure-passage hole required per gasket on centreline.

[a] Break sharp corner on inside diameter of groove.

Dimensions in millimetres

Ring number	Nominal size	Outside diameter of ring OD $^{0}_{-0,15}$	Height of ring H [b] $^{+0,20}_{0}$	Width of ring A [b] $^{+0,20}_{0}$	Diameter of flat ODT ± 0,05	Width of flat C $^{+0,15}_{0}$	Hole size D ± 0,5	Depth of groove E $^{+0,5}_{0}$	Outside diameter of groove G $^{+0,10}_{0}$	Width of groove N $^{+0,10}_{0}$
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	680	759,36	35,87	13,11	754,28	8,03	1,6	21,43	768,33	22,91
BX 168	680	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

[b] 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 below 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 53. This includes manually actuated valves and valves designed for actuators.

Table 53 — Operating cycle requirements for valves

	PR 1	**PR 2**
Operating cycles	3 cycles	200 cycles

10.5.3 Design

10.5.3.1 Dimensions

a) Nominal size

Valves shall be identified by the nominal valve size in Tables 54* through 59*.

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 54* through 59* as applicable.

3) Valves with any other end connector

   There are no requirements for 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 54* through 59*. 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 only be supplied in sizes 52 mm to 103 mm (2 $^1/_{16}$ in to 4 $^1/_{16}$ in) and rated working pressures 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

Gate valves shall be supplied with a handwheel. Plug valves shall be furnished with a wrench (or bar) operating mechanism or with a handwheel-actuated gear mechanism. All handwheels shall be spoked and 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

a) Body, bonnet, and end connectors

Body, bonnet, and end-connector material shall comply with Clause 5.

b) 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

a) Drift test

All assembled full-bore valves shall pass a drift test as described in 7.4.9.3.1.

b) 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 54 — Flanged plug and gate valves for 13,8 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valve bore	Face-to-face valve length ± 2			
			Full-bore gate valves	Plug valves		
(in)	mm	$^{+0,8}_{0}$		Full-bore plug valves	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
2 1/16 × 1 13/16	52 × 46	46,0	295	—	295	—
2 1/16	52	52,4	295	333	295	295
2 9/16	65	65,1	333	384	333	333
3 1/8	79	79,4	359	448	359	359
3 1/8 × 3 3/16	79 × 81	81,0	359	448	359	—
4 1/16	103	103,2	435	511	435	435
4 1/16 × 4 1/8	103 × 105	104,8	435	511	435	—
4 1/16 × 4 1/4	103 × 108	108,0	435	511	435	—
5 1/8	130	130,2	562	638	—	—
7 1/16 × 6	179 × 152	152,4	562	727	562	562
7 1/16 × 6 3/8	179 × 162	161,9	562	—	—	—
7 1/16 × 6 5/8	179 × 168	168,3	—	—	—	—
7 1/16	179	179,4	664	740	—	—
7 1/16 × 7 1/8	179 × 181	181,0	664	740	—	—

Table 55 — Flanged plug and gate valves for 20,7 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valve bore	Face-to-face valve length ± 2			
			Full-bore gate valves	Plug valves		
(in)	mm	$^{+0,8}_{0}$		Full-bore plug valves	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
2 1/16 × 1 13/16	52 × 46	46,0	371	—	371	—
2 1/16	52	52,4	371	384	371	371
2 9/16	65	65,1	422	435	422	422
3 1/8	79	79,4	435	473	384	384
3 1/8 × 3 3/16	79 × 81	81,0	435	473	384	—
4 1/16	103	103,2	511	562	460	460
4 1/16 × 4 1/8	103 × 105	104,8	511	562	460	—
4 1/16 × 4 1/4	103 × 108	108,0	511	562	460	—
5 1/8	130	130,2	613	664	—	—
7 1/16 × 6	179 × 152	152,4	613	765	613	613
7 1/16 × 6 3/8	179 × 162	161,9	613	—	—	—
7 1/16 × 6 5/8	179 × 168	168,3	—	—	—	—
7 1/16	179	179,4	714	803	—	—
7 1/16 × 7 1/8	179 × 181	181,0	714	803	—	—

Table 56 — Flanged plug and gate valves for 34,5 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valve bore	Face-to-face valve length ± 2			
			Full-bore gate valves	Plug valves		
				Full-bore plug valves	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
(in)	mm	$^{+0,8}_{0}$				
2 $^{1}/_{16}$ × 1 $^{13}/_{16}$	52 × 46	46,0	371	—	371	—
2 $^{1}/_{16}$	52	52,4	371	394	371	371
2 $^{9}/_{16}$	65	65,1	422	457	422	473
3 $^{1}/_{8}$	79	79,4	473	527	473	473
3 $^{1}/_{8}$ × 3 $^{3}/_{16}$	79 × 81	81,0	473	527	473	—
4 $^{1}/_{16}$	103	103,2	549	629	549	549
4 $^{1}/_{16}$ × 4 $^{1}/_{8}$	103 × 105	104,8	549	629	549	—
4 $^{1}/_{16}$ × 4 $^{1}/_{4}$	103 × 108	108,0	549	629	549	—
5 $^{1}/_{8}$	130	130,2	727	—	—	—
7 $^{1}/_{16}$ × 5 $^{1}/_{8}$	179 × 130	130,2	737	—	—	—
7 $^{1}/_{16}$ × 6	179 × 152	152,4	737	—	—	711
7 $^{1}/_{16}$ × 6 $^{1}/_{8}$	179 × 155	155,6	737	—	—	—
7 $^{1}/_{16}$ × 6 $^{3}/_{8}$	179 × 162	161,9	737	—	—	—
7 $^{1}/_{16}$ × 6 $^{5}/_{8}$	179 × 168	168,3	737	—	—	—
7 $^{1}/_{16}$	179	179,4	813	978	—	—
7 $^{1}/_{16}$ × 7 $^{1}/_{8}$	179 × 181	181,0	813	978	—	—
9	228	228,6	1 041	—	—	—

Table 57 — Flanged plug and gate valves for 69,0 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valves	
		Bore	Face-to-face length ± 2
(in)	mm	$^{+0,8}_{0}$	
1 $^{13}/_{16}$	46	46,0	464
2 $^{1}/_{16}$	52	52,4	521
2 $^{9}/_{16}$	65	65,1	565
3 $^{1}/_{16}$	78	77,8	619
4 $^{1}/_{16}$	103	103,2	670
5 $^{1}/_{8}$	130	130,2	737
7 $^{1}/_{16}$ × 6 $^{3}/_{8}$	179 × 162	161,9	889
7 $^{1}/_{16}$	179	179,4	889

Table 58 — Flanged plug and gate valves for 103,5 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valves		
		Bore	Face-to-face valve length ± 2	
(in)	mm	$^{+0,8}_{0}$	Short pattern	Long pattern
1 13/16	46	46,0	457	—
2 1/16	52	52,4	483	597
2 9/16	65	65,1	533	635
3 1/16	78	77,8	598	—
4 1/16	103	103,2	737	—
5 1/8	130	130,2[a]	889	—

[a] Tolerance on 5 1/8 bore is $^{+1,0}_{0}$.

Table 59 — Flanged plug and gate valves for 138,0 MPa rated working pressure
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Full-bore valves	
		Bore	Face-to-face valve length ± 2
(in)	mm	$^{+0,8}_{0}$	
1 13/16	46	46,0	533
2 1/16	52	52,4	584
2 9/16	65	65,1	673
3 1/16	78	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 noted.

10.5.4.2.2 Dimensions

a) Valve size

Table 60* and Table 61* specify the maximum valve size for a given bore centre to centre, or flange centre to bore centre. Smaller nominal size 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 Table 60* and Table 61*.

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 will be 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

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 and described in 7.4.9.

10.5.4.2.9 Marking

Multiple valves shall be marked in conformance with Clause 8.

10.5.4.2.10 Storing and shipping

Multiple valves shall be stored and shipped in conformance with Clause 9.

Table 60 — 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 US Customary units)

Dimensions in millimetres

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	
(in)	mm					*OD*	Lineic mass kg/m
		13,8 MPa; 20,7 MPa and 34,5 MPa					
$1\,^{13}/_{16}$	46	70,64	35,32	35,32	179	139,7	25
$2\,^{1}/_{16}$	52	90,09	45,05	45,05	179	177,8	57
$2\,^{9}/_{16} \times 2\,^{1}/_{16}$	65 × 52	90,09	41,91	48,18	179	177,8	43
$2\,^{9}/_{16} \times 2\,^{1}/_{16}$	65 × 52	101,60	47,63	53,98	228	193,7	58
$2\,^{9}/_{16}$	65	101,60	50,80	50,80	228	193,7	44
$2\,^{9}/_{16}$	65	114,30	57,15	57,15	228	219,1	73
$3\,^{1}/_{8} \times 2\,^{1}/_{16}$	79 × 52	116,28	51,00	65,28	228	219,1	73
$3\,^{1}/_{8} \times 2\,^{9}/_{16}$	79 × 65	128,19	64,10	64,10	279	244,5	80
$3\,^{1}/_{8}$	78	128,19	64,10	64,10	279	244,5	80
		69,0 MPa					
$1\,^{13}/_{16}$	46	70,64	35,32	35,32	179	139,7	25
$2\,^{1}/_{16}$	52	90,09	45,05	45,05	179	177,8	57
$2\,^{9}/_{16} \times 2\,^{1}/_{16}$	65 × 52	90,09	41,91	48,18	179	177,8	43
$2\,^{9}/_{16} \times 2\,^{1}/_{16}$	65 × 52	101,60	47,63	53,98	228	193,7	58
$2\,^{9}/_{16}$	65	101,60	50,80	50,80	228	193,7	44
$2\,^{9}/_{16}$	65	114,30	57,15	57,15	228	219,1	73
$3\,^{1}/_{16}$	78	128,19	64,10	64,10	279	244,5	80

Table 61 — Centre distances of conduit bores for triple, quadruple and quintuple parallel bore valves
(see Annex B for US Customary units)

Dimensions in millimetres

Nominal size (in)	Maximum valve size mm	Flange centre to bore centre	Minimum end-connector size	Basic casing size OD	Basic casing size Lineic mass kg/m
		13,8 MPa; 20,7 MPa and 34,5 MPa rated working pressures			
		Triple valve			
1 13/16	46	47,63	179	168,3	35,7
2 1/16	52	49,21	228	177,8	38,7
2 1/16	52	53,98	228	193,7	58,0
2 9/16	65	71,44	279	244,5	79,6
		Quadruple valve			
1 13/16	46	73,03	279	219,1	53,6
1 13/16	46	77,79	279	244,5	All
2 1/16	52	77,79	279	244,5	79,6
2 9/16	65	87,31	279	273,1	82,6
2 9/16	65	101,60	346	298,5	80,4
		Quintuple valve			
2 1/16	52	77,79	279	244,5	79,6
		69,0 MPa rated working pressure			
		Triple valve			
1 13/16	46	47,63	179	168,3	35,7
2 1/16	52	49,21	228	177,8	38,7
2 1/16	52	53,98	228	193,7	58,0
2 9/16	65	71,44	279	244,5	79,6
		Quadruple valve			
2 9/16	65	87,31	279	273,1	82,6

10.5.5 Actuated valves

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 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 and described in 7.4.9.

e) Marking

Actuated valves shall be marked to conform 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

a) General

Valves, including multiple, prepared for actuators shall include all parts needed 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 bonnet and actuator.

e) Marking

Valves prepared for actuators shall be marked to conform 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 or the wafer-type. 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);

— single-plate, wafer-type, long pattern (see Figure 16);

— single-plate, wafer-type, short pattern (see Figure 17);

— dual-plate, wafer-type, long pattern (see Figure 18).

10.5.7.2.2 Dimensions

a) Nominal size

Check valves shall be identified by the nominal valve size in column 1 of Tables 62*, 63*, 64*, 65, 66 and 67.

b) Face-to-face dimension

The face-to-face dimension for flanged-end check valves shall correspond to the dimensions shown in Tables 62*, 63*, 65, 66 and 67.

c) Bores

1) Full-opening

All full-opening valves shall have round passage-ways through the body and seats. Bore diameter shall conform to the bore dimensions given in Table 64*.

2) Reduced-opening

Regular lift and swing check valves and wafer-type 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

a) Drift test

Check valves do not require a drift test.

b) Other testing

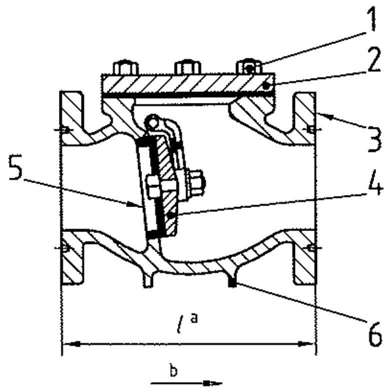
All assembled check valves shall successfully complete all applicable tests required and described in 7.4.9.

10.5.7.5 Marking

Valves shall be marked to conform with Clause 8.

10.5.7.6 Storing and shipping

All check valves shall be stored and shipped in accordance with Clause 9.

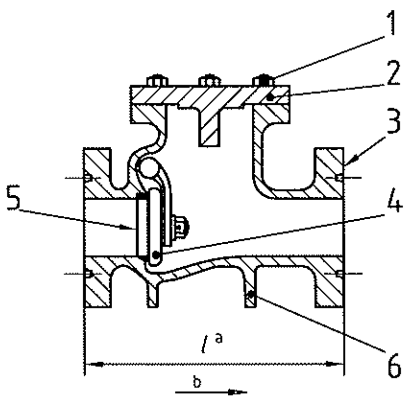


Key

1 cover studs and nuts
2 cover
3 body
4 disc
5 seat ring
6 support ribs or legs

a Face-to-face dimension.
b Direction of flow.

Figure 13 — Regular swing check valve

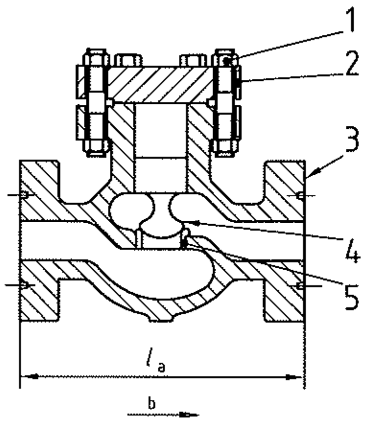


Key

1 cover studs and nuts
2 cover
3 body
4 disc
5 seat ring
6 support ribs or legs

a Face-to-face dimension.
b Direction of flow.

Figure 14 — Full-opening swing check valve

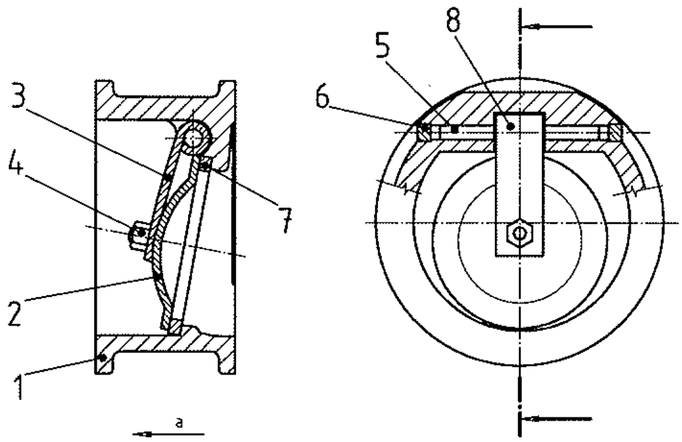


Key

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

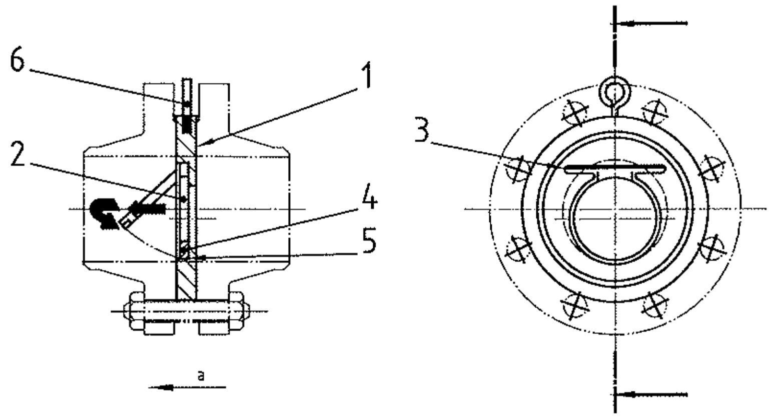


Key

1 body
2 closure plate stud assembly
3 hinge
4 nut
5 hinge pin
6 hinge pin retainers
7 seat ring
8 bearing spacers

[a] Direction of flow.

Figure 16 — Typical single-plate wafer-type check valve, long pattern

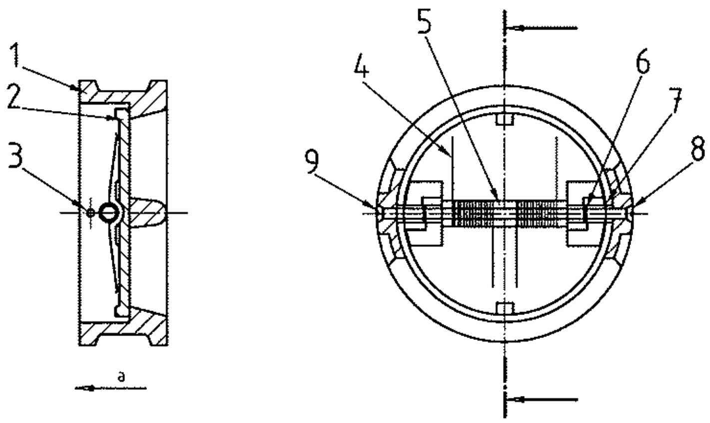


Key

1 body
2 clapper
3 pin
4 clapper seal
5 body seat
6 lifting eye

a Direction of flow.

Figure 17 — Typical single-plate wafer-type check valve, short pattern



Key

1 body
2 closure plate
3 stop pin
4 spring
5 hinge pin
6 plate lug bearings
7 body lug bearings
8 stop pin retainers
9 hinge pin retainers

a Direction of flow.

Figure 18 — Typical dual-plate wafer-type check valve, long pattern

Table 62 — 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 US Customary units)

Dimensions in millimetres

Nominal size		Face-to-face valve length ± 2				
		Short pattern			Long pattern	
(in)	mm	13,8 MPa	20,7 MPa	34,5 MPa	20,7 MPa	34,5 MPa
2 1/16	52	295	371	371	—	—
2 9/16	65	333	422	422	—	—
3 1/8	79	359	384	473	435	—
4 1/16	103	435	460	549	511	—
7 1/16	179	562	613	711	—	737
9	228	664	740	841	—	—
11	279	790	841	1000	—	—

Table 63 — Single and dual plate wafer-type check valves for use with flanges for 13,8 MPa; 20,7 MPa and 34,5 MPa rated working pressures (see Annex B for US Customary units)

Dimensions in millimetres

Nominal size		Face-to-face length ± 2					
		13,8 MPa		20,7 MPa		34,5 MPa	
(in)	mm	Short pattern	Long pattern	Short pattern	Long pattern	Short pattern	Long pattern
2 1/16	52	19	70	19	70	19	70
2 9/16	65	19	83	19	83	19	83
3 1/8	78	19	83	19	83	22	86
4 1/16	103	22	102	22	102	32	105
7 1/16	179	28	159	35	159	44	159
9	228	38	206	44	206	57	206
11	279	57	241	57	248	73	254

Table 64 — 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 US Customary units)

Dimensions in millimetres

Nominal size		Minimum bore size $^{+1,6}_{0}$		
(in)	mm	13,8 MPa	20,7 MPa	34,5 MPa
2 1/16	52	52,5	49,3	42,9
2 9/16	65	62,7	59,0	54,0
3 1/8	78	77,9	73,7	66,6
4 1/16	103	102,3	97,2	87,3
7 1/16	179	146,3	146,3	131,8
9	228	198,5	189,0	173,1
11	279	247,7	236,6	215,9

Table 65 — 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)	
(in)	mm	mm	(in)
1 $^{13}/_{16}$	46	464	(18,25)
2 $^{1}/_{16}$	52	521	(20,50)
2 $^{9}/_{16}$	65	565	(22,25)
3 $^{1}/_{16}$	78	619	(24,38)
4 $^{1}/_{16}$	103	670	(26,38)
5 $^{1}/_{8}$	130	737	(29,00)
7 $^{1}/_{16}$	179	889	(35,00)

Table 66 — 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)	
(in)	mm	mm	(in)
1 $^{13}/_{16}$	46	457	(18,00)
2 $^{1}/_{16}$	52	483	(19,00)
2 $^{9}/_{16}$	65	533	(21,00)
3 $^{1}/_{16}$	78	598	(23,56)
4 $^{1}/_{16}$	103	737	(29,00)

Table 67 — 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)	
(in)	mm	mm	(in)
1 $^{13}/_{16}$	46	533	(21,00)
2 $^{1}/_{16}$	52	584	(23,00)
2 $^{9}/_{16}$	65	673	(26,50)
3 $^{1}/_{16}$	78	775	(30,50)

10.6 Casing and tubing heads

10.6.1 General

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 which 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 which seal casing strings and hanger and packing mechanisms which 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

a) General

All head ends using flanged end connectors shall be flanged or studded in conformance with 10.1.

b) Casing-head housing with threaded bottom connector

Threaded bottom connectors for housings shall be threaded in conformance with 10.2.

c) Other end connectors

Other end connectors shall be in conformance with 10.18.

NOTE This International Standard is not applicable to housing-to-casing weld preparations.

10.6.3.3 Outlet connectors

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 conformance 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 preparations shall be in accordance with Annex L.

c) ISO 10422 threaded

ISO 10422 threaded outlets shall be in conformance with 10.2.

d) Other end connectors

Other end connectors shall be in conformance with 10.18.

10.6.3.4 Flange counter-bores

This International Standard is not applicable to 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

a) 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 68*) of the largest casing over which the body is to be 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 68*.

b) Reduced-opening vertical bore

The vertical bores specified in Table 68* 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.

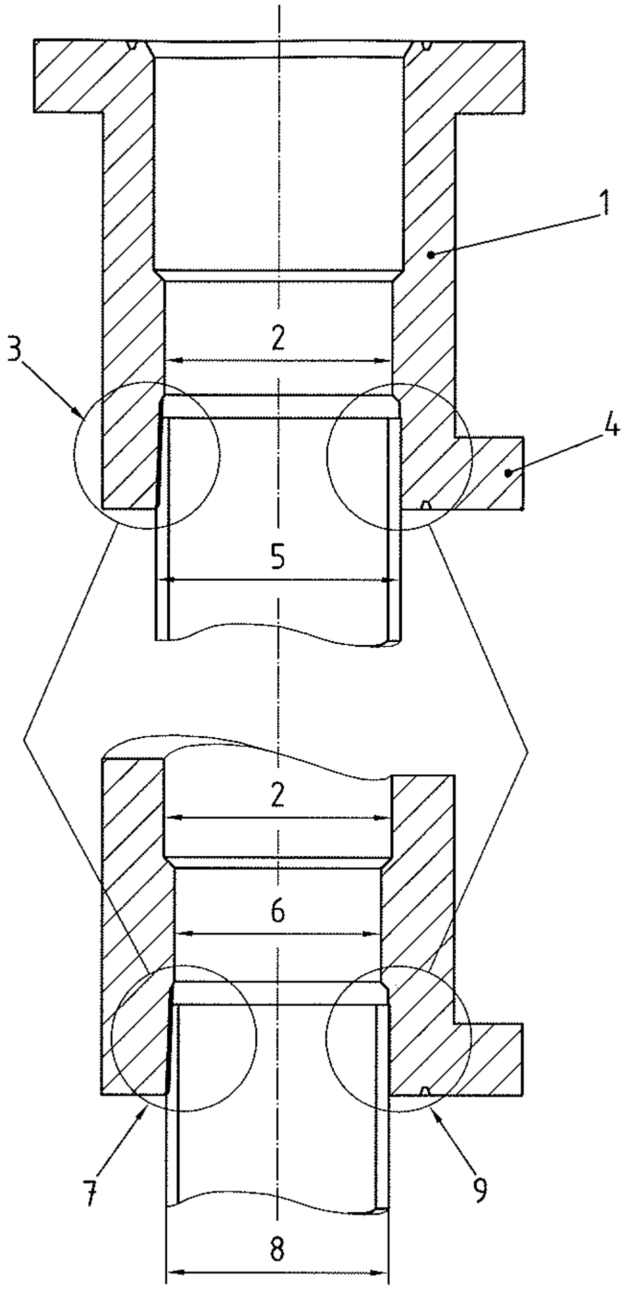
Typical illustrations of such adaptations are shown in Figure 19. Reduced vertical bores may also be supplied for heavier weights of casing than those listed in Table 68*. Reduced vertical bores for this application shall be 0,8 mm (0,03 in) larger than the drift diameter of the heaviest wall casing over which it will be used.

c) 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 68*. 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 conformance with 4.2.1. Account shall be taken of the rated working pressure limitations for threaded connectors based on size and type of thread.



Key

1 wellhead body
2 regular full-opening bore
3 threaded bottom connection
4 bottom connector
5 maximum size casing (attached or beneath the body)
6 reduced full-opening bore
7 casing thread
8 smaller size casing
9 integral bore, adapter or pilot

Figure 19 — Typical reduced-opening vertical bore

Table 68 — Minimum vertical full-opening body bores and maximum casing sizes
(see Annex B for US Customary units)

Nominal connector [a]			Casing beneath body			Minimum vertical full-opening wellhead body bore
Nominal size and bore of connector		Rated working pressure	Label [b]	Nominal lineic mass [b]	Specified drift diameter	
(in)	mm	MPa	*OD*	kg/m	mm	mm
7 1/16	179	13,8	7	25,30	162,89	163,8
7 1/16	179	20,7	7	29,76	160,81	161,5
7 1/16	179	34,5	7	34,23	158,52	159,5
7 1/16	179	69,0	7	43,16	153,90	154,7
7 1/16	179	103,5	7	56,55	147,19	148,1
7 1/16	179	138,0	7	56,55	147,19	148,1
9	228	13,8	8 5/8	35,72	202,49	203,2
9	228	20,7	8 5/8	47,62	198,02	198,9
9	228	34,5	8 5/8	53,57	195,58	196,3
9	228	69,0	8 5/8	59,53	193,04	193,5
9	228	103,5	8 5/8	72,92	187,60	188,2
11	279	13,8	10 3/4	60,27	251,31	252,0
11	279	20,7	10 3/4	60,27	251,31	252,0
11	279	34,5	10 3/4	75,90	246,23	247,1
11	279	69,0	9 5/8	79,62	212,83	213,6
11	279	103,5	9 5/8	79,62	212,83	213,6
13 5/8	346	13,8	13 3/8	81,10	316,46	317,5
13 5/8	346	20,7	13 3/8	90,78	313,92	314,7
13 5/8	346	34,5	13 3/8	107,15	309,65	310,4
13 5/8	346	69,0	11 3/4	89,29	269,65	270,8
16 3/4	425	13,8	16	96,73	382,58	383,3
16 3/4	425	20,7	16	125,01	376,48	377,4
16 3/4	425	34,5	16	125,01	376,48	377,4
16 3/4	425	69,0	16	125,01	376,48	377,4
18 3/4	476	34,5	18 5/8	130,21	446,20	446,8
18 3/4	476	69,0	18 5/8	130,21	446,20	446,8
20 3/4	527	20,7	20	139,89	480,97	481,8
21 1/4	540	13,8	20	139,89	480,97	481,8
21 1/4	540	34,5	20	139,89	480,97	481,8
21 1/4	540	69,0	20	139,89	480,97	481,8

[a] Upper-end connections of wellhead body.

[b] Maximum size and minimum mass of casing on which bore is based.

10.6.3.7 Test, vent, injection and gauge connectors

a) General

Test, vent, injection and gauge connectors shall be in conformance 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.

10.6.4 Materials

a) Bodies, flanges and other connectors

Material used for bodies, flanges and other connectors shall comply with Clause 5.

b) 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

a) General

All heads shall be marked to conform with Clause 8.

b) Cross-over spools

All casing-head spools and tubing-head spools used as cross-over spools shall additionally be marked to conform 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 hanger

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, and 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, and hanger will receive back-pressure valve.

10.7.1.2 General performance requirements

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. Additionally, pressure load shall be considered with the hanging load.

c) Group 3

Same as Group 2. Additionally:

— 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. Additionally, 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. Additionally:

- 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 this subclause shall be interpreted to be a requirement of a wrap-around seal type tubing hanger.

10.7.2 Specific performance requirements

10.7.2.1 Slip hangers

a) Load capacity

The load capacity for slip hangers shall be as specified in Table 69.

b) Temperature rating

The temperature rating of slip hangers shall be in accordance with 4.2.2. Choosing the temperature rating is the ultimate responsibility of the user. In making these selections, the user should consider the temperature the equipment will experience in drilling and/or production service.

NOTE 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 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 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 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 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 69 — Performance requirements for slip hangers

	PR1	PR2
Load capacity	1 cycle at minimum rated load to maximum rated load	3 cycles at minimum rated load to maximum rated load

10.7.2.2 Mandrel hangers

a) Load capacity

The load capacity for mandrel hangers shall be as specified in Table 70. They shall seal 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 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 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 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. 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.

e) Performance requirements for Group 4 mandrel hangers

Group 4 mandrel hangers shall meet the general requirements of 4.1. They shall seal 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.

f) Performance requirements for Group 5 mandrel hangers

Group 5 mandrel hangers shall meet the general requirements of 4.1. They shall seal 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 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 70 — Performance requirements for mandrel hangers

	PR1	PR2
Load capacity	1 cycle at minimum rated load to maximum rated load	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 conformance with 10.2. Other threaded connectors shall be in conformance with 10.18.

10.7.3.3 Maximum diameter

The maximum outside diameter of any hanger intended to run through a blowout preventer shall not exceed that shown in Table 71.

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

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 may 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 will satisfy 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 may affect equipment interchangeability.

Table 71 — Maximum hanger outside diameter for wellheads

Nominal size [a] and minimum through-bore of drill-through equipment		Rated working pressure		Maximum outside diameter of hanger	
(in)	mm	MPa	(psi)	mm	(in)
7 $^{1}/_{16}$	179	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	178,05	(7,010)
7 $^{1}/_{16}$	179	69,0; 103,5 and 138,0	(10 000; 15 000 and 20 000)	178,05	(7,010)
9	228	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	226,90	(8,933)
9	228	69,0 and 103,5	(10 000 and 15 000)	226,90	(8,933)
11	279	13,8; 20,7 and 34,5	(2 000; 3 000 and 5 000)	277,32	(10,918)
11	279	69,0 and 103,5	(10 000 and 15 000)	277,32	(10,918)
13 $^{5}/_{8}$	346	13,8 and 20,7	(2 000 and 3 000)	343,48	(13,523)
13 $^{5}/_{8}$	346	34,5 and 69,0	(5 000 and 10 000)	343,48	(13,523)
16 $^{3}/_{4}$	425	13,8 and 20,7	(2 000 and 3 000)	422,28	(16,625)
16 $^{3}/_{4}$	425	34,5 and 69,0	(5 000 and 10 000)	422,28	(16,625)
18 $^{3}/_{4}$	476	34,5 and 69,0	(5 000 and 10 000)	473,08	(18,625)
21 $^{1}/_{4}$	540	13,8	(2 000)	536,58	(21,125)
20 $^{3}/_{4}$	527	20,7	(3 000)	523,88	(20,625)
21 $^{1}/_{4}$	540	34,5 and 69,0	(5 000 and 10 000)	536,58	(21,125)

[a] Nominal size of upper end connection of wellhead body in which 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

Hangers need not 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 to conform 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 compliance 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 upon the completion method to be used. In addition to serving as adapters, they may 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

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 72.

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 73.

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

a) Lower connector

Flanged or studded lower connectors shall be in conformance with 10.1. Other connectors shall be in conformance with 10.18.

b) Upper connector

The upper connector of an independent adapter shall be flanged or studded, in conformance with 10.1, or threaded, in conformance with 10.2, or have an other-end connector in conformance with 10.18 or hub end connectors according to ISO 13533 or swivel flanges according to ISO 13628-4. The bores of upper threaded connectors having a 2 $^{1}/_{2}$, 3, or 4 nominal size 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 $^{+0,8}_{0}$ mm ($^{+0,03}_{0}$ in).

Table 72 — Performance requirements for Group 1 tubing-head adapters

	PR1	PR2
Pressure integrity	1 cycle	3 cycles
Shall withstand maximum rated pressure internally.		

Table 73 — Performance requirements for Group 2 tubing-head adapters

	PR1	PR2
Pressure integrity	1 cycle	3 cycles
Load capacity [a]	1 cycle	3 cycles
Shall withstand maximum rated pressure internally.		
[a] 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 conformance 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 conformance 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 and described in 7.4.9.

10.8.6 Marking

Tubing-head adapters shall be marked to conform 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 which include restrictions or orifices to control the flowrate of fluids. Chokes are not intended to be used as shutoff valves.

a) Adjustable chokes

Adjustable chokes have an externally controlled variable-area orifice coupled with an orifice-area-indicating mechanism as shown in Figure 20. 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 21.

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 74. 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.

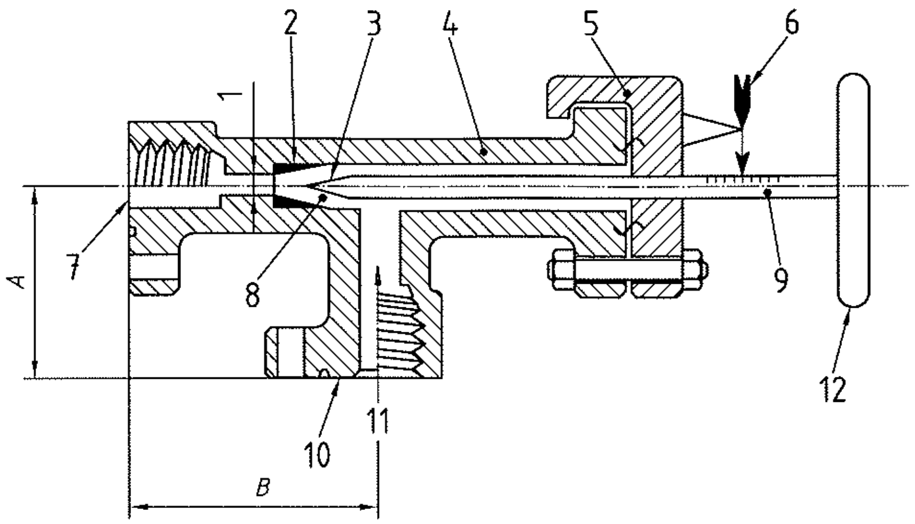
10.9.3.3 Nominal size

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 [increments of 0,4 mm ($^{1}/_{64}$ in)] whose area is equal to the total choke orifice area.

Table 74 — Performance requirements for chokes

	PR1	PR2
Operating cycles [a]	3 cycles	200 cycles
Seat-to-body sealing	1 cycle	3 cycles

[a] Operating cycles do not apply to positive chokes.

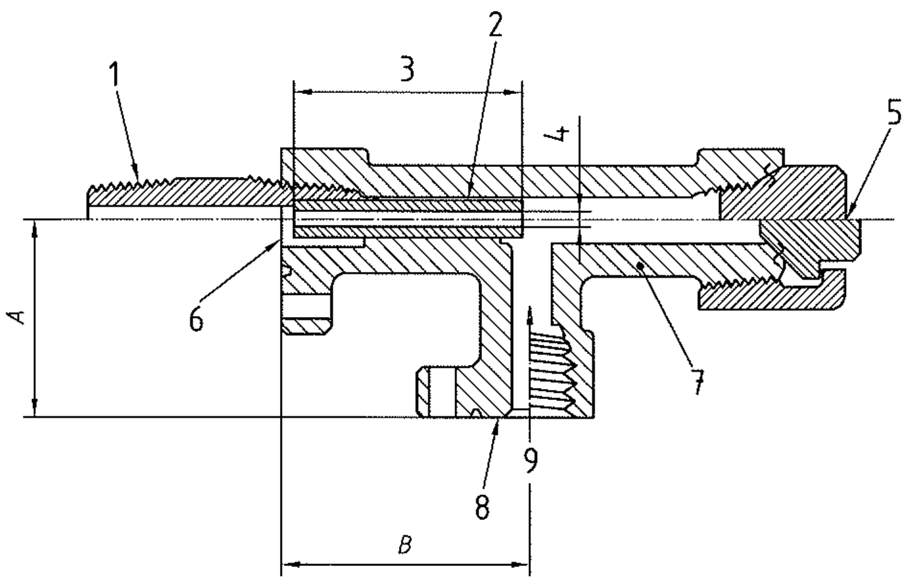


Key

1 maximum orifice diameter
2 removable seat
3 stem tip
4 body
5 bonnet
6 indicating mechanism (type is optional)
7 outlet connection
8 orifice area
9 stem
10 inlet connection
11 flow direction
12 handwheel or lever

NOTE For dimensions A and B, see Table A.11.

Figure 20 — Typical adjustable choke



Key

1 cage nipple (optional)
2 removable flow bean
3 orifice length
4 orifice diameter
5 plug or cap
6 outlet connection
7 body
8 inlet connection
9 flow direction

NOTE For dimensions A and B, see Table A.11.

Figure 21 — Typical positive choke

10.9.3.4 Rated working pressure

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 ($^1/_{64}$ in).

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 ($^1/_{32}$ in) or 0,4 mm ($^1/_{64}$ in). Actuated chokes are not required to be equipped with indicating mechanisms.

10.9.4 Material

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 and described in 7.4.9.

10.9.6 Marking

All choke bodies and flow beans shall be marked to conform 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

This subclause covers additional requirements for tees and crosses.

10.10.2 Design

10.10.2.1 Nominal size and pressure rating

a) General

Nominal sizes and pressure ratings for tees and crosses shall be as specified in Tables 75* and 76*, except as specified as follows.

b) Exceptions

Over-size entrance bores of 81 mm and 108 mm (3 $^{3}/_{16}$ in and 4 $^{1}/_{4}$ in) with tolerance of $^{+0,8}_{0}$ mm ($^{+0,03}_{0}$ in) are allowable for 79 mm and 103 mm (3 $^{1}/_{8}$ in and 4 $^{1}/_{16}$ in) nominal sizes in 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 54*; 55* and 56*.

10.10.2.2 End connectors

All end connectors shall conform with 10.1 or 10.18.

10.10.2.3 Dimensions

Bore and centreline-to-face dimensions shall conform to those shown in Tables 75* and 76*.

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.

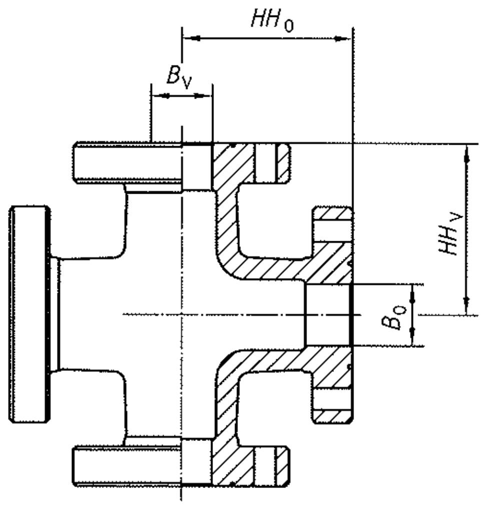
10.10.5 Marking

Marking shall conform with Clause 8.

10.10.6 Storing and shipping

Tees and crosses shall be stored and shipped in accordance with Clause 9.

Table 75 — 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 US Customary units)



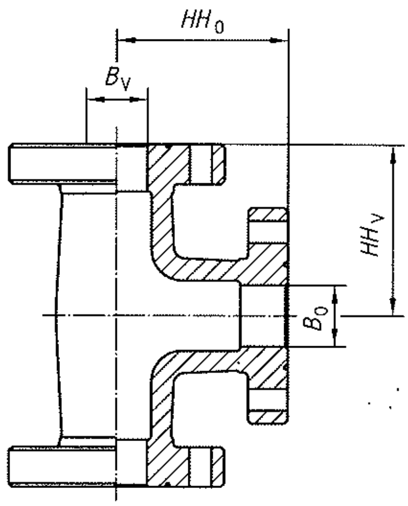
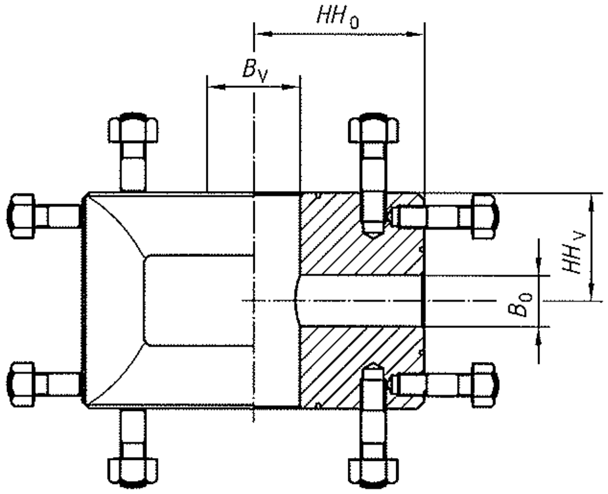


Table 75 *(continued)*

Dimensions in millimetres

Nominal size and bore		Centre-to-face vertical run HH_V	Centre-to-face horizontal run HH_O
Vertical B_V $^{+0,8}_{0}$	Outlet B_O $^{+0,8}_{0}$	$\pm$ 0,8	$\pm$ 0,8
13,8 MPa			
52	52	147,5	147,5
65	52	151,0	160,5
65	65	166,5	166,5
78	52	154,0	170,0
78	65	166,5	173,0
78	78	179,5	179,5
103	52	160,5	201,5
103	65	173,0	205,0
103	78	182,5	208,0
103	103	217,5	217,5
20,7 Mpa			
78	52	185,5	198,5
78	65	200,0	201,5
78	78	192,0	192,0
103	52	192,0	224,0
103	65	206,5	227,0
103	78	205,0	224,0
103	103	230,0	230,0
34,5 Mpa			
52	52	185,5	185,5
65	52	189,0	200,0
65	65	211,0	211,0
78	52	195,5	211,0
78	65	209,5	214,5
78	78	236,5	236,5
103	52	201,5	233,5
103	65	216,0	236,5
103	78	227,0	243,0
103	103	274,5	274,5
130	52	230,0	268,5
130	65	244,5	271,5
130	78	255,5	278,0
130	103	278,0	284,0
130	130	309,5	309,5
69,0 Mpa			
52	46	169,5	174,0
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
103,5 MPa			
52	46	186,5	188,0
52	52	193,5	193,5
65	46	193,0	204,0
65	52	200,0	209,5
65	65	216,0	216,0
78	46	199,5	220,5
78	52	207,0	226,0
78	65	223,0	232,5
78	78	239,5	239,5
103	46	220,5	260,5
103	52	228,0	266,0
103	65	243,5	272,5
103	78	260,5	279,5
103	103	297,0	297,0
130	46	238,0	290,5
130	52	244,5	295,5
130	65	260,5	301,5
130	78	278,0	309,5
130	103	314,5	324,0
130	130	343,0	343,0
138,0 MPa			
46	46	227,0	227,0
52	46	235,0	242,0
52	52	250,0	250,0
65	46	243,0	261,0
65	52	258,0	269,0
65	65	277,0	277,0
78	46	252,5	277,0
78	52	267,5	259,5
78	65	286,5	293,0
78	78	302,5	302,5
103	46	282,5	321,5
103	52	297,5	321,5
103	65	316,5	337,5
103	78	332,5	347,0
103	103	377,0	377,0

Table 76 — 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 US Customary units)



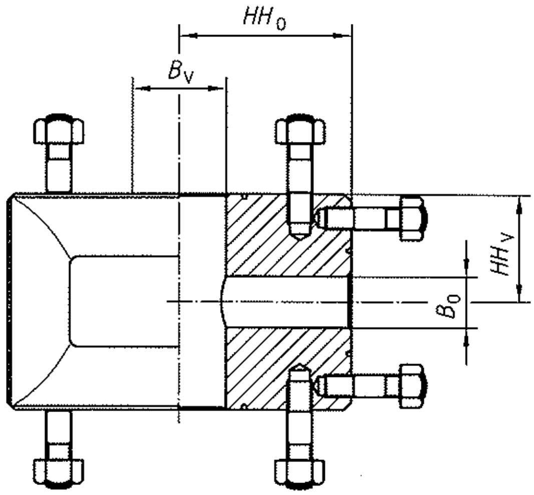


Table 76 *(continued)*

Dimensions in millimetres

Nominal size and bore Vertical B_V $^{+0,8}_{0}$	Nominal size and bore Outlet B_O $^{+0,8}_{0}$	Centre-to-face vertical run HH_V ± 0,8	Centre-to-face horizontal run HH_O ± 0,8
13,8 MPa			
52	52	89,0	89,0
65	52	89,0	101,5
65	65	114,5	114,5
78	52	89,0	114,5
78	65	114,5	114,5
78	78	114,5	114,5
103	52	114,5	139,5
103	65	114,5	139,5
103	78	114,5	139,5
103	103	139,5	139,5
20,7 MPa			
78	52	114,5	127,0
78	65	127,0	127,0
78	78	127,0	127,0
103	52	114,5	155,5
103	65	127,0	155,5
103	78	127,0	155,5
103	103	155,5	155,5
34,5 MPa			
52	52	114,5	114,5
65	52	114,5	127,0
65	65	127,0	127,0
78	52	114,5	139,5
78	65	139,5	139,5
78	78	139,5	139,5
103	52	114,5	165,0
103	65	127,0	165,0
103	78	139,5	165,0
103	103	165,0	165,0
130	52	155,5	193,5
130	65	155,5	193,5
130	78	155,5	193,5
130	103	202,5	202,5
130	130	202,5	202,5
69,0 MPa			
46	46	111,0	111,0
52	46	111,0	111,0
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
103,5 MPa			
46	46	127,0	127,0
52	46	127,0	127,0
52	52	127,0	127,0
65	46	139,5	139,5
65	52	139,5	139,5
65	65	139,5	139,5
78	46	160,5	160,5
78	52	160,5	160,5
78	65	160,5	160,5
78	78	160,5	160,5
103	46	193,5	193,5
103	52	193,5	193,5
103	65	193,5	193,5
103	78	193,5	193,5
103	103	193,5	193,5
130	46	168,0	222,0
130	52	168,0	222,0
130	65	168,0	222,0
130	78	168,0	222,0
130	103	235,0	235,0
130	130	235,0	235,0
138,0 MPa			
46	46	164,5	164,5
52	46	164,5	164,5
52	52	164,5	164,5
65	46	185,0	185,0
65	52	185,0	185,0
65	65	185,0	185,0
78	46	202,5	202,5
78	52	202,5	202,5
78	65	202,5	202,5
78	78	202,5	202,5
103	46	251,5	251,5
103	52	251,5	251,5
103	65	251,5	251,5
103	78	251,5	251,5
103	103	251,5	251,5

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

This subclause covers test and gauge connections for use on 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi) equipment. Connections of lower-pressure equipment are described in 4.4.4.

10.11.2 Design

a) Types

Type I, II and III connections are defined and illustrated in Figure 22.

b) Dimensions

Type I, II and III connections shall conform to the dimensions stipulated in Figure 22.

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 type 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 NACE MR 0175.

10.11.4 Testing

The equipment furnished under this subclause 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.

10.12 Fluid sampling devices

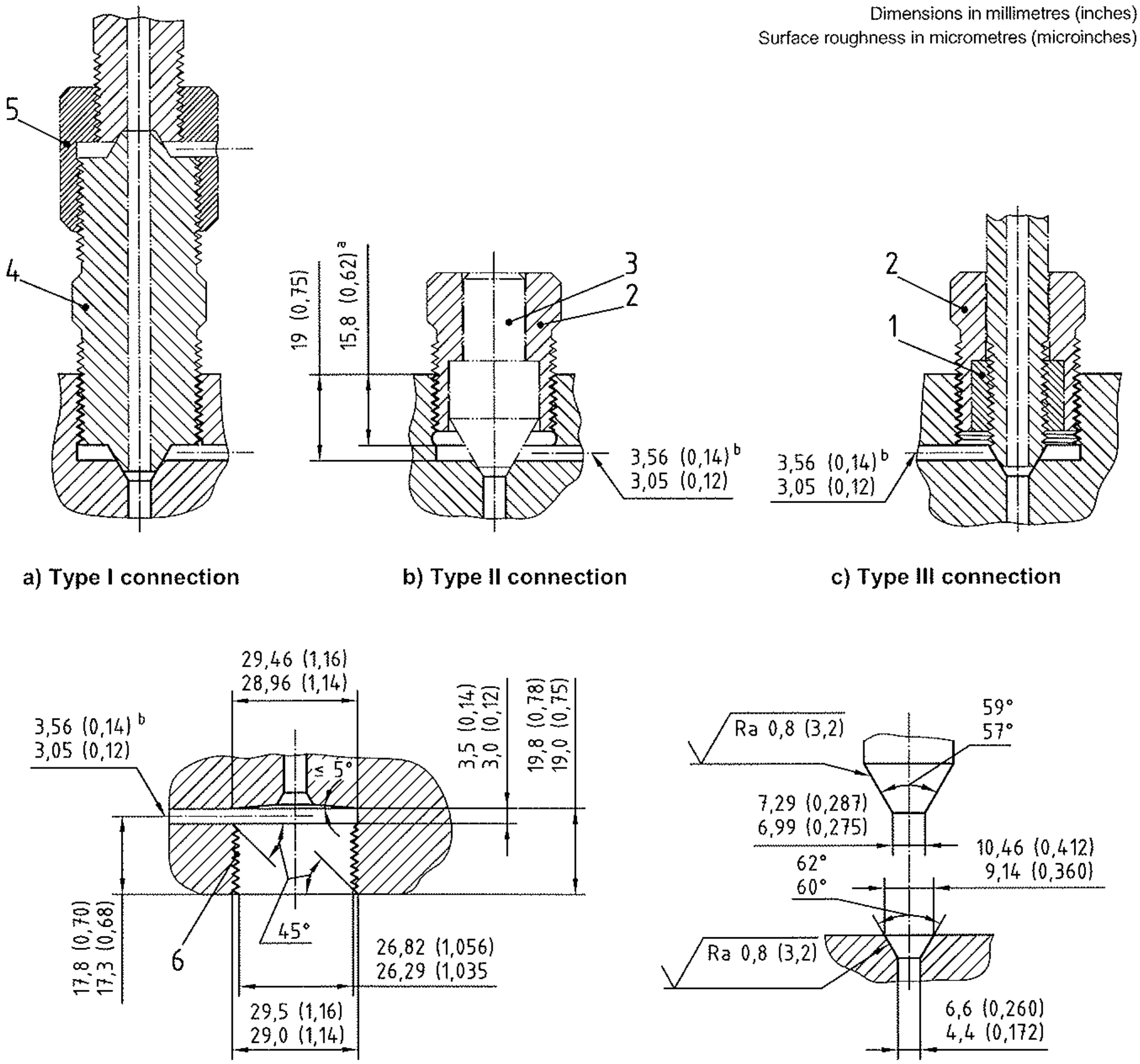
10.12.1 General

This subclause covers sampling devices used for sampling the well fluid. 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 77.

Dimensions in millimetres (inches)
Surface roughness in micrometres (microinches)



a) Type I connection **b) Type II connection** **c) Type III connection**

d) Female preparation **e) Seat detail**

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.

Figure 22 — Test and gauge connections for 103,5 MPa and 138,0 MPa (15 000 psi and 20 000 psi) rated working pressure

Table 77 — Performance requirements for fluid sampling devices

	PR1	PR2
Pressure integrity	1 cycle	3 cycles
Shall seal maximum rated pressure internally.		

10.12.3 Design

a) End connectors

End connectors shall be in conformance 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 International Standard 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 to conform 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

This subclause covers 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.

10.13.2 Design

See design requirements for equipment.

10.13.3 Materials

See materials 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 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. No part or equipment on an assembled tree shall be removed or replaced during storing or shipping unless the tree is successfully retested and then retagged.

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.

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 78.

Table 78 — Performance requirements for cross-over connectors

	PR1	PR2
Pressure integrity	1 cycle	3 cycles
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 23, 24, 25 or 26.

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.

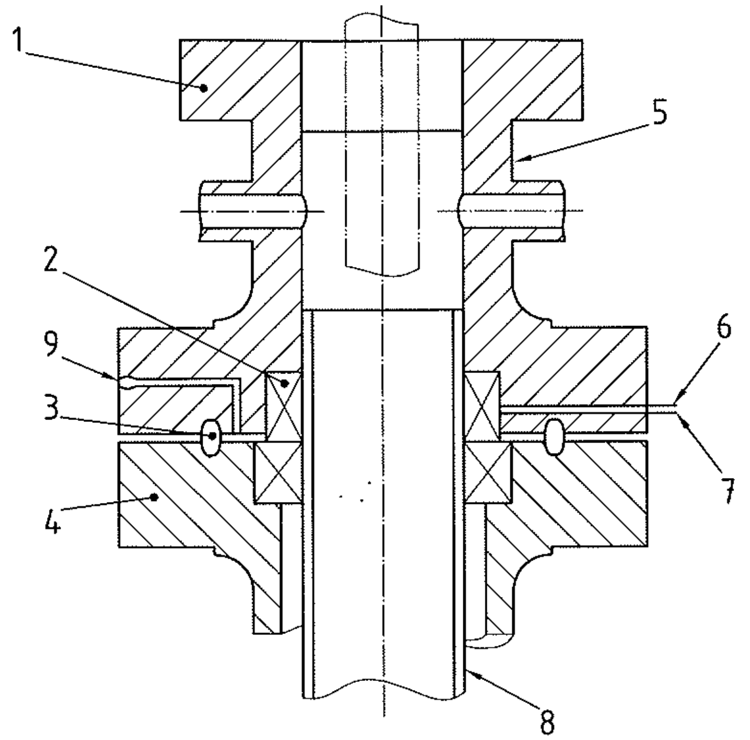
The restricted-area pack-off and its retention means shall be designed so the pressure-induced loads transferred from containment of full working pressure by the upper connector and/or any upper stage do not cause the requirements of 4.3.3 to be exceeded at any part of the body or lower connector. See Figures 23, 24 and 25.

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.

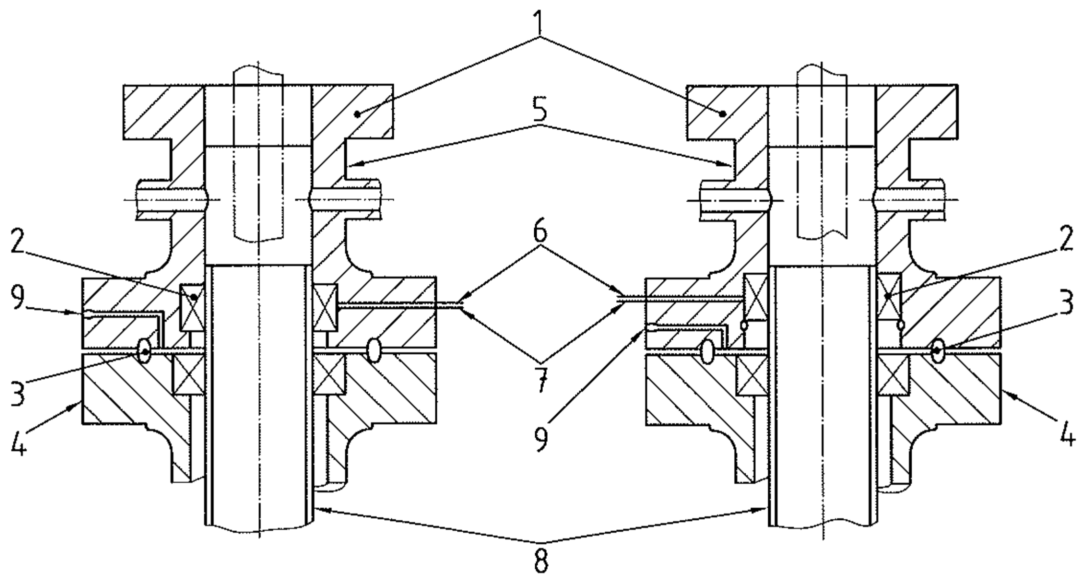
CAUTION — Manufacturers and users are reminded that the tolerances of casing and tubing outside diameters vary substantially between the various editions of ISO 11960 and API Spec 5CT. In general, the tolerance has increased over time; this may affect equipment interchangeability.



Key

1 upper connector
2 restricted-area pack-off
3 ring gasket
4 lower connector
5 spool
6 upper pressure rating
7 lower pressure rating
8 inner casing
9 test port

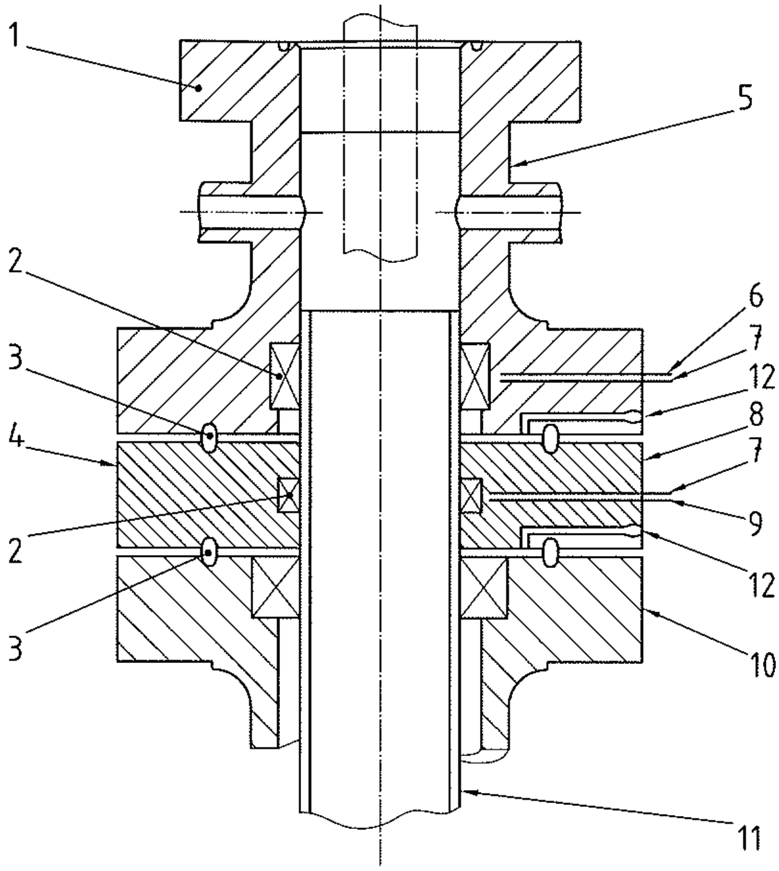
Figure 23 — Cross-over spool with restricted-area pack-off supported by lower head



Key

1 upper connector of spool
2 restricted-area pack-off
3 ring gasket
4 lower connector
5 spool
6 upper pressure rating
7 lower pressure rating
8 inner casing
9 test port

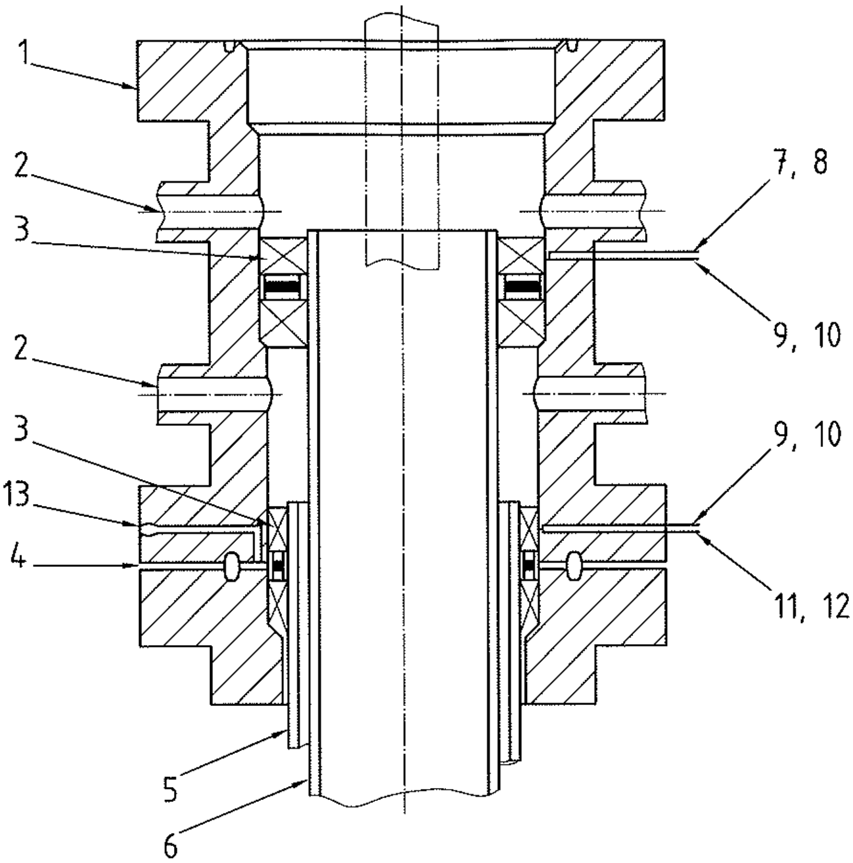
Figure 24 — Cross-over spool with restricted-area pack-offs supported by upper spool



Key

1 upper connector of spool
2 restricted-area pack-off
3 ring gasket
4 second connector
5 spool
6 upper pressure rating
7 second pressure rating
8 cross-over
9 lower pressure rating
10 lower connector
11 inner casing
12 test port

Figure 25 — Cross-over flange



Key

1 upper connector
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 26 — Multi-stage cross-over spool

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

a) Pressure-containing components which 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 to conform with Clause 8.

10.14.7 Storing and shipping

All cross-over connectors shall be stored and shipped in accordance with Clause 9.

10.15 Adapter and spacer spools

10.15.1 General

Adapter and spacer spools are wellhead sections which have no provision for suspension of tubular members, and which may have no provision for sealing of tubular members.

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

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 other end connectors in accordance with 10.18 or 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

This subclause covers hydraulic, pneumatic and electric-powered actuators for wellhead and christmas tree equipment. 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 79.

Table 79 — Performance requirements for actuators

	PR1	PR2
Operating cycles	3 cycles	200 cycles

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 (pneumatic or hydraulic powered).

10.16.3.3 Fluid connectors

Fluid connectors shall be in accordance with 4.4.4. Pneumatic or hydraulic powered actuators may have connections smaller than $^1/_2$ 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 class 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. Thermal protection for the motor shall be provided.

10.16.3.7 Actuation forces

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 Pneumatic or hydraulic 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 which 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, only non-complying heat lots need 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 which could 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

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 which meet material class AA (Table 3) 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. Stems do not have to be separately tested.

Water with or without additives, gas or hydraulic fluid may be used as the testing fluid.

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

The test pressure shall be a minimum of 1,5 times the maximum working pressure for actuators with a maximum working pressure less than or equal to 138 MPa (20 000 psi); above 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.

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; 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. 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 actutors 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 to conform to 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 which will 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 80.

Table 80 — Performance requirements for packing mechanisms for lock screws, alignment pins and retainer screws

	PR1	PR2
Pressure integrity	1 cycle	3 cycles
Shall seal maximum rated pressure across seal.		

10.17.3 Design

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 (OECs)

10.18.1 General

This subclause covers other end connectors which may be used for joining pressure-containing or pressure-controlling equipment and whose dimensions are not specified in this International Standard.

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 81.

Table 81 — Performance requirements for other end connectors (OECs)

	PR1	PR2
Pressure integrity [a]	1 cycle	3 cycles
Bending moments	[b]	[b]
Make-and-break	[c]	[c]

[a] Shall seal maximum rated pressure internally.
[b] Shall withstand manufacturer's rated bending moments, if applicable.
[c] Shall withstand manufacturer's make-and-break cycles, if applicable.

10.18.3 Design

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 which utilizes OECs shall successfully complete the tests required in 7.4.9 and the appropriate subclause of Clause 10. Loose OECs are not required to be tested.

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

This subclause covers top connectors which provide access to the christmas tree bore. 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

a) Top connectors shall be designed to satisfy 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

a) Pressure-containing components of the top connector which 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

a) Top connectors which 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 which 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

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

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 19). 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 to conform with the requirements of Clause 9 and shall be equipped with a bleeder plug.

10.20 Surface and underwater safety valves and actuators

10.20.1 General

This subclause covers safety valves and actuators used in the secondary master position in surface and underwater wellhead applications. Safety valves are non-threaded, actuated valves designed to close upon loss of power supply. Included are complete assemblies, valves adapted for actuators, actuators and heat-sensitive lock-open devices.

a) Valves

Safety valves shall meet the requirements defined in 10.5 for PR2 and those specified for PSL 2. Safety valves shall meet the performance requirements specified in Annex I and those shown in Table 82.

b) Actuators

Actuators shall meet the minimum performance requirements of 10.16.2.

Table 82 — Operating cycle requirements for safety valves

	PR2 class I	PR2 class II
Operating cycles	500 cycles	500 cycles
Medium	Water or other suitable fluid [see 10.20.4.3 a)]	2 % sand slurry mixture [see 10.20.4.3 a)]

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 compliance 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

A multiple or block-type valve qualifies as a wellhead SSV for performance requirement PR2 standard service and Annex I class I or II service, without verification testing, if it is of the same internal design as an SSV valve within the manufacturer's product line which has passed the verification 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 flanges and ring joints 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-flow-line (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, if 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 pressurised 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 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

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 Table 83.

10.20.4.3 Verification testing

a) PR2 class I and II service

To verify 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 which would affect the SSV/USV valve bore sealing mechanism shall require re-qualification by verification 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.

10.20.4.4 Verification 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 27 and 8.5.

10.20.6 Storage and shipping

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 to be furnished to 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 Table 83.

b) Shipping report

A report in accordance with Table 84 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.

Table 83 — Example of SSV/USV functional test data sheet

SSV/USV valve data:
Manufacturer __________
Valve catalog or model No. __________ Serial No. __________ Size __________
Rated working pressure __________ Temperature rating __________
Valve bore __________ Material class __________ PSL __________ PR 2 class __________
Class II SSV/USV valve performance test agency __________ Test report No. __________
SSV/USV actuator data:
Manufacturer __________
Valve catalog or model No. __________ Serial No. __________ Size __________
Rated working pressure __________ Temperature rating __________
Valve bore material class __________ PSL __________ PR 2 class __________
Functional test data:
I. SSV/USV actuator seal test __________ 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 __________
II. Drift check
Drift mandrel OD __________
Visual inspection __________ Performed by __________
III. SSV/USV actuator operational test __________ Performed by __________
Number of cycles completed __________
IV. SSV/USV valve body and bonnet hydrostatic test performed by __________
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 __________
V. SSV/USV valve seat test performed by __________
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 __________

Table 84 — Surface safety valve or underwater safety valve shipping report (Example)

SSV/USV valve data:		
Manufacturer ____________		
Catalogue or model No. ____________	Serial No. ____________	Size ____________
Working pressure rating ____________	Temperature rating: Max. ____________	Min. ____________
Material class ____________	PSL ____________	PR 2 class ____________
Date of manufacture (month and year) ____________		
PR 2 SSV/USV valve performance test agency ____________	Test report No. ____________	
SSV/USV actuator data:		
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 ____________		

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:

a) type, model and size for which the manual is applicable;

b) performance requirements for which these types, model, and sizes are suitable;

c) temperature and working pressure ranges for which the unit(s) are designed;

d) drawings and illustrations giving dimensional data of unit(s), as required, for installation or operation;

e) parts list.

10.20.7.3.2 Inspection and testing

The following minimum inspection and testing information shall be included:

a) a checklist for visual inspection prior to hook-up;

b) written and graphic instructions for field hook-ups;

c) 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, as specified in Annex J.

10.21 Bullplugs

10.21.1 General

Bullplugs shall meet the 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 85*. 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.

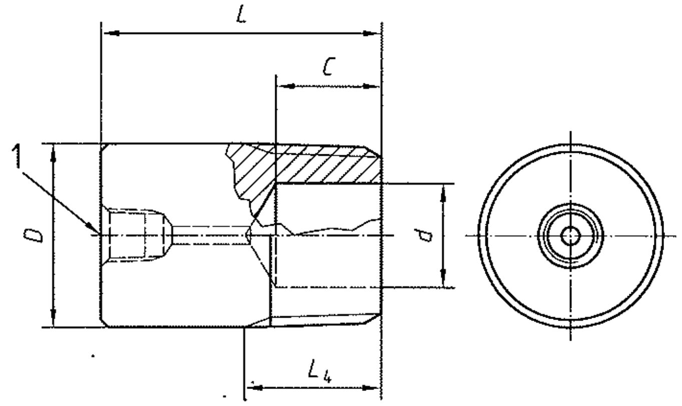
10.21.2.4 Thread engagement

Threaded connections shall comply with 10.2. Bullplugs with ISO 10422 line pipe threads shall be assembled with mating parts in conformance with Table 86. Thread compounds tested in accordance with ISO 13678 shall be used.

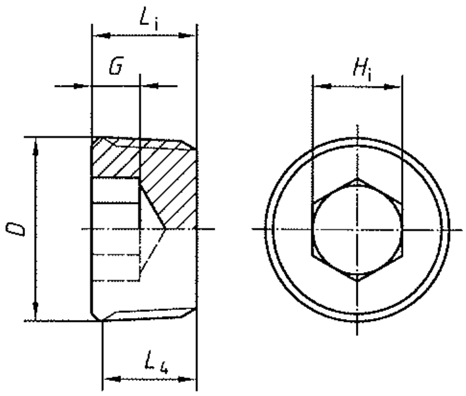
10.21.3 Materials

Bullplug material shall conform to 5.2 and material requirements of PSL 3. This International Standard is not applicable to bullplugs and threaded connections with components of less than material designation 60K.

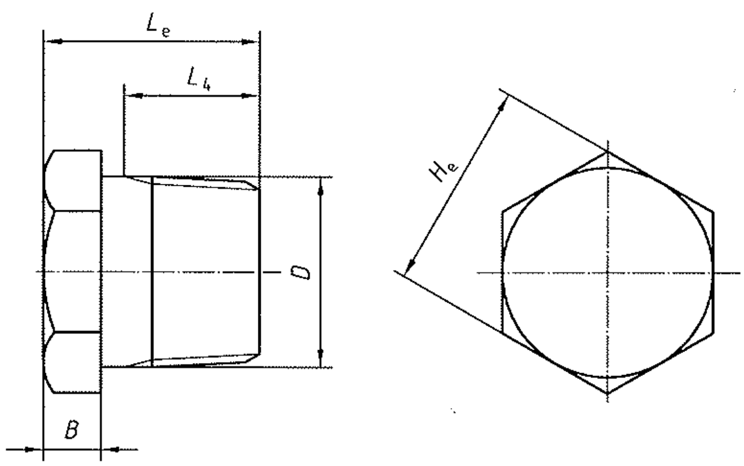
Table 85 — Bullplugs (see ISO 10422 for thread dimensions and tolerances)
(see Annex B for US Customary units)



a) Round plug



b) Plug with internal hex



c) Plug with external hex

Key
1 test or gauge port (optional)

Table 85 *(continued)*

Dimensions in millimetres

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 [a]	Diameter of counter-bore [b]	Overall length [b]	Hex size (across flats)	Height of hex [b]	Length of plug with external hex [b]	Internal hex size	Depth of hex [b]	Length of plug with internal hex [b]
(in)	D	L_4	C	d	L	H_e	B	L_e	H_i	G	L_i
1/2	21,43 [c]	19,85	None	None	51,0	22,2 [e]	7,9	28,7	9,7 [h]	7,9	25,4
3/4	26,59 [c]	20,15	None	None	51,0	27,0 [f]	9,7	31,8	14,2 [i]	7,9	25,4
1	33,34 [d]	25,01	None	None	51,0	34,9 [g]	9,7	35,1	16,0 [j]	9,7	25,4
1 1/4	42,07 [d]	25,62	27,0	22,4	51,0	—	—	—	—	—	—
1 1/2	48,42 [d]	26,04	27,0	25,4	51,0	—	—	—	—	—	—
2	60,33 [d]	26,88	27,0	38,1	102,0	—	—	—	—	—	—
2 1/2	73,03 [d]	39,91	41,5	44,5	102,0	—	—	—	—	—	—
3	88,90 [d]	41,50	41,5	57,2	102,0	—	—	—	—	—	—
3 1/2	101,60 [d]	42,77	44,5	69,9	102,0	—	—	—	—	—	—
4	114,30 [d]	44,04	44,5	76,2	102,0	—	—	—	—	—	—

a Tolerance ± 0,5

b Tolerance $^{+1,0}_{0}$

c Tolerance $^{+0,20}_{0}$

d Tolerance $^{+0,25}_{0}$

e Tolerance $^{0}_{-0,64}$

f Tolerance $^{0}_{-0,79}$

g Tolerance $^{0}_{-1,04}$

h Tolerance $^{0}_{-0,10}$

i Tolerance $^{0}_{-0,13}$

j Tolerance $^{0}_{-0,15}$

Table 86 — Recommended bullplug installation procedure

Size (in)	Minimum recommended turns past hand-tight condition
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.

NOTE 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 Quality control

Product specification levels are not applicable to bullplugs. The quality control requirements shall be in accordance with Table 26.

10.21.5 Marking

Bullplugs shall be marked to conform to 8.11.

10.21.6 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 this subclause 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 meet the requirements of 5.2 and 5.10, except no impact testing is required. 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.

10.22.5 Quality control

Product specification levels are not applicable to valve-removal plugs. The quality control requirements shall be in accordance with Table 26. Pressure testing is not required for valve-removal preparations and valve-removal plugs.

10.22.6 Marking

Marking shall be according to 8.10.

10.22.7 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 which 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 requirements of tubing hangers.

10.24.2 Design

See 10.21.2.

10.24.3 Materials

Body material shall meet the requirements of 5.11. 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 26.

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

This annex provides guidelines for enquiry and purchase of wellhead and christmas tree equipment. These guidelines consist of data sheets to be completed by the purchaser, a series of typical wellhead and christmas tree configurations, and a decision tree for determining product specification levels.

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, 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 Figure A.3, 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. Table A.2 contains general information which pertains to the entire well. Tables A.3 to A.12 are designed to be used for 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 performance verification 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.1 and A.2. Also included are examples of casing and bit programmes that are consistent with the wellheads as shown.

A.4 Product specification levels (PSL)

A.4.1 General

PSL 1 includes practices currently being implemented by a broad spectrum of the industry for service conditions recommended in this Annex A.

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 A.

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 A.

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 A. The designation PSL 3G is only utilized in those clauses and tables where 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 only used for primary equipment.

Figure A.3 shows the recommended specification level for primary equipment. Primary equipment of a wellhead assembly includes 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 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.3.

A.4.2 NACE MR 0175

This applies if the partial pressure of hydrogen sulfide (H_2S) in the produced fluid equals or exceeds the minimum amount specified by NACE MR 0175 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 70×10^{-6} [70 parts per million (ppm)] can develop in case of a leak (human sense of smell cannot detect concentrations higher than 70×10^{-6}).

Alternatively use "Yes" if the radius of exposure (ROE) to 100 ppm H_2S is greater than 15 m (50 ft) from the wellhead. ROE is defined in Texas Railroad Commission Rule 36, see A.4.5. Other methods of calculating ROE may apply depending on local regulations.

The above requires the knowledge of the adjusted open-flowrate of offset wells. If this is not available, but if hydrogen sulfide can be expected, a 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.3.

The proximity assessment should consider the potential impact of an uncontrolled emission of H_2S threatening life and environment near the wellhead. The following list of items can be used for determining potential risk:

a) 100 ppm ROE of H_2S 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 ppm ROE of H_2S 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 (ROE) of H_2S

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 ROE determination is used in the United States only. Other methods of calculating ROE may apply depending on local regulations.

A.4.5.2 For determining the location of the 100 ppm ROE:

$$X = [(1{,}589)(\text{mole fraction } H_2S)(q)]^{0{,}625\,8}$$

For determining the location of the 500 ppm ROE:

$$X = [(0{,}454\,6)(\text{mole fraction } H_2S)(q)]^{0{,}625\,8}$$

where

X is the radius of exposure, in feet;

q is the maximum volume flowrate determined to be available for escape, in cubic feet per day;

H_2S is the mole fraction of hydrogen sulfide in the gaseous mixture available for escape.

A.4.5.3 The volume flowrate 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 flowrate of offset wells, or the field-average current-adjusted open flowrate, whichever is larger.

b) The escape rate used in determining the radius of exposure shall be corrected to standard conditions of 14,65 psia and 60 °F (16 °C).

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 Table A.2. 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 Table A.2 may also influence fluid corrosivity.

The purchaser should determine if materials shall meet NACE MR 0175 for sour service. NACE MR 0175 is only concerned with the metallic material requirements to prevent sulfide stress cracking and not with resistance to general corrosion. Consideration should also be given to the carbon dioxide partial pressure, which generally relates to corrosivity in wells as shown in Table A.1. This table is a guideline only.

Analysis of produced fluids may 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_2S 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 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_2 partial pressure

Retained fluids	Relative corrosivity	Partial pressure of CO_2	
		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)

Table A.2 — Wellhead equipment data sheet — General

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_2 __________ (mg) __________ Chlorides __________ (mg)

__________ H_2S __________ (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 NACE MR 0175 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: __________ m³/d oil/condensate

__________ m³/d gas

__________ m³/d S&W [a]

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

Top joint in string

	Size (OD)	**kg/m** (lb/ft)	**Grade**	**Connection**	**Total string hanging wt** daN (lbs)	**Bit size** mm (in)
Conductor						
Surface casing						
Protective casing						
Production casing						
Tubing						
Type of completion: single or multiple						

[a] Sand and water.

Table A.3 — Wellhead equipment data sheet — Casing-head housing

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 [a] ________	No ________
External coating? No ____ Yes ____	If yes, type ________
Internal coating? No ____ Yes ____	If yes, type ________
Flange bolting requirements (Table 49)	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: ________	
[a] If yes, specify what and by whom.	

Table A.4 — Wellhead equipment data sheet — Casing-head spool

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 [a] ______	No ______
External coating? No ______ Yes ______	If yes, type ______
Internal coating? No ______ Yes ______	If yes, type ______
Flange bolting requirements (Table 49)	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: ______	

[a] If yes, specify what and by whom.

Table A.5 — Wellhead equipment data sheet — Tubing-head spool

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 [a] ____________ No ____________
External coating? No ______ Yes ______ If yes, type ____________
Internal coating? No ______ Yes ______ If yes, type ____________
Flange bolting requirements (Table 49) 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: ____________

[a] If yes, specify what and by whom.

Table A.6 — Wellhead equipment data sheet — Cross-over flange

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 [a] ____________	No ____________	
External coating? No ______ Yes ______	If yes, type ____________	
Internal coating? No ______ Yes ______	If yes, type ____________	
Flange bolting requirement (Table 49)	Non-exposed ____ Exposed ____	Exposed (low strength) ____
Main run (studs): ____________ (nuts): ______		
[a] If yes, specify what and by whom.		

Table A.7 — Wellhead equipment data sheet — Tubing head adaptor

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 [a] ____________	No ____________	
External coating? No ______ Yes ______	If yes, type ____________	
Internal coating? No ______ Yes ______	If yes, type ____________	
Flange bolting requirement (Table 49)	Non-exposed ____ Exposed ____	Exposed (low strength) ____
Main run (studs): ____________ (nuts): ______		
[a] If yes, specify what and by whom.		

Table A.8 — Wellhead equipment data sheet — Christmas tree and choke

Christmas tree – Single ___ Dual ___ Solid block ___ Stacked ___

	Size	Material [a]	PSL	PR	Witness? [b]	External coating? If yes, state type	Flanged bolting requirements [c] 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: ______

[a] 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.

[b] If yes, specify what and by whom.

[c] Indicate required bolting for the applicable retained fluid and temperature classification specified in Table 49.

Table A.9 — Wellhead equipment data sheet — Compact casing-head housing

Compact casing-head housing		PSL: ______ PR: ______
A. Bottom 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: ______
Base plate requirements:	______	
Witness? No ______	Yes [a] ______	
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 49)	Non-exposed ______	Exposed ______ Exposed (low strength) ______
Outlet inboard (studs): ______	(nuts): ______	
Outlet other (studs): ______	(nuts): ______	
Other requirements: ______		

[a] If yes, specify what and by whom.

Table A.9 *(continued)*

B. 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:	______	
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 49)	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: ______		

Table A.10 — Wellhead equipment data sheet — Wellhead safety valves

Wellhead safety valves	
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 (PR 2 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 ______

Table A.11 — Wellhead equipment data sheet — Choke sizing

Application				
Fluid				
Quantity				
End connections / A&B Dimensions [a]				
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 ΔP			
Temperature at inlet				
Oil	Flowrate			
	S.G. (if available)			
Gas	Flowrate			
	or G.O.R.			
	S.G. (if available)			
Liquid	Flowrate			
	S.G. (if available)			
Manual/actuated				
Actuator type/make/model				
Power source				
Manual override				
Position indication	Local		Remote/position transmitter	
Positioner				
Additional comments				

[a] See Figures 20 and 21.

Table A.12 — Wellhead equipment data sheet — Actuator and bonnet

Pneumatic	Quantity ____	**Hydraulic**	Quantity ____
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 ____

Electric Quantity ____

Supply requirements/specifications

Pneumatic	**Hydraulic**
Availability ____ MPa (psi)	Availability ____ MPa (psi)
Max. ____ Min. ____	Max. ____ Min. ____
Clean air ____	Well fluid
Nitrogen ____	non-NACE ____ NACE ____
Well gas ____ non-NACE ____	Self-contained ____
Other ____ NACE ____	Other ____

Electric

Voltage ____

DC ____ AC ____ Phase ____ Frequency ____

Current available ____

Other ____

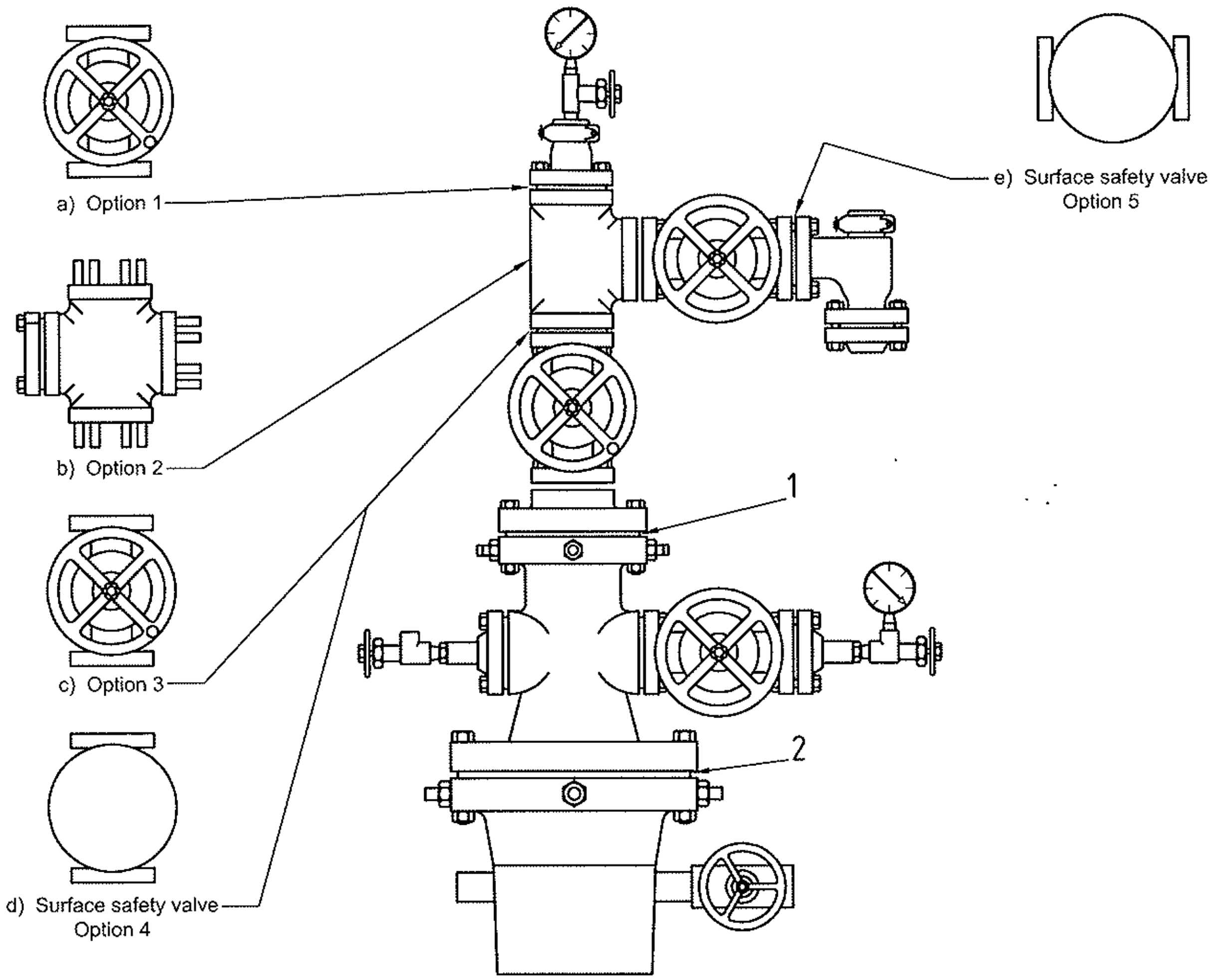
Actuator requirements	**Field data**
Specifications **Actuator**	Customer ____
Temperature rating (Table 2)	Field location ____
Retained fluid (Table A.1)	Platform ____
Materials class (Table 3)	Well No. ____
External coating? No ____ Yes ____	Closed-in tubing head pressure ____ MPa (psi)
If yes type ____	
	Accessories
	Fusible hold-open device ____
	Manual hold-open device ____
	Quick exhaust valve ____
	Position indication a) local ____
	b) remote ____

Bonnet requirements

Size ____		**Specification**	**PSL**
Model ____		SSV PR2 ____	2 ____
Maximum working pressure ____	MPa (psi)		3 ____
			3G ____
			4 ____

Material class:

Temperature rating:



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 $^{5}/_{8}$) × 139,7 (5 $^{1}/_{2}$) 244,5 (9 $^{5}/_{8}$) × 177,8 (7) 273,1 (10 $^{3}/_{4}$) × 193,7 (7 $^{5}/_{8}$)	200,0 (7 $^{7}/_{8}$) 215,9 (8 $^{1}/_{2}$) or 222,2 (8 $^{3}/_{4}$) 250,8 (9 $^{7}/_{8}$)	279 – 20,7 (11 – 3 000) or 279 – 34,5 (11 – 5 000)	179 – 34,5 (7 $^{1}/_{16}$ – 5 000)

Figure A.1 — Typical wellhead and tree configuration 34,5 MPa (5 000 psi) rated working pressure

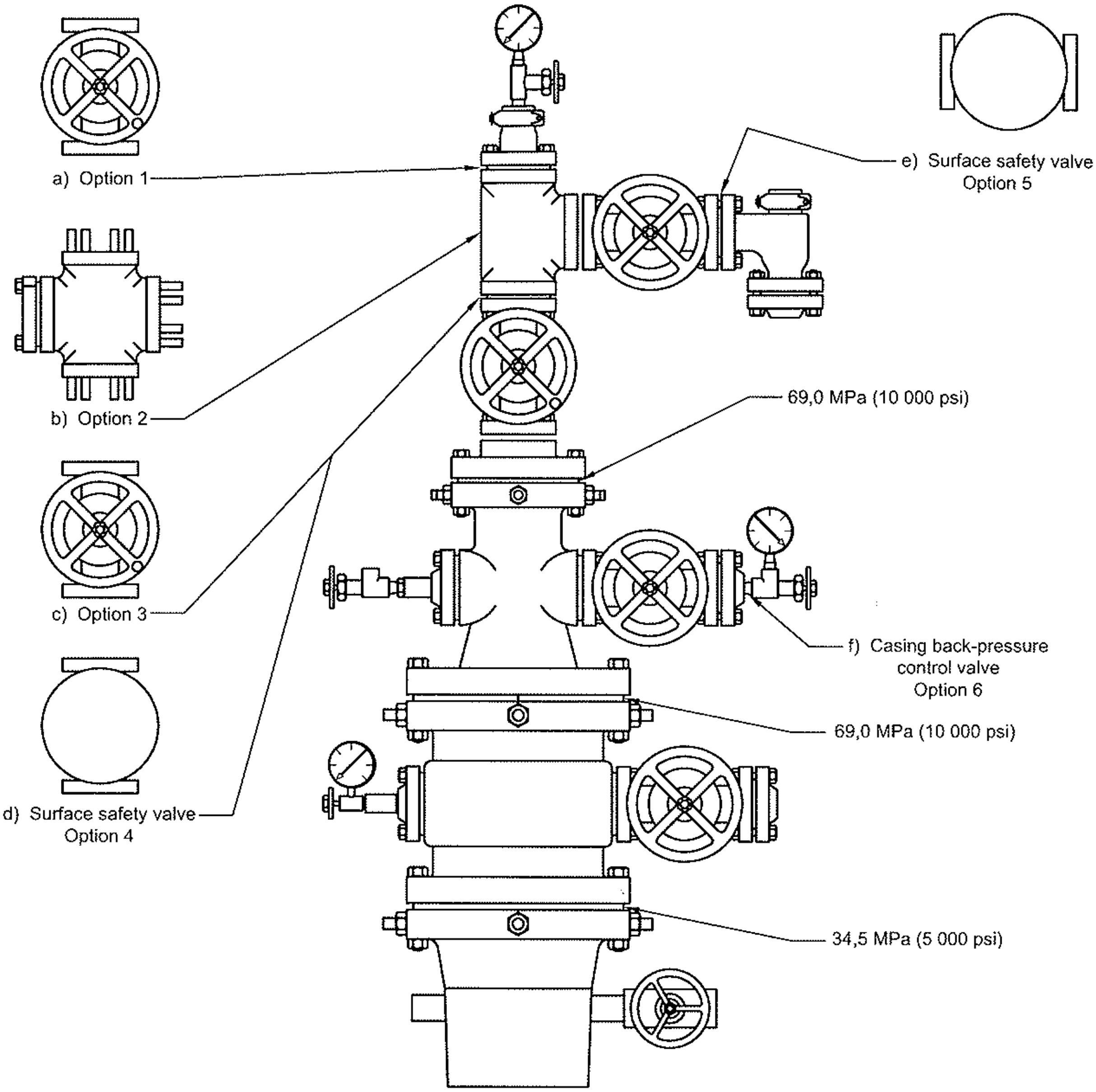


Figure A.2 — Typical wellhead and tree configuration 69,0 MPa (10 000 psi) rated working pressure

Typical programmes (metric)

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 – 69,0 279 – 69,0	179 – 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 (US Customary 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 $^{3}/_{4}$ × 7 $^{5}/_{8}$	14 $^{3}/_{4}$ × 9 $^{7}/_{8}$ or 9 $^{1}/_{2}$	16 $^{3}/_{4}$ – 5 000	11 – 10 000	7 $^{1}/_{16}$ – 10 000
16 × 11 $^{3}/_{4}$ × 9 $^{5}/_{8}$ × 7 Liner	14 $^{3}/_{4}$ × 10 $^{5}/_{8}$ × 8 $^{1}/_{2}$	16 $^{3}/_{4}$ – 5 000	13 $^{5}/_{8}$ – 10 000 11 – 10 000	7 $^{1}/_{16}$ – 10 000
13 $^{3}/_{8}$ × 9 $^{5}/_{8}$ × 7	12 $^{1}/_{4}$ × 8 $^{1}/_{2}$ × 6	13 $^{5}/_{8}$ – 5 000	11 – 10 000	7 $^{1}/_{16}$ – 10 000
10 $^{3}/_{4}$ × 7 $^{5}/_{8}$ × 5	9 $^{7}/_{8}$ × 6 $^{1}/_{2}$	11 – 5 000	11 – 10 000	7 $^{1}/_{16}$ – 10 000

Figure A.2 — Typical wellhead and tree configuration 69,0 MPa (10 000 psi) rated working pressure
(continued)

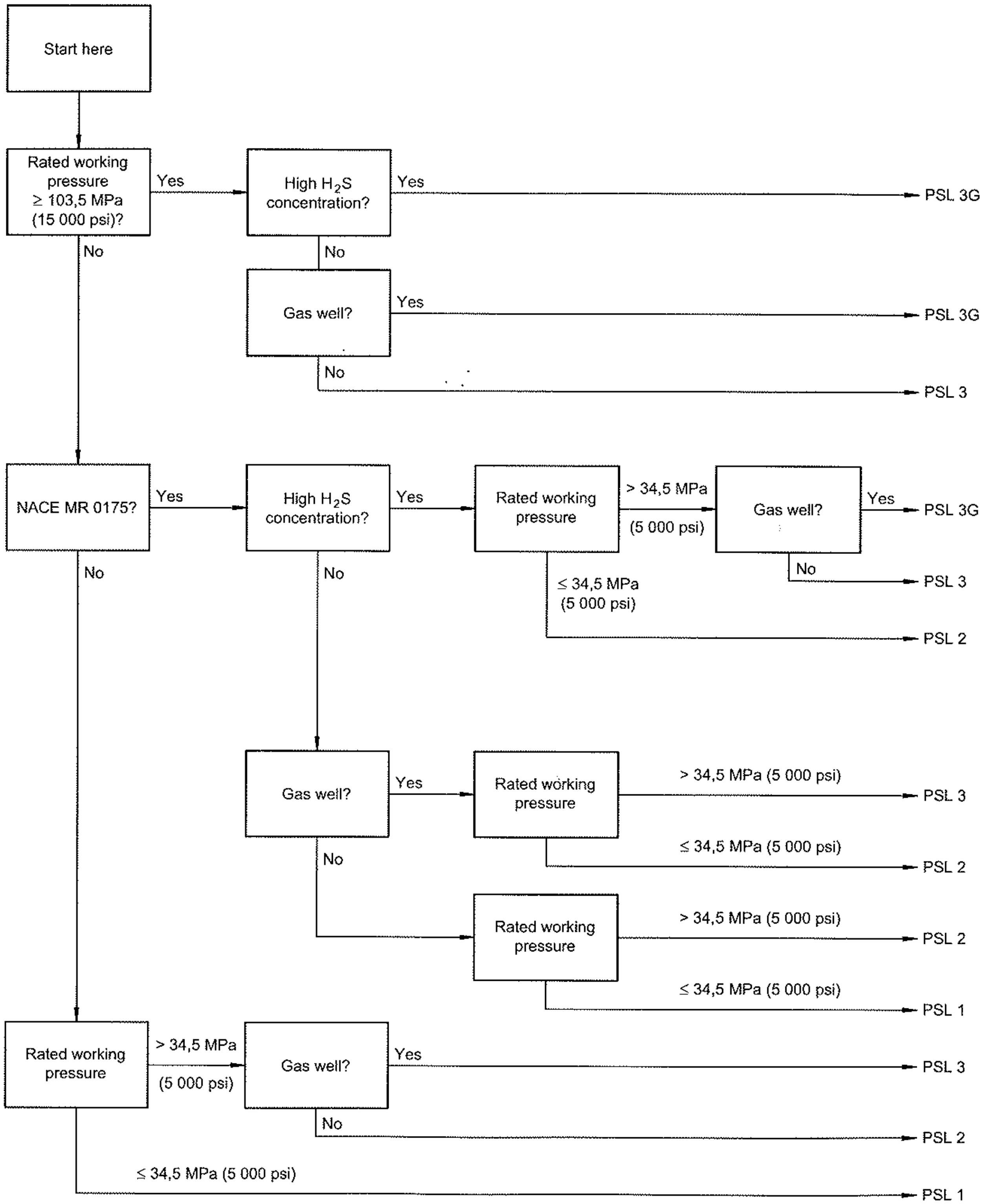


Figure A.3 — Recommended minimum PSL for primary parts of wellhead and christmas tree equipment

Annex B
(informative)

US Customary unit tables and data for this International Standard

B.1 General information

B.1.1 Purpose

This annex provides dimensions and data expressed in US Customary units which may be used as alternative units to those SI units used in the body of this International Standard.

The dimensional values obtained by application of the conversion rules in this annex are different from the results that would be obtained by exact conversion of the dimensional values given 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. 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. Therefore, a dimension of 4,31 in the tables actually means 4 $^{5}/_{16}$ 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 in = 109,537 5 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 in ≈ 4,312 5 in ≈ 109,537 5 mm ≈ 110 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 US Customary 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 in pounds per square inch, while still using convenient simple numbers:

MPa	psi
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 US Customary unit values to SI unit values, to the nearest millimetre. Thus, the following nominal sizes are equivalent:

mm	in
46	1 $^{13}/_{16}$
52	2 $^{1}/_{16}$
65	2 $^{9}/_{16}$
78 or 79	3 $^{1}/_{16}$ or 3 $^{1}/_{8}$
103	4 $^{1}/_{16}$
130	5 $^{1}/_{8}$
179	7 $^{1}/_{16}$
228	9
279	11
346	13 $^{5}/_{8}$
425	16 $^{3}/_{4}$
476	18 $^{3}/_{4}$
527	20 $^{3}/_{4}$
540	21 $^{1}/_{4}$
680	26 $^{3}/_{4}$
762	30

B.2.3 Type 6B flange dimensions — Interchangeability

The design of 6B flanges is based on the design of ASME B16.5 steel flanges. This common set of dimensions permits some interchangeability between the two designs if ring joint flanges are used on the corresponding ANSI flanges. For this reason it was decided to preserve this interchangeability by considering the previously published ANSI metric flange dimensions when establishing the metric sizes for this International Standard. This resulted in slightly different bolt hole sizes than would result from using the rounding rules in B.2.5, since the metric ANSI flanges are usable with metric fasteners. Other dimensions were rounded using the rules in B.2.5, resulting in slightly more accurate flange thickness and bolt circle dimensions, but which are well within the tolerance range of the previously published ASME B16.5 dimensions.

B.2.4 Fasteners — Sizes

The metric flanges are to be used with inch fasteners. Adoption of metric fasteners on 6BX flanges is not practical due to the compact design of the flanges and due to the fact that metric fasteners with equivalent strength are slightly larger than inch fasteners. The use of metric fasteners on 6B flanges is possible, however metric fasteners with the strength and hardness requirements necessary to satisfy the requirements of this International Standard are difficult to obtain.

B.2.5 Rounding rules

The following rules were used to develop flange dimensions:

a) Maximum bore

Round to the nearest 0,1 mm.

EXAMPLE 1 2,09 in ≈ 2,093 5 in ≈ 53,181 25 mm ≈ 53,2 mm.

b) Flange OD

Round to the nearest 5 mm. This is consistent with ANSI practice.

EXAMPLE 2 8,12 in ≈ 8,125 in ≈ 206,375 mm ≈ 205 mm. Tolerance: 0,06 in ≈ 2 mm; 0,12 in ≈ 3 mm.

c) Maximum chamfer

EXAMPLE 3 0,12 in ≈ 3 mm; 0,25 in ≈ 6 mm.

d) Raised-face diameter

Round to nearest 1 mm. Tolerance: + 1 mm.

e) Thickness of flange

Round up to next 0,1 mm. Tolerance: + 3 mm.

f) J1, J2 and J3 dimensions

Round to nearest 0,1 mm. Tolerance on J1: – 3 mm.

g) Radius at back face

Convert as follows:

mm	in
10	0,38
16	0,62
19	0,75
21	0,81
25	1,00

h) Bolt hole location

Tolerance: 0,8 mm.

i) Bolt circle

Round to nearest 0,1 mm.

j) Bolt hole diameter

Round up to next even millimetre. Tolerances are as follows:

Hole size	Tolerance
< 42 mm	$\left(\begin{smallmatrix}+2\\-0,5\end{smallmatrix}\right)$ mm
≥ 42 mm	$\left(\begin{smallmatrix}+2,5\\-0,5\end{smallmatrix}\right)$ mm
> 74 mm	$\left(\begin{smallmatrix}+3\\-0,5\end{smallmatrix}\right)$ mm

k) Stud lengths

Recalculate in metric units and round to nearest 5 mm.

l) 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. Tolerance: $\left(\begin{smallmatrix}+0,5\\0\end{smallmatrix}\right)$ mm.

— Q dimension: Round to nearest 0,01 mm. Tolerance: + 0,25 mm.

m) Rough machine dimensions for inlaid ring grooves

Round all dimensions up to the nearest 0,5 mm. Tolerance: + 0,8 mm.

n) 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 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 ± 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 will always be within the tolerance range of 0,005 in when a tolerance of 0,12 mm is applied.

EXAMPLE Dimension, 1,390 in from flange centre ± 0,005 in. Alternatives are as follows:

Lower limit: 1,385 in ≈ 35,179 mm (35,18 or 35,19).

Centre: 1,390 in ≈ 35,306 mm (35,30 or 35,31).

Upper limit: 1,395 in ≈ 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) = 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) = 1 newton per square millimetre (N/mm^2)

NOTE 1 bar = 0,1 MPa.

B.4.3 Impact energy

1 foot-pound (ft-lb) = 1,355 818 joule (J)

B.4.4 Torque

1 foot-pound (ft-lb) = 1,355 818 newton metre (N·m)

B.4.5 Temperature

Celsius = 5/9 (Fahrenheit – 32)

B.4.6 Force

1 pound-force (lbf) = 4,448 222 newton (N)

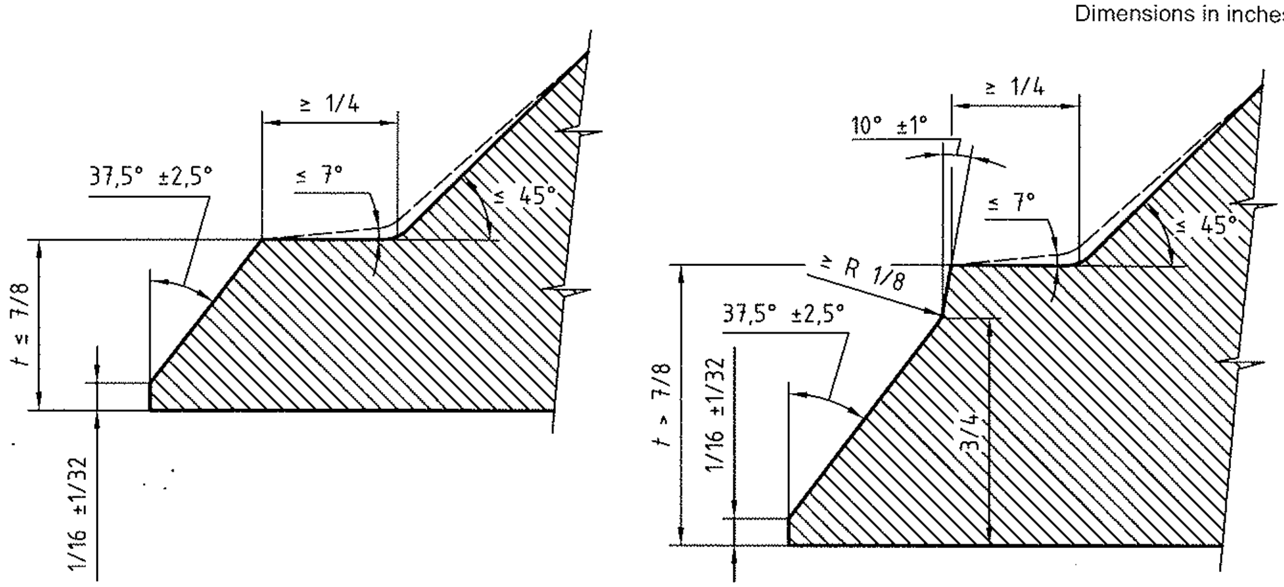
B.4.7 Mass

1 pound-mass (lbm) = 0,453 592 37 kilogram (kg) exactly

B.5 US Customary unit tables and figures

US Customary 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 annex should review all notes and explanations that accompany the same table specified in the main body of this International Standard.

Dimensions in inches



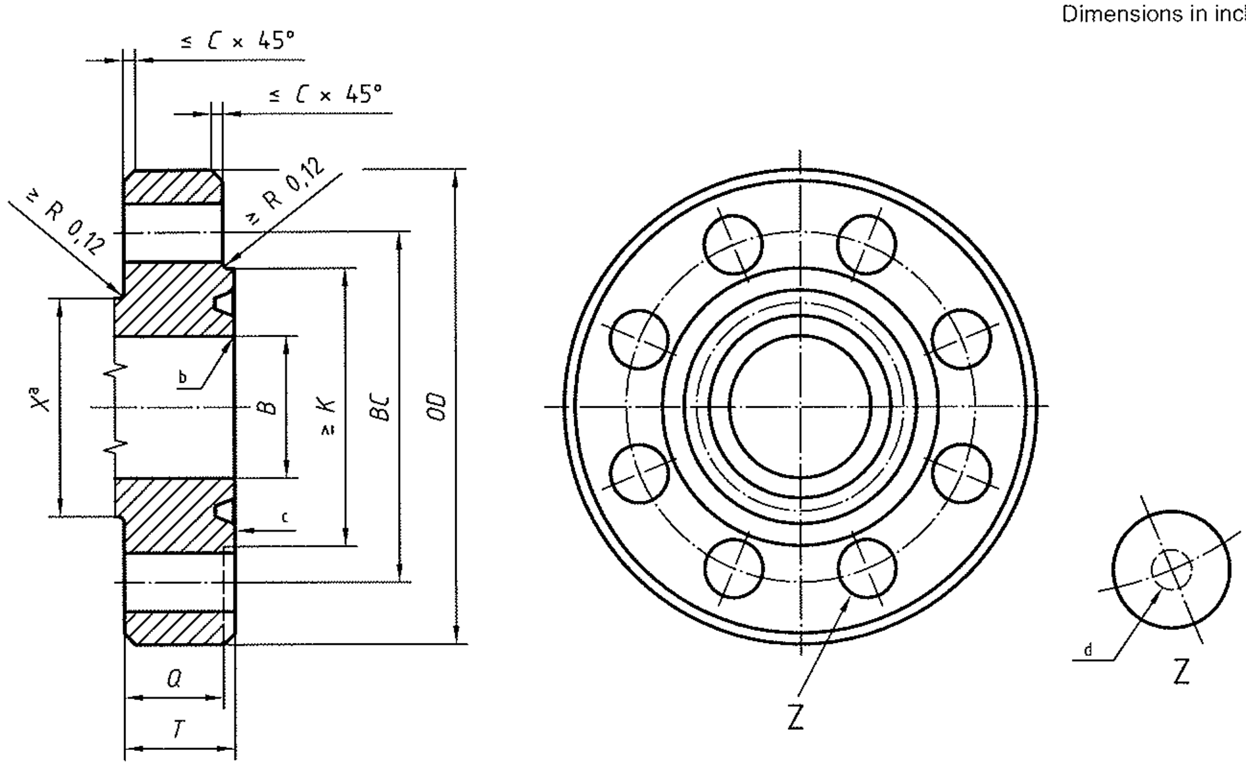
a) For neck thickness ⩽ 7/8

b) For neck thickness > 7/8

Figure B.9 — Weld end preparation for type 6B and 6BX weld neck flanges (US Customary units)

Table B.36 — Type 6B flanges for 2 000 psi rated working pressure (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Reference dimension.

b Break sharp corners.

c Top.

d Bolt hole centreline located within 0,03 in of theoretical BC and equal spacing.

a) Flange section integral flange

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
	B	OD	tol.	C	K	T $^{+0,12}_{0}$	Q	X
2 1/16	2,09	6,50	± 0,06	0,12	4,25	1,31	1,00	3,31
2 9/16	2,59	7,50	± 0,06	0,12	5,00	1,44	1,12	3,94
3 1/8	3,22	8,25	± 0,06	0,12	5,75	1,56	1,25	4,62
4 1/16	4,28	10,75	± 0,06	0,12	6,88	1,81	1,50	6,00
5 1/8	5,16	13,00	± 0,06	0,12	8,25	2,06	1,75	7,44
7 1/16	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 5/8	13,66	22,00	± 0,12	0,25	16,25	2,94	2,62	15,75
16 3/4	16,78	27,00	± 0,12	0,25	20,00	3,31	3,00	19,50
21 1/4	21,28	32,00	± 0,12	0,25	25,00	3,88	3,50	24,00

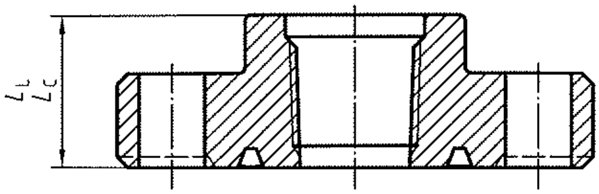
Table B.36 *(continued)*

Dimensions in inches

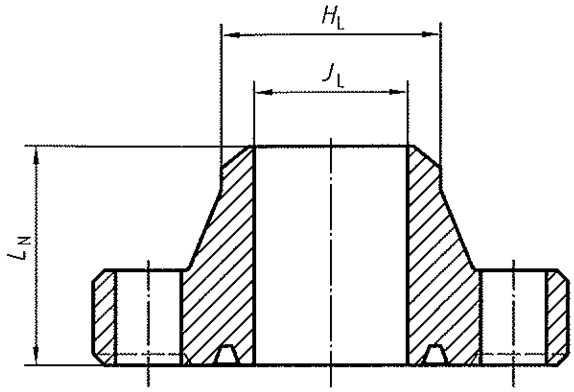
(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	**Bolting dimensions**						
	Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
	BC				tol. [e]	L_{ssb}	R or RX
2 $^{1}/_{16}$	5,00	8	$^{5}/_{8}$	0,75	+ 0,06	4,50	23
2 $^{9}/_{16}$	5,88	8	$^{3}/_{4}$	0,88	+ 0,06	5,00	26
3 $^{1}/_{8}$	6,62	8	$^{3}/_{4}$	0,88	+ 0,06	5,25	31
4 $^{1}/_{16}$	8,50	8	$^{7}/_{8}$	1,00	+ 0,06	6,00	37
5 $^{1}/_{8}$	10,50	8	1	1,12	+ 0,06	6,75	41
7 $^{1}/_{16}$	11,50	12	1	1,12	+ 0,06	7,00	45
9	13,75	12	1 $^{1}/_{8}$	1,25	+ 0,06	8,00	49
11	17,00	16	1 $^{1}/_{4}$	1,38	+ 0,06	8,75	53
13 $^{5}/_{8}$	19,25	20	1 $^{1}/_{4}$	1,38	+ 0,06	9,00	57
16 $^{3}/_{4}$	23,75	20	1 $^{1}/_{2}$	1,62	+ 0,09	10,25	65
21 $^{1}/_{4}$	28,50	24	1 $^{5}/_{8}$	1,75	+ 0,09	11,75	73

[e] Minimum bolt hole tolerance is – 0,02.

Table B.36 *(continued)*



b) Threaded flange



c) Welding neck line-pipe flange

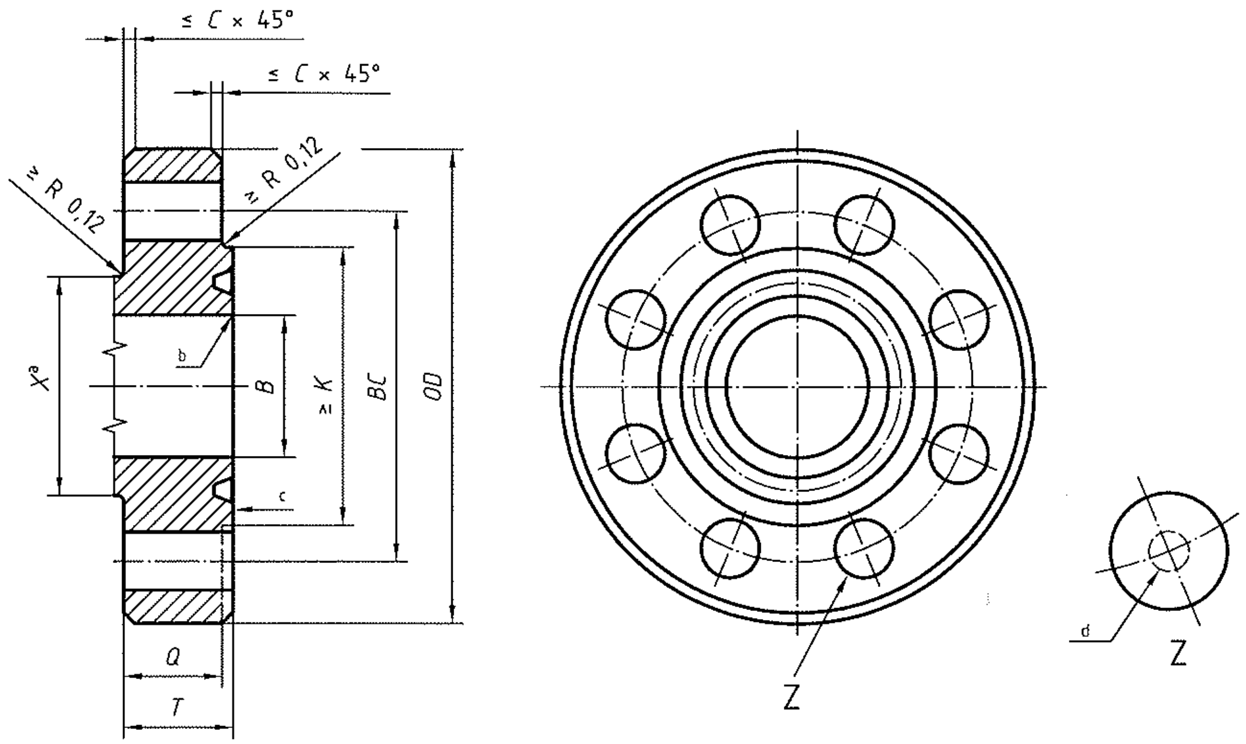
Dimensions in inches

(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.[f]	J_L
2 $^1/_{16}$	1,75	—	3,19	2,38	+ 0,09	2,10
2 $^9/_{16}$	1,94	—	3,44	2,88	+ 0,09	2,50
3 $^1/_8$	2,12	—	3,56	3,50	+ 0,09	3,10
4 $^1/_{16}$	2,44	3,50	4,31	4,50	+ 0,09	4,06
5 $^1/_8$	2,69	4,00	4,81	5,56	+ 0,09	4,84
7 $^1/_{16}$	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 $^5/_8$	3,94	3,94	—	—	—	—
16 $^3/_4$	4,50	4,50	—	—	—	—
21 $^1/_4$	5,38	5,38	—	—	—	—

[f] Minimum tolerance for this dimension is – 0,03.

Table B.37 — Type 6B flanges for 3 000 psi rated working pressure (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

[a] Reference dimension.

[b] Break sharp corners.

[c] Top.

[d] Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

a) Flange section integral flange

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
	B	OD	tol.	C	K	T $^{+0,12}_{0}$	Q	X
2 $^{1}/_{16}$	2,09	8,50	± 0,06	0,12	4,88	1,81	1,50	4,12
2 $^{9}/_{16}$	2,59	9,62	± 0,06	0,12	5,38	1,94	1,62	4,88
3 $^{1}/_{8}$	3,22	9,50	± 0,06	0,12	6,12	1,81	1,50	5,00
4 $^{1}/_{16}$	4,28	11,50	± 0,06	0,12	7,12	2,06	1,75	6,25
5 $^{1}/_{8}$	5,16	13,75	± 0,06	0,12	8,50	2,31	2,00	7,50
7 $^{1}/_{16}$	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 $^{5}/_{8}$	13,66	24,00	± 0,12	0,25	16,50	3,44	3,12	16,50
16 $^{3}/_{4}$	16,78	27,75	± 0,12	0,25	20,62	3,94	3,50	20,00
20 $^{3}/_{4}$	20,78	33,75	± 0,12	0,25	25,50	4,75	4,25	24,50

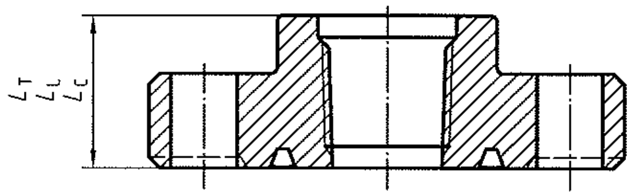
Table B.37 *(continued)*

Dimensions in inches

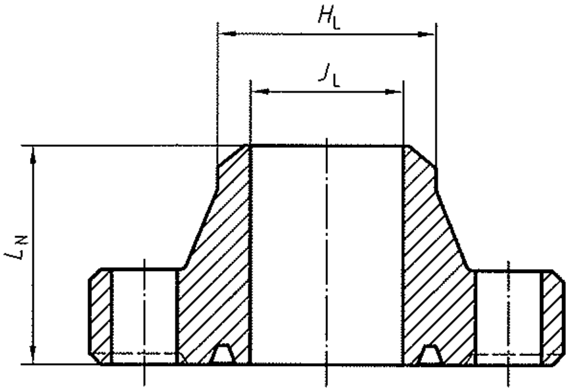
(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	**Bolting dimensions**						
	Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
	BC				tol. [e]	L_{ssb}	R or RX
2 $^{1}/_{16}$	6,50	08	$^{7}/_{8}$	1,00	+ 0,06	6,00	24
2 $^{9}/_{16}$	7,50	08	1	1,12	+ 0,06	6,50	27
3 $^{1}/_{8}$	7,50	08	$^{7}/_{8}$	1,00	+ 0,06	6,00	31
4 $^{1}/_{16}$	9,25	08	1 $^{1}/_{8}$	1,25	+ 0,06	7,00	37
5 $^{1}/_{8}$	11,00	08	1 $^{1}/_{4}$	1,38	+ 0,06	7,75	41
7 $^{1}/_{16}$	12,50	12	1 $^{1}/_{8}$	1,25	+ 0,06	8,00	45
9	15,50	12	1 $^{3}/_{8}$	1,50	+ 0,06	9,00	49
11	18,50	16	1 $^{3}/_{8}$	1,50	+ 0,06	9,50	53
13 $^{5}/_{8}$	21,00	20	1 $^{3}/_{8}$	1,50	+ 0,06	10,25	57
16 $^{3}/_{4}$	24,25	20	1 $^{5}/_{8}$	1,75	+ 0,09	11,75	66
20 $^{3}/_{4}$	29,50	20	2	2,12	+ 0,09	14,50	74

[e] Minimum bolt hole tolerance is – 0,02.

Table B.37 *(continued)*



b) Threaded flange



c) Welding neck line-pipe flange

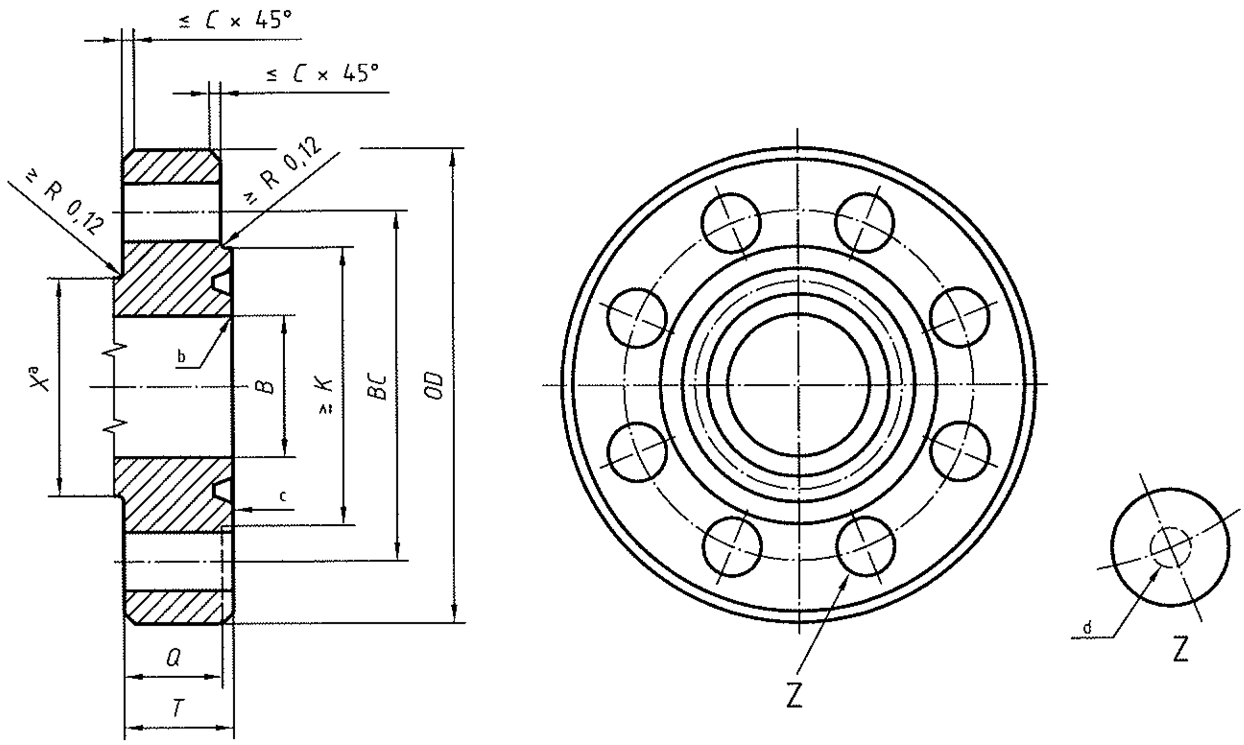
Dimensions in inches

(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.[f]	J_L
2 $^1/_{16}$	2,56	—	2,56	4,31	2,38	+ 0,09	1,97
2 $^9/_{16}$	2,81	—	2,81	4,44	2,88	+ 0,09	2,35
3 $^1/_8$	2,44	—	2,94	4,31	3,50	+ 0,09	2,93
4 $^1/_{16}$	3,06	3,50	3,50	4,81	4,50	+ 0,09	3,86
5 $^1/_8$	3 44	4,00	—	5,31	5,56	+ 0,09	4,84
7 $^1/_{16}$	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 $^5/_8$	4,94	4,94	—	—	—	—	—
16 $^3/_4$	5,06	5,69	—	—	—	—	—
20 $^3/_4$	6,75	6,75	—	—	—	—	—

[f] Minimum tolerance for this dimension is – 0,03.

Table B.38 — Type 6B flanges for 5 000 psi rated working pressure (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Reference dimension.

b Break sharp corners.

c Top.

d Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

a) Flange section integral flange

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
	B	OD	tol.	C	K	T $^{+0,12}_{0}$	Q	X
2 1/16	2,09	8,50	± 0,06	0,12	4,88	1,81	1,50	4,12
2 9/16	2,59	9,62	± 0,06	0,12	5,38	1,94	1,62	4,88
3 1/8	3,22	10,50	± 0,06	0,12	6,62	2,19	1,88	5,25
4 1/16	4,28	12,25	± 0,06	0,12	7,62	2,44	2,12	6,38
5 1/8	5,16	14,75	± 0,06	0,12	9,00	3,19	2,88	7,75
7 1/16	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

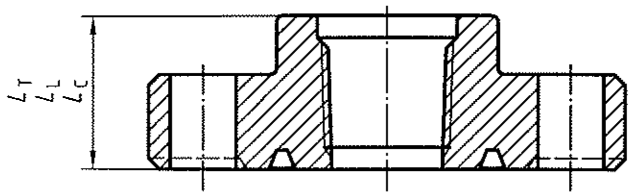
Table B.38 *(continued)*

Dimensions in inches

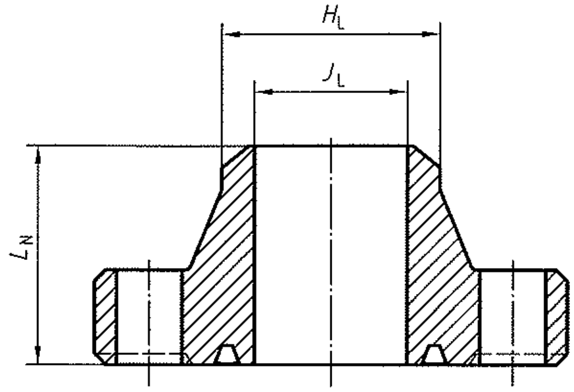
(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Nominal size and bore of flange	**Bolting dimensions**						
	Diameter of bolt circle	**Number of bolts**	**Diameter of bolts**	**Diameter of bolt holes**		**Length of stud bolts**	**Ring number**
	BC				tol. [e]	L_{ssb}	R or RX
2 $^1/_{16}$	6,50	8	$^7/_8$	1,00	+ 0,06	6,00	24
2 $^9/_{16}$	7,50	8	1	1,12	+ 0,06	6,50	27
3 $^1/_8$	8,00	8	1 $^1/_8$	1,25	+ 0,06	7,25	35
4 $^1/_{16}$	9,50	8	1 $^1/_4$	1,38	+ 0,06	8,00	39
5 $^1/_8$	11,50	8	1 $^1/_2$	1,62	+ 0,06	10,00	44
7 $^1/_{16}$	12,50	12	1 $^3/_8$	1,50	+ 0,06	10,75	46
9	15,50	12	1 $^5/_8$	1,75	+ 0,09	12,00	50
11	19,00	12	1 $^7/_8$	2,00	+ 0,09	13,75	54

[e] Minimum bolt hole tolerance is – 0,02.

Table B.38 *(continued)*



b) Threaded flange



c) Welding neck line-pipe flange

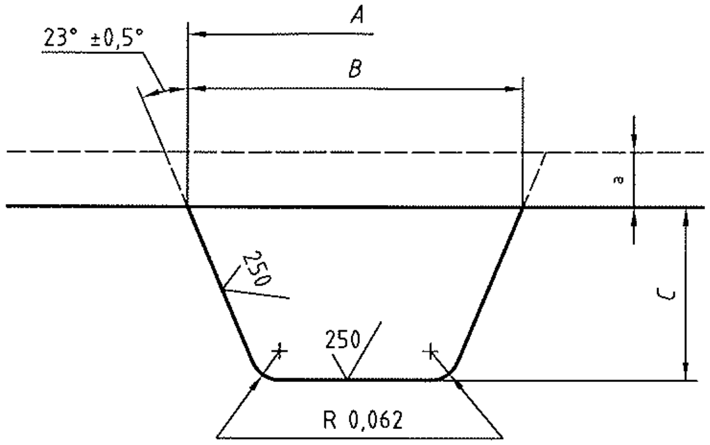
Dimensions in inches

(1)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Hub and bore dimensions							
Nominal size and bore of flange	**Hub length threaded line-pipe flange**	**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.[f]	J_L
2 $^1/_{16}$	2,56	—	2,56	4,31	2,38	+ 0,09	1,72
2 $^9/_{16}$	2,81	—	2,81	4,44	2,88	+ 0,09	2,16
3 $^1/_8$	3,19	—	3,19	4,94	3,50	+ 0,09	2,65
4 $^1/_{16}$	3 88	3,88	3,88	5,19	4,50	+ 0,09	3 47
5 $^1/_8$	4,44	4,44	—	6,44	5,56	+ 0,09	4,34
7 $^1/_{16}$	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

[f] Minimum tolerance for this dimension is – 0,03.

Table B.39 — Rough machining detail for corrosion-resistant ring groove (US Customary units)

Dimensions in inches
Surface roughness in microinches



a Allow 1/8 in or greater for final machining of weld overlay.

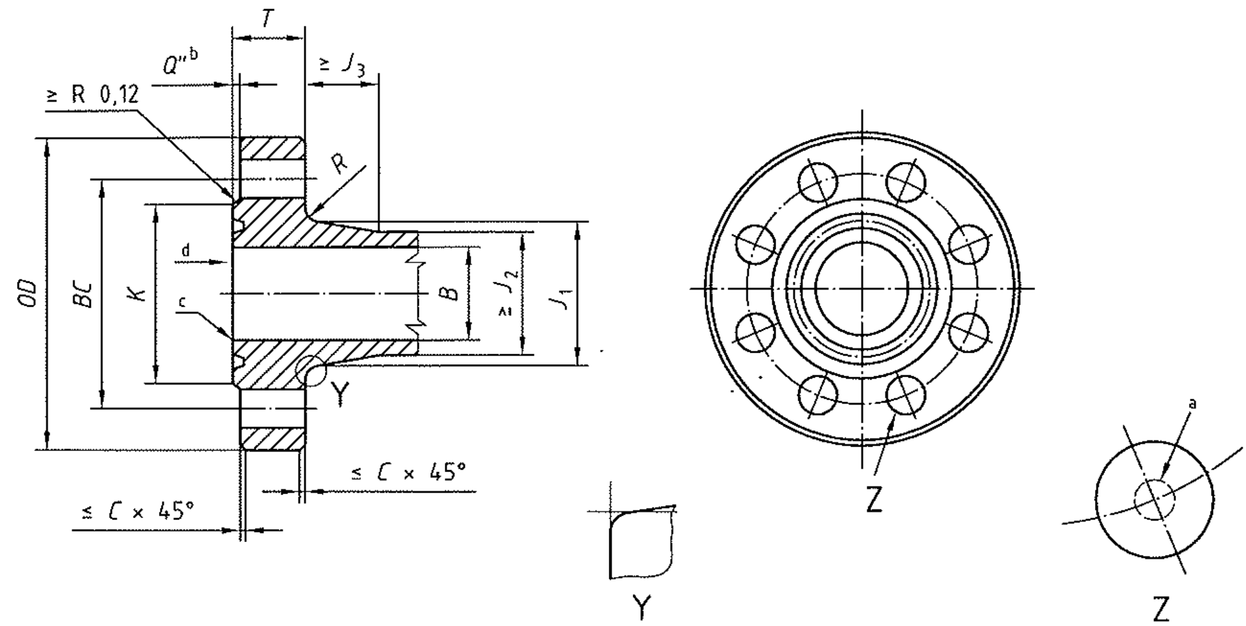
Dimensions in inches

Ring number	Outside diameter of groove A $^{+0,03}_{0}$	Width of groove B $^{+0,03}_{0}$	Depth of groove C $^{+0,03}_{0}$	Ring number	Outside diameter of groove A $^{+0,03}_{0}$	Width of groove B $^{+0,03}_{0}$	Depth of groove C $^{+0,03}_{0}$
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 [b]	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 [b]	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 [b]	2,36	0,50	0,30
R 37	6,67	0,75	0,45	R 205 [b]	2,80	0,50	0,42
R 39	7,17	0,75	0,45	R 210 [b]	4,20	0,66	0,39
				R 215 [b]	5,92	0,75	0,45

b See 10.1.2.4.5.

Table B.40 — Type 6BX integral flanges for 2 000 psi; 3 000 psi; 5 000 psi and 10 000 psi rated working pressures (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Bolt hole centreline located within 0,03 in of theoretical BC and equal spacing.

b $Q''_{max.} = E$ (Table B.52);
$Q''_{min.}$ = 0,12 inch;
Q'' may be omitted on studded flanges.

c Break sharp corners.

d Top.

Table B.40 *(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	T	J_1	J_2	J_3	R
					$\pm 0{,}06$	$^{+0{,}12}_{0}$	$^{0}_{-0{,}12}$			
	2 000 psi									
26 3/4	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 3/4	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 5/8	13,66	26,50	± 0,12	0,25	18,00	4,44	18,94	16,69	4,50	0,62
16 3/4	16,78	30,38	± 0,12	0,25	21,06	5,13	21,88	20,75	3,00	0,75
18 3/4	18,78	35,62	± 0,12	0,25	24,69	6,53	26,56	23,56	6,00	0,62
21 1/4	21,28	39,00	± 0,12	0,25	27,62	7,12	29,88	26,75	6,50	0,69
	10 000 psi									
1 13/16	1,84	7,38	± 0,06	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 1/16	2,09	7,88	± 0,06	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 9/16	2,59	9,12	± 0,06	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 1/16	3,09	10,62	± 0,06	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 1/16	4,09	12,44	± 0,06	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,12	8,81	7,19	3,19	0,38
7 1/16	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 5/8	13,66	30,25	± 0,12	0,25	20,38	6,62	21,75	19,50	4,50	0,62
16 3/4	16,78	34,31	± 0,12	0,25	22,69	6,62	25,81	23,69	3,00	0,75
18 3/4	18,78	40,94	± 0,12	0,25	27,44	8,78	29,62	26,56	6,12	0,62
21 1/4	21,28	45,00	± 0,12	0,25	30,75	9,50	33,38	30,00	6,50	0,81

Table B.40 *(continued)*

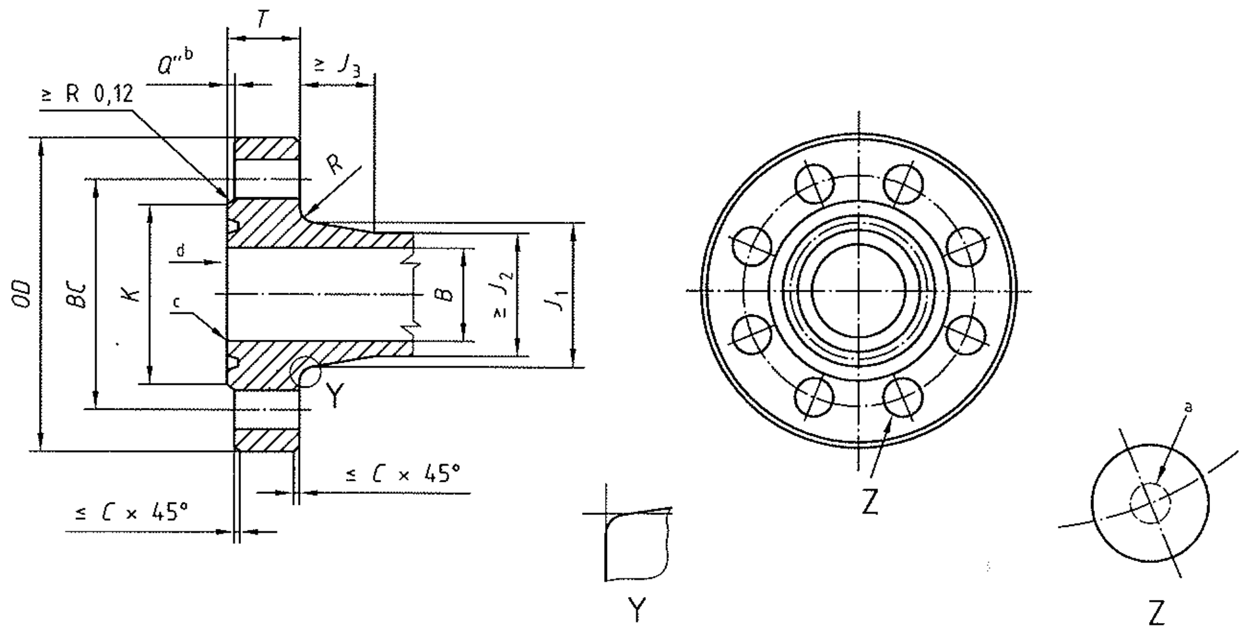
Dimensions in inches

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
	BC				tol. [e]	L_{ssb}	BX
	2 000 psi						
26 $^3/_4$	37,50	20	1 $^3/_4$	1,88	+ 0,09	13,75	167
30	40,94	32	1 $^5/_8$	1,75	+ 0,09	14,25	303
	3 000 psi						
26 $^3/_4$	39,38	24	2	2,12	+ 0,09	17,00	168
30	42,94	32	1 $^7/_8$	2,00	+ 0,09	17,75	303
	5 000 psi						
13 $^5/_8$	23,25	16	1 $^5/_8$	1,75	+ 0,09	12,50	160
16 $^3/_4$	26,62	16	1 $^7/_8$	2,00	+ 0,09	14,50	162
18 $^3/_4$	31,62	20	2	2,12	+ 0,09	17,50	163
21 $^1/_4$	34,88	24	2	2,12	+ 0,09	18,75	165
	10 000 psi						
1 $^{13}/_{16}$	5,75	8	$^3/_4$	0,88	+ 0,06	5,00	151
2 $^1/_{16}$	6,25	8	$^3/_4$	0,88	+ 0,06	5,25	152
2 $^9/_{16}$	7,25	8	$^7/_8$	1,00	+ 0,06	6,00	153
3 $^1/_{16}$	8,50	8	1	1,12	+ 0,06	6,75	154
4 $^1/_{16}$	10,19	8	1 $^1/_8$	1,25	+ 0,06	8,00	155
5 $^1/_8$	11,81	12	1 $^1/_8$	1,25	+ 0,06	8,75	169
7 $^1/_{16}$	15,88	12	1 $^1/_2$	1,62	+ 0,09	11,25	156
9	18,75	16	1 $^1/_2$	1,62	+ 0,09	13,00	157
11	22,25	16	1 $^3/_4$	1,88	+ 0,09	15,00	158
13 $^5/_8$	26,50	20	1 $^7/_8$	2,00	+ 0,09	17,25	159
16 $^3/_4$	30,56	24	1 $^7/_8$	2,00	+ 0,09	17,50	162
18 $^3/_4$	36,44	24	2 $^1/_4$	2,38	+ 0,09	22,50	164
21 $^1/_4$	40,25	24	2 $^1/_2$	2,62	+ 0,09	24,50	166

[e] Minimum bolt hole tolerance is – 0,02.

Table B.41 — Type 6BX integral flanges for 15 000 psi and 20 000 psi rated working pressures (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

b $Q''_{max.} = E$ (Table B.52);
$Q''_{min.}$ = 0,12 inch;
Q'' may be omitted on studded flanges.

c Break sharp corners.

d Top.

Table B.41 *(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 ± 0,06	T $^{+0,12}_{0}$	J_1 $^{0}_{-0,12}$	J_2	J_3	R
	15 000 psi									
1 13/16	1,84	8,19	± 0,06	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 1/16	2,09	8,75	± 0,06	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 9/16	2,59	10,00	± 0,06	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 1/16	3,09	11,31	± 0,06	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 1/16	4,09	14,19	± 0,06	0,12	7,62	3,09	7,69	6,25	2,88	0,38
5 1/8	5,16	16,50	± 0,06	0,12	8,88	3,88	9,62	7,88	3,22	0,62
7 1/16	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 5/8	13,66	34,88	± 0,12	0,25	21,31	8,06	23,44	20,81	4,50	1,00
18 3/4	18,78	45,75	± 0,12	0,25	28,44	10,06	32,00	28,75	6,12	1,00
	20 000 psi									
1 13/16	1,84	10,12	± 0,06	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 1/16	2,09	11,31	± 0,06	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 9/16	2,59	12,81	± 0,06	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 1/16	3,09	14,06	± 0,06	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 1/16	4,09	17,56	± 0,06	0,12	8,62	4,19	9,56	8,12	2,88	0,38
7 1/16	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 5/8	13,66	45,75	± 0,12	0,25	24,19	11,50	27,31	24,75	5,25	1,00

Table B.41 *(continued)*

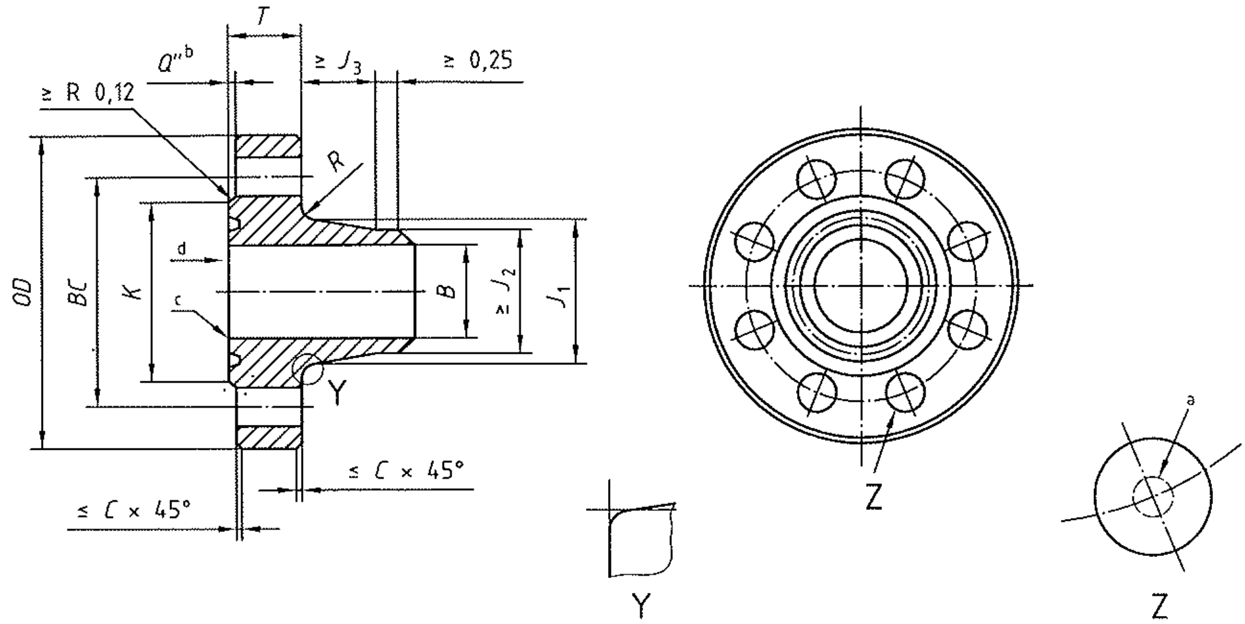
Dimensions in inches

(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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
	BC				tol.[e]	L_{ssb}	BX
	15 000 psi						
1 $^{13}/_{16}$	6,31	8	$^{7}/_{8}$	1,00	+ 0,06	5,50	151
2 $^{1}/_{16}$	6,88	8	$^{7}/_{8}$	1,00	+ 0,06	6,00	152
2 $^{9}/_{16}$	7,88	8	1	1,12	+ 0,06	6,75	153
3 $^{1}/_{16}$	9,06	8	1 $^{1}/_{8}$	1,25	+ 0,06	7,50	154
4 $^{1}/_{16}$	11,44	8	1 $^{3}/_{8}$	1,50	+ 0,06	9,25	155
5 $^{1}/_{8}$	13,50	12	1 $^{1}/_{2}$	1,62	+ 0,09	11,50	169
7 $^{1}/_{16}$	16,88	16	1 $^{1}/_{2}$	1,62	+ 0,09	12,75	156
9	21,75	16	1 $^{7}/_{8}$	2,00	+ 0,09	15,75	157
11	28,00	20	2	2,12	+ 0,09	19,25	158
13 $^{5}/_{8}$	30,38	20	2 $^{1}/_{4}$	2,38	+ 0,09	21,25	159
18 $^{3}/_{4}$	40,00	20	3	3,12	+ 0,12	26,75	164
	20 000 psi						
1 $^{13}/_{16}$	8,00	8	1	1,12	+ 0,06	7,50	151
2 $^{1}/_{16}$	9,06	8	1 $^{1}/_{8}$	1,25	+ 0,06	8,25	152
2 $^{9}/_{16}$	10,31	8	1 $^{1}/_{4}$	1,38	+ 0,06	9,25	153
3 $^{1}/_{16}$	11,31	8	1 $^{3}/_{8}$	1,50	+ 0,06	10,00	154
4 $^{1}/_{16}$	14,06	8	1 $^{3}/_{4}$	1,88	+ 0,09	12,25	155
7 $^{1}/_{16}$	21,81	16	2	2,12	+ 0,09	17,50	156
9	27,00	16	2 $^{1}/_{2}$	2,62	+ 0,09	22,38	157
11	29,50	16	2 $^{3}/_{4}$	2,88	+ 0,09	23,75	158
13 $^{5}/_{8}$	40,00	20	3	3,12	+ 0,12	30,00	159

[e] Minimum bolt hole tolerance is – 0,02.

Table B.42 — Type 6BX welding neck flanges for 10 000 psi and 15 000 psi rated working pressures (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Bolt hole centreline located within 0,03 in of theoretical BC and equal spacing.

b $Q''_{max.} = E$ (Table B.52);
$Q''_{min.} = 0,12$ inch.

c Break sharp corners.

d Top.

Table B.42 *(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	T	J_1	J_2	J_3	R
					± 0,06	$^{+0,12}_{0}$	$^{0}_{-0,12}$			
	10 000 psi									
1 $^{13}/_{16}$	1,84	7,38	± 0,06	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 $^{1}/_{16}$	2,09	7,88	± 0,06	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 $^{9}/_{16}$	2,59	9,12	± 0,06	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 $^{1}/_{16}$	3,09	10,62	± 0,06	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 $^{1}/_{16}$	4,09	12,44	± 0,06	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 $^{1}/_{8}$	5,16	14,06	± 0,06	0,12	8,69	3,13	8,81	7,19	3,19	0,38
7 $^{1}/_{16}$	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 $^{5}/_{8}$	13,66	30,25	± 0,12	0,25	20,38	6,62	21,75	19,50	4,50	0,62
16 $^{3}/_{4}$	16,78	34,31	± 0,12	0,25	22,69	6,62	25,81	23,69	3,00	0,75
	15 000 psi									
1 $^{13}/_{16}$	1,84	8,19	± 0,06	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 $^{1}/_{16}$	2,09	8,75	± 0,06	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 $^{9}/_{16}$	2,59	10,00	± 0,06	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 $^{1}/_{16}$	3,09	11,31	± 0,06	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 $^{1}/_{16}$	4,09	14,19	± 0,06	0,12	7,62	3,09	7,69	6,25	2,88	0,38
5 $^{1}/_{8}$	5,16	16,50	± 0,06	0,12	8,88	3,88	9,62	7,88	3,22	0,62
7 $^{1}/_{16}$	7,09	19,88	± 0,12	0,25	12,00	4,69	12,81	10,88	3,62	0,62

Table B.42 *(continued)*

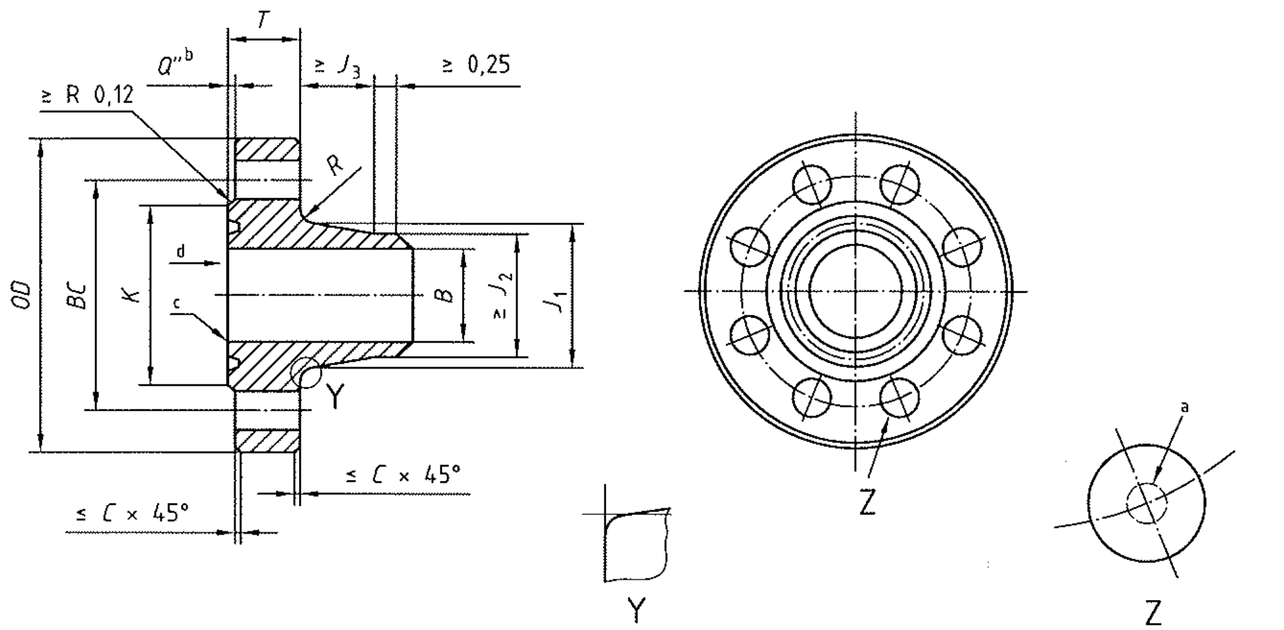
Dimensions in inches

(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	Diameter of bolt holes		Minimum length of stud bolts	Ring number
	BC				tol.[e]	L_{ssb}	BX
	10 000 psi						
1 3/16	5,75	8	3/4	0,88	+ 0,06	5,00	151
2 1/16	6,25	8	3/4	0,88	+ 0,06	5,25	152
2 9/16	7,25	8	7/8	1,00	+ 0,06	6,00	153
3 1/16	8,50	8	1	1,12	+ 0,06	6,75	154
4 1/16	10,19	8	1 1/8	1,25	+ 0,06	8,00	155
5 1/8	11,81	12	1 1/8	1,25	+ 0,06	8,75	169
7 1/16	15,88	12	1 1/2	1,62	+ 0,09	11,25	156
9	18,75	16	1 1/2	1,62	+ 0,09	13,00	157
11	22,25	16	1 3/4	1,88	+ 0,09	15,00	158
13 5/8	26,50	20	1 7/8	2,00	+ 0,09	17,25	159
16 3/4	30,56	24	1 7/8	2,00	+ 0,09	17,50	162
	15 000 psi						
1 13/16	6,31	8	7/8	1,00	+ 0,06	5,50	151
2 1/16	6,88	8	7/8	1,00	+ 0,06	6,00	152
2 9/16	7,88	8	1	1,12	+ 0,06	6,75	153
3 1/16	9,06	8	1 1/8	1,25	+ 0,06	7,50	154
4 1/16	11,44	8	1 3/8	1,50	+ 0,06	9,25	155
5 1/8	13,50	12	1 1/2	1,62	+ 0,09	11,50	169
7 1/16	16,88	16	1 1/2	1,62	+ 0,09	12,75	156

[e] Minimum bolt hole tolerance is – 0,02.

Table B.43 — Type 6BX welding neck flanges for 20 000 psi rated working pressure (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

[a] Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

[b] $Q''_{max.} = E$ (Table B.52);
$Q''_{min.}$ = 0,12 inch.

[c] Break sharp corners.

[d] Top.

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 ± 0,06	T $^{+0,12}_{0}$	J_1 $^{0}_{-0,12}$	J_2	J_3	R
	20 000 psi									
1 $^{13}/_{16}$	1,84	10,12	± 0,06	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 $^{1}/_{16}$	2,09	11,31	± 0,06	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 $^{9}/_{16}$	2,59	12,81	± 0,06	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 $^{1}/_{16}$	3,09	14,06	± 0,06	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 $^{1}/_{16}$	4,09	17,56	± 0,06	0,12	8,62	4,19	9,56	8,12	2,88	0,38
7 $^{1}/_{16}$	7,09	25,81	± 0,12	0,25	13,88	6,50	15,19	13,31	3,81	0,62

Table B.43 *(continued)*

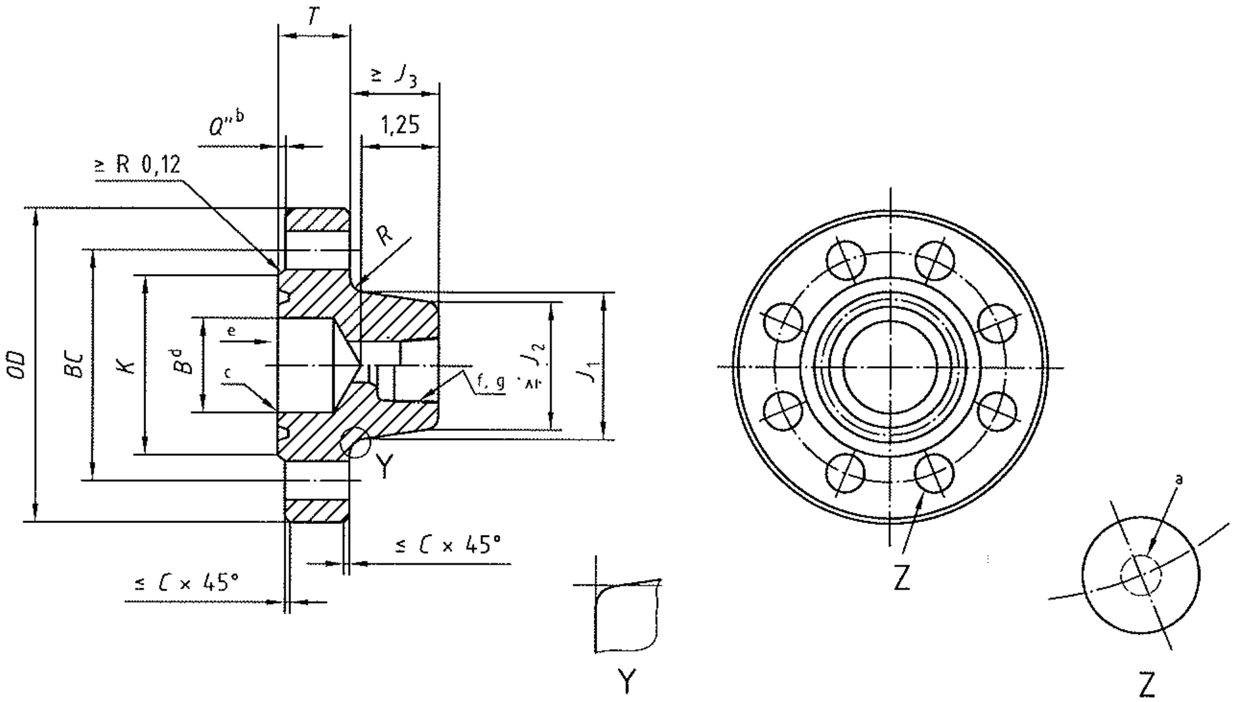
Dimensions in inches

(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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
	BC				tol.[e]	L_{ssb}	BX
	20 000 psi						
1 $^{13}/_{16}$	8,00	8	1	1,12	+ 0,06	7,50	151
2 $^{1}/_{16}$	9,06	8	1 $^{1}/_{8}$	1,25	+ 0,06	8,25	152
2 $^{9}/_{16}$	10,31	8	1 $^{1}/_{4}$	1,38	+ 0,06	9,25	153
3 $^{1}/_{16}$	11,31	8	1 $^{3}/_{8}$	1,50	+ 0,06	10,00	154
4 $^{1}/_{16}$	14,06	8	1 $^{3}/_{4}$	1,88	+ 0,09	12,25	155
7 $^{1}/_{16}$	21,81	16	2	2,12	+ 0,09	17,50	156

[e] Minimum bolt hole tolerance is – 0,02.

Table B.44 — Type 6BX blind and test flanges for 10 000 psi and 15 000 psi rated working pressures (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

[a] Bolt hole centreline located within 0,03 in of theoretical BC and equal spacing.

[b] $Q''_{max.} = E$ (Table B.52);
$Q''_{min.}$ = 0,12 inch.

[c] Break sharp corners.

[d] This bore optional.

[e] Top.

[f] Test connection. See Figure 22.

[g] $^1/_2$ inch line-pipe or NPT threads (maximum 10 000 psi working pressure).

Table B.44 *(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	T	J_1	J_2	J_3	R
					± 0,06	$^{+0,12}_{0}$	$^{0}_{-0,12}$			
	10 000 psi									
1 13/16	1,84	7,38	± 0,06	0,12	4,12	1,66	3,50	2,56	1,91	0,38
2 1/16	2,09	7,88	± 0,06	0,12	4,38	1,73	3,94	2,94	2,03	0,38
2 9/16	2,59	9,12	± 0,06	0,12	5,19	2,02	4,75	3,62	2,25	0,38
3 1/16	3,09	10,62	± 0,06	0,12	6,00	2,30	5,59	4,34	2,50	0,38
4 1/16	4,09	12,44	± 0,06	0,12	7,28	2,77	7,19	5,75	2,88	0,38
5 1/8	5,16	14,06	± 0,06	0,12	8,69	3,13	8,81	7,19	3,19	0,38
	15 000 psi									
1 13/16	1,84	8,19	± 0,06	0,12	4,19	1,78	3,84	2,81	1,88	0,38
2 1/16	2,09	8,75	± 0,06	0,12	4,50	2,00	4,38	3,25	2,12	0,38
2 9/16	2,59	10,00	± 0,06	0,12	5,25	2,25	5,06	3,94	2,25	0,38
3 1/16	3,09	11,31	± 0,06	0,12	6,06	2,53	6,06	4,81	2,50	0,38
4 1/16	4,09	14,19	± 0,06	0,12	7,62	3,09	7,69	6,25	2,88	0,38

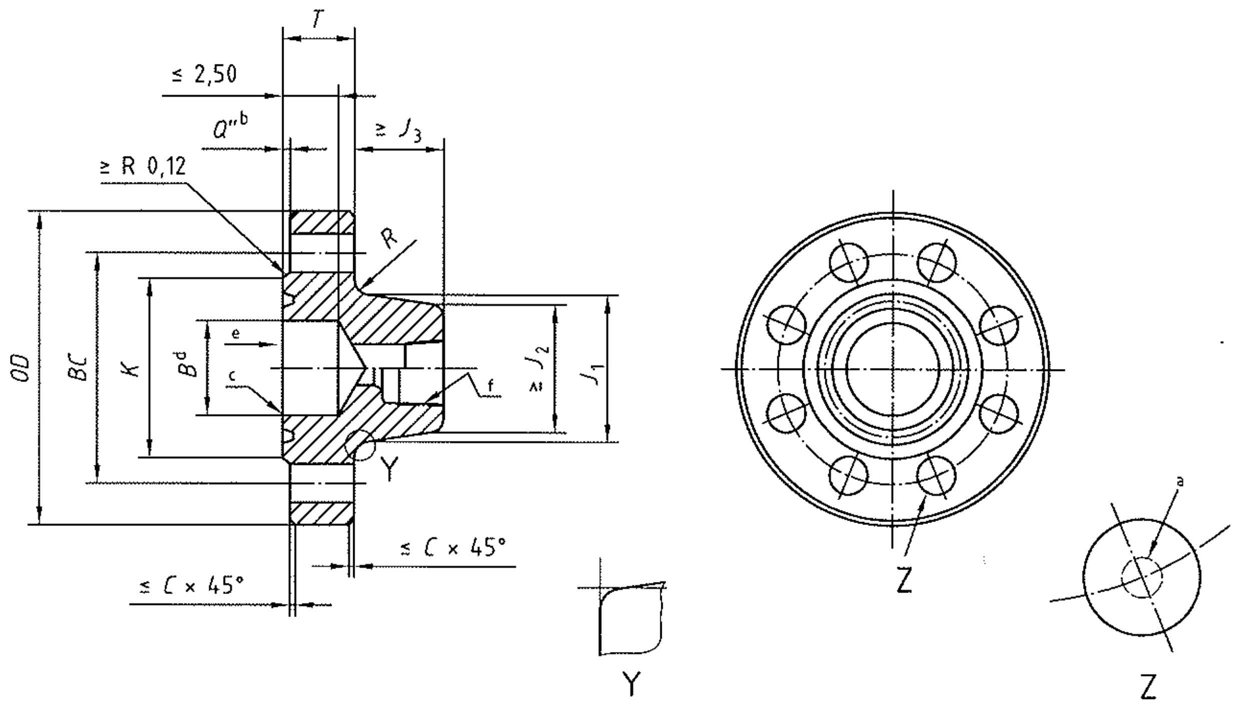
Dimensions in inches

(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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
	BC				tol.[h]	L_{ssb}	BX
	10 000 psi						
1 13/16	5,75	8	3/4	0,88	+ 0,06	5,00	151
2 1/16	6,25	8	3/4	0,88	+ 0,06	5,25	152
2 9/16	7,25	8	7/8	1,00	+ 0,06	6,00	153
3 1/16	8,50	8	1	1,12	+ 0,06	6,75	154
4 1/16	10,19	8	1 1/8	1,25	+ 0,06	8,00	155
5 1/8	11,81	12	1 1/8	1,25	+ 0,06	8,75	169
	15 000 psi						
1 13/16	6,31	8	7/8	1,00	+ 0,06	5,50	151
2 1/16	6,88	8	7/8	1,00	+ 0,06	6,00	152
2 9/16	7,88	8	1	1,12	+ 0,06	6,75	153
3 1/16	9,06	8	1 1/8	1,25	+ 0,06	7,50	154
4 1/16	11,44	8	1 3/8	1,50	+ 0,06	9,25	155

[h] Minimum bolt hole tolerance is – 0,02.

Table B.45 — Type 6BX blind and test flanges for 15 000 psi and 20 000 psi rated working pressures (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Bolt hole centreline located within 0,03 in of theoretical BC and equal spacing.

b $Q''_{max.} = E$ (Table B.52);
$Q''_{min.} = 0{,}12$ inch.

c Break sharp corners.

d This bore optional.

e Top.

f Test connection. See Figure 22.

Table B.45 *(continued)*

Dimensions in inches

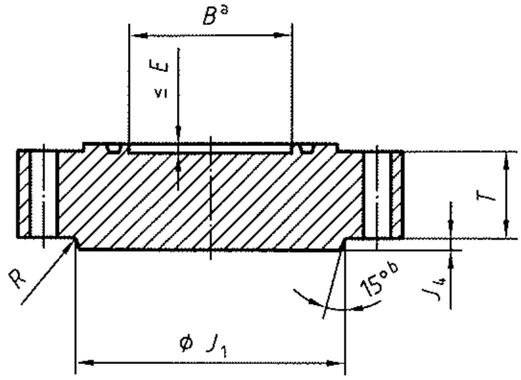
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Nominal size and bore of flange	**Basic flange dimensions**									
	Maximum bore	**Outside diameter of flange**		**Maximum chamfer**	**Diameter of raised face**	**Total thickness of flange**	**Large diameter of hub**	**Small diameter of hub**	**Length of 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
	15 000 psi									
5 1/8	5,16	16,50	± 0,06	0,12	8,88	3,88	9,62	7,88	3,22	0,62
	20 000 psi									
1 13/16	1,84	10,12	± 0,06	0,12	4,62	2,50	5,25	4,31	1,94	0,38
2 1/16	2,09	11,31	± 0,06	0,12	5,19	2,81	6,06	5,00	2,06	0,38
2 9/16	2,59	12,81	± 0,06	0,12	5,94	3,12	6,81	5,69	2,31	0,38
3 1/16	3,09	14,06	± 0,06	0,12	6,75	3,38	7,56	6,31	2,50	0,38
4 1/16	4,09	17,56	± 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**	**Diameter of bolt holes**		**Minimum length of stud bolts**	**Ring number**
	BC				tol.[9]	L_{ssb}	BX
	15 000 psi						
5 1/8	13,50	12	1 1/2	1,62	+ 0,09	11,50	169
	20 000 psi						
1 13/16	8,00	8	1	1,12	+ 0,06	7,50	151
2 1/16	9,06	8	1 1/8	1,25	+ 0,06	8,25	152
2 9/16	10,31	8	1 1/4	1,38	+ 0,06	9,25	153
3 1/16	11,31	8	1 3/8	1,50	+ 0,06	10,00	154
4 1/16	14,06	8	1 3/4	1,88	+ 0,09	12,25	155

[9] Minimum bolt hole tolerance is – 0,02.

Table B.46 — 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 (US Customary units)



a Counter-bore.

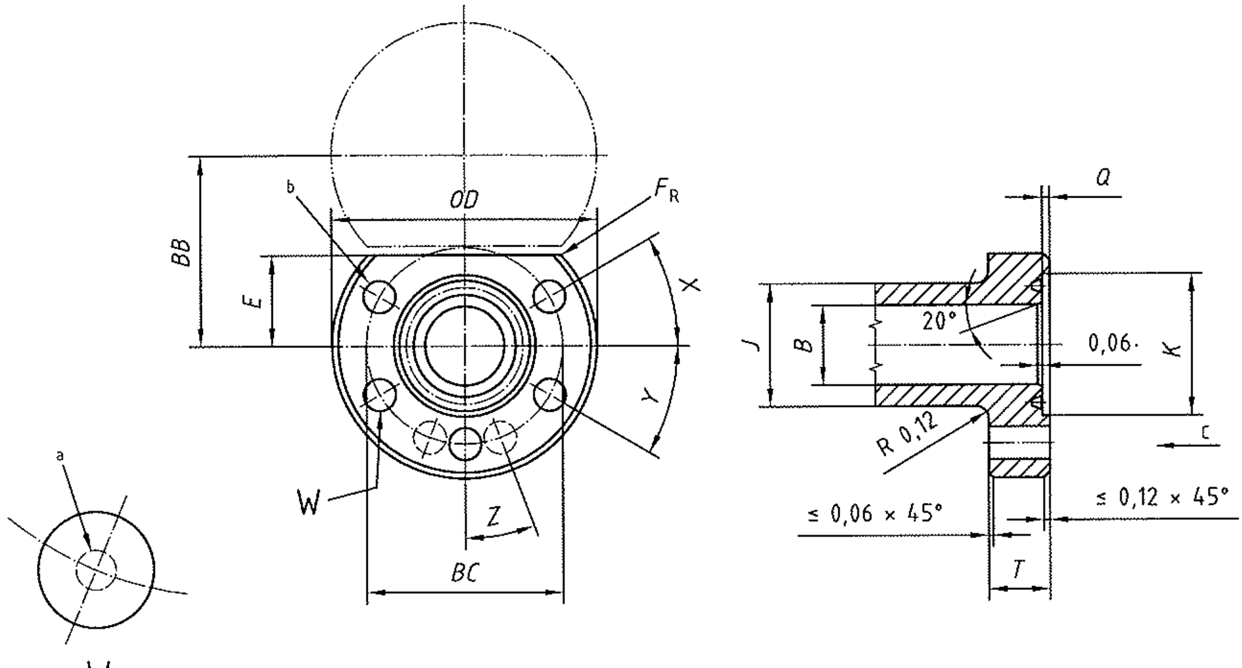
b Maximum slope.

Dimensions in inches

Nominal size B	Flange thickness T	Hub diameter J_1	Counter-bore depth E	Added hub thickness J_4
	2 000 psi			
26 3/4	4,97	32,91	0,844	0,38
30	5,28	36,69	0,906	0,69
	3 000 psi			
26 3/4	6,34	34,25	0,844	0,00
30	6,58	38,19	0,906	0,50
	5 000 psi			
13 5/8	4,44	18,94	0,562	0,94
16 3/4	5,12	21,88	0,328	0,69
18 3/4	6,53	26,56	0,719	0,75
21 1/4	7,12	29,88	0,750	0,88
	10 000 psi			
5 1/8	3,12	8,81	0,375	0,25
7 1/16	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 5/8	6,62	21,75	0,625	0,69
16 3/4	6,62	25,81	0,328	1,19
18 3/4	8,78	29,62	0,719	1,00
21 1/4	9,50	33,38	0,750	1,25
	15 000 psi			
5 1/8	3,88	9,62	0,375	0,25
7 1/16	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 5/8	8,06	23,44	0,625	0,69
18 3/4	10,06	32,00	0,719	1,38
	20 000 psi			
7 1/16	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 5/8	11,50	27,31	0,625	0,56
NOTE For dimensions not listed, see Tables B.40 to B.45 as applicable.				

Table B.47 — Dimensions for 5 000 psi rated working pressure segmented flanges for dual completion (US Customary units)

Dimensions in inches



NOTE Ring groove to be concentric with bore within 0,010 total indicator runout.

a Bolt hole centreline located within 0,03 in of theoretical *BC* and equal spacing.

b Bolt holes: *L*, *M*.

c Top.

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Nominal size and bore of flange	Basic flange dimensions										
	Maxi-mum bore	Outside diameter of flange		Total thick-ness of flange	Distance flat to centre	Minimum radius	Diameter of hub		Diameter counter-bore	Depth of counter-bore	Ring number
	B	OD	tol.	T $^{+0,12}_{0}$	E − 0,02	F_R	J	tol.	K	Q + 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

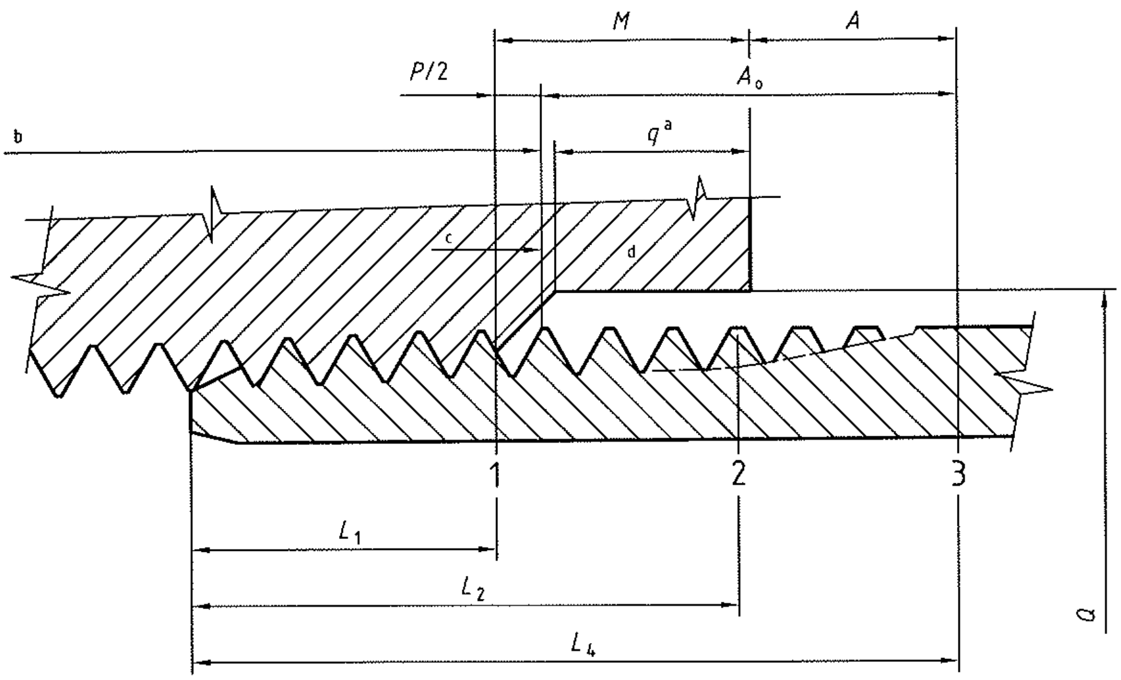
Table B.47 *(continued)*

Dimensions in inches

(1)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Nominal and bore 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
	BC	*L*	tol.[d]	*M*	*X*	*Y*	*Z*				*BB*
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	—

[d] Minimum bolt hole tolerance is – 0,02.

Table B.48 — Pipe thread counter-bore and stand-off dimensions (see ISO 10422 for dimensions L_1, L_2 and L_4) (US Customary units)



Key

1 plane of handtight engagement

2 plane of effective thread length

3 plane of vanish point

[a] Reference dimension.

[b] Internal thread length.

[c] Without counter-bore.

[d] With counter-bore.

Table B.48 *(continued)*

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Hand-tight standoff			Counter-bore	
Nominal thread size	Length: plane of vanish point to hand-tight plane $A + M$	Thread without counter-bore A_o	Thread with shallow counter-bore A	Length: face of counter-bore to hand-tight plane M	Diameter Q	Depth q
	Line-pipe threads					
$^1/_8$	0,212 4	0,193 9	0,039 8	0,172 6	0,47	0,13
$^1/_4$	0,394 6	0,366 8	0,214 5	0,180 1	0,60	0,13
$^3/_8$	0,360 6	0,332 8	0,179 1	0,181 5	0,74	0,13
$^1/_2$	0,461 5	0,425 8	0,135 7	0,325 8	0,93	0,25
$^3/_4$	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 $^1/_4$	0,588 5	0,545 0	0,255 2	0,333 3	1,75	0,25
1 $^1/_2$	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 $^1/_2$	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 $^1/_2$	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

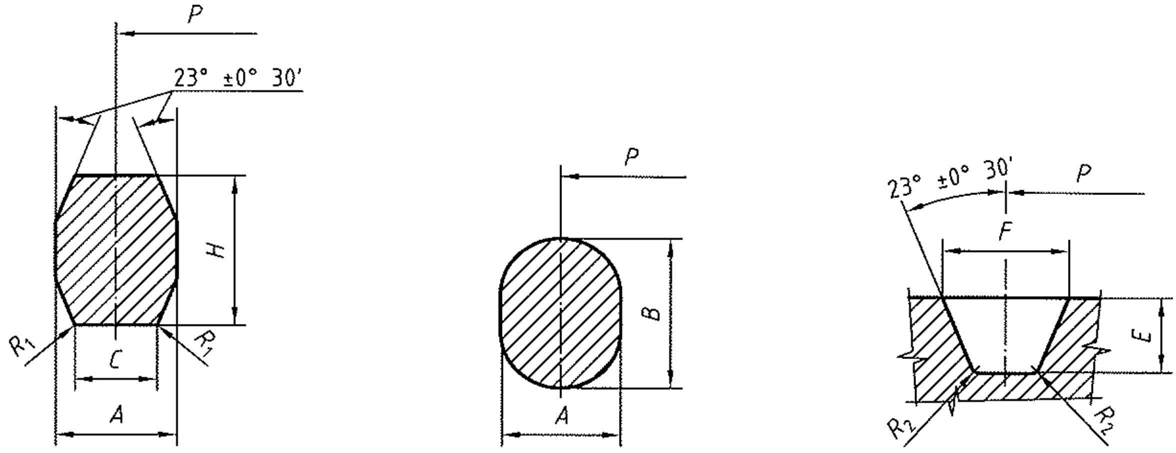
Table B.48 *(continued)*

Dimensions in inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Hand-tight standoff			Counter-bore	
Nominal thread size	Length: plane of vanish point to hand-tight plane	Thread without counter-bore	Thread with shallow counter-bore	Length: face of counter-bore to hand-tight plane	Diameter	Depth
	$A + M$	A_o	A	M	Q	q
	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 [e]	1,146	1,083 5	0,655 6	0,490 4	10,88	0,38
11 3/4 [e]	1,146	1,083 5	0,655 6	0,490 4	11,88	0,38
13 3/8 [e]	1,146	1,083 5	0,628 1	0,517 9	13,56	0,38
16 [e]	1,146	1,083 5	0,625 6	0,520 4	16,19	0,38
20 [e]	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

[e] Short casing threads only (long casing threads not covered).

Table B.50 — Type R ring gaskets (US Customary units)



a) Octagonal

b) Oval

c) Groove

Dimensions in inches

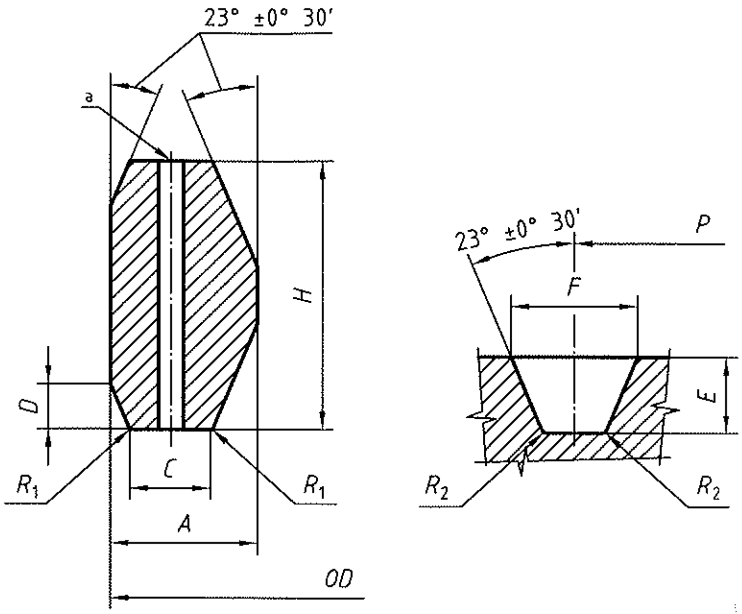
Ring number	Pitch diameter of ring (groove) P ± 0,007 (± 0,005)	Width of ring A ± 0,008	Height of ring oval B ± 0,02	Height of ring octagonal H ± 0,02	Width of flat of octagonal ring C ± 0,008	Radius in octagonal ring R_1 ± 0,02	Depth of groove E $^{+0,02}_{0}$	Width of groove F ± 0,008	Radius in groove 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
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

Table B.50 *(continued)*

Dimensions in inches

Ring number	Pitch diameter of ring (groove) P ± 0,007 (± 0,005)	Width of ring A ± 0,008	Height of ring oval B ± 0,02	Height of ring octagonal H ± 0,02	Width of flat of octagonal ring C ± 0,008	Radius in octagonal ring R_1 ± 0,02	Depth of groove E $^{+0,02}_{0}$	Width of groove F ± 0,008	Radius in groove R_2 max.	Approx. distance between made-up flanges S
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

Table B.51 — Type RX pressure-energized ring gaskets (US Customary units)

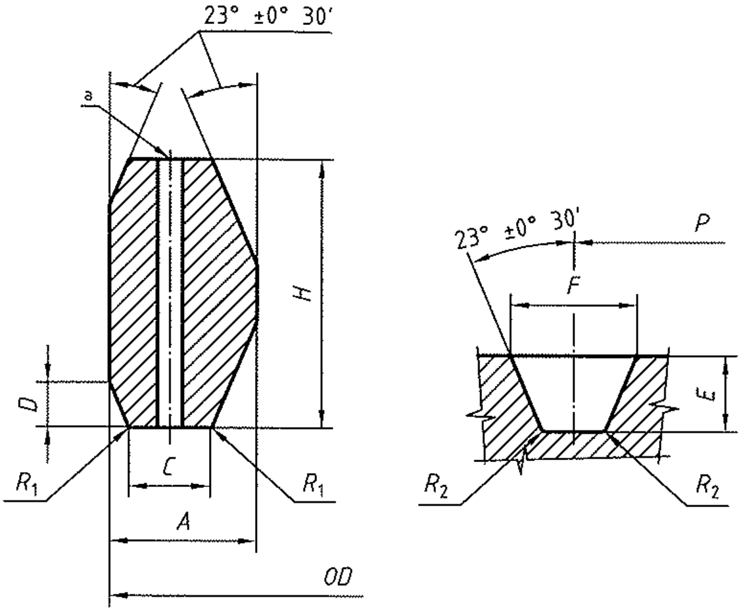


[a] The pressure passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. Centreline of hole shall be located at midpoint of dimension C. Hole diameter shall be 0,06 in for rings RX-82 through RX-85, 0,09 in for rings RX-86 and RX-87, and 0,12 in for rings RX-88 through RX-91.

Dimensions in inches

Ring number	Pitch diameter of ring and 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	OD	A [d]	C	D	H [d]	R_1	E	F	R_2	S
	± 0,005	$^{+0,020}_{0}$	$^{+0,008}_{0}$	$^{+0,006}_{0}$	$^{0}_{-0,03}$	$^{+0,008}_{0}$	± 0,02	$^{+0,02}_{0}$	± 0,008	max.	
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	0,97 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

Table B.51 *(continued)*



[a] The pressure passage hole illustrated in the RX ring cross-section applies to rings RX-82 through RX-91 only. Centreline of hole shall be located at midpoint of dimension *C*. 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 ring and 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	OD	A [d]	C	D	H [d]	R_1	E	F	R_2	S
	± 0,005	$^{+0,020}_{0}$	$^{+0,008}_{0}$	$^{+0,006}_{0}$	$^{0}_{-0,03}$	$^{+0,008}_{0}$	± 0,02	$^{+0,02}_{0}$	± 0,008	max.	
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 [b]	0,445	0,02 [c]	0,16	0,219	0,03	—
RX 205	2,250	2,453	0,219	0,120	0,072 [b]	0,437	0,02 [c]	0,16	0,219	0,02	—
RX 210	3,500	3,844	0,375	0,213	0,125 [b]	0,750	0,03 [c]	0,25	0,375	0,03	—
RX 215	5,125	5,547	0,469	0,210	0,167 [b]	1,000	0,06 [c]	0,31	0,469	0,03	—

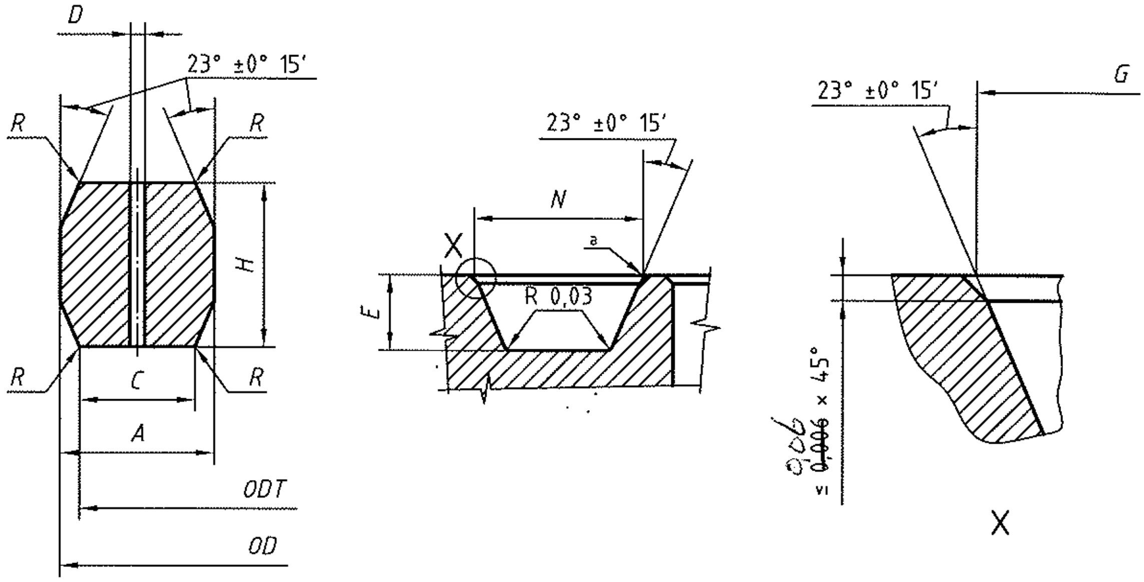
[b] Tolerance on these dimensions is $^{0}_{-0,015}$.

[c] Tolerance on these dimensions is $^{+0,02}_{0}$.

[d] 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.52 — Type BX pressure-energized ring gaskets (US Customary units)

Dimensions in inches



Radius R shall be 8 % to 12 % of the gasket height H. One pressure-passage hole required per gasket on centreline.

[a] Break sharp corner on inside diameter of groove.

Dimensions in inches

Ring number	Nominal size	Outside diameter of ring	Height of ring	Width of ring	Diameter of flat	Width of flat	Hole size	Depth of groove	Outside diameter of groove	Width of groove
		OD	H[b]	A[b]	ODT	C	D	E	G	N
		$^{0}_{-0,006}$	$^{+0,008}_{0}$	$^{+0,008}_{0}$	± 0,002	$^{+0,006}_{0}$	± 0,02	$^{+0,02}_{0}$	$^{+0,004}_{0}$	$^{+0,004}_{0}$
BX 150	1 11/16	2,842	0,366	0,366	2,790	0,314	0,06	0,22	2,893	0,450
BX 151	1 13/16	3,008	0,379	0,379	2,954	0,325	0,06	0,22	3,062	0,466
BX 152	2 1/16	3,334	0,403	0,403	3,277	0,346	0,06	0,23	3,395	0,498
BX 153	2 9/16	3,974	0,448	0,448	3,910	0,385	0,06	0,27	4,046	0,554
BX 154	3 1/16	4,600	0,488	0,488	4,531	0,419	0,06	0,30	4,685	0,606
BX 155	4 1/16	5,825	0,560	0,560	5,746	0,481	0,06	0,33	5,930	0,698
BX 156	7 1/16	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 5/8	16,800	1,012	1,012	16,657	0,869	0,12	0,62	17,033	1,279
BX 160	13 5/8	15,850	0,938	0,541	15,717	0,408	0,12	0,56	16,063	0,786
BX 161	16 3/4	19,347	1,105	0,638	19,191	0,482	0,12	0,67	19,604	0,930
BX 162	16 3/4	18,720	0,560	0,560	18,641	0,481	0,06	0,33	18,832	0,705
BX 163	18 3/4	21,896	1,185	0,684	21,728	0,516	0,12	0,72	22,185	1,006
BX 164	18 3/4	22,463	1,185	0,968	22,295	0,800	0,12	0,72	22,752	1,290
BX 165	21 1/4	24,595	1,261	0,728	24,417	0,550	0,12	0,75	24,904	1,071
BX 166	21 1/4	25,198	1,261	1,029	25,020	0,851	0,12	0,75	25,507	1,373
BX 167	26 3/4	29,896	1,412	0,516	29,696	0,316	0,06	0,84	30,249	0,902
BX 168	26 3/4	30,128	1,412	0,632	29,928	0,432	0,06	0,84	30,481	1,018
BX 169	5 1/8	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 5/8	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

[b] 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.54 — Flanged plug and gate valves for 2 000 psi rated working pressure (US Customary 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	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
2 1/16 × 1 13/16	1,81	11,62	—	11,62	—
2 1/16	2,06	11,62	13,12	11,62	11,62
2 9/16	2,56	13,12	15,12	13,12	13,12
3 1/8	3,12	14,12	17,62	14,12	14,12
3 1/8 × 3 3/16	3,19	14,12	17,62	14,12	—
4 1/16	4,06	17,12	20,12	17,12	17,12
4 1/16 × 4 1/8	4,12	17,12	20,12	17,12	—
4 1/16 × 4 1/4	4,25	17,12	20,12	17,12	—
5 1/8	5,12	22,12	25,12	—	—
7 1/16 × 6	6,00	22,12	28,62	22,12	22,12
7 1/16 × 6 3/8	6,38	22,12	—	—	—
7 1/16 × 6 5/8	6,62	—	—	—	—
7 1/16	7,06	26,12	29,12	—	—
7 1/16 × 7 1/8	7,12	26,12	29,12	—	—

Table B.55 — Flanged plug and gate valves for 3 000 psi rated working pressure (US Customary 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	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
2 1/16 × 1 13/16	1,81	14,62	—	14,62	—
2 1/16	2,06	14,62	15,12	14,62	14,62
2 9/16	2,56	16,62	17,12	16,62	16,62
3 1/8	3,12	17,12	18,62	15,12	15,12
3 1/8 × 3 3/16	3,19	17,12	18,62	15,12	—
4 1/16	4,06	20,12	22,12	18,12	18,12
4 1/16 × 4 1/8	4,12	20,12	22,12	18,12	—
4 1/16 × 4 1/4	4,25	20,12	22,12	18,12	—
5 1/8	5,12	24,12	26,12	—	—
7 1/16 × 6	6,00	24,12	30,12	24,12	24,12
7 1/16 × 6 3/8	6,38	24,12	—	—	—
7 1/16 × 6 5/8	6,62	—	—	—	—
7 1/16	7,06	28,12	31,62	—	—
7 1/16 × 7 1/8	7,12	28,12	31,62	—	—

Table B.56 — Flanged plug and gate valves for 5 000 psi rated working pressure (US Customary 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	Reduced-opening plug valves	Full-bore and reduced-opening ball valves
2 1/16 × 1 13/16	1,81	14,62	—	14,62	—
2 1/16	2,06	14,62	15,50	14,62	14,62
2 9/16	2,56	16,62	18,00	16,62	18,62
3 1/8	3,12	18,62	20,75	18,62	18,62
3 1/8 × 3 3/16	3,19	18,62	20,75	18,62	—
4 1/16	4,06	21,62	24,75	21,62	21,62
4 1/16 × 4 1/8	4,12	21,62	24,75	21,62	—
4 1/16 × 4 1/4	4,25	21,62	24,75	21,62	—
5 1/8	5,12	28,62	—	—	—
7 1/16 × 5 1/8	5,12	29,00	—	—	—
7 1/16 × 6	6,00	29,00	—	—	28,00
7 1/16 × 6 1/8	6,12	29,00	—	—	—
7 1/16 × 6 3/8	6,38	29,00	—	—	—
7 1/16 × 6 5/8	6,62	29,00	—	—	—
7 1/16	7,06	32,00	38,50	—	—
7 1/16 × 7 1/8	7,12	32,00	38,50	—	—
9	9,00	41,00	—	—	—

Table B.57 — Flanged plug and gate valves for 10 000 psi rated working pressure (US Customary units)

Dimensions in inches

Nominal size	Full-bore valves	
	Bore $^{+0,03}_{0}$	Face-to-face valve length ± 0,06
1 13/16	1,81	18,25
2 1/16	2,06	20,50
2 9/16	2,56	22,25
3 1/16	3,06	24,38
4 1/16	4,06	26,38
5 1/8	5,12	29,00
7 1/16 × 6 3/8	6,38	35,00
7 1/16	7,06	35,00

Table B.58 — Flanged plug and gate valves for 15 000 psi rated working pressure (US Customary units)

Dimensions in inches

Nominal size	Full-bore valves		
	Bore	Face-to-face valve length ± 0,06	
	$^{+0,03}_{0}$	Short pattern	Long pattern
1 $^{13}/_{16}$	1,81	18,00	—
2 $^{1}/_{16}$	2,06	19,00	23,50
2 $^{9}/_{16}$	2,56	21,00	25,00
3 $^{1}/_{16}$	3,06	23,56	—
4 $^{1}/_{16}$	4,06	29,00	—
5 $^{1}/_{8}$	5,12[a]	35,00	—

[a] Tolerance on 5 $^{1}/_{8}$ bore is $^{+0,04}_{0}$.

Table B.59 — Flanged gate valves for 20 000 psi rated working pressure (US Customary units)

Dimensions in inches

Nominal size	Full-bore valves	
	Bore $^{+0,03}_{0}$	Face-to-face valve length ± 0,06
1 $^{13}/_{16}$	1,81	21,00
2 $^{1}/_{16}$	2,06	23,00
2 $^{9}/_{16}$	2,56	26,50
3 $^{1}/_{16}$	3,06	30,50

Table B.60 — 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 (US Customary 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 13/16	2,781	1,390	1,390	7 1/16	5 1/2	17
2 1/16	3,547	1,774	1,774	7 1/16	7	38
2 9/16 × 2 1/16	3,547	1,650	1,897	7 1/16	7	29
2 9/16 × 2 1/16	4,000	1,875	2,125	9	7 5/8	39
2 9/16	4,000	2,000	2,000	9	7 5/8	29,7
2 9/16	4,500	2,250	2,250	9	8 5/8	49
3 1/8 × 2 1/16	4,578	2,008	2,570	9	8 5/8	49
3 1/8 × 2 9/16	5,047	2,524	2,524	11	9 5/8	53,5
3 1/8	5,047	2,524	2,524	11	9 5/8	53,5
	10 000 psi					
1 13/16	2,78	1,390	1,390	7 1/16	5 1/2	17
2 1/16	3,55	1,774	1,774	7 1/16	7	38
2 9/16 × 2 1/16	3,55	1,650	1,897	7 1/16	7	29
2 9/16 × 2 1/16	4,00	1,875	2,125	9	7 5/8	39
2 9/16	4,00	2,000	2,000	9	7 5/8	29,7
2 9/16	4,50	2,250	2,250	9	8 5/8	49
3 1/16	5,05	2,524	2,524	11	9 5/8	53,5

Table B.61 — Centre distances of conduit bores for triple, quadruple and quintuple parallel bore valves (US Customary 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 13/16	1,875	7 1/16	6 5/8	24
2 1/16	1,938	9	7	26
2 1/16	2,125	9	7 5/8	39
2 9/16	2,812	11	9 5/8	53,5
	Quadruple valve			
1 13/16	2,875	11	8 5/8	36
1 13/16	3,062	11	9 5/8	All
2 1/16	3,062	11	9 5/8	53,5
2 9/16	3,438	11	10 3/4	55,5
2 9/16	4,000	13 5/8	11 3/4	54
	Quintuple valve			
2 1/16	3,062	11	9 5/8	53,5
	10 000 psi rated working pressure			
	Triple valve			
1 13/16	1,875	7 1/16	6 5/8	24
2 1/16	1,938	9	7	26
2 1/16	2,125	9	7 5/8	39
2 9/16	2,812	11	9 5/8	53,5
	Quadruple valve			
2 9/16	3,438	11	10 3/4	55,5

Table B.62 — Regular and full-opening flanged swing and lift check valves for 2 000 psi; 3 000 psi and 5 000 psi rated working pressures (US Customary 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 1/16	11,62	14,62	14,62	—	—
2 9/16	13,12	16,62	16,62	—	—
3 1/8	14,12	15,12	18,62	17,12	—
4 1/16	17,12	18,12	21,62	20,12	—
7 1/16	22,12	24,12	28,00	—	29,00
9	26,12	29,12	33,12	—	—
11	31,12	33,12	39,38	—	—

Table B.63 — Single and dual plate wafer-type check valves for use with flanges for 2 000 psi; 3 000 psi and 5 000 psi rated working pressures (US Customary units)

Dimensions in inches

Nominal size	Face-to-face valve length ± 0,06					
	2 000 psi		3 000 psi		5 000 psi	
	Short pattern	Long pattern	Short pattern	Long pattern	Short pattern	Long pattern
2 $^{1}/_{16}$	0,75	2,75	0,75	2,75	0,75	2,75
2 $^{9}/_{16}$	0,75	3,25	0,75	3,25	0,75	3,25
3 $^{1}/_{8}$	0,75	3,25	0,75	3,25	0,88	3,38
4 $^{1}/_{16}$	0,88	4,00	0,88	4,00	1,25	4,12
7 $^{1}/_{16}$	1,12	6,25	1,38	6,25	1,75	6,25
9	1,50	8,12	1,75	8,12	2,25	8,12
11	2,25	9,50	2,25	9,75	2,88	10,00

Table B.64 — Minimum bore sizes for full-opening check valves for 2 000 psi; 3 000 psi and 5 000 psi rated working pressures (US Customary units)

Dimensions in inches

Nominal size	Minimum bore size $^{+0,06}_{0}$		
	2 000 psi	3 000 psi	5 000 psi
2 $^{1}/_{16}$	2,067	1,939	1,689
2 $^{9}/_{16}$	2,469	2,323	2,125
3 $^{1}/_{8}$	3,068	2,900	2,624
4 $^{1}/_{16}$	4,026	3,826	3,438
7 $^{1}/_{16}$	5,761	5,761	5,189
9	7,813	7,439	6,813
11	9,750	9,314	8,500

Table B.68 — Minimum vertical full-opening body bores and maximum casing sizes (US Customary units)

Nominal connector [a]		Casing beneath body			Minimum vertical full-opening wellhead body bore
Nominal size and bore of connector	Rated working pressure	Label [b]	Nominal lineic mass [b]	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

[a] Upper-end connections of wellhead body.

[b] Maximum size and minimum mass of casing on which bore is based.

Table B.75 — 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 (US Customary units)

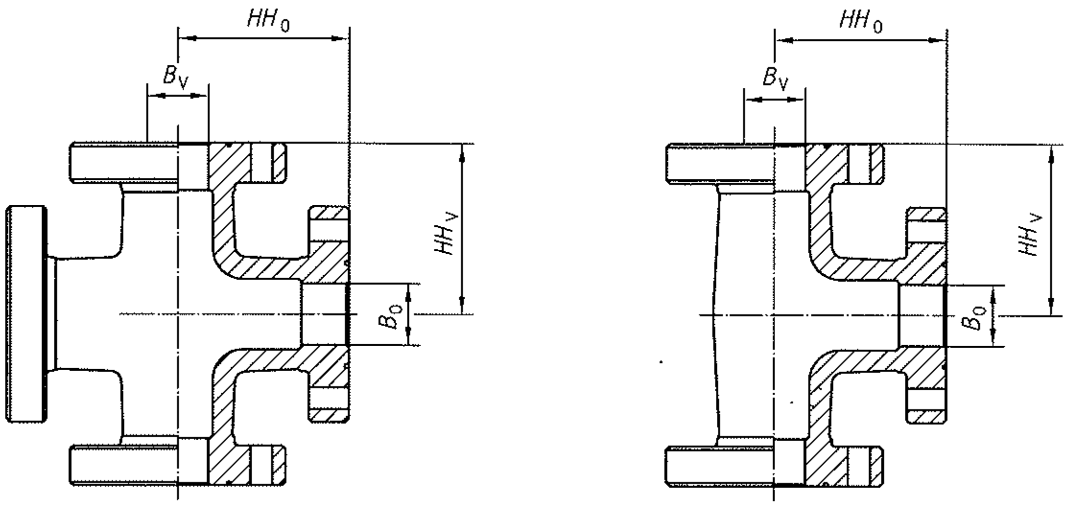


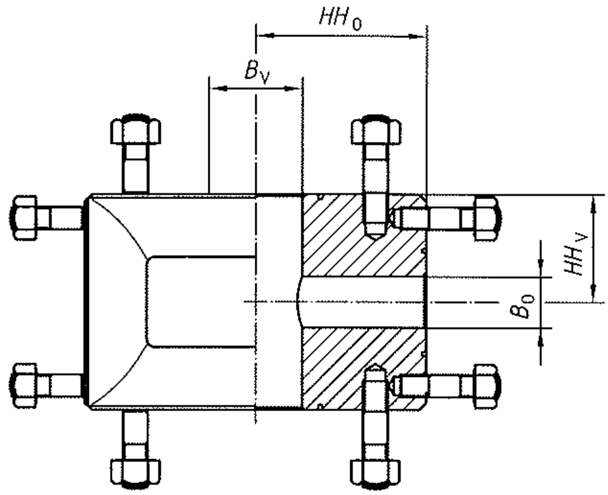
Table B.75 *(continued)*

Dimensions in inches

Nominal size and bore Vertical B_V $^{+0,03}_{0}$	Nominal size and bore Outlet B_O $^{+0,03}_{0}$	Centre-to-face vertical run HH_V ± 0,03	Centre-to-face horizontal run HH_O ± 0,03
2 000 psi			
2 1/16	2 1/16	5,81	5,81
2 9/16	2 1/16	5,94	6,31
2 9/16	2 9/16	6,56	6,56
3 1/8	2 1/16	6,06	6,69
3 1/8	2 9/16	6,56	6,81
3 1/8	3 1/8	7,06	7,06
4 1/16	2 1/16	6,31	7,94
4 1/16	2 9/16	6,81	8,06
4 1/16	3 1/8	7,19	8,19
4 1/16	4 1/16	8,56	8,56
3 000 psi			
3 1/8	2 1/16	7,31	7,81
3 1/8	2 9/16	7,88	7,94
3 1/8	3 1/8	7,56	7,56
4 1/16	2 1/16	7,56	8,81
4 1/16	2 9/16	8,12	8,94
4 1/16	3 1/8	8,06	8,81
4 1/16	4 1/16	9,06	9,06
5 000 psi			
2 1/16	2 1/16	7,31	7,31
2 9/16	2 1/16	7,44	7,88
2 9/16	2 9/16	8,31	8,31
3 1/8	2 1/16	7,69	8,31
3 1/8	2 9/16	8,25	8,44
3 1/8	3 1/8	9,31	9,31
4 1/16	2 1/16	7,94	9,19
4 1/16	2 9/16	8,50	9,31
4 1/16	3 1/8	8,94	9,56
4 1/16	4 1/16	10,81	10,81
5 1/8	2 1/16	9,06	10,56
5 1/8	2 9/16	9,62	10,69
5 1/8	3 1/8	10,06	10,94
5 1/8	4 1/16	10,93	11,19
5 1/8	5 1/8	12,19	12,19
10 000 psi			
2 1/16	1 13/16	6,67	6,84
2 1/16	2 1/16	6,92	6,92
2 9/16	1 13/16	6,95	7,47
2 9/16	2 1/16	7,20	7,55
2 9/16	2 9/16	7,83	7,83
3 1/16	1 13/16	7,23	8,22
3 1/16	2 1/16	7,48	8,30
3 1/16	2 9/16	8,11	8,58
3 1/16	3 1/16	8,86	8,86
4 1/16	1 13/16	7,81	9,25
4 1/16	2 1/16	8,06	9,33
4 1/16	2 9/16	8,69	9,61
4 1/16	3 1/16	9,44	9,89
4 1/16	4 1/16	10,34	10,34
5 1/8	1 13/16	8,19	10,06
5 1/8	2 1/16	8,44	10,12
5 1/8	2 9/16	9,06	10,42
5 1/8	3 1/16	9,81	10,69
5 1/8	4 1/16	10,72	11,19
5 1/8	5 1/8	11,53	11,53

Nominal size and bore Vertical B_V $^{+0,03}_{0}$	Nominal size and bore Outlet B_O $^{+0,03}_{0}$	Centre-to-face vertical run HH_V ± 0,03	Centre-to-face horizontal run HH_O ± 0,03
15 000 psi			
2 1/16	1 13/16	7,34	7,41
2 1/16	2 1/16	7,62	7,62
2 9/16	1 13/16	7,59	8,03
2 9/16	2 1/16	7,88	8,25
2 9/16	2 9/16	8,50	8,50
3 1/16	1 13/16	7,86	8,69
3 1/16	2 1/16	8,16	8,91
3 1/16	2 9/16	8,78	9,16
3 1/16	3 1/16	9,44	9,44
4 1/16	1 13/16	8,69	10,25
4 1/16	2 1/16	8,97	10,47
4 1/16	2 9/16	9,59	10,72
4 1/16	3 1/16	10,25	11,00
4 1/16	4 1/16	11,69	11,69
5 1/8	1 13/16	9,38	11,44
5 1/8	2 1/16	9,63	11,63
5 1/8	2 9/16	10,25	11,88
5 1/8	3 1/16	10,94	12,18
5 1/8	4 1/16	12,38	12,75
5 1/8	5 1/8	13,50	13,50
20 000 psi			
1 13/16	1 13/16	8,94	8,94
2 1/16	1 13/16	9,25	9,53
2 1/16	2 1/16	9,84	9,84
2 9/16	1 13/16	9,56	10,28
2 9/16	2 1/16	10,16	10,59
2 9/16	2 9/16	10,91	10,91
3 1/16	1 13/16	9,94	10,91
3 1/16	2 1/16	10,53	10,22
3 1/16	2 9/16	11,28	11,53
3 1/16	3 1/16	11,91	11,91
4 1/16	1 13/16	11,12	12,66
4 1/16	2 1/16	11,72	12,66
4 1/16	2 9/16	12,47	13,28
4 1/16	3 1/16	13,09	13,66
4 1/16	4 1/16	14,84	14,84

Table B.76 — 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 (US Customary units)



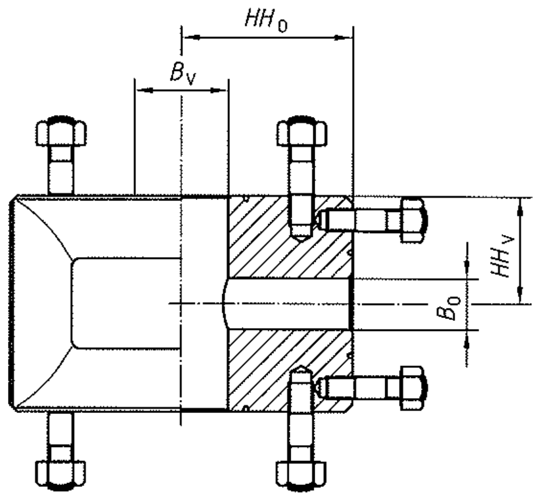


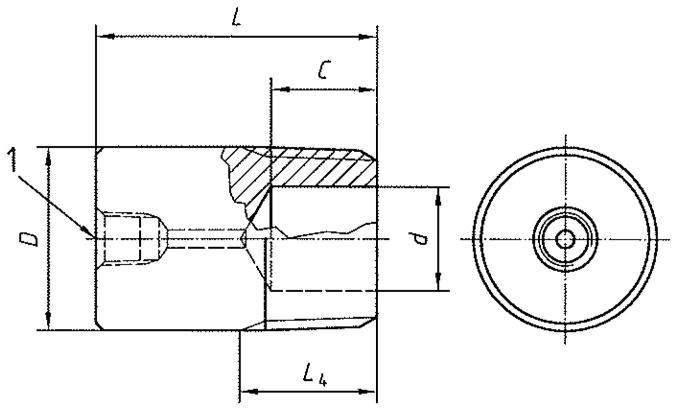
Table B.76 *(continued)*

Dimensions in inches

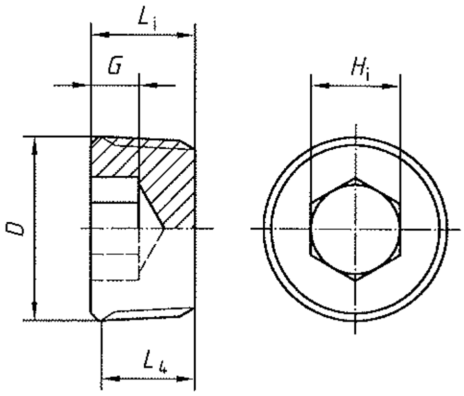
Nominal size and bore Vertical B_V $^{+0,03}_{0}$	Nominal size and bore Outlet B_O $^{+0,03}_{0}$	Centre-to-face vertical run HH_V ± 0,03	Centre-to-face horizontal run HH_O ± 0,03
2 000 psi			
2 1/16	2 1/16	3,50	3,50
2 9/16	2 1/16	3,50	4,00
2 9/16	2 9/16	4,50	4,50
3 1/8	2 1/16	3,50	4,50
3 1/8	2 9/16	4,50	4,50
3 1/8	3 1/8	4,50	4,50
4 1/16	2 1/16	4,50	5,50
4 1/16	2 9/16	4,50	5,50
4 1/16	3 1/8	4,50	5,50
4 1/16	4 1/16	5,50	5,50
3 000 psi			
3 1/8	2 1/16	4,50	5,00
3 1/8	2 9/16	5,00	5,00
3 1/8	3 1/8	5,00	5,00
4 1/16	2 1/16	4,50	6,12
4 1/16	2 9/16	5,00	6,12
4 1/16	3 1/8	5,00	6,12
4 1/16	4 1/16	6,12	6,12
5 000 psi			
2 1/16	2 1/16	4,50	4,50
2 9/16	2 1/16	4,50	5,00
2 9/16	2 9/16	5,00	5,00
3 1/8	2 1/16	4,50	5,50
3 1/8	2 9/16	5,50	5,50
3 1/8	3 1/8	5,50	5,50
4 1/16	2 1/16	4,50	6,50
4 1/16	2 9/16	5,00	6,50
4 1/16	3 1/8	5,50	6,50
4 1/16	4 1/16	6,50	6,50
5 1/8	2 1/16	6,12	7,62
5 1/8	2 9/16	6,12	7,62
5 1/8	3 1/8	6,12	7,62
5 1/8	4 1/16	7,97	7,97
5 1/8	5 1/8	7,97	7,97
10 000 psi			
1 13/16	1 13/16	4,38	4,38
2 1/16	1 13/16	4,38	4,38
2 1/16	2 1/16	4,38	4,38
2 9/16	1 13/16	4,50	5,12
2 9/16	2 1/16	4,50	5,12
2 9/16	2 9/16	5,12	5,12
3 1/16	1 13/16	4,50	5,88
3 1/16	2 1/16	4,50	5,88
3 1/16	2 9/16	5,12	5,88
3 1/16	3 1/16	5,88	5,88
4 1/16	1 13/16	4,50	6,88
4 1/16	2 1/16	4,50	6,88
4 1/16	2 9/16	5,12	6,88
4 1/16	3 1/16	5,88	6,88
4 1/16	4 1/16	6,88	6,88
5 1/8	1 13/16	5,25	7,75
5 1/8	2 1/16	5,25	7,75
5 1/8	2 9/16	5,25	7,75
5 1/8	3 1/16	6,75	7,75
5 1/8	4 1/16	6,75	7,75
5 1/8	5 1/8	7,75	7,75

Nominal size and bore Vertical B_V $^{+0,03}_{0}$	Nominal size and bore Outlet B_O $^{+0,03}_{0}$	Centre-to-face vertical run HH_V ± 0,03	Centre-to-face horizontal run HH_O ± 0,03
15 000 psi			
1 13/16	1 13/16	5,00	5,00
2 1/16	1 13/16	5,00	5,00
2 1/16	2 1/16	5,00	5,00
2 9/16	1 13/16	5,50	5,50
2 9/16	2 1/16	5,50	5,50
2 9/16	2 9/16	5,50	5,50
3 1/16	1 13/16	6,31	6,31
3 1/16	2 1/16	6,31	6,31
3 1/16	2 9/16	6,31	6,31
3 1/16	3 1/16	6,31	6,31
4 1/16	1 13/16	7,62	7,62
4 1/16	2 1/16	7,62	7,62
4 1/16	2 9/16	7,62	7,62
4 1/16	3 1/16	7,62	7,62
4 1/16	4 1/16	7,62	7,62
5 1/8	1 13/16	6,62	8,75
5 1/8	2 1/16	6,62	8,75
5 1/8	2 9/16	6,62	8,75
5 1/8	3 1/16	6,62	8,75
5 1/8	4 1/16	9,25	9,25
5 1/8	5 1/8	9,25	9,25
20 000 psi			
1 13/16	1 13/16	6,47	6,47
2 1/16	1 13/16	6,47	6,47
2 1/16	2 1/16	6,47	6,47
2 9/16	1 13/16	7,28	7,28
2 9/16	2 1/16	7,28	7,28
2 9/16	2 9/16	7,28	7,28
3 1/16	1 13/16	7,97	7,97
3 1/16	2 1/16	7,97	7,97
3 1/16	2 9/16	7,97	7,97
3 1/16	3 1/16	7,97	7,97
4 1/16	1 13/16	9,91	9,91
4 1/16	2 1/16	9,91	9,91
4 1/16	2 9/16	9,91	9,91
4 1/16	3 1/16	9,91	9,91
4 1/16	4 1/16	9,91	9,91

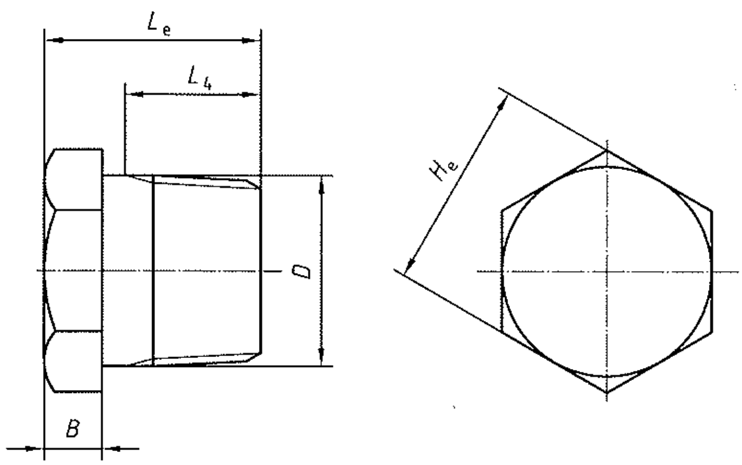
Table B.85 — Bullplugs (see ISO 10422 for thread dimensions and tolerances)
(US Customary units)



a) Round plug



b) Plug with internal hex



c) Plug with external hex

Key

1 test or gauge port (optional)

Table B.85 *(continued)*

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 [a]	Diameter of counter-bore [b]	Overall length [b]	Hex size (across flats)	Height of hex [b]	Length of plug with external hex [b]	Internal hex size	Depth of hex	Length of plug with internal hex [b]
	D	L_4	C	d	L	H_e	B	L_e	H_i	G	L_i
$^1/_2$	0,84 [c]	0,781 5	None	None	2	0,88 [e]	0,31	1,13	0,38 [h]	0,31	1,00
$^3/_4$	1,05 [c]	0,793 5	None	None	2	1,06 [f]	0,38	1,25	0,56 [i]	0,31	1,00
1	1,32 [d]	0,984 5	None	None	2	1,38 [g]	0,38	1,38	0,63 [j]	0,38	1,00
1 $^1/_4$	1,66 [d]	1,008 5	1,06	0,88	2	—	—	—	—	—	—
1 $^1/_2$	1,90 [d]	1,025 2	1,06	1,00	2	—	—	—	—	—	—
2	2,38 [d]	1,058 2	1,06	1,50	4	—	—	—	—	—	—
2 $^1/_2$	2,88 [d]	1,571 2	1,63	1,75	4	—	—	—	—	—	—
3	3,50 [d]	1,633 7	1,63	2,25	4	—	—	—	—	—	—
3 $^1/_2$	4,00 [d]	1,683 7	1,75	2,75	4	—	—	—	—	—	—
4	4,50 [d]	1,733 7	1,75	3,00	4	—	—	—	—	—	—

[a] Tolerance $\pm 0,020$

[b] Tolerance $^{+0,04}_{0}$

[c] Tolerance $^{+0,008}_{0}$

[d] Tolerance $^{+0,010}_{0}$

[e] Tolerance $^{0}_{-0,025}$

[f] Tolerance $^{0}_{-0,031}$

[g] Tolerance $^{0}_{-0,041}$

[h] Tolerance $^{0}_{-0,004}$

[i] Tolerance $^{0}_{-0,005}$

[j] Tolerance $^{0}_{-0,006}$

Annex C
(informative)

Method of calculating stud bolt lengths for type 6B and 6BX flanges

C.1 Calculation

C.1.1 General

The following formulae were used in establishing stud bolt lengths listed in the tables and are included here for 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

$$L_{CSB} = A + n$$

where

L_{CSB} is the calculated stud bolt length (effective thread length, excluding end points)

A is $2\,(T + 0{,}50t + d) + S$ (i.e. stud bolt length exclusive of negative length tolerance, n)

T is the total flange thickness

t 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 50* and 51* for R and RX stand-off values; S equals zero for BX assemblies. See C.4 and Figure C.1

n is the negative tolerance on bolt length: $^1/_{16}$ in for lengths up to 12 in inclusive. $^1/_8$ in for lengths over 12 in to 18 in inclusive. $^1/_4$ in for lengths over 18 in.

C.1.3 Specified stud bolt length

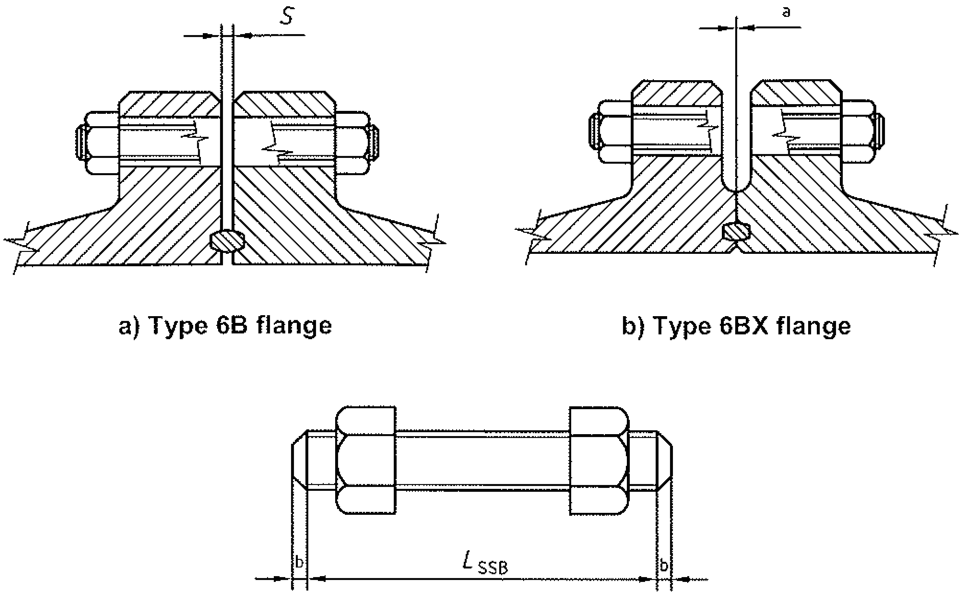
L_{SSB} = Specified stud bolt length (effective thread length, excluding end points), which is L_{CSB} rounded off to the nearest commercially available length.

C.2 Rounding-off procedure

If L_{CSB} is 0,010 in (or more) greater than any $^1/_4$ in increment, round off upward to the next $^1/_4$ in increment; if less than 0,010 in, round off downward to the next $^1/_4$ 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.



a) Type 6B flange

b) Type 6BX flange

c) Stud bolt with nuts

[a] No standoff.

[b] Point height.

Figure C.1 — Flange make-up and stud length

Table C.1 — Point-height of stud bolts

Bolt diameter	**Maximum point height**	
in	mm	in
$^1/_2$ to $^7/_8$	3,2	(0,12)
Over $^7/_8$ to 1 $^1/_8$	4,8	(0,19)
Over 1 $^1/_8$ to 1 $^5/_8$	6,4	(0,25)
Over 1 $^5/_8$ to 1 $^7/_8$	7,9	(0,31)
Over 1 $^7/_8$ to 2 $^1/_4$	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 50* and 51* 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

The torque values shown in the tables of this annex have been shown to be acceptable values for use in type 6B and 6BX flanges in some services. The user should refer to API TR 6AF, TR 6AF1, 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 which assume certain friction coefficients for the friction between the studs and nuts, and between the nuts and the flange face.

Some factors which 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 A 193 Grades B7 and B7M, which are 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

The following equations are used to calculate the values in Tables D.1 and D.2:

$$A_s = \frac{\pi}{4}[D - (0{,}974\ 3 \times P)]^2$$

$$F = \sigma A_s$$

$$T = \frac{F \cdot E(P + \pi f \cdot E \cdot S)}{2(\pi E - P \cdot f \cdot S)} + F \cdot f\left[\frac{H + D + K}{4}\right]$$

where

A_s is the stress area, in square millimetres (square inches)

D is the thread major diameter, in millimetres (inches)

E is the pitch diameter of thread, in millimetres (inches)

F is the force per stud, newtons (pound-force)

f is the friction coefficient

H is the hex size (nut) = 1,5 D + 3,175 mm (0,125 in)

K is the nut internal chamfer = 3,175 mm (0,125 in)

P is the thread pitch = $\dfrac{1}{\text{number of threads per unit length}}$, in millimetres (inches)

S is the secant 30° = 1,154 7

T is the torque

σ is the stress in stud.

Torque obtained using units of millimetres and newtons will be in units of newton millimetres and can be divided by 1 000 to obtain newton metres (N·m). Torque obtained using units of inches and pounds will be 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 $^5/_8$ in) – 13,8 MPa (2 000 psi)

425 mm (16 $^3/_4$ in) – 13,8 MPa (2 000 psi)

540 mm (21 $^1/_4$ in) – 13,8 MPa (2 000 psi)

346 mm (13 $^5/_8$ 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 = 275 MPa			Studs with S_y = 720 MPa bolt stress = 360 MPa			Studs with S_y = 655 MPa bolt stress = 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
(in)	mm	mm	kN	N·m	N·m	kN	N·m	N·m	kN	N·m	N·m
0,500	12,70	1,954	25	36	61	33	48	80	—	—	—
0,625	15,88	2,309	40	70	118	52	92	155	—	—	—
0,750	19,05	2,540	59	122	206	78	160	270	—	—	—
0,875	22,23	2,822	82	193	328	107	253	429	—	—	—
1,000	25,40	3,175	107	288	488	141	376	639	—	—	—
1,125	28,58	3,175	140	413	706	184	540	925	—	—	—
1,250	31,75	3,175	177	569	981	232	745	1 285	—	—	—
1,375	34,93	3,175	219	761	1 320	286	996	1 727	—	—	—
1,500	38,10	3,175	265	991	1 727	346	1 297	2 261	—	—	—
1,625	41,28	3,175	315	1 263	2 211	412	1 653	2 894	—	—	—
1,750	44,45	3,175	369	1 581	2 777	484	2 069	3 636	—	—	—
1,875	47,63	3,175	428	1 947	3 433	561	2 549	4 493	—	—	—
2,000	50,80	3,175	492	2 366	4 183	644	3 097	5 476	—	—	—
2,250	57,15	3,175	631	3 375	5 997	826	4 418	7 851	—	—	—
2,500	63,50	3,175	788	4 635	8 271	1 032	6 068	10 828	—	—	—
2,625	66,68	3,175	—	—	—	—	—	—	1 040	6 394	11 429
2,750	69,85	3,175	—	—	—	—	—	—	1 146	7 354	13 168
3,000	76,20	3,175	—	—	—	—	—	—	1 375	9 555	17 156
3,250	82,55	3,175	—	—	—	—	—	—	1 624	12 154	21 878
3,750	95,25	3,175	—	—	—	—	—	—	2 185	18 685	33 766
3,875	98,43	3,175	—	—	—	—	—	—	2 338	20 620	37 293
4,000	101,6	3,175	—	—	—	—	—	—	2 496	22 683	41 057

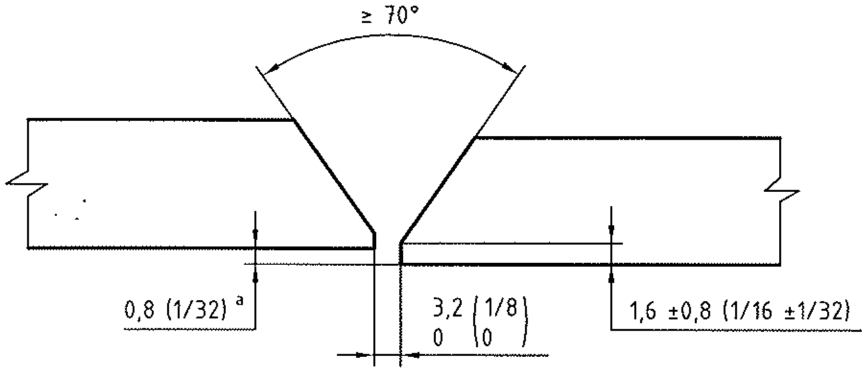
Table D.2 — Recommended torques for flange bolting (US Customary units)

Stud diameter	Threads per in	Studs with S_y = 80 ksi bolt stress = 40 ksi			Studs with S_y = 105 ksi bolt stress = 52,5 ksi			Studs with S_y = 95 ksi bolt stress = 47,5 ksi		
		Tension	Torque	Torque	Tension	Torque	Torque	Tension	Torque	Torque
D	N	F	f = 0,07	f = 0,13	F	f = 0,07	f = 0,13	F	f = 0,07	f = 0,13
in	1/in	lbf	ft·lbf	ft·lbf	lbf	ft·lbf	ft·lbf	lbf	ft·lbf	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

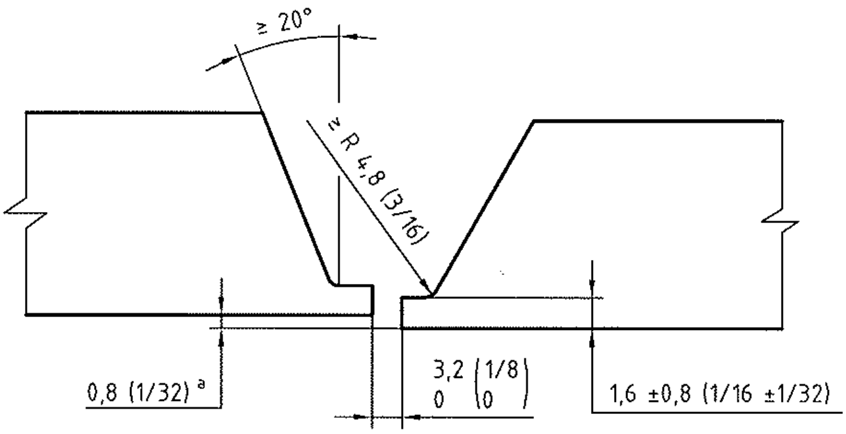
Annex E
(informative)

Recommended weld groove design dimensions

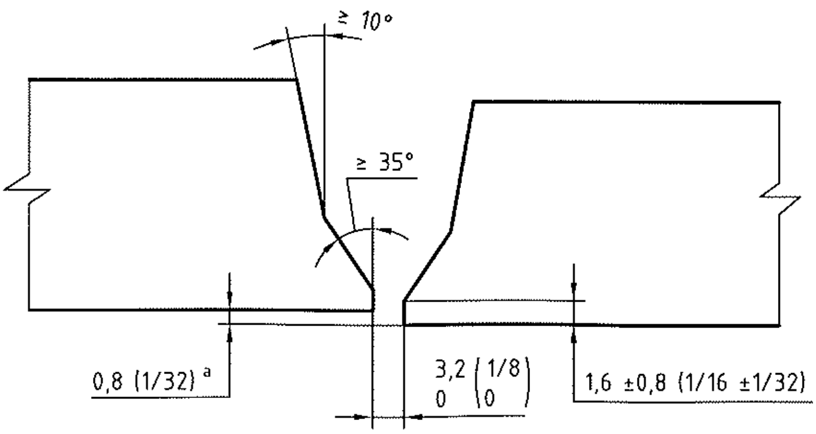
Dimensions in millimetres (inches)



a) V-groove



b) U-groove

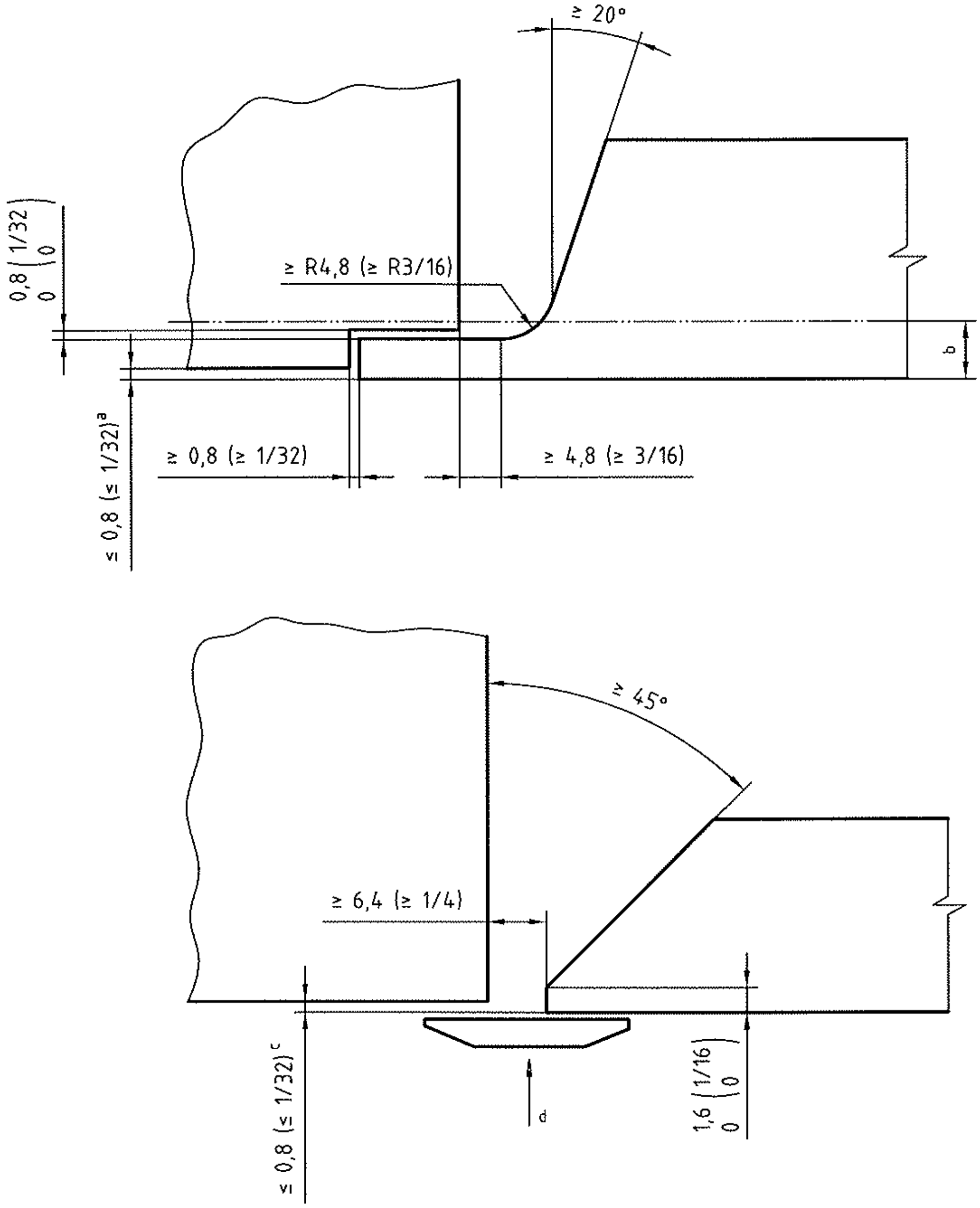


c) Heavy wall V-groove

[a] Maximum misalignment.

Figure E.1 — Pipe butt welds

Dimensions in millimetres (inches)



a Maximum misalignment (unless removed by machining).

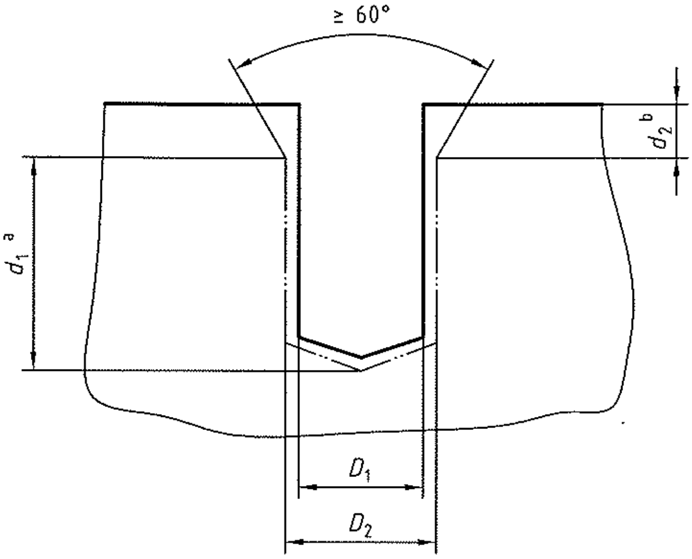
b Remove to sound metal by machining.

c Maximum misalignment.

d Backing to be removed. Material to be compatible with base material.

Figure E.2 — Attachment welds

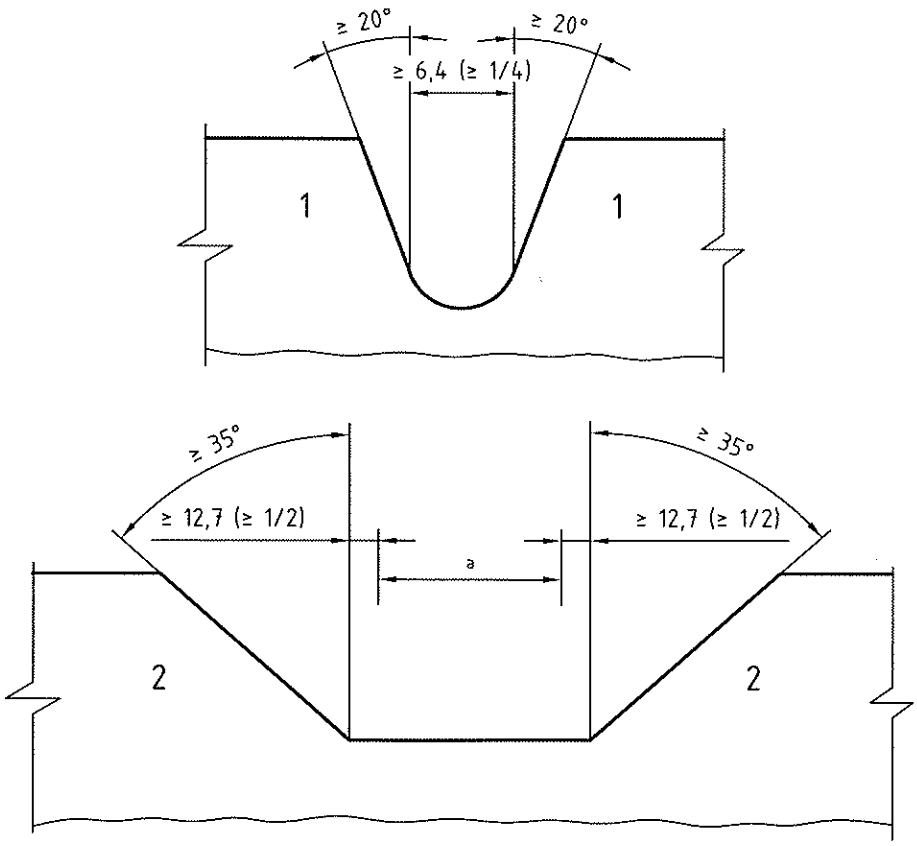
Dimensions in millimetres (inches)



[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

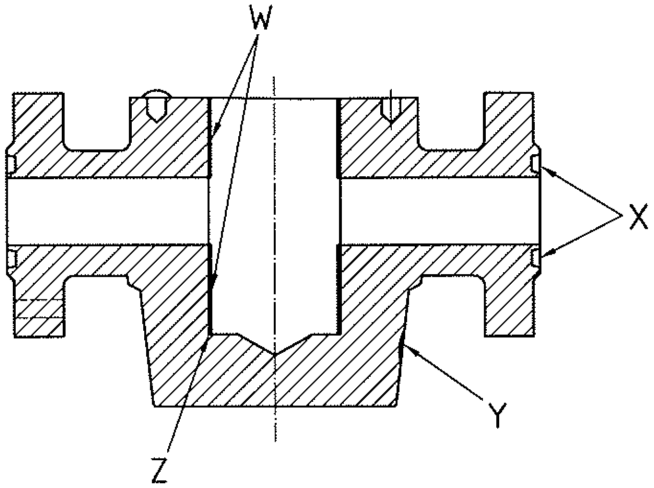
2 End

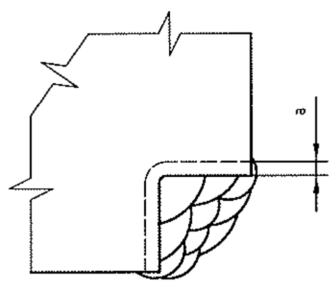
[a] Original area.

b) Excavation for repair (removal of sample discontinuities in weld metal and base metal)

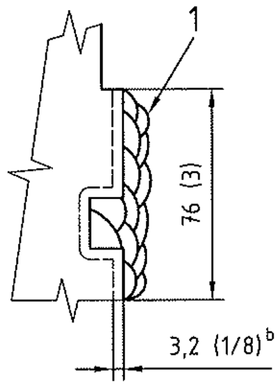
Figure E.3 — Repairs

Dimensions in millimetres (inches)

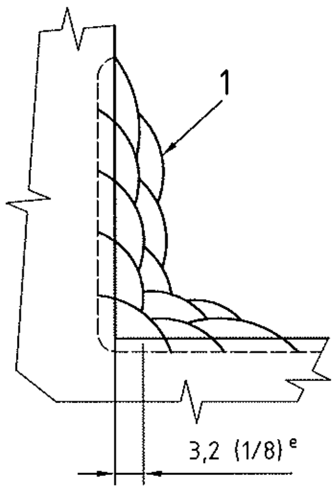




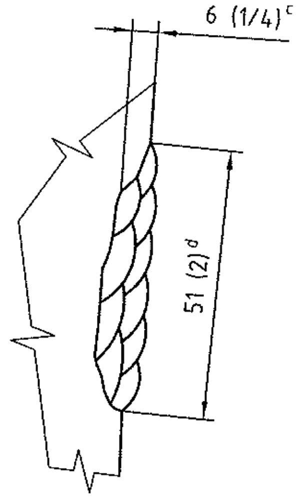
a) Bushing/seat cavity (W)



b) Ring groove (X)



c) Body cavity (Z)



d) Body repair (Y)

Key

1 optional additional layers

a Thickness of weld after machining to approx. 5 ($^3/_{16}$).

b Weld thickness after machining.

c Maximum weld after machining (approx.).

d By 19 ($^3/_4$) width.

e Minimum build-up.

Figure E.4 — Weld repair and overlay, typical weld bead sequences

Annex F
(informative)

Performance verification procedures

F.1 Performance verification — General requirements

F.1.1 Application

F.1.1.1 General

This annex provides performance verification 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). The performance verification procedures in this annex are to be applied to designs of products, including design changes. Verification testing specified in this annex is intended to 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 verification tests

Verification tests that have been completed in accordance with verification testing requirements of API Spec 6A, during its validity, will satisfy the requirements of this annex.

F.1.2 Effect of changes in product

a) Design changes

A design that undergoes a substantive change becomes a new design requiring performance verification. A substantive change is a change identified by the manufacturer which affects the performance of the product in the intended service condition. This may include changes in fit, form, function or material.

NOTE Fit, when defined as the geometric relationship between parts, would include 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, would include the tolerance criteria used during the design of a seal and its mating parts.

b) Metallic materials

A change in metallic materials may not require new performance verification if the suitability of the new material can be substantiated by other means.

c) Non-metallic seals

A change in non-metallic materials may not require new performance verification 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 performance verification in accordance with F.1.13.

F.1.3 Compliance

All products evaluated in performance verification tests shall comply with the applicable design requirements of this International Standard. Test articles shall be hydrostatically tested to PSL1 prior to verification testing.

F.1.4 Products for verification testing

F.1.4.1 General

Performance verification testing, if applicable, shall be performed on prototypes or production models of equipment made in accordance with this International Standard to verify 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

Performance verification testing shall be conducted on full-size products or fixtures that represent the specified dimensions for the relevant components of the end product being verified, unless otherwise specified in this Annex.

F.1.4.3 Product dimensions

The actual dimensions of equipment subjected to verification testing 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 would 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

Verification testing 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 is not met. Products that support tubulars shall be capable of supporting rated load without collapsing the tubulars below the drift diameter.

F.1.6.3 Pressure integrity

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

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^3 per hour, per 25,4 mm of nominal bore size
	Stem seal	60 cm^3 per hour
	Static (bonnet seal, end connections)	20 cm^3 per hour
Valves, check	Through-bore	5 cm^3 per minute, per 25,4 mm of nominal bore size
	Stem seal	60 cm^3 per hour
	Static (bonnet seal, end connections)	20 cm^3 per hour
Chokes	Dynamic (stem seal)	60 cm^3 per hour
	Static (bonnet seal, end connections)	20 cm^3 per hour
Actuators	All actuator fluid retaining seals	60 cm^3 per hour
Hangers	Annular pack-off or bottom casing/tubing pack-off	10 cm^3 per hour, per 25,4 mm of tubing/casing size
Tubing head adapter, other end connections, fluid sampling devices, closures according this International Standard	External closure	20 cm^3 per hour

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 the product and component design does not contain defects to the extent that any performance requirement is not met.

F.1.7 Hydrostatic testing

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

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 verified, 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 verified. 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

a) Location of temperature measurement

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

a) Start of hold periods

Hold periods shall start after pressure and temperature stabilization has occurred and the equipment with 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/hour), 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 per minute (1 °F per minute). 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 (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 1.

a) Start at room temperature with atmospheric pressure and raise temperature to maximum.

b) Apply test pressure, hold for a minimum period of 1 h, then release pressure.

c) Lower temperature to minimum.

d) Apply test pressure, minimum hold period 1 h, then release pressure.

e) Raise temperature to room temperature.

f) Apply test pressure at room temperature and maintain 50 % to 100 % of test pressure while raising temperature to maximum.

g) Hold period 1 h minimum at test pressure.

h) Reduce temperature to minimum while maintaining 50 % to 100 % of test pressure.

i) Minimum hold period 1 h at test pressure.

j) Raise temperature to room temperature while maintaining 50 % to 100 % of test pressure.

k) Release pressure, then raise temperature to maximum.

l) Apply test pressure, minimum hold period 1 h, and then release pressure.

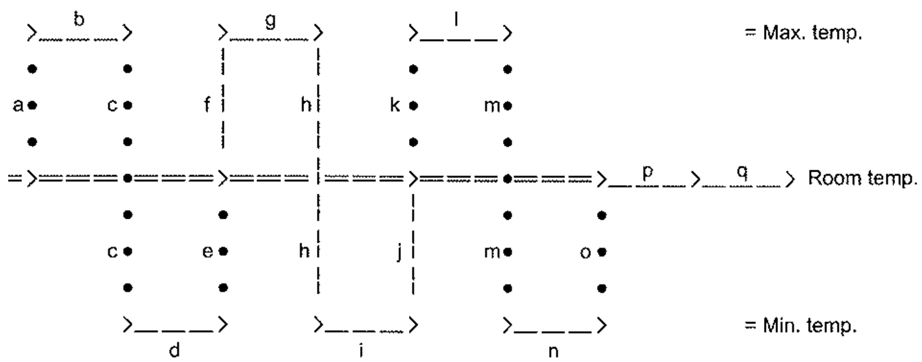
m) Reduce temperature to minimum.

n) Apply test pressure, minimum hold period 1 h, and then release pressure.

o) Raise temperature to room temperature.

p) Apply test pressure, minimum hold period 1 h, and then release pressure.

q) Apply 5 % to 10 % of test pressure, minimum hold period 1 h, and then release pressure.



Key

• • • • Atmospheric pressure

——— Test pressure

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 which are exposed to fluids, either produced from or injected into a well, shall undergo the performance verification procedure described in this subclause.

F.1.13.2 Intent of procedure

The intent of this procedure is to verify 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 verified 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.

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 overpressurized 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	Gas phase
AA/BB	[a]	5 % vol. fraction CO_2/95 % vol. fraction CH_4
CC	[a]	80 % vol. fraction CO_2/20 % vol. fraction CH_4
DD/EE	[a]	10 % vol. fraction H_2S/5 % vol. fraction CO_2/85 % vol. fraction CH_4
FF/HH	[a]	10 % vol. fraction H_2S/80 % vol. fraction CO_2/10 % vol. fraction CH_4
Water shall be added to the liquid phase.		

[a] 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 the maximum specified temperature rating for the temperature classification being tested (F.1.9). Alternatively, the test temperature shall be 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 (F.1.10).

F.1.13.5.3 Fixture testing

Alternatively, 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.

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 overpressurized with the appropriate gas or gas mixture for the materials class being tested.

b) Temperature

The test temperature shall be the maximum specified temperature rating for the temperature classification being tested (F.1.9). Alternatively, the test temperature shall be 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 ± 5 °C (75 ± 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 (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

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 (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^3. No sustained bubbles shall be observed (20 cm^3/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^3. No sustained bubbles shall be observed (20 cm^3/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^3. No sustained bubbles shall be observed (20 cm^3/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 verify the members of a product family in accordance with the requirements and limitations described in this subclause.

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 Verification by pressure rating

The test product may be used to qualify products of the same family having equal or lower pressure ratings.

F.1.14.3.2 Verification by size

Testing of one size of a product family shall verify products one nominal size larger and one nominal size smaller than the tested size. Testing of two sizes also verifies all nominal sizes between the two sizes tested.

a) Determination of choke nominal size

The choke nominal size shall be defined as the size of the maximum orifice which may 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 $^{13}/_{16}$ in and 2 $^{1}/_{16}$ 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 which 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 will be 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 follows:

mm	(in)
46 or 52	1 13/16 or 2 1/16
65	2 9/16
78 or 79	3 1/16 or 3 1/8
103 or 105	4 1/16 or 4 1/8
130	5 1/8
179	7 1/16
228	9
279	11
346	13 5/8
425	16 3/4
476	18 3/4
527 or 540	20 3/4 or 21 1/4
679	26 3/4
762	30

2) Nominal pipe sizes shall be as follows:

mm	(in)
52,4	2 1/16
60,3	2 3/8
73,0	2 7/8
88,9	3 1/2
101,6	4
114,3	4 1/2
127,0	5
139,7	5 1/2
168,3	6 5/8
177,8	7
193,7	7 5/8
219,1	8 5/8
244,5	9 5/8
273,1	10 3/4
298,4	11 3/4
339,7	13 3/8
406,4	16
473,0	18 5/8
508,0	20

f) Determination of actuator nominal size

Sizes shall be determined by the manufacturer.

F.1.14.3.3 Verification by temperature rating

The temperature range verified by the test product shall verify all temperature classifications that fall entirely within that range.

F.1.14.3.4 Verification by standard test fluid rating for non-metallic seals

The standard test fluid rating verified by the test product shall verify all products of the same product family and material properties as the test product. See Table F.3.

Table F.3 — Scaling for non-metallic seals

Material of products tested	Class of products verified
AA/BB	AA, BB
CC	AA, BB, CC
DD/EE	AA, BB, DD, EE
FF/HH	AA through HH

F.1.14.3.5 Verification by PSL

Verification of equipment is independent of the PSL of the production equipment.

F.1.15 Documentation

F.1.15.1 Verification files

The manufacturer shall maintain a file on each verification test.

F.1.15.2 Contents of verification files

Verification 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 were qualified by the verification test 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

This subclause describes the calibration requirements for equipment which is necessary to conduct the verification tests described in this annex. Test equipment which 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 the following subclause, 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, to 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 verification testing, equipment shall be calibrated in accordance with the requirements of the manufacturer and this International Standard.

F.2 Product-specific verification testing

F.2.1 General

F.2.1.1 Verification testing

This subclause contains procedures which are specific and unique to the product being tested. The procedures shall be in addition to the procedures of F.1 unless otherwise specified in this annex. There are two performance verification levels, corresponding to performance requirement levels PR1 and PR2.

F.2.1.2 Acceptance criteria

Unless noted otherwise, acceptance criteria for specific steps in this subclause 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 performance verification as the manually actuated products.

Verification of a manual valve or choke shall verify 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 verification through fixture testing or product testing. These functional differences to be considered shall include, but may not be limited to,:

— 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 verification 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 can be tested separately.

F.2.2 Performance verification testing for PR1 valves (see Table F.4)

F.2.2.1 General

Acceptance criteria, unless noted otherwise for specific steps in this subclause, shall be in accordance with F.1.

F.2.2.2 Verification test procedure

Table F.4 — Performance verification tests 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 shall be measured. This is not applicable to check valves.

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

a) The downstream end of the valve shall be filled with the test medium at 1 % or less of test pressure.

b) Pressure equal to the rated working pressure shall be applied against the upstream side of the gate or plug. All subsequent seat tests shall be in the same direction.

c) The valve shall be fully opened, 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) The valve shall be fully closed while pressure is maintained within the limits of the preceding step.

e) The downstream pressure shall be bled to 1 % or less of test pressure after the valve is fully closed.

f) The above steps shall be repeated until a minimum of three open-and-close cycles have been carried out.

F.2.2.2.2.2 Procedure for check valves

a) Pressure equal to the rated working pressure shall be applied to the downstream side of the valve, while the upstream side is vented to atmosphere. The pressure shall then be relieved to 1 % or less of test pressure, and the valve unseated.

b) The above step shall be repeated 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

Hydrostatic or gas testing, with the testing medium selected in accordance with F.1.7 or F.1.8, shall be performed.

The static body test pressure shall be the rated working pressure of the valve. The body test shall consist of three parts:

a) the primary pressure-holding period of 3 min;

b) the reduction of pressure to zero;

c) the secondary pressure-holding period of 15 min.

F.2.2.2.3.2 Seat static pressure test

Hydrostatic or gas testing, with the testing medium selected in accordance with F.1.7 or F.1.8, shall be performed.

Valves intended for bidirectional installation shall be tested in both directions for the first seat test specified below. Valves intended for single-direction installation shall be marked accordingly, and tested 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 parts:

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 Performance verification testing for PR2 valves (see Table F.4)

F.2.3.1 General

Acceptance criteria, unless noted otherwise for specific steps in this subclause, shall be in accordance with F.1.

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 Verification test procedure

F.2.3.3.1 Force or torque measurement

This shall be carried out 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

This shall be carried out in accordance with F.2.2.2.2.1, except the minimum number of open-and-close cycles shall be 160.

F.2.3.3.2.2 Procedure for check valves

This shall be carried out in accordance with F.2.2.2.2.2, except the minimum number of pressure cycles shall be 160.

F.2.3.3.3 Dynamic test at maximum rated temperature

A dynamic test at maximum rated temperature shall be performed as in F.2.2.2.2, except 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

A gas body test at maximum rated temperature shall be performed as follows.

a) Gate and plug valves shall be in the partially open position during testing. Check valves shall be tested 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 the pressure is not released 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, the valve shall be closed. Rated working pressure shall be maintained on the upstream side of the gate or plug and released on the downstream side. Check valves shall be tested from the downstream side. There shall be one hold period of not less than 1 h duration. Pressure is then released.

F.2.3.3.6 Low-pressure seat test at maximum rated temperature

Valves shall be subjected to a differential pressure of no less than 5 % nor more than 10 % of the rated working pressure. Pressure shall be applied on the upstream side of the gate or plug and released on the downstream side for one hold period of a minimum of 1 h. Check valves shall have the low-pressure seat test pressure applied 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 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

This shall be carried out 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

This shall be carried out 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

This shall be carried out 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). Gate and plug valves shall be partially open.

F.2.3.3.12 Body pressure holding test at room temperature

Perform step F.1.11.3 p), but do not release pressure. Gate and plug valves shall be partially open.

F.2.3.3.13 Gas seat test at room temperature

At the end of the hold period of F.2.3.3.12, the valve shall be closed. Rated working pressure shall be maintained on the upstream side of the gate or plug and released on the downstream side. Check valves shall be tested from the downstream side. There shall be one pressure-holding period of not less than 15 min duration. Pressure is then released.

F.2.3.3.14 Body low-pressure holding test

Perform step F.1.11.3 q). Gate and plug valves shall be partially open.

F.2.3.3.15 Low-pressure seat test at room temperature

Valves shall be subjected to a differential pressure of no less than 5 % nor more than 10 % of the rated working pressure. One hold period of a minimum of 1 h duration shall be applied (in each direction, for bidirectional valves). Check valves shall have the low-pressure seat test pressure applied on the downstream end of the valve, with the opposite end vented to atmosphere.

F.2.3.3.16 Final force or torque measurement

This shall be carried out in accordance with F.2.2.2.1.

F.2.4 Performance verification for PR1 actuators (see Table F.5)

Actuators including electric actuators shall be subjected to a functional test to demonstrate proper assembly and operation. Test medium for pneumatic actuators shall be a gas. Test medium for hydraulic actuators shall be a suitable hydraulic fluid. The tests shall be performed at room temperature.

The following test procedure is in lieu of the pressure/temperature test of F.1.11.

The actuator seals shall be pressure-tested in two steps by applying pressures of 20 % and 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; 3 min at each pressure test for hydraulic actuators. The actuator seal test above shall be repeated a minimum of three times.

Table F.5 — Performance verification tests 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 Performance verification for PR2 actuators (see Table F.5)

Actuators including electric actuators shall be subjected 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. The actuator shall be tested either on a valve/choke or on a fixture which 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 which occur when the valve is opened against differential pressure. If the bonnet assembly is part of the actuator, verification of stem seal and bonnet design shall be performed to verify 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

The actuator seals shall be pressure-tested in two steps by applying pressures at 20 % and 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; 3 min at each test pressure for hydraulic actuators. The actuator seal test above shall be repeated a minimum of three times.

b) Dynamic open/close pressure cycling test at room temperature

The actuator shall be tested 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

The actuator shall be tested for proper operation by cycling the actuator an equivalent of 20 open-close-open valve cycles at 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

The actuator shall be tested 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 Performance verification for PR1 chokes (see Table F.6)

F.2.6.1 General

Verification of an adjustable choke also verifies a positive choke that has the same body design and seat seal design.

F.2.6.2 Static pressure testing at room temperature

F.2.6.2.1 Body static pressure test

Hydrostatic or gas testing, with the test medium selected in accordance with F.1.7 or F.1.8, shall be performed.

The static body test pressure shall be the rated working pressure of the choke. The body test shall consist of three parts:

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

Hydrostatic or gas testing, with the test medium selected in accordance with F.1.7 or F.1.8, shall be performed.

A hydrostatic seat-to-body seal test shall be performed by applying rated working pressure. The seat-to-body seal test shall consist of the following three parts (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 Performance verification for PR2 chokes (see Table F.6)

F.2.7.1 General

Verification of an adjustable choke also verifies 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.

F.2.7.2 Force or torque measurement

The break-away and running torques shall be measured.

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.6 — Performance verification tests 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 [a]	Objective evidence	160 cycles as specified in F.2.7.4
Dynamic open/close cycling pressure test at maximum temperature [a]	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 [a]	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
[a] Does not apply to a positive choke.		

F.2.7.3 Hydrostatic seat-to-body seal test

A hydrostatic seat-to-body seal test shall be performed at room temperature by applying rated working pressure and holding for a minimum of 1 h to verify 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 verify the seat-to-body seal, following steps F.2.7.3, F.2.7.9, F.2.7.10 and F.2.7.11. In this case, step 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. Internal pressure shall be adjusted 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 maximum rated temperature by repeating F.2.7.4 except as follows:

a) 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

A gas body test shall be performed 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

A dynamic test shall be performed at minimum rated temperature by repeating F.2.7.5 except at minimum temperature.

F.2.7.8 Gas body test at minimum rated temperature

A gas body test shall be performed at 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

Steps F.1.11.3 e) through F.1.11.3 o) shall be performed with the seat open.

F.2.7.10 Body pressure holding test at room temperature

Step F.1.11.3 p) shall be performed with the seat open, but do not release pressure.

F.2.7.11 Body low-pressure holding test

Step F.1.11.3 q) shall be performed with the seat open.

F.2.7.12 Second seat-to-body seal test at room temperature

A second hydrostatic seat-to-body seal test shall be performed by applying rated working pressure at room temperature and holding for a minimum of 1 h to verify 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 Performance verification testing for PR1 casing-head housings, casing-head spools, tubing-head spools, cross-over connectors, and adapter and spacer spools (see Table F.7)

F.2.8.1 General

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 any other required performance characteristic is not 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

Performance testing 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.7 — Performance verification 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 Performance verification testing for PR2 casing-head housings, casing-head spools, tubing-head spools, cross-over connectors and adapter and spacer spools (see Table F.7)

F.2.9.1 General

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 any other required performance characteristic is not 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

Performance testing shall be in accordance with F.2.8.2.

F.2.10 Performance verification testing for PR1 Group 1 slip hangers (see Table F.8)

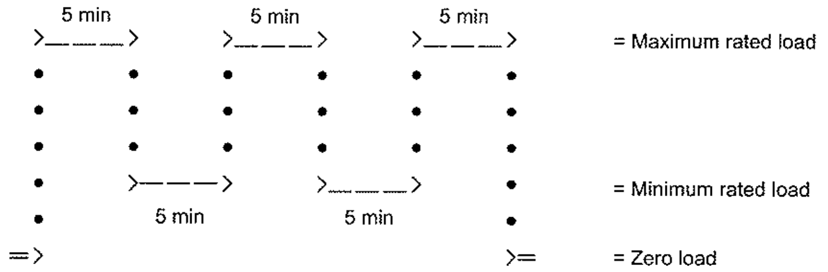
Load cycling capacity shall be verified by objective evidence.

F.2.11 Performance verification testing for PR2 Group 1 slip hangers (see Table F.8)

Table F.8 — Performance verification 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.



Key

• • • • Atmospheric pressure

Figure F.2 — Load cycle testing for hangers

F.2.12 Performance verification testing for PR1 Group 2 slip hangers (see Table F.9)

F.2.12.1 Load cycling

Load cycling capacity shall be verified by objective evidence.

F.2.12.2 Pressure cycle

One pressure cycle shall be performed across the annular seal in one direction at room temperature with a hold period of 15 min.

Table F.9 — Performance verification 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 Performance verification testing for PR2 Group 2 slip hangers (see Table F.9)

F.2.13.1 Load cycling

The load cycle test specified in Figure F.2 shall be performed.

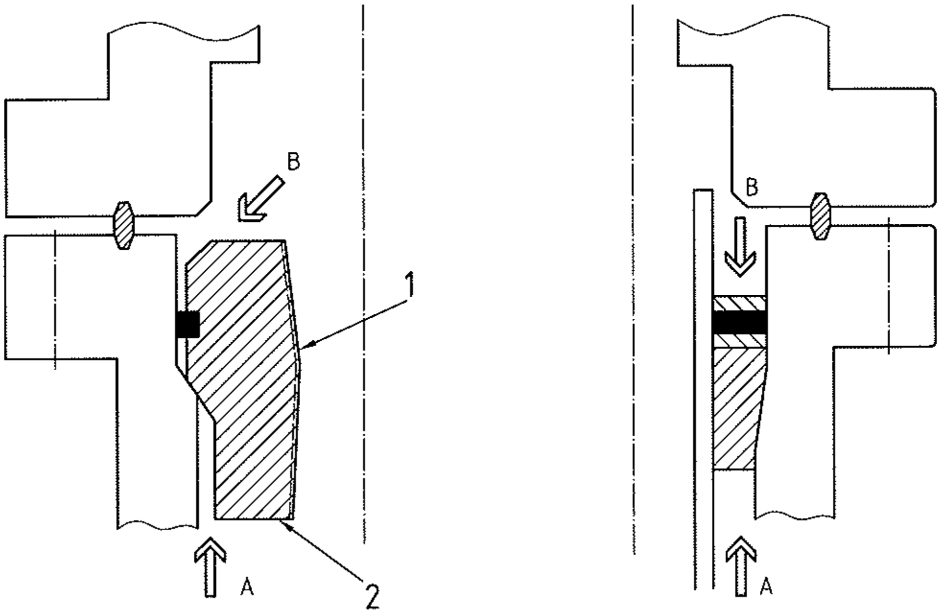
F.2.13.2 Pressure/temperature testing with load

Cycle testing shall be performed in accordance with F.1.11 from either direction A or 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 Performance verification testing for PR1 Group 3 slip hangers (see Table F.10)

Same as for PR1 Group 2 slip hangers, plus test independently but in the same manner 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. The ring joint pressure area as identified in Figure F.4 shall be hydrostatically tested 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, testing shall be performed at the appropriate pressure for each direction.



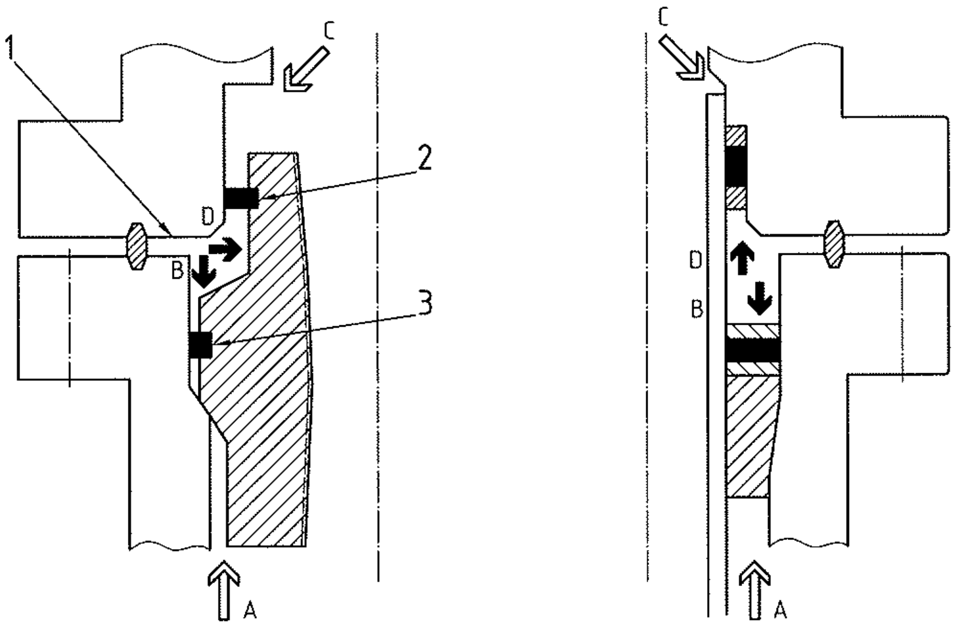
Key

1 wellbore pressure area

2 annular pressure area

A, B Directions of pressure application (see text)

Figure F.3 — Group 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 Performance verification testing for PR2 Group 3 slip hangers (see Table F.10)

Same as for PR2 Group 2 slip type hangers, plus test independently but in the same manner with external pressure across the annular pack-off in the other direction as identified in Figure F.3. The bottom casing pack-off shall also be tested from above in the same manner. The ring joint pressure area as identified in Figure F.4 shall be hydrostatically tested 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, testing shall be performed 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.10 — Performance verification 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 F1.11 and F2.15
Thermal cycle	Objective evidence	As specified in F1.11 and F2.15
Fluid compatibility	Objective evidence	As specified in F1.13
Pressure from below seal(s)	1 cycle at room temperature and rated pressure	As specified in F1.11 and F2.15

F.2.16 Performance verification testing for PR1 Group 4 slip hangers (see Table F.11)

Same as PR1 Group 3 hangers. Retention of the hanger shall be verified by objective evidence.

F.2.17 Performance verification testing for PR2 Group 4 slip hangers (see Table F.11)

Same as PR2 Group 3 hangers, with additional test of retention feature in accordance with Table F.11.

Table F.11 — Performance verification 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 Performance verification testing for PR1 Group 1 mandrel hangers (see Table F.12)

Load cycling and pressure integrity shall be verified by objective evidence.

F.2.19 Performance verification testing for PR2 Group 1 mandrel hangers (see Table F.12)

F.2.19.1 Internal pressure test

One internal pressure test shall be performed 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 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 the threaded connection shall be tested. The test may be performed in a fixture separate from the hanger.

F.2.19.2 Load cycling

The hanger shall be load-tested by applying rated capacity load as shown in Figure F.2. Load testing of the end connections is not required.

Table F.12 — Performance verification 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 Performance verification testing for PR1 Group 2 mandrel hangers (see Table F.13)

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.13 — Performance verification 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 Performance verification testing for PR2 Group 2 mandrel hangers (see Table F.13)

F.2.21.1 Load cycling

The load cycle test specified in F.2.11 shall be performed.

F.2.21.2 Internal pressure test

Hangers shall be internally pressure-tested as specified for PR2 Group 1 mandrel hangers (see F.2.19.1).

F.2.22 Performance verification testing for PR1 Group 3 mandrel hangers (see Table F.14)

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.14 — Performance verification 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

Same as for PR1 Group 2 mandrel type hangers, plus test at room temperature, one cycle for a 5-min minimum hold period, independently but in the same manner with external pressure from the opposite side of annular seal as identified in Figure F.3. For extended neck hangers, Figure F.4, also test in the same manner the bottom casing pack-off at room temperature, one cycle for a 5-min minimum hold period. The ring gasket pressure area shall be hydrostatically tested for extended neck hangers 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 above, testing shall be performed at the appropriate pressure for each direction.

F.2.23 Performance verification testing for PR2 Group 3 mandrel hangers (see Table F.14)

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

Same as for PR2 Group 2 mandrel type hangers, plus test independently but in the same manner with external pressure from the opposite side of the annular seal as identified in Figure F.3. For extended neck hangers, Figure F.4, also test in the same manner the bottom casing pack-off from above. The ring gasket pressure area shall be hydrostatically tested 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.

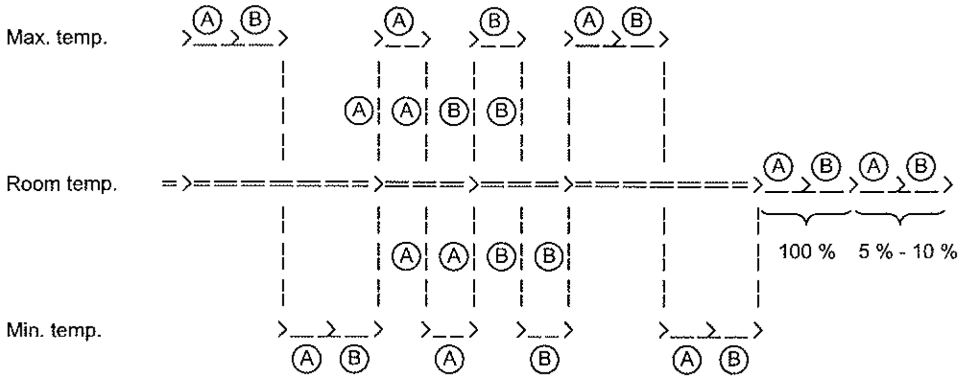


Figure F.5 — Pressure – temperature cycles for Group 3 slip and mandrel hangers, without bottom casing pack-off (pressure directions A and B per Figures F.3 and F.4)

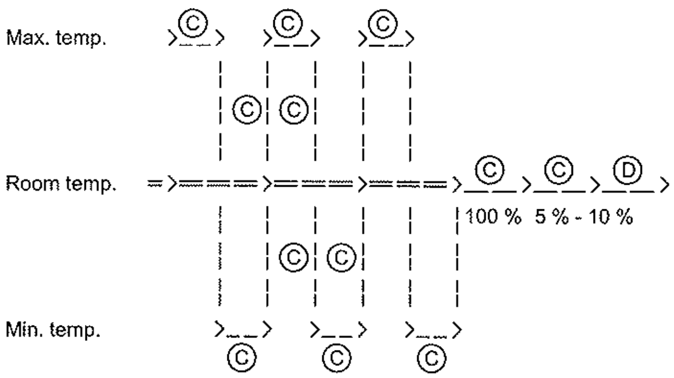


Figure F.6 — Pressure – temperature cycles for Group 3 slip and mandrel hangers, with bottom casing pack-off tested separately (pressure directions C and D per Figure F.4)

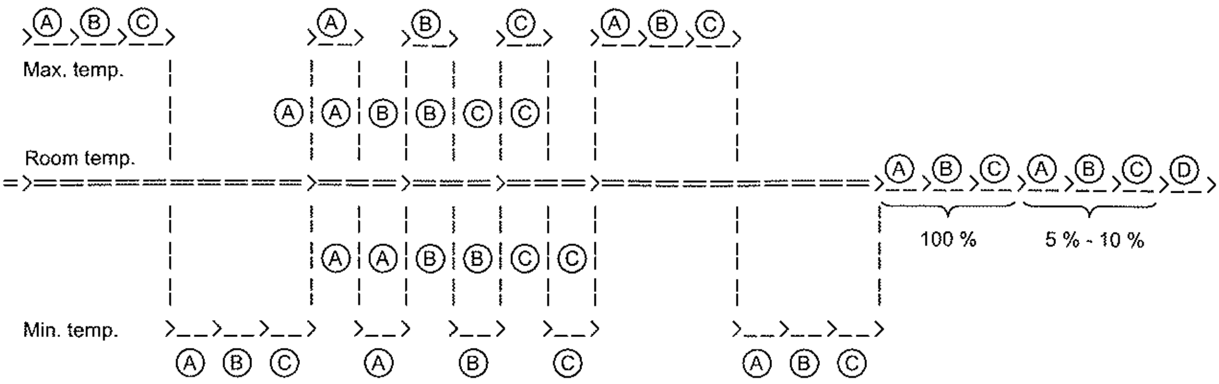


Figure F.7 — Pressure – temperature cycles for Group 3 slip and mandrel hangers, with bottom casing pack-off tested concurrently (pressure directions A, B, C and D per Figure F.4)

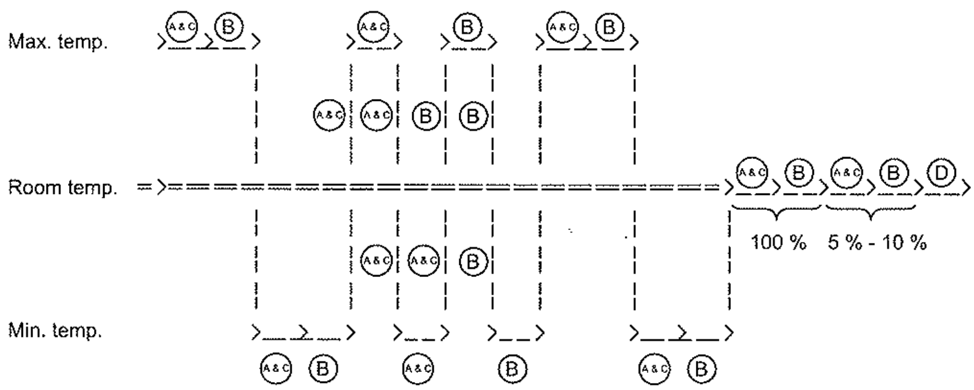


Figure F.8 — Pressure – temperature cycles for Group 3 slip and mandrel hangers, with bottom casing pack-off tested concurrently (pressure directions A, B, C and D per Figure F.4, A and C tested together)

F.2.23.3 Internal pressure test

Hangers shall be internally pressure-tested as specified for PR2 Group 1 mandrel hangers.

F.2.23.4 Load cycling

The load cycle test specified in F.2.11 shall be performed.

F.2.24 Performance verification testing for PR1 Group 4 mandrel hangers (see Table F.15)

Same as PR1 Group 3 hangers. Retention of the hanger shall be verified by objective evidence.

F.2.25 Performance verification testing for PR2 Group 4 mandrel hangers (see Table F.15)

F.2.25.1 Pressure/temperature cycling

Same as PR2 Group 3 hangers. Three pressure/temperature cycles shall be performed as specified in F.1.11 while the hanger is held in place by a retention feature.

F.2.25.2 Internal pressure test

Hangers shall be internally pressure-tested as specified for PR2 Group 1 mandrel hangers.

Table F.15 — Performance verifications 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 Performance verification testing for PR1 Group 5 mandrel hangers (see Table F.16)

Same as PR1 Group 4 hangers except test hanger retention feature with full blind annular pack-off load at room temperature with pressure from below. Back-pressure valve preparation shall be verified by objective evidence.

F.2.27 Performance verification testing for PR2 Group 5 mandrel hangers (see Table F.16)

F.2.27.1 Pressure/temperature cycling

Same as PR2 Group 4 hangers, except 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 3 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

Hangers shall be internally pressure-tested as specified for PR2 Group 1 mandrel hangers.

Table F.16 — Performance verification 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 Performance verification testing for packing mechanisms for PR1 lock screws, alignment pins and retainer screws (see Table F.17)

PR1 products shall be verified by objective evidence.

F.2.29 Performance verification testing for packing mechanisms for PR2 lock screws, alignment pins and retainer screws (see Table F.17)

Apply simulated maximum load shall be applied at the manufacturer's recommended torque and then perform the pressure/temperature cycle test of F.1.11.

Table F.17 — Performance verification 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 Performance verification testing for PR1 Group 1 tubing head adapters (see Table F.18)

Pressure integrity shall be verified by objective evidence.

Table F.18 — Performance verification for Group 1 tubing head adapters

PR Level	PR1	PR2
Internal pressure integrity	Objective evidence	As specified in F.2.31

F.2.31 Performance verification testing for PR2 Group 1 tubing head adapters (see Table F.18)

Performance testing 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 Performance verification testing for PR1 Group 2 tubing head adapters (see Table F.19)

F.2.32.1 Load cycling

Load cycling capacity shall be verified by objective evidence.

F.2.32.2 Internal pressure test

Performance testing shall be in accordance with F.2.31.

Table F.19 — Performance verification 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 Performance verification testing for PR2 Group 2 tubing head adapters (see Table F.19)

F.2.33.1 Load cycling

The load cycle test shall be performed as specified in F.2.11.

F.2.33.2 Internal pressure test

Internal pressure test of the tubing head adaptor shall be performed, including the end connections, as specified in F.2.31.

One internal pressure test at room temperature shall be performed 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 the threaded connection shall be tested. The test may be performed in a fixture separate from the hanger.

F.2.34 Performance verification testing for PR1 other end connectors (see Table F.20)

PR1 connectors shall be verified by objective evidence.

Table F.20 — Performance verification 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 Performance verification testing for PR2 other end connectors (see Table F.20)

F.2.35.1 PR2 verification test

The entire connector shall be tested as specified in F.1.11.

F.2.35.2 Make-and-break cycles

The connector shall be subjected to the manufacturer's rated make-and-break cycles independent of the test in F.2.35.1. Working pressure shall be applied to the connector for a 5-min hold period after each make-up of the connector.

F.2.35.3 Bending moments

The connector shall be subjected 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 Performance verification testing for PR1 fluid sampling devices (see Table F.21)

PR1 fluid sampling devices shall be verified by objective evidence.

Table F.21 — Performance verification 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 Performance verification testing for PR2 fluid sampling devices (see Table F.21)

The complete assembly shall be tested as specified in F.1.11.

F.2.38 Performance verification testing for ring gaskets, bolting and other specified products

Verification 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 verification

Table F.22 provides a summary of the product-specific cycle requirements.

Table F.22 — Summary of product-specific verification

Component	Pressure cycling test[a] (Cycles)		Temperature cycling test[a] (Cycles)		Endurance cycling test[a] (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 [b]	Not required	PMR [b]	Not required	PMR [b]
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 [b]	Not required	PMR [b]	Not required	PMR [b]
Other loose connectors						
Weld neck connectors	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]
Blind connectors	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]
Threaded connectors	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]
Adapter and spacer connectors	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]
Bullplugs and valve-removal plugs	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]
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 [b]	N/A	PMR [b]	N/A	PMR [b]
Running and testing tools	N/A	PMR [b]	N/A	PMR [b]	N/A	PMR [b]

NOTE 1 Performance verification 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.

[a] Pressure cycles, temperature cycles, and endurance cycles are run as specified in the text and are not cumulative.

[b] Per manufacturer's rating.

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 — This annex 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), 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 class 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)
NOTE See Table 2 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

Some flanges specified in this International Standard have been demonstrated to be capable of use at full working pressure at elevated temperatures. In addition, some other end connectors are capable of use 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

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.

For the operating conditions which 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.

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 5. 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 E 21 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 5, 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 5 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.

Yield derating shall be calculated as follows:

$$Y_r = \frac{E_{ty}}{R_{ty}}$$

where

Y_r is the yield reduction ratio at temperature;

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:

$$S_e = Y_r S_y$$

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 need not 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 are taken from API TR 6AF1, Table 2.1.

G.5.2.3.2 ASME Boiler and Pressure Vessel Code

S_e can be found for some materials in ASME, Section II, Part D, Table Y-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
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.		

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 Clause 4.

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 conformance with all requirements of section 4 or section 9 of API Spec 7:1997. 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 according to section 10 of API Spec 7:1997.

Casing or tubing threads shall be in conformance with ISO 10422 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 may 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 68*.

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 as under H.2.3 above.

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 which 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 which 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 only apply to major load-bearing tools such as casing and tubing running tools, cup-type tester and seal assembly setting tools required to transmit torque which is higher than 50 % of the make-up torque of the tool.

H.3.2.2 Heat treatment

Heat treatment shall be performed in conformance 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 $^1/_4$ 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 which 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 ASTM A 370. Impact test temperature shall be no higher than the lowest anticipated service temperature.

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 $^1/_4$ 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 $^1/_4$ T envelope for solid QTCs or within 3 mm ($^1/_8$ in) of 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 will 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

Minimum yield strength MPa (psi)	Minimum tensile strength MPa (psi)	Minimum elongation %	Brinell hardness HBW	Charpy V-notch minimum impact requirement
690 (100 000)	930 (135 000)	13	260 to 321	42 J at – 20 °C (31 ft·lb at – 4 °F)

Lower yield and tensile 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.

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 verify 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 parts:

— 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 4.6 of API Spec 7:1997 below the tooljoint tong space as a minimum. Wear bushings shall be marked "ISO 10423" followed by the drift internal diameter, 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)

Performance verification procedures for surface safety valves and underwater safety valves

I.1 General

I.1.1 Purpose

This annex provides requirements to

a) verify that a valve designed and manufactured to satisfy the PR2 requirements of 10.5 can 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 could be expected to cause an SSV/USV valve failure.

b) demonstrate that the verification testing covered by this annex qualifies specific valve-bore sealing mechanisms which are manufactured in accordance with this International Standard for PR2 class II valves.

I.1.2 Performance requirements

To qualify a SSV/USV for class I service, the valve shall pass the verification test specified in I.3.

To qualify a SSV/USV for class II service, the valve shall pass the verification test specified in I.4.

A valve qualified for class II also satisfies the requirements of class I.

I.1.3 Verification testing

The verification testing requirements in this annex are not represented as duplicating actual well conditions. Verification tests that have been completed in accordance with verification testing requirements of API Spec 14D or API Spec 6AV1, during their validity, will satisfy the requirements of this annex.

I.2 General requirements for a PR2 class I or II for SSV/USV verification test facility

I.2.1 General

The typical piping arrangement and test section detail of a test facility for PR2 class II SSV/USV verification testing are shown in Figures I.1 and I.2.

I.2.2 Design considerations

a) The test facility shall be designed to permit the verification 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^3 and equipped with a low level pump shutdown control.

I.2.3.2 **Sand slurry tank and associated accessories**.

A cylindrical, cone-bottom sand slurry tank with a minimum capacity of 1 m^3 shall be provided, 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 and controls**.

Circulating pumps with drivers and special equipment for pumping the sand slurry and freshwater at the required flowrates and pressures shall be installed. At least one pump shall be provided with a variable-speed motor for circulation flowrate 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**.

The circulation piping shall be installed in an arrangement similar to that shown in Figure I.1. Block valves shall be provided as indicated in Figure I.2. 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.2, 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 flowrate of 0,3 m^3/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 flowrate 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 analog signals.

I.3 PR2 class I SSV/USV valve verification testing

I.3.1 General

To qualify a specific SSV/USV design for PR2 class I, the manufacturer shall test a 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.3.2 Verification test requirements

A flanged nominal 2 $^{1}/_{16}$, 52 mm 34,5 MPa (5 000 psi) rated working pressure SSV/USV valve shall be used for the qualifying test. The valve to be tested shall be hydrostatically and functionally tested in accordance with 7.4.9 and be PR2-verified. 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 which would affect the SSV/USV valve-bore sealing mechanism shall require requalification by verification testing.

I.3.3 Documentation (verification files)

The manufacturer is required to maintain a file on each test, including any retest that may have been 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 of Annex F and shall be retained for 10 years after a design has been discontinued.

I.3.4 Verification test procedure

The following procedures are general and are intended to show the limits and extent of the class I service SSV/USV verification test.

a) Install the SSV/USV in the test section of a fluid circulating system as depicted in Figures I.1 and I.2.

b) Seat-test the SSV/USV for pressure integrity at rated working pressure using freshwater 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 full open position for a 50-h period. At the end of this period, repeat the SSV/USV seat test of I.3.4 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. Differential pressure across the SSV/USV seat shall increase to approximately 2,8 MPa (400 psi) upon each SSV/USV closure. Following 500 cycles of operation, repeat the SSV/USV seat test of I.3.4 b). No leakage shall be allowed after a 3-min stabilization period. During this phase of testing, perform 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.3.5 Test equipment calibration requirement

Test equipment calibration requirements shall satisfy F.1.16.

Pressure-measuring devices shall meet the requirements of 7.2.2.

I.3.6 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.4 PR2 class II SSV/USV verification testing

I.4.1 SSV/USV valve seat leakage test procedure for PR2 class II SSV/USV services

Record results on the form of Table 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 flowrate of 0,30 m^3/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 to 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 (2 000 psi) ± 5 % 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.4.2 Sand slurry flow test procedure for PR2 class II SSV/USV services

Record results using the form in Table I.1.

Step 1: Circulate sand slurry at a minimum flowrate of 0,30 m^3/min (77 US gpm) while bypassing the test section until slurry viscosity and sand content stabilize with slurry agitator on.

Step 2: Determine sand content of slurry according to ISO 10414-1. Adjust sand content of circulating fluid to 2 % (1,5 % to 2,5 % acceptable) by adding 40 US to 60 US mesh sand or diluting mixture with freshwater.

Step 3: Determine viscosity of sand slurry sample with Marsh funnel viscometer according to ISO 10414-1. Adjust viscosity to 100 s (120 s maximum and 90 s minimum) 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 flowrate to a minimum of 0,30 m^3/min. Record flowrate, sand percentage and viscosity.

Step 6: Pump sand slurry through SSV/USV for 25 h ± 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 ± 1 h at a minimum flowrate of 0,30 m^3/min (77 US gpm).

Step 9: Check for leakage with fresh water using the procedure in I.4.1 b).

Step 10: Check for leakage with nitrogen using the procedure in I.4.1 c).

I.4.3 Test for sand slurry flow while valve cycling during circulation for PR2 class II SSV/USV services

Record results using the form in Table I.1.

Step 1: Circulate sand slurry at a minimum flowrate of 0,30 m^3/min (77 US gpm) while bypassing the test section with slurry agitator on.

Step 2: See step 2 of I.4.2.

Step 3: See step 3 of I.4.2.

Step 4: See step 4 of I.4.2.

Step 5: See step 5 of I.4.2.

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) ± 10 % across the SSV/USV valve when closed.

Step 8: Open and close SSV/USV 500 cycles (– 0 + 10 cycles).

Step 9: See step 9 of I.4.2.

Step 10: See step 10 of I.4.2.

Table I.1 — Example of a PR2 class II SSV/USV valve test form

Test report number ______________________

I. Tested SSV/USV valve and SSV/USV actuator verification

	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.

____

____

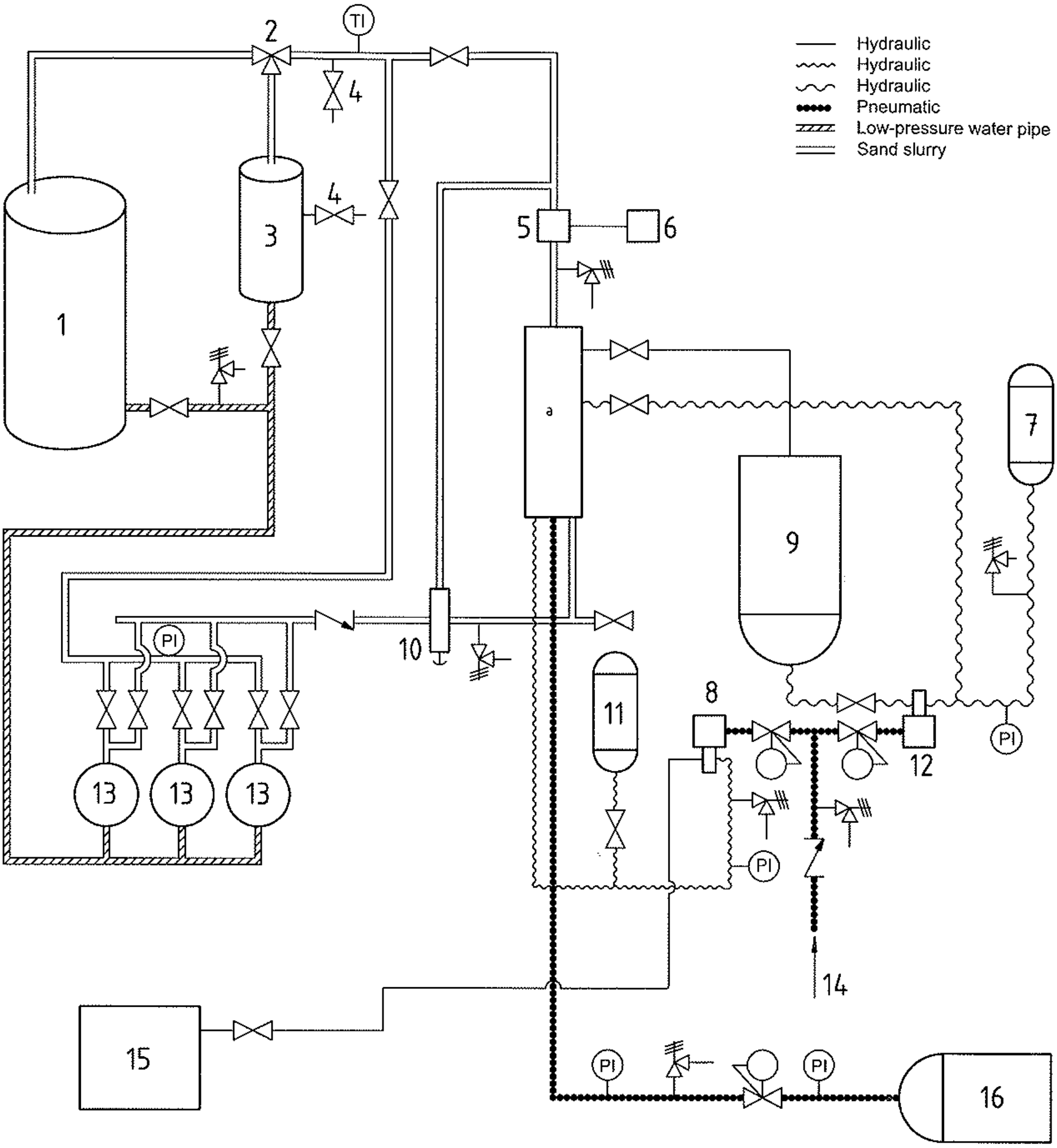
____

____

SSV/USV qualified for PR2 class II sandy services (Yes, No) ________

Date: ________

Tested by ______________________

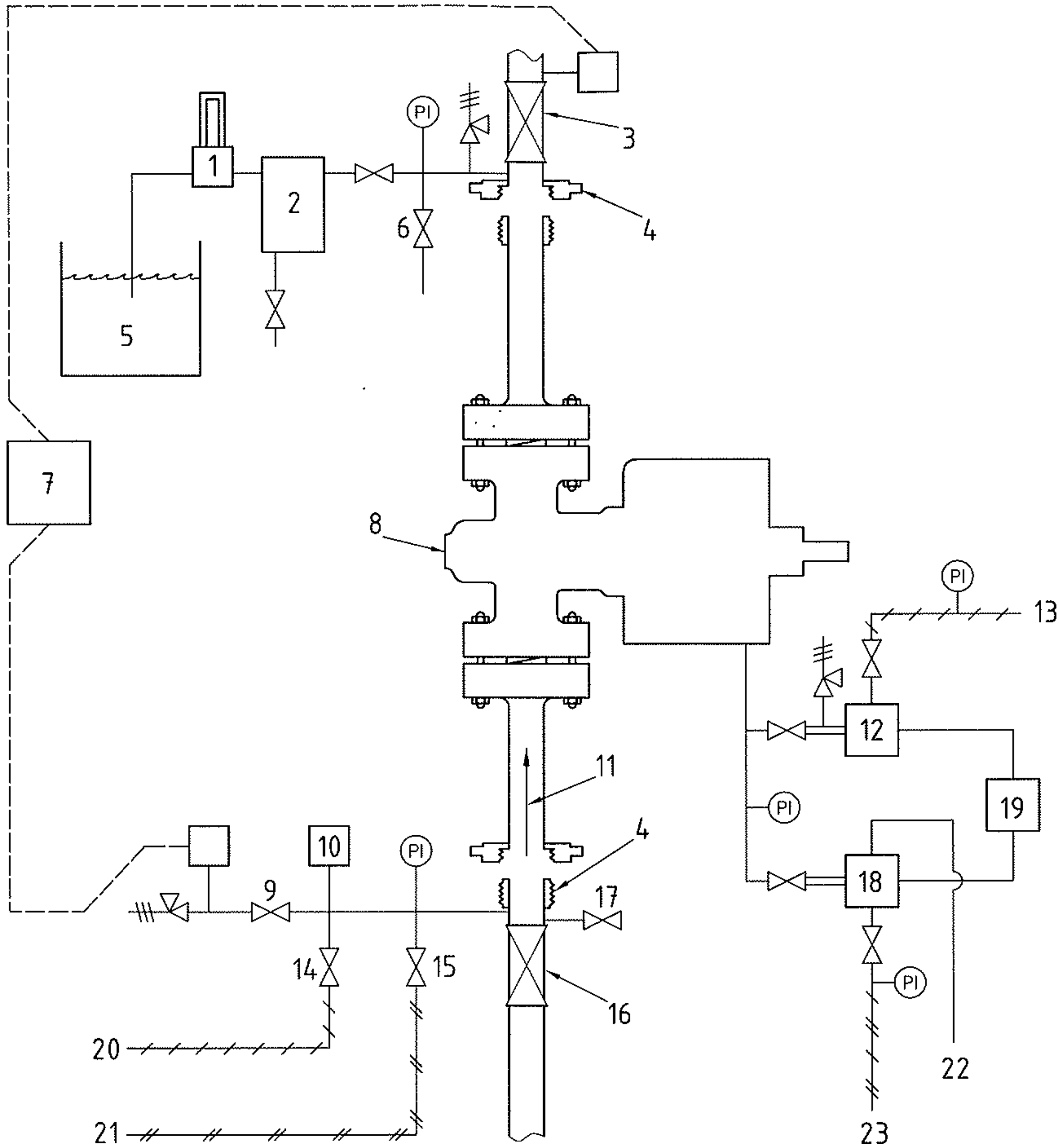


Key

1 water tank
2 two-position three-way diverter valve
3 sand slurry tank
4 sample connections for sand content and viscosity analyses
5 flow meter
6 flow recorder
7 hydraulic pressure accumulator, hydraulic oil supply
8 high-pressure water supply pump
9 hydraulic oil reservoir
10 adjustable back-pressure control
11 hydraulic pressure accumulator, high-pressure water supply
12 hydraulic oil supply pump
13 circulation pumps
14 air supply
15 clean freshwater tank
16 nitrogen supply

[a] See Figure I.2, test section detail.

Figure I.1 — Example of piping arrangement test facility for PR2 class II sandy service SSV/USV verification testing



Key

1 air flow meter
2 leaked nitrogen scrubber
3 downstream isolation valve
4 hammer union
5 water
6 downstream bleed valve
7 differential pressure transducer
8 SSV/USV
9 differential pressure transducer isolation valve
10 upstream pressure transducer
11 flow of test fluid
12 three-way solenoid valve air supply
13 air supply
14 nitrogen pressure manifold valve
15 high-pressure water manifold valve
16 upstream isolation valve
17 upstream bleed valve
18 three-way solenoid valve hydraulic oil supply
19 cyclic timer to control air and hydraulic solenoid valves
20 nitrogen supply
21 high-pressure water supply
22 hydraulic oil return to reservoir
23 hydraulic oil supply

Figure I.2 — Example of SSV/USV verification test section detail

Annex J

Note to users of API Specification 6A:

In this US National Adoption of ISO 10423, Annex J is withdrawn. This includes original pages 349-361. However, page numbers for the remaining annexes are still consistent with those in ISO 10423.

All references in the body of this specification to Annex J are also withdrawn and should be ignored.

As there are no requirements for repair or remanufacture, no API Specification 6A product can be marked as such.

Annex K
(informative)

Recommended specifications for top connectors for christmas trees

K.1 General

This annex 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 yield strength of 517 MPa (75 000 psi) and a maximum hardness of 237 HBW in order to be suitable for H_2S 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 indicated in Figure K.1 (and Figure 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 Table K.1, Table K.2 and Table K.3 and for the flanges to the appropriate tables and requirements of 10.1 or hubs according to ISO 13533.

The maximum bore for top connectors listed in Table K.2 will typically not be large enough to pass a drift as specified in Table 18, and will 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 Table K.5, Table K.6 and Table K.7 and shall conform to SAE AS 568 A.

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. Top connectors shall be shipped with a bleeder plug.

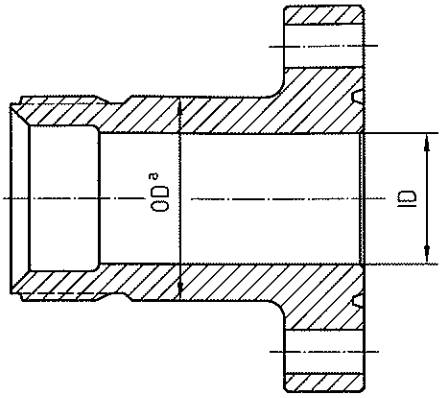
Table K.1 — Standard top connector sizes

Nominal size tree cap		Rated working pressure		Thread size	Seal bore diameter	
(in)	mm	MPa	(psi)	A [a] (in)	mm	(in)
2 9/16	65	103,5	(15 000)	5 3/4 — 4THD Acme-2G	101,60	(4,000)
2 9/16	65	138,0	(20 000)	6 1/4 — 4THD Acme-2G	101,60	(4,000)
3	76	34,5	(5 000)	5 3/4 — 4THD Acme-2G	101,60	(4,000)
3	76	69,0	(10 000)	5 3/4 — 4THD Acme-2G	101,60	(4,000)
3	76	103,5	(15 000)	7 1/2 — 4THD Acme-2G	139,70	(5,500)
4	102	34,5	(5 000)	8 3/8 — 4THD Acme-2G	133,35	(5,250)
4	102	69,0	(10 000)	8 3/8 — 4THD Acme-2G	133,35	(5,250)
4	102	103,5	(15 000)	9 1/2 — 4THD Acme-2G	158,75	(6,250)
5	127	34,5	(5 000)	9 — 4THD Acme-2G	171,45	(6,750)
5	127	69,0	(10 000)	9 — 4THD Acme-2G	171,45	(6,750)
5	127	103,5	(15 000)	12 1/4 — 4THD Acme-2G	177,80	(7,000)
6 3/8	162	34,5	(5 000)	9 1/2 — 4THD Acme-2G	203,20	(8,000)
6 3/8	162	69,0	(10 000)	11 1/2 — 4THD Acme-2G	209,55	(8,250)

NOTE Material to be suitable for material class DD, EE, FF or HH having a minimum yield strength of 517 MPa (75 000 psi).

[a] See Figure K.1 and Figure K.2.

Table K.2 — Top connector body, inside and outside diameter combinations

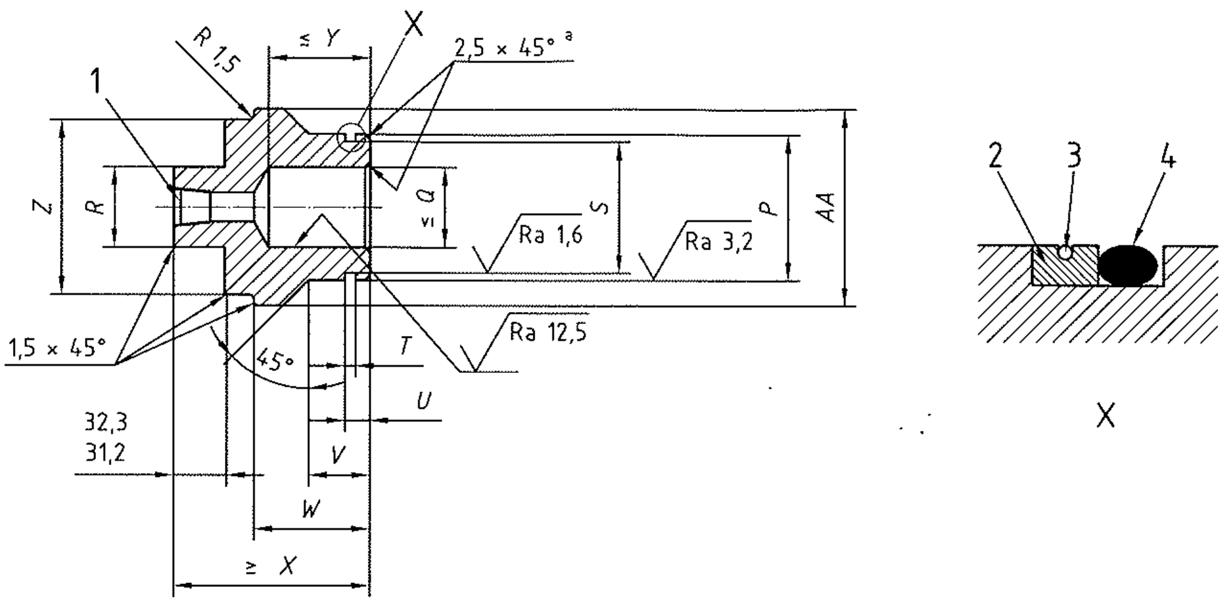


a Boss.

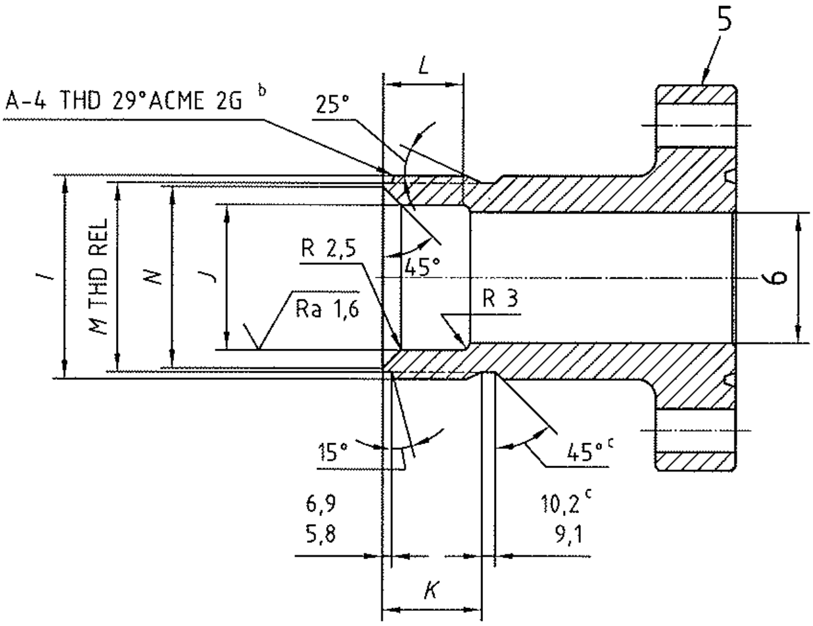
Thread size	Rated working pressure		Maximum bore [b]		Minimum boss outside diameter [a]	
(in)	MPa	(psi)	mm	(in)	mm	(in)
5 $^3/_4$ — 4THD Acme-2G	34,5	(5 000)	51,3	(2,02)	63,2	(2,49)
5 $^3/_4$ — 4THD Acme-2G	34,5	(5 000)	64,0	(2,52)	79,0	(3,11)
5 $^3/_4$ — 4THD Acme-2G	34,5	(5 000)	76,7	(3,02)	94,5	(3,72)
5 $^3/_4$ — 4THD Acme-2G	69,0	(10 000)	51,3	(2,02)	69,9	(2,75)
5 $^3/_4$ — 4THD Acme-2G	69,0	(10 000)	64,0	(2,52)	87,9	(3,46)
5 $^3/_4$ — 4THD Acme-2G	69,0	(10 000)	76,7	(3,02)	104,6	(4,12)
5 $^3/_4$ — 4THD Acme-2G	103,5	(15 000)	51,3	(2,02)	83,3	(3,28)
5 $^3/_4$ — 4THD Acme-2G	103,5	(15 000)	67,0	(2,52)	104,6	(4,12)
5 $^3/_4$ — 4THD Acme-2G	103,5	(15 000)	66,6	(2,62)	109,0	(4,29)
6 $^1/_4$ — 4THD Acme-2G	138,0	(20 000)	66,6	(2,62)	144,5	(5,69)
7 $^1/_2$ — 4THD Acme-2G	103,5	(15 000)	76,7	(3,02)	126,7	(4,99)
8 $^3/_8$ — 4THD Acme-2G	34,5	(5 000)	102,1	(4,02)	125,7	(4,95)
8 $^3/_8$ — 4THD Acme-2G	69,0	(10 000)	102,1	(4,02)	139,2	(5,48)
9 $^1/_2$ — 4THD Acme-2G	103,5	(15 000)	102,1	(4,02)	166,4	(6,55)
9 $^1/_2$ — 4THD Acme-2G	34,5	(5 000)	162,6	(6,4)	200,2	(7,88)
9 — 4THD Acme-2G	34,5	(5 000)	127,5	(5,02)	157,0	(6,18)
9 — 4THD Acme-2G	69,0	(10 000)	127,5	(5,02)	174,0	(6,85)
12 $^1/_4$ — 4THD Acme-2G	103,5	(15 000)	127,5	(5,02)	212,1	(8,35)
11 $^1/_2$ — 4THD Acme-2G	69,0	(10 000)	162,6	(6,4)	221,7	(8,73)

b See Figure K.1 and Figure K.2.

Dimensions in millimetres
Surface roughness in micrometres



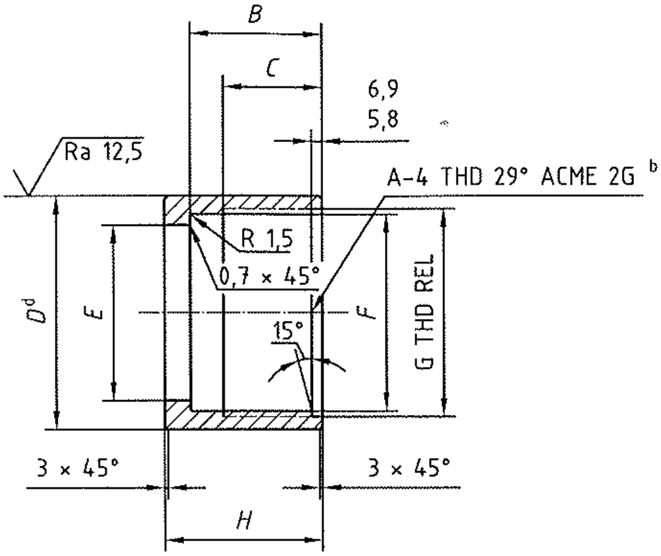
a) Blanking plug



b) Body

Figure K.1 — Top connector for christmas tree (see Figure K.2 for US Customary units)

Dimensions in millimetres
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 10.1

a Use 1,5 × 45° for radial wall thickness less than 10,16 mm.

b Remove feather edge (see Table K.1).

c If applicable.

d Gripping grooves 1,5 ± 0,5 wide × 1,0 ± 0,5 deep × 45° walls. Typically 36 grooves along entire length equally spaced around OD. Visually inspect grooves only.

Figure K.1 — Top connector for christmas tree *(continued)*

Table K.3 — Dimensions for top connectors (see Figure K.1)
(see Table K.4 for US Customary units)

Dimensions in millimetres

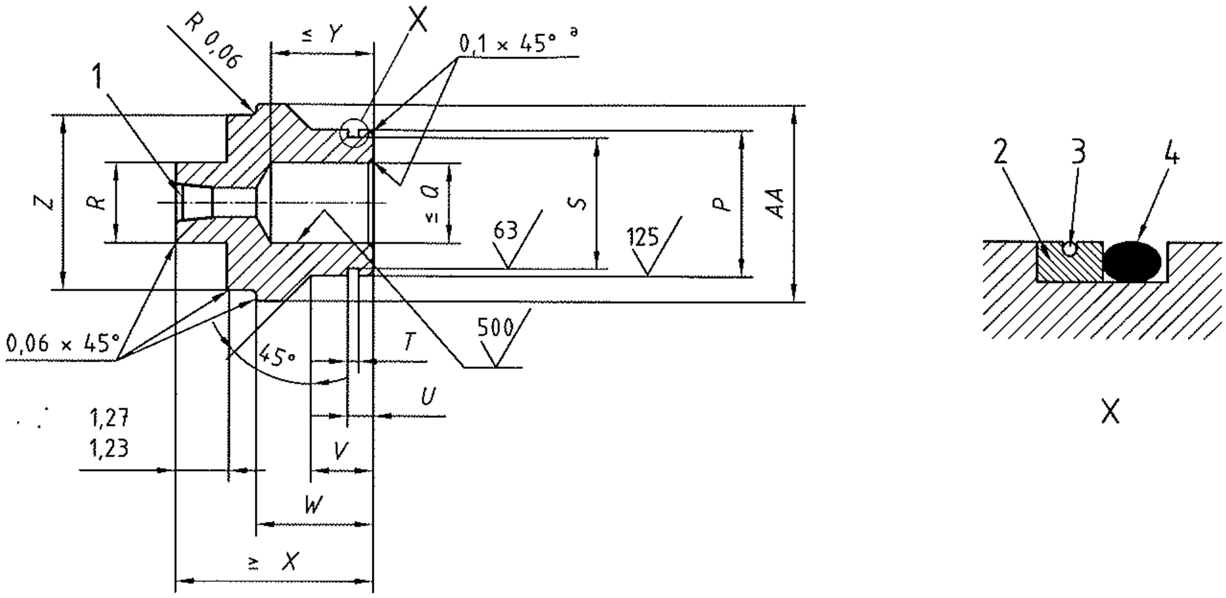
Dimensions	Nominal size $2\,^{9}/_{16}$ / Rated working pressure 103,5 MPa	3 / 34,5	3 / 69,0	$2\,^{9}/_{16}$ / 138,0	3 / 103,5	4 / 34,5	4 / 69,0
B	113,3/114,3			114,3/115,3	113,8/114,3	118,6/119,1	
C	88,9/91,9			91,9/92,5	88,9/89,4	92,2/92,7	
D	166,1/165,1			191,5/190,5	216,9/215,9	242,6/242,1	
E	115,6/116,1			134,6/135,1	155,2/155,7	182,1/182,6	
F	139,70/140,00			152,40/152,70	184,15/184,45	206,38/206,68	
G	147,57/148,08			160,27/160,78	192,02/192,53	214,25/214,76	
H	140,7/139,7			140,7/139,7	140,7/139,7	140,0/138,9	
I	146,05/145,72			158,75/158,42	190,50/190,17	212,73/212,39	
J	101,60/101,75			101,60/101,75	139,70/139,85	133,35/133,50	
K	86,9/85,9			82,8/81,8	91,4/90,4	95,8/94,7	
L	75,7/76,7			91,4/92,5	75,7/76,7	67,6/68,6	
M	137,52/137,01			150,16/149,68	181,81/181,31	203,96/203,45	
N	126,5/127,5			145,5/146,6	164,6/165,6	188,5/189,5	
P	101,50/101,35			101,50/101,35	139,60/139,45	133,25/133,10	
Q	66,5			66,5	91,7	102,1	
R	51,3/50,3			51,3/50,3	51,3/50,3	51,3/50,3	
S	92,35/92,20			92,35/92,20	130,45/130,30	121,46/121,31	
T	6,6/7,6			17,0/18,0	17,5/18,5	9,1/10,2	
U	18,5/19,6			34,5/35,6	34,5/35,6	18,5/19,6	
V	60,5/61,5			60,5/61,5	60,5/61,5	36,1/37,1	
W	106,2/105,2			114,8/113,8	106,2/105,2	97,0/96,0	
X	166,9			174,5	165,4	148,3	
Y	76,2			88,9	76,2	70,4	
Z	114,8/114,3			133,9/133,4	154,4/153,9	178,3/177,8	
AA	139,4/138,9			151,9/151,4	181,9/181,4	204,7/204,2	

Table K.3 (*continued*)

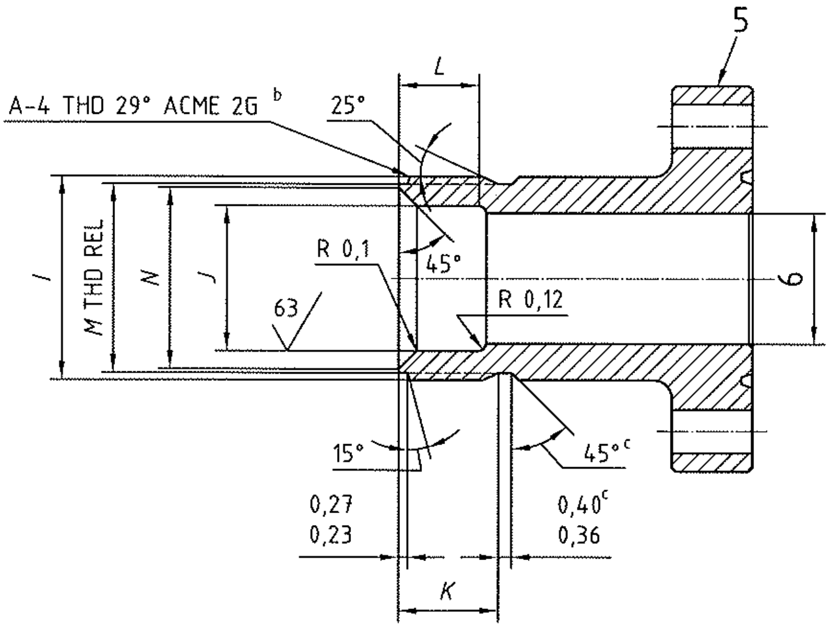
Dimensions in millimetres

Dimensions	Nominal size 4	5	5	5	6 3/8	6 3/8
	Rated working pressure MPa					
	103,5	34,5	69,0	103,5	34,5	69,0
B	116,8/117,3	113,8/114,3		177,8/178,3	113,8/114,3	153,4/153,9
C	101,6/102,1	101,6/102,1		136,7/137,2	101,6/102,1	123,7/125,2
D	277,9/276,9	267,7/266,7		369,3/368,3	267,7/266,7	331,2/330,2
E	209,6/210,1	200,9/201,4		261,4/261,9	217,2/217,7	253,2/253,7
F	234,95/235,25	222,25/222,55		304,80/305,10	234,95/235,25	285,75/286,05
G	242,82/243,33	230,12/230,63		312,67/313,18	242,82/243,33	293,62/294,13
H	140,7/139,7	140,7/139,7		222,8/221,7	140,7/139,7	186,2/185,2
I	241,30/240,97	228,60/228,27		311,15/310,82	241,30/240,97	292,10/291,77
J	158,75/158,90	171,45/171,60		177,80/177,95	203,20/203,35	209,55/209,70
K	82,3/81,3	100,6/99,6		118,6/117,6	102,1/101,1	117,9/116,8
L	88,9/89,9	72,6/73,7		111,3/112,3	68,6/69,6	94,7/95,8
M	234,44/233,93	219,81/219,30		302,11/301,60	232,46/231,95	283,11/282,60
N	218,2/219,2	202,7/203,7		289,1/290,1	228,1/229,1	272,5/273,6
P	158,65/158,50	171,35/171,20		177,70/177,55	203,10/202,95	209,45/209,30
Q	102,1	140,7		130,0	177,8	162,6
R	51,3/50,3	51,3/50,3		51,3/50,3	51,3/50,3	51,3/50,3
S	146,86/146,71	159,56/159,41		165,91/165,76	191,31/191,16	197,66/197,51
T	17,0/18,0	9,1/10,2		19,8/20,8	9,1/10,2	19,8/20,8
U	31,2/32,3	23,1/24,1		40,6/41,7	20,3/21,3	40,6/41,7
V	52,8/53,8	53,3/54,4		51,3/52,3	53,3/54,4	51,3/52,3
W	118,9/117,9	102,1/101,1		159,3/158,2	91,4/90,4	124,5/123,4
X	172,0	157,7		236,0	150,6	189,5
Y	83,8	95,0		114,3	53,3	96,5
Z	206,8/206,2	200,2/199,6		260,6/260,1	216,4/215,9	252,5/252,0
AA	233,4/232,9	220,7/220,2		303,5/303,0	233,9/233,4	284,2/283,7

Dimensions in inches
Surface roughness in micro-inches



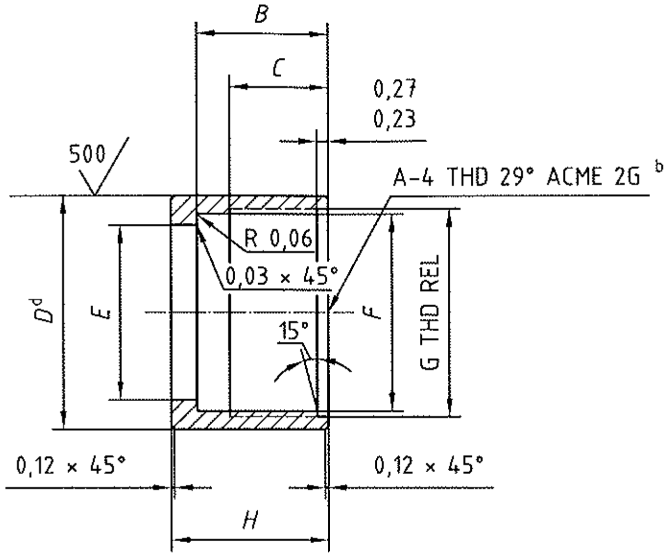
a) Blanking plug



b) Body

Figure K.2 — Top connector for christmas tree (US Customary units)

Dimensions in inches
Surface roughness in micro-inches



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 10.1

[a] Use 0,06 × 45° for radial wall thickness less than 0,40 in.

[b] Remove feather edge (see Table K.1).

[c] If applicable.

[d] Gripping grooves 0,06 ± 0,02 wide × 0,04 ± 0,02 deep × 45° walls. Typically 36 grooves along entire length equally spaced around OD. Visually inspect grooves only.

Figure K.2 — Top connector for christmas tree *(continued)*

Table K.4 — Dimensions for top connectors (see Figure K.2) (US Customary units)

Dimensions in inches

	Nominal size						
	$2\,^{9}/_{16}$	3	3	$2\,^{9}/_{16}$	3	4	4
	Rated working pressure psi						
Dimensions	15 000	5 000	10 000	20 000	15 000	5 000	10 000
B	4,46/4,50			4,50/4,54	4,48/4,50	4,67/4,69	
C	3,50/3,62			3,62/3,64	3,50/3,52	3,63/3,65	
D	6,54/6,50			7,54/7,50	8,54/8,50	9,55/9,53	
E	4,55/4,57			5,30/5,32	6,11/6,13	7,17/7,19	
F	5,500/5,512			6,000/6,012	7,250/7,262	8,125/8,137	
G	5,810/5,830			6,310/6,330	7,560/7,580	8,435/8,455	
H	5,54/5,50			5,54/5,50	5,54/5,50	5,51/5,47	
I	5,750/5,737			6,250/6,237	7,500/7,487	8,375/8,362	
J	4,000/4,006			4,000/4,006	5,500/5,506	5,250/5,256	
K	3,42/3,38			3,26/3,22	3,60/3,56	3,77/3,73	
L	2,98/3,02			3,60/3,64	2,98/3,02	2,66/2,70	
M	5,414/5,394			5,912/5,893	7,158/7,138	8,030/8,010	
N	4,98/5,02			5,73/5,77	6,48/6,52	7,42/7,46	
P	3,996/3,990			3,996/3,990	5,496/5,490	5,246/5,240	
Q	2,62			2,62	3,61	4,02	
R	2,02/1,98			2,02/1,98	2,02/1,98	2,02/1,98	
S	3,636/3,630			3,636/3,630	5,136/5,130	4,782/4,776	
T	0,26/0,30			0,67/0,71	0,69/0,73	0,36/0,40	
U	0,73/0,77			1,36/1,40	1,36/1,40	0,73/0,77	
V	2,38/2,42			2,38/2,42	2,38/2,42	1,42/1,46	
W	4,18/4,14			4,52/4,48	4,18/4,14	3,82/3,78	
X	6,57			6,87	6,51	5,84	
Y	3,00			3,50	3,00	2,77	
Z	4,52/4,50			5,27/5,25	6,08/6,06	7,02/7,00	
AA	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	Nominal size 5 and 5	Nominal size 5	Nominal size $6\ ^3/_8$	Nominal size $6\ ^3/_8$
	Rated working pressure psi				
	15 000	5 000 and 10 000	15 000	5 000	10 000
B	4,60/4,62	4,48/4,50	7,00/7,02	4,48/4,50	6,04/6,06
C	4,00/4,02	4,00/4,02	5,38/5,40	4,00/4,02	4,87/4,93
D	10,94/10,90	10,54/10,50	14,54/14,50	10,54/10,50	13,04/13,00
E	8,25/8,27	7,91/7,93	10,29/10,31	8,55/8,57	9,97/9,99
F	9,250/9,262	8,750/8,762	12,000/12,012	9,250/9,262	11,250/11,262
G	9,560/9,580	9,060/9,080	12,310/12,330	9,56/9,58	11,56/11,58
H	5,54/5,50	5,54/5,50	8,77/8,73	5,54/5,50	7,33/7,29
I	9,500/9,487	9,000/8,987	12,250/12,237	9,500/9,487	11,500/11,487
J	6,250/6,256	6,750/6,756	7,000/7,006	8,000/8,006	8,250/8,256
K	3,24/3,20	3,96/3,92	4,67/4,63	4,02/3,98	4,64/4,60
L	3,50/3,54	2,86/2,90	4,38/4,42	2,70/2,74	3,73/3,77
M	9,230/9,210	8,654/8,634	11,894/11,874	9,152/9,132	11,146/11,126
N	8,59/8,63	7,98/8,02	11,38/11,42	8,98/9,02	10,73/10,77
P	6,246/6,240	6,746/6,740	6,996/6,990	7,996/7,990	8,246/8,240
Q	4,02	5,54	5,12	7,00	6,40
R	2,02/1,98	2,02/1,98	2,02/1,98	2,02/1,98	2,02/1,98
S	5,782/5,776	6,282/6,276	6,532/6,526	7,532/7,526	7,782/7,776
T	0,67/0,71	0,36/0,40	0,78/0,82	0,36/0,40	0,78/0,82
U	1,23/1,27	0,91/0,95	1,60/1,64	0,80/0,84	1,60/1,64
V	2,08/2,12	2,10/2,14	2,02/2,06	2,10/2,14	2,02/2,06
W	4,68/4,64	4,02/3,98	6,27/6,23	3,60/3,56	4,90/4,86
X	6,77	6,21	9,29	5,93	7,46
Y	3,30	3,74	4,50	2,10	3,80
Z	8,14/8,12	7,88/7,86	10,26/10,24	8,52/8,50	9,94/9,92
AA	9,19/9,17	8,69/8,67	11,95/11,93	9,21/9,19	11,19/11,17

Table K.5 — Seals for top connector plugs for H_2S service

Nominal size (in)	Rated working pressure MPa	(psi)	Seals [c]	Back-up ring required [a]
2 $^9/_{16}$	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 $^9/_{16}$	138,0	(20 000)	SAE AS 568-342-90 FKM SAE AS 568-153-80 FKM [b]	Yes
3	103,5	(15 000)	SAE AS 568-354-90 FKM SAE AS 568-159-80 FKM [b]	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 568-436-90 FKM SAE AS 568-161-80 FKM [b]	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 [b]	Yes
6 $^3/_8$	34,5	(5 000)	SAE AS 568-443-90 FKM	—
6 $^3/_8$	69,0	(10 000)	SAE AS 568-444-90 FKM SAE AS 568-168-80 FKM [b]	Yes

NOTE All O-rings specified are suitable for H_2S service.

[a] See Figure K.3 and Table K.6 for back-up ring details and dimensions.

[b] The O-rings marked 80 (durometer) are used on the outside of a back-up ring.

[c] FKM according to ASTM D 1418.

Table K.6 — Back-up ring for O-ring seal (see Figure K.3) (see Table K.7 for US Customary units)

Dimensions in millimetres

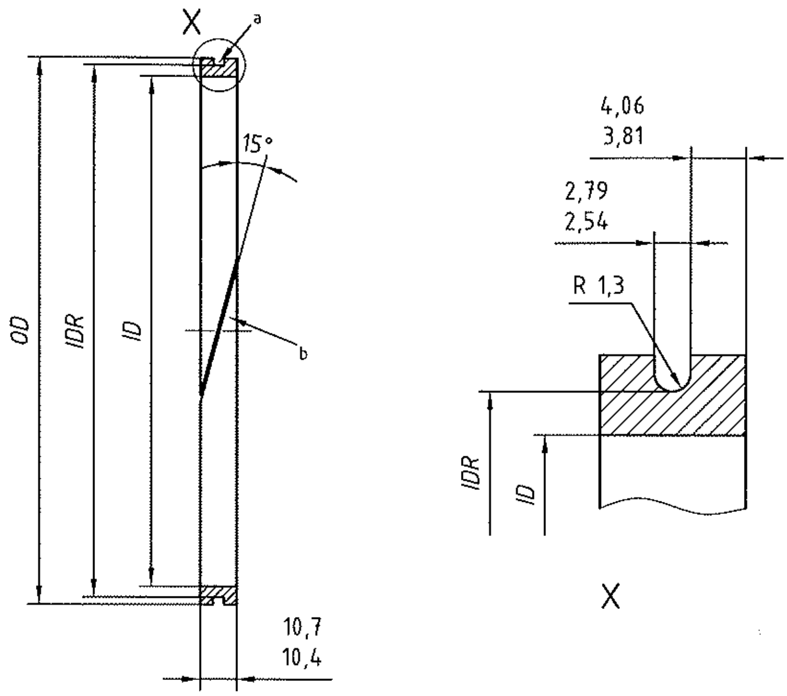
Nominal size		Rated working pressure			
(in)	mm	MPa	*OD*	*IDR*	*ID*
2 $^{9}/_{16}$	65	138,0	102,84 to 102,95	97,79 to 98,04	93,65 to 93,75
3	76	103,5	140,94 to 141,10	135,64 to 136,14	131,80 to 131,95
4	102	103,5	159,94 to 160,10	154,69 to 154,94	148,31 to 148,46
5	127	103,5	178,59 to 178,74	172,97 to 173,23	166,70 to 166,85
6 $^{3}/_{8}$	162	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 (see Figure K.4) (US Customary units)

Dimensions in inches

Nominal size		Rated working pressure			
(in)	mm	psi	*OD*	*IDR*	*ID*
2 $^{9}/_{16}$	65	20 000	4,049 to 4,053	3,85 to 3,86	3,687 to 3,691
3	76	15 000	5,549 to 5,555	5,34 to 5,36	5,189 to 5,195
4	102	15 000	6,297 to 6,303	6,09 to 6,10	5,839 to 5,845
5	127	15 000	7,031 to 7,037	6,81 to 6,82	6,563 to 6,569
6 $^{3}/_{8}$	162	10 000	8,281 to 8,287	8,06 to 8,07	7,813 to 7,819

Dimensions in millimetres



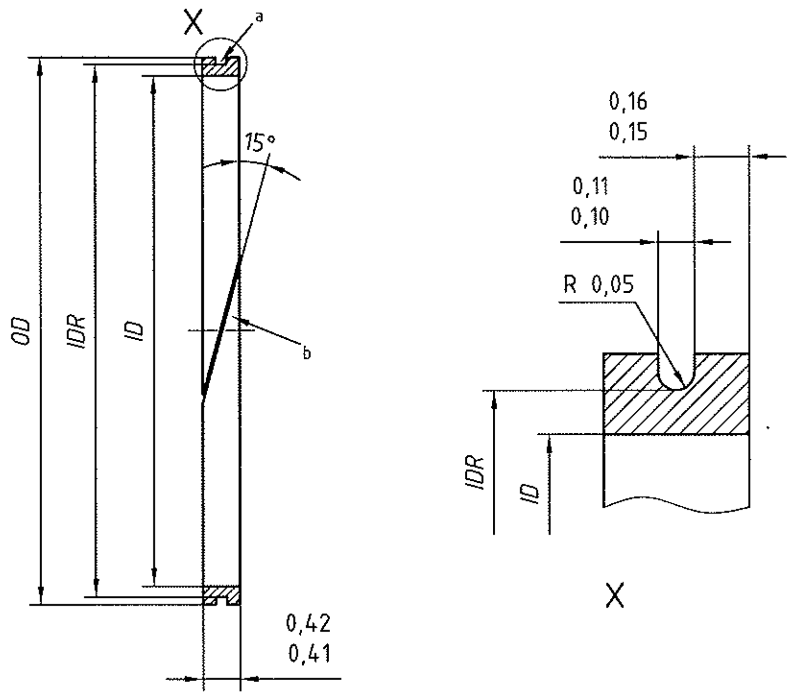
Material: Nylon. Prior to installation soften by boiling in water for 4 h.

[a] For O-ring size, see Table K.5.

[b] Make 1 cut as shown 0,8 mm wide flush cut, steps not allowed.

Figure K.3 — Back-up ring for O-ring seal (see Figure K.4 for US Customary units)

Dimensions in inches



Material: Nylon. Prior to installation soften by boiling in water for 4 h.

[a] For O-ring size, see Table K.5.

[b] Make 1 cut as shown 0,03 in wide flush cut, steps not allowed.

Figure K.4 — Back-up ring for O-ring seal (US Customary 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 diameter (reference 1° 47' 24" with the centreline). Tolerances on angles, unless otherwise noted, shall be ± 0° 30'.

NOTE The sharp-vee thread is specified in API Bul 5A, second edition, October 1944, Table 9. This document is out of print. However the contents of API Bul 5A, Table 9 are still valid for designing gauges for measuring sharp-vee threads.

Table L.1 — Valve-removal preparation dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure (see Figures L.1 and L.2)

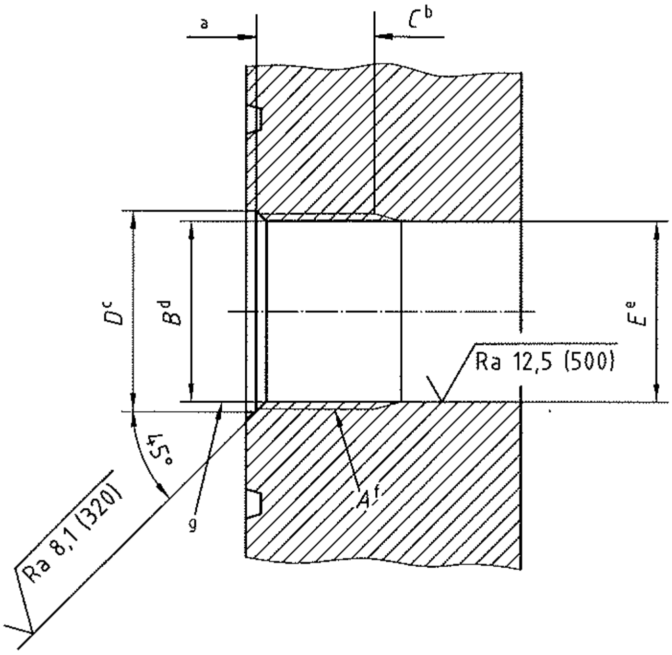
Dimensions in millimetres

Nominal outlet size mm	Maximum working pressure MPa	Nominal thread OD *A* (in)	Threads per inch TPI (ref)	Thread type	Thread bore *B* ± 0,13	Full thread length *C* (ref)	Chamfer and counter-bore diameter *D* ± 0,8	Straight bore *E* ± 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

Dimensions in inches

Nominal outlet size in	Maximum working pressure psi	Nominal thread OD *A* in	Threads per inch TPI (ref)	Thread type	Thread bore *B* ± 0,005	Full thread length *C* (ref)	Chamfer and counter-bore diameter *D* ± 0,03	Straight bore *E* ± 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

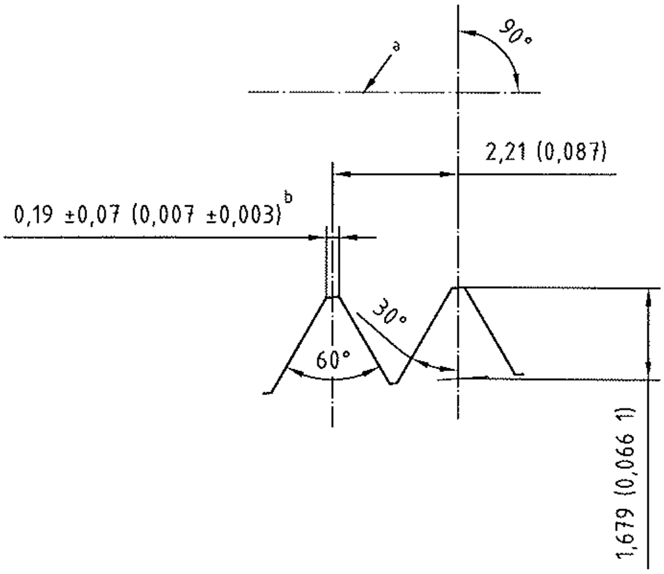
Surface roughness in micrometres (micro-inches)



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)



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

L.3.2 Valve-removal plug dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) working pressure shall be in accordance with Table L.2 and Figures L.3, L.4 and L.5. Included thread taper for all sizes shall be 1 in 16 on diameter (reference 1° 47' 24" with the centreline). Tolerance on angles, unless otherwise noted shall be ± 0° 30'.

NOTE The sharp-vee thread is specified in API Bul 5A, second edition, October 1944, Table 9. This document is out of print. However the contents of API Bul 5A, Table 9 are still valid for designing gauges for measuring sharp-vee threads. The dimensions specified in Table L.2 of this annex are designed to be gauge flush to two threads of the removal plugs.

Table L.2 — Valve-removal plug dimensions for 13,8 MPa (2 000 psi) through 69,0 MPa (10 000 psi) rated working pressure

Metric units — See Figures L.3 and L.5

Dimensions in millimetres

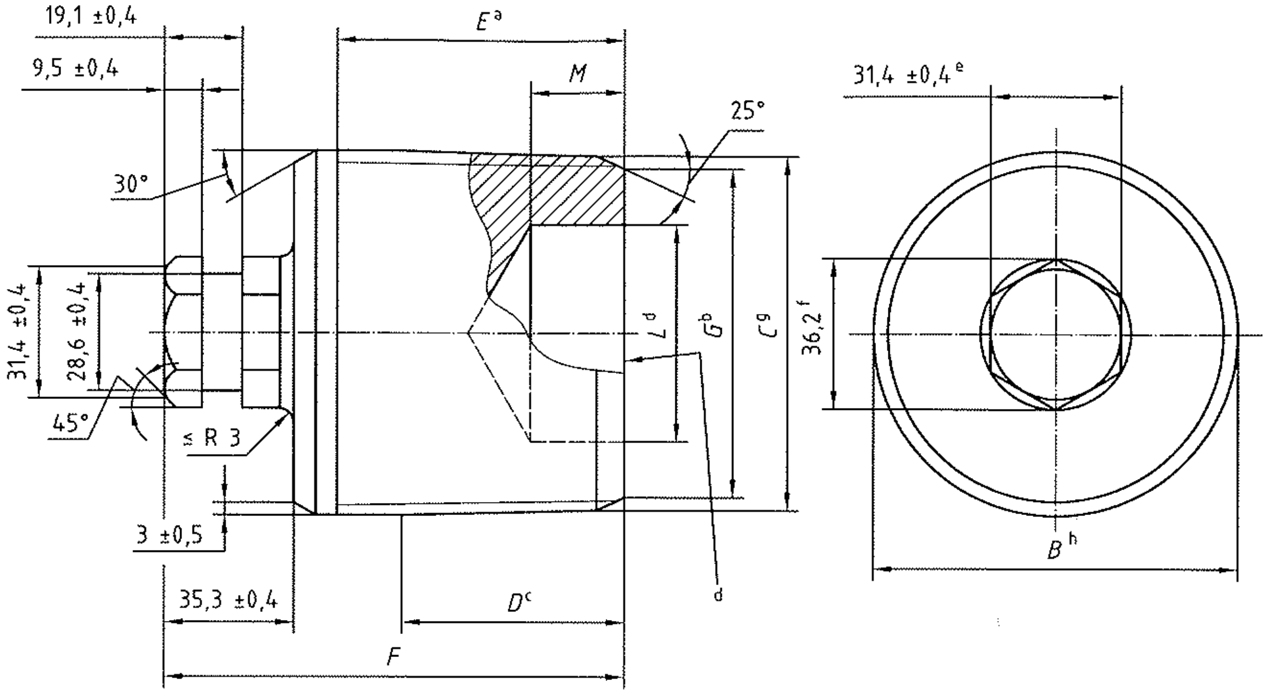
Nominal outlet size	Maximum working pressure	Nominal thread OD	Threads per inch	Thread type	Diameter at large end	Diameter at small end	Length of taper	Length of full thread	Overall length of plug	Chamfer diameter	Counter-bore diameter	Counter-bore depth
		A	TPI		*B*	*C*	*D*	*E*	*F*	*G*	*L*	*M*
mm	MPa	(in)	(ref)		± 0,12	± 0,12	(ref)	(ref)	± 0,8	± 0,4	± 0,4	± 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

US Customary units — See Figures L.4 and L.5

Dimensions in inches

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
		A	TPI		*B*	*C*	*D*	*E*	*F*	*G*	*L*	*M*
in	psi	in	(ref)		± 0,005	± 0,005	(ref)	(ref)	± 0,03	± 0,015	± 0,015	± 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

Dimensions in millimetres



Threads shall gauge flush to two threads deep.

a Total thread.

b Chamfer at end.

c End of taper.

d Drill *L*, *M* deep.

e Across flats.

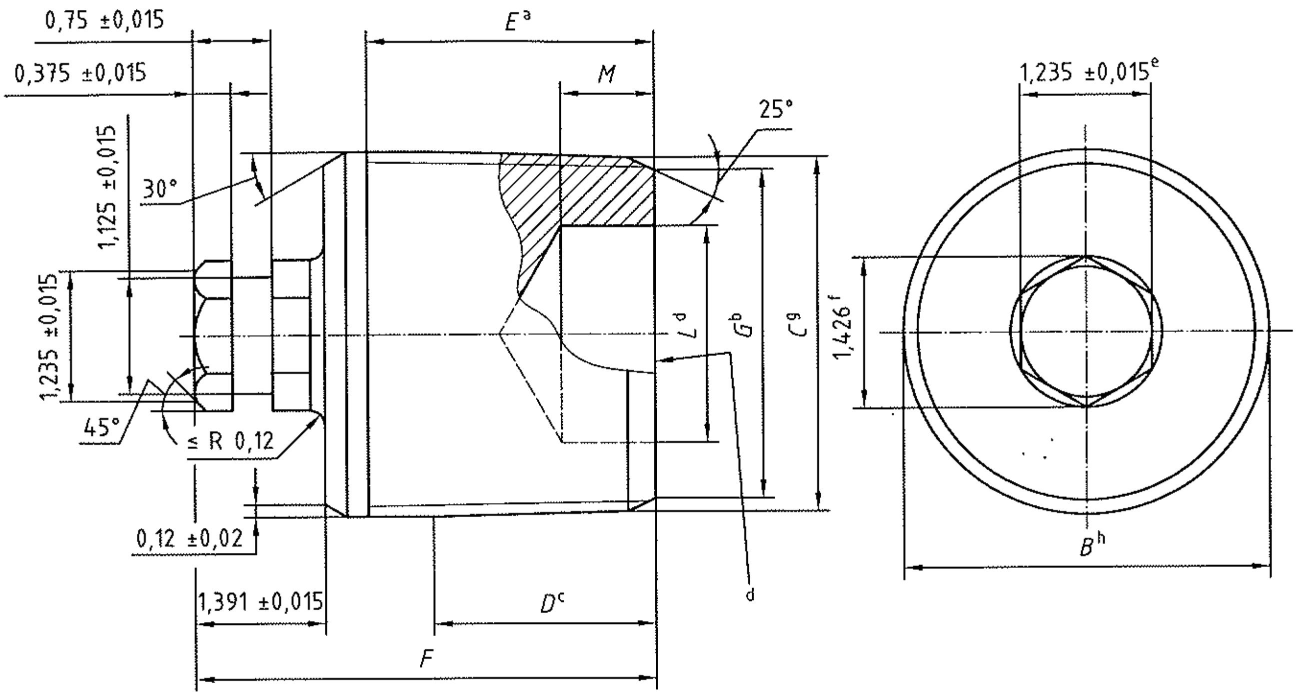
f Across corners.

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 US Customary units)

Dimensions in inches



Threads shall gauge flush to two threads deep.

a Total thread.

b Chamfer at end.

c End of taper.

d Drill *L*, *M* deep.

e Across flats.

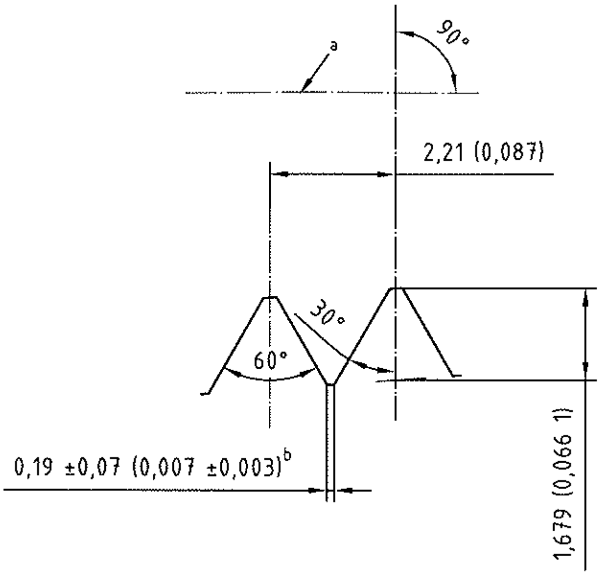
f Across corners.

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
(US Customary units)

Dimensions in millimetres (inches)



a Bore centreline.

b Crest width.

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 ± 0° 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 (see Figure L.6)

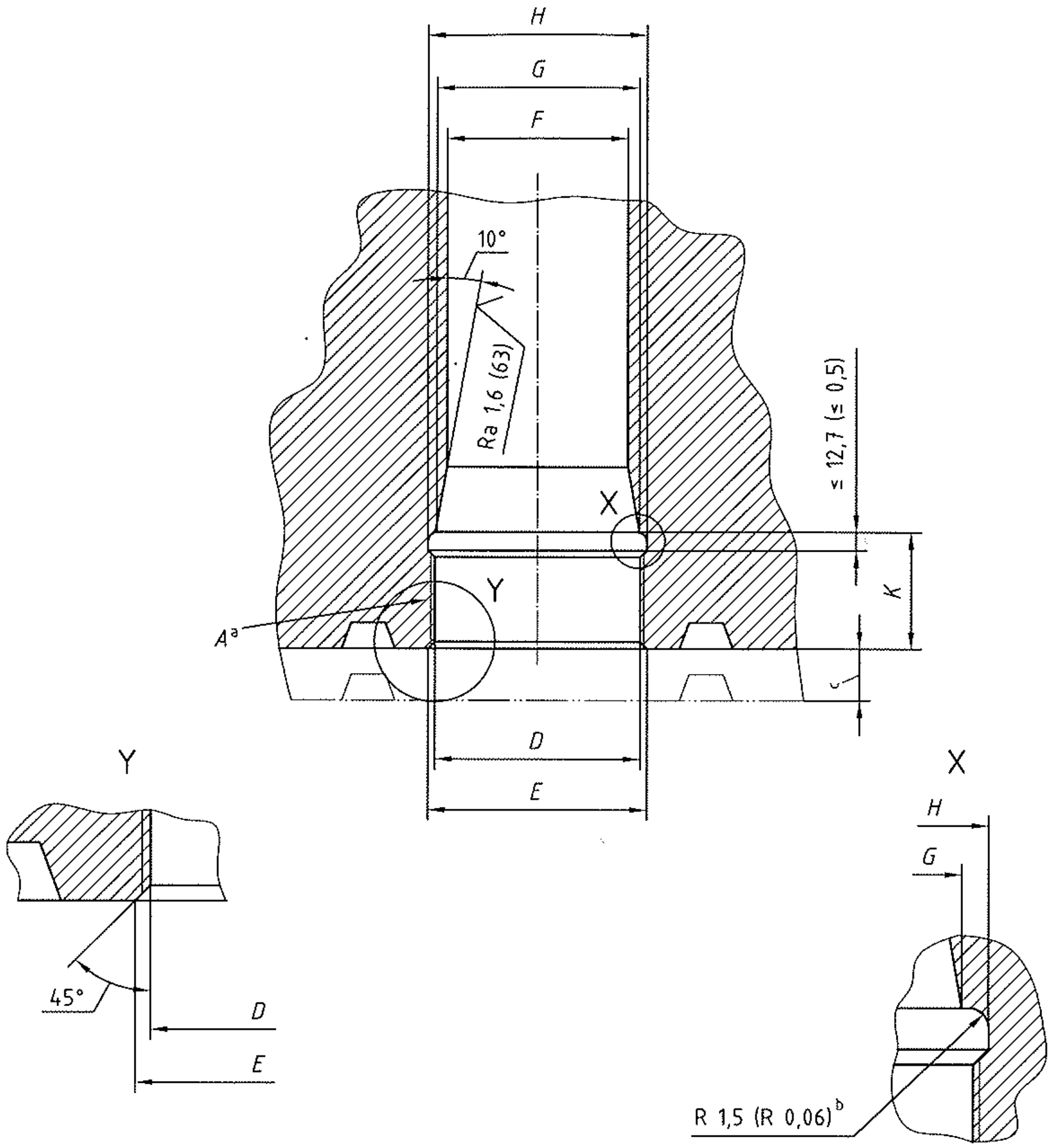
Dimensions in millimetres

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**
		A	TPI	*D*	*E*	*F*	*G*	*H*	*K*
mm	MPa	(in)	(ref)	± 0,10	± 0,4	± 0,13	± 0,05	± 0,4	± 0,4
46	138,0	$1\,^3/_4$	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	$2\,^1/_2$	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

Dimensions in inches

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**
		A	TPI	*D*	*E*	*F*	*G*	*H*	*K*
in	psi	in	(ref)	± 0,004	± 0,015	± 0,005	± 0,005	± 0,015	± 0,015
$1\,^{13}/_{16}$	20 000	$1\,^3/_4$	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	$2\,^1/_2$	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

Dimensions in millimetres (inches)
Surface roughness in micrometres (micro-inches)



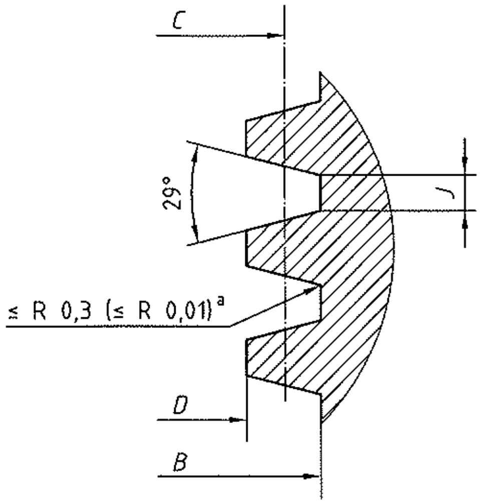
[a] Thread.

[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

Dimensions in millimetres (inches)



Key

B Major diameter

C Pitch diameter

D Minor diameter

J Reference

[a] 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

L.3.4 Valve-removal plug dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) working pressure shall be in accordance with Table L.5 and Figures L.8 and L.9. Valve-removal plug thread form dimensions shall be in accordance with Table L.6 and Figure L.10. Tolerance on angles, unless otherwise noted, shall be ± 0° 30'. All diameters to be concentric within 0,13 mm (0,005 in) total indicator reading.

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

Metric units — See Figure L.7

Dimensions in millimetres

(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**
		A	TPI	*B*	*C*	*D*	*J*
mm	MPa	(in)	(ref)	± 0,25	± 0,25	± 0,10	(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

US Customary units — See Figure L.7

Dimensions in inches

(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**
		A	TPI	*B*	*C*	*D*	*J*
in	psi	in	(ref)	± 0,010	± 0,010	± 0,004	(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

Table L.5 — Valve-removal plug dimensions for 103,5 MPa (15 000 psi) through 138,0 MPa (20 000 psi) rated working pressure

Metric units — See Figure L.8

Dimensions in millimetres

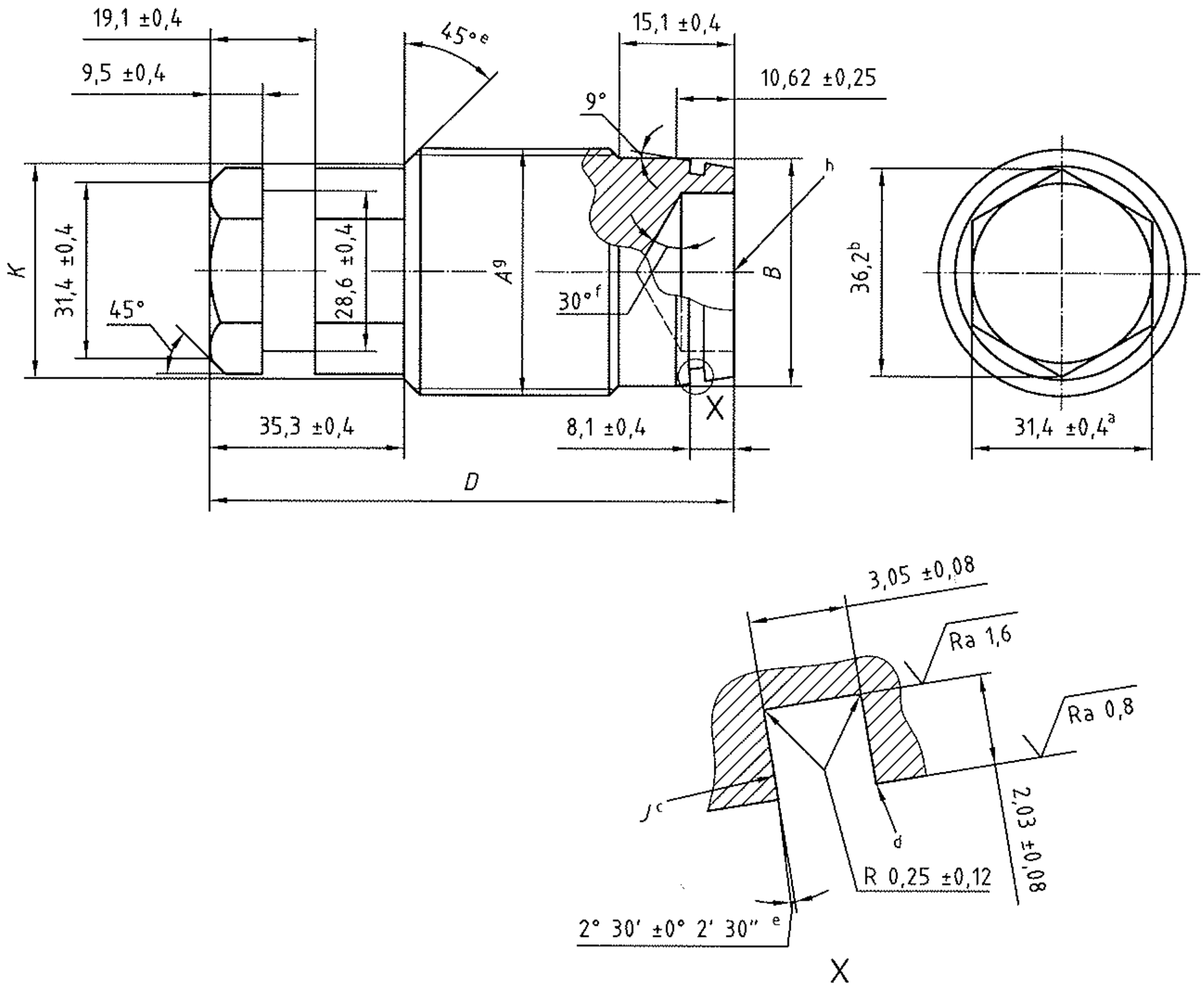
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominal outlet size	**Maximum working pressure**	**Nominal thread size**	**Threads per inch**	**Large taper diameter**	**Overall length**	**SAE AS-568 O-ring size No.**	**Chamfer diameter**	**Counter-bore diameter**	**Counter-bore depth**
		A	TPI	*B*	*D*	*J*	*K*	*L*	*M*
mm	MPa	(in)	(ref)	± 0,25	± 0,8		± 0,8	± 0,4	± 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

US Customary units — See Figure L.9

Dimensions in inches

(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-568 O-ring size No.**	**Chamfer diameter**	**Counter-bore diameter**	**Counter-bore depth**
		A	TPI	*B*	*D*	*J*	*K*	*L*	*M*
in	psi	in	(ref)	± 0,010	± 0,03		± 0,03	± 0,015	± 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

Dimensions in millimetres
Surface roughness in micrometres



a Across flats.

b Across corners.

c Install (SAE AS 568A O-ring size number).

d Break corners approx. *R* 0,12.

e Typical.

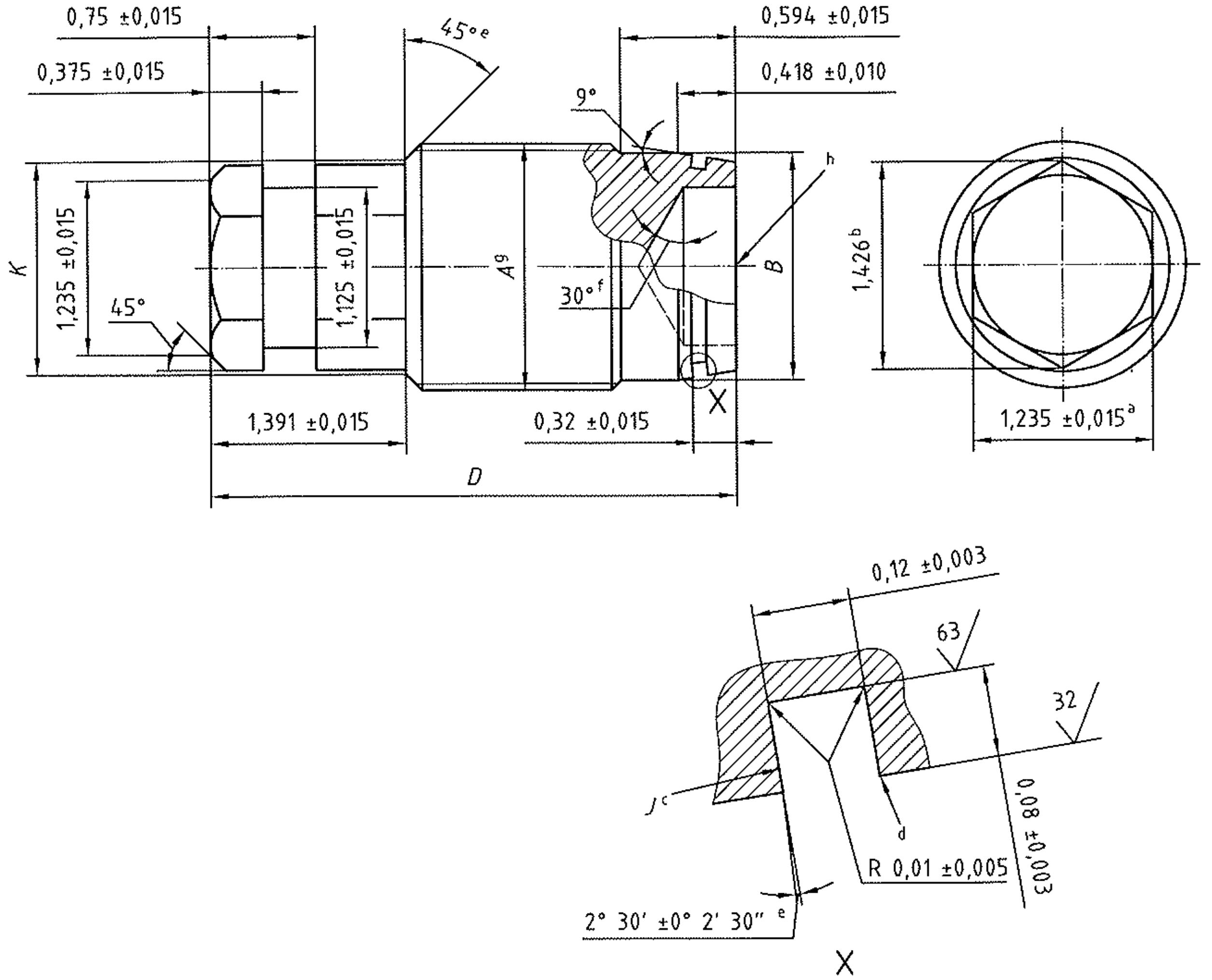
f Optional.

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 US Customary units)

Dimensions in inches
Surface roughness in micro-inches



a Across flats.

b Across corners.

c Install (SAE AS 568A O-ring size number).

d Break corners approx. R 0,005.

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
(US Customary 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 (see Figure L.10)

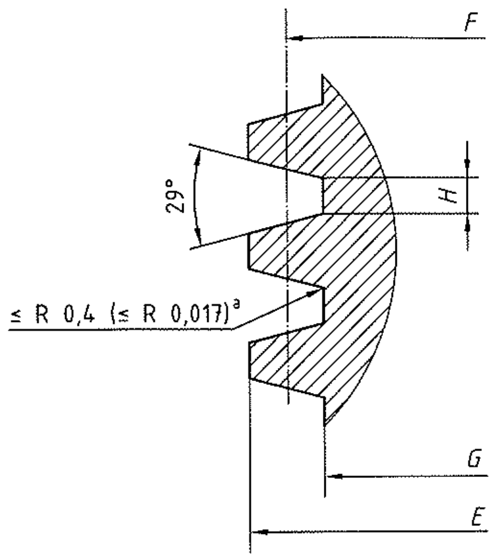
Dimensions in millimetres

Nominal outlet size mm	Maximum working pressure MPa	Nominal thread size *A* (in)	Threads per inch TPI (ref)	Thread major diameter *E* ± 0,10	Thread pitch diameter *F* ± 0,3	Thread minor diameter *G* ± 0,3	Width of thread at root *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

Dimensions in inches

Nominal outlet size in	Maximum working pressure psi	Nominal thread size *A* in	Threads per inch TPI (ref)	Thread major diameter *E* ± 0,004	Thread pitch diameter *F* ± 0,010	Thread minor diameter *G* ± 0,010	Width of thread at root *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

Dimensions in millimetres (inches)



Key

E major diameter

F pitch diameter

G minor diameter

H reference

[a] 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.4 Materials

Valve-removal plug body material shall meet the requirements of 5.2, PSL 2, except no impact testing is required. Material shall be to 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.

L.5 Quality control

Product specification levels are not applicable to valve removal plugs. The quality control requirements shall be in accordance with Table 26. Pressure testing is not required for valve-removal preparations and valve-removal plugs.

L.6 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.7 Storing and shipping

Valve-removal plugs shall be stored and shipped in accordance with Clause 9.

Annex M
(informative)

List of tables and figures

M.1 General

For those who are familiar with the API Spec 6A:1996 numbering of figures and tables, tables have been included in this annex comparing the numbering of this International Standard and API Spec 6A:1996, seventeenth edition. A list of all figures and tables in this International Standard is also given.

M.2 Figure numbers of this International Standard and API Spec 6A

Table M.1 — Conversion of figure numbers

API Spec 6A Figure	ISO 10423 Figure	API Spec 6A Figure	ISO 10423 Figure
1.1	1	A1	A.1
1.2	2	A2	A.2
5.1	3	A3	A.3
6.1	4	Metric Fig. 10.2	9
6.2	5	C1	C.1
6.3	6	E [d]	E.1
7.1	7	E [d]	E.2
10.1	8	E [d]	E.3
10.2	B.9	E [d]	E.4
10.3	[a]	F1.1	F.1
10.4	10	F2.1	F.2
10.5	11	F2.2	F.3
10.6	12	F2.3	F.4
10.7	13	F2.4	F.5
10.8	14	F2.5	F.6
10.9	15	F2.6	F.7
10.10	16	F2.7	F.8
10.11	17	[e]	I.1
10.12	18	[e]	I.2
10.13	19	[f]	K.1
10.14	20	[f]	K.2
10.15	21	[f]	K.3
10.16	[b]	[f]	K.4
10.17	[b]	[f]	L.1
10.18	[c]	[f]	L.2
10.19	[c]	[f]	L.3
10.20	22	[f]	L.4
10.21	23	[f]	L.5
10.22	24	[f]	L.6
10.23	25	[f]	L.7
10.24	26	[f]	L.8
		[f]	L.9
		[f]	L.10

[a] Incorporated in Table 48 (10.4).
[b] Incorporated in Table 75 (10.41).
[c] Incorporated in Table 76 (10.42).
[d] API Spec 6A (appendix E) 4 unnumbered figures.
[e] From API Spec 6AV1.
[f] Not existing in API Spec 6A.

M.3 Table numbers of this International Standard and API Spec 6A

Table M.2 — Conversion of table numbers

API Spec 6A Table	ISO 10423 Table	API Spec 6A Table	ISO 10423 Table	API Spec 6A Table	ISO 10423 Table	API Spec 6A Table	ISO 10423 Table
4.1	1	10.11	B.45	Exhibit A1	A.2	F2.1	F.4
4.2	2	10.12	B.47	Exhibit A2	A.3	F2.2	F.5
4.3	3	10.13	B.46	Exhibit A3	A.4	F2.3	F.6
4.4	deleted	10.14	B.48	Exhibit A4	A.5	F2.4	F.7
5.1	5	10.15	49	Exhibit A5	A.6	F2.5	F.8
5.2	4	10.16	B.50	Exhibit A6	A.7	F2.6	F.9
5.3	6	10.17	B.51	Exhibit A7	A.8	F2.7	F.10
5.4	7	10.18	B.52	Exhibit A8	A.9	F2.8	F.11
5.5	8	10.19	53	Exhibit A9	A.10	F2.9	F.12
5.6	9	10.20	B.54	[a]	A.11	F2.10	F.13
5.7	10	10.21	B.55	[a]	A.12	F2.11	F.14
7.1	11	10.22	B.56	MT 10.2	36	F2.12	F.15
7.2	12	10.23	B.57	MT 10.3	37	F2.13	F.16
7.3	13	10.24	B.58	MT 10.4	38	F2.14	F.17
7.4	14	10.25	B.59	MT 10.5	39	F2.15	F.18
7.5	15	10.26	B.60	MT 10.6	40	F2.16	F.19
7.6	16	10.27	B.61	MT 10.7	41	F2.17	F.20
7.7	17	10.28	B.62	MT 10.8	42	F2.18	F.21
7.8	18	10.29	B.63	MT 10.9	43	[a]	F.22
7.9	19	10.30	B.64	MT 10.10	44	G1	G.1
7.10	20	10.31	65	MT 10.11	45	G2	G.2
7.11	21	10.32	66	MT 10.12	47	G3	G.3
7.12	22	10.33	67	MT 10.13	46	[a]	H.1
7.13	23	10.34	B.68	MT 10.16	50	[a]	I.1
7.14	24	10.35	69	MT 10.17	51	[a]	J.1
7.15	25	10.36	70	MT 10.18	52	[a]	J.2
[a]	26	10.37	71	MT 10.20	54	[a]	J.3
8.1	27	10.38	72	MT 10.21	55	[a]	K.1
8.2	28	10.39	73	MT 10.22	56	[a]	K.2
8.3	29	10.40	74	MT 10.23	57	[a]	K.2
8.4	30	10.41	B.75	MT 10.24	58	[a]	K.3
8.5	31	10.42	B.76	MT 10.25	59	[a]	K.4
8.6	32	10.43	77	MT 10.26	60	[a]	K.5
8.7	33	10.44	78	MT 10.27	61	[a]	K.6
8.8	34	10.45	79	MT 10.28	62	[a]	K.7
10.1	35	10.46	80	MT 10.29	63	[a]	L.1
10.2	B.36	10.47	81	MT 10.30	64	[a]	L.2
10.3	B.37	10.48	82	MT 10.41	75	[a]	L.3
10.4	B.38	10.49	83	MT 10.42	76	[a]	L.4
10.5	B.39	10.50	84	C1	C.1	[a]	L.5
10.6	B.40	[a]	85	D1	D.2	[a]	L.6
10.7	B.41	[a]	B.85	D2	D.1	[a]	M.1
10.8	B.42	[a]	86	F1.1	F.1	[a]	M.2
10.9	B.43	A1	A.1	F1.2	F.2	[a]	M.3
10.10	B.44	A2	deleted	F1.3	F.3	[a]	M.4

[a] Not existing in API Spec 6A.

M.4 List of all figures and tables which form part of this International Standard

Table M.3 — List of all figures in this International Standard

Table M.4 — List of all tables in this International Standard

Annex N
(Informative)

API MONOGRAM AND TEST AGENCY LICENSING

N.0 Introduction

The API Monogram Program allows a licensee to apply the API Monogram to products. Products stamped with the API Monogram provide observable evidence and a representation by the Licensee that, on the date indicated, they were produced in accordance with a verified quality management system and in accordance with an API product specification. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of a organization's quality management system with the demonstrated ability to meet specific product specification requirements.

When used in conjunction with the requirements of the API License Agreement, API Specification Q1, including Annex A, 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 both the requirements described in API Specification Q1 in total, and the requirements of an API product specification.

For information on becoming an API Monogram Licensee, please contact API at 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8000.

N.1 References

In addition to the referenced standards listed in Clause 2, this Annex references the following standards:

API Specification Q1
API Specification 6AV1

N.2 Marking Requirements

N.2.1 API Monogram Marking Requirements

For API licensees wishing to mark their products with the API Monogram, manufacturers shall mark equipment with 'API 6A' and the API Monogram in addition to or in place of 'ISO 10423' in the location specified in Clause 8.

N.2.2 Repair and Remanufacture

Annex J of ISO 10423 is withdrawn in the publication of API Specification 6A. There are no requirements for repair or remanufacture of equipment in this specification and products shall not be marked or monogrammed as such.

N.3 Additional Requirements

The requirements for Test Agency Licensing are given in API Specification 6AV1, Appendix A.

Annex O
(Normative)

API REGIONAL ANNEX

NOTE: Modifications listed in this annex are indicated with an arrow (➔) in the left margin at the location of the revision.

O.1 Technical Modifications to ISO 10423:2003

API Committee 1 / Subcommittee 6 has balloted and approved the following technical revisions for the National Adoption of ISO 10423.

Clause/Subclause	Modification
2	Replace "For undated references, the latest edition of the referenced document (including any amendments) applies." with "Standards referenced in this specification may be replaced by other international or national standards that can be shown to meet or exceed the requirements of the referenced standard. Manufacturers who use other standards in lieu of standards referenced herein are responsible for documenting the equivalency of the standards. Referenced standards used by the Manufacturer may be either the applicable revision shown in Section 2 and herein, or the latest revision. When the latest edition is specified it may be used on issue and shall become mandatory 6 months from the date of the revision."
2	Add the following normative references: "ASTM A 609, *Specification for Ultrasonic Examination for Carbon and Low-Alloy Steel Castings* ASTM E 186, *Standard Reference Radiographs for Heavy-Walled (2 to 4½ in.) Steel Castings* ASTM E 208, *Standard Reference Radiographs for Heavy-Walled (4½ to 12 in.) Steel Castings* ASTM E 446, *Standard Reference Radiographs for Steel Castings Up to 2 in. in Thickness*" Replace the normative reference "NACE MR0175:1999" with: "NACE MR0175 / ISO 15156, *Petroleum and natural gas industries – Materials for use in H2S-containing environments in oil and gas production* Note: All references to "NACE MR0175" in this International Standard refer to the NACE MR0175/ISO 15156 document above."
3.1	Add the following definitions: **prolongation** an extension of a piece of raw material or an extension of a production part made integrally during forging, hot working, cold working, or casting **Test Agency** any independent third party which provides a test facility and administers a testing program which meet the Class II SSV/USV valve verification testing requirements of Annex I of this specification and API Specification 6AV1.
4.1	Replace in the last sentence "Valves operating as safety valves . . ." with "SSVs and USVs (Clause 10.20) . . ."

Table 2 Replace Table 2 with the following:

Table 2 - Temperature ratings

Temperature Classification	Operating range C		Operating range 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
R	Room temperature		Room temperature	
S	-18	60	0	140
T	-18	82	0	180
U	-18	121	0	250
V	2	121	35	250

4.2.3 Replace entire clause with the following:

4.2.3.1 General

Equipment shall be designed with materials, including metallics, which meet 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 can be met, stainless steels may be used in place of carbon and low-alloy steels and 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 NACE MR0175/ISO 15156 for material processing and material properties (e.g. hardness). Choosing Material Class and specific materials for specific conditions is the ultimate responsibility of the purchaser.

Material Classes DD, EE, FF, HH shall include as part of the designation and marking the maximum allowable partial pressure of H2S in psia. The maximum allowable partial pressure shall be as defined by NACE MR0175/ISO 15156 at the designated API temperature class for the limiting component(s) in the equipment assembly. For example, "FF-1,5" indicates Material Class FF rated at 1,5 psia H2S maximum allowable partial pressure. Where no H2S limit is defined by NACE MR0175/ISO 15156 for the partial pressure, 'NL' shall be used for marking (i.e. "DD-NL").

Users of this International Standard should recognize that resistance to cracking caused by H2S is influenced by a number of other factors for which some limits are given in NACE MR0175/ISO 15156. These include, but are not limited to:
- pH
- Temperature
- Chloride concentration
- Elemental sulfur

In making the material selections, the purchaser should also consider the various environmental factors and production variables listed in Annex A.

4.2.3.3 Material Class ZZ

NACE MR0175/ISO 15156 includes provisions for the qualification of materials for a specific sour service application which is outside the parameters defined in that standard, by means of testing or documented field history. This can include the use of materials in fluid conditions exceeding the limits defined in MR0175/ISO 15156, or the use of materials not addressed in MR0175/ISO 15156. 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 Replace Table 3 with revised Table 3 as follows:

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[a]	Carbon or low-alloy steel[b]	Carbon or low-alloy steel[b]
EE — Sour service[a]	Carbon or low-alloy steel[b]	Stainless steel[b]
FF — Sour service[a]	Stainless steel[b]	Stainless steel[b]
HH — Sour service[a]	CRAs[b c d]	CRAs[b c d]

[a] As defined by NACE MR 0175/ISO 15156. In compliance with NACE MR 0175/ISO 15156.
[b] In compliance with NACE MR 0175/ISO 15156.
[c] CRA required on retained fluid wetted surfaces only; CRA cladding of low allow or stainless steel is permitted.
[d] CRA as defined in clause 3 of this International Standard; NACE MR0175/ISO 15156 definition of CRA does not apply.

5.3.2.1 b) Replace the title with "PSL 2-4 requirements"
Replace the first sentence with "The requirements for PSL 2-4 are identical to the requirements for PSL 1."

5.3.2.1 c) Delete entire subclause.

5.4.3.1 b) Replace the title with "PSL 2-4 requirements"
Replace the first sentence with "The requirements for PSL 2-4 are identical to the requirements for PSL 1."

5.4.3.1 c) Delete entire subclause.

Table 6 Replace Table 6 with the following:

Table 6 — Charpy V-notch impact requirements (10 mm × 10 mm)

Temperature		Minimum average impact value Transverse direction J(ft·lbf)		
Temperature classification	**Test temperature °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)
R	– 18 (0)	—	—	20 (15)
S	– 18 (0)	—	—	20 (15)
T	– 18 (0)	—	—	20 (15)
U	– 18 (0)	—	—	20 (15)
V	– 18 (0)	—	—	20 (15)

5.6.1 Add the following at the end of the existing section:
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 may 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 raw material. For a production part with a complex shape or varying cross section, the prolongation need not be an extension of the largest cross section of the part. However, the extension shall meet or exceed the minimum equivalent round (ER) required for a separate TC.

5.7.1 Add the following at the end of the existing section:
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 may 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 raw material. For a production part with a complex shape or varying cross section, the prolongation need not be an extension of the largest cross section of the part. However, the extension shall meet or exceed the minimum equivalent round (ER) required for a separate QTC.

7.2.2.2 Replace the clause with:
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).

7.4.2.1.2 Revise the Title of Clause 7.4.2.1.2 as follows:

7.4.2.1.2 Impact testing (for temperature classifications K, L and N)

7.4.2.2.8 b)	Replace the second sentence with "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, nonmetallic stringers), they shall be examined by liquid penetrant surface NDE methods, or removed and re-inspected to verify their non-relevancy."
7.4.2.3.15 b) 1)	Add "- Castings: Ultrasonic examinations of casting shall be performed in accordance with the flat bottom hole procedures specified in ASTM A 609 (except immersion method may be used) and ASTM E 428."
7.4.2.3.15 c) 1)	Replace the first sentence with "Radiographic examination of hot-worked parts or castings shall be performed in accordance with methods specified in 7.4.2.2.14."
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 E 186: *Standard Reference Radiographs for Heavy-Walled (2 to 4½ in.) Steel Castings.* ASTM E 208: *Standard Reference Radiographs for Heavy-Walled (4½ to 12 in.) Steel Castings.* ASTM E 446: *Standard Reference Radiographs for Steel Castings Up to 2 in. in Thickness.*

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 a) and 7.4.11.5	Replace in both subclauses "threads" with "threads or retention profiles".
7.5.3.2	Delete from the title "and back-pressure valve".
8.1.1	Add the following at the end of the section: "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."
10.2.1	Replace in the first sentence "The requirements for loose and integral . . . " with "The requirements for integral . . .".
Table 54	Add the following dimension for Nominal size 7 1/16 x 6 5/8 under Face-to-face valve length, Full-bore gate valves: 562 mm
Table 55	Add the following dimension for Nominal size 7 1/16 x 6 5/8 under Face-to-face valve length, Full-bore gate valves: 613 mm
10.6.3.3 b)	Replace the second paragraph with "Valve removal plug preparations shall be in accordance with annex L".

10.8.3.2 b)	Add in the second sentence the word "inch" before "nominal size".
10.9.3.7	Add the following subclauses at the end of the clause: "a) Proration beans Proration beans shall have a net effective orifice length of 6 in. +-0.06 in. (152.4 mm, +- 1.5 mm). The orifice diameters of these beans shall be specified in 1/64 in. diametrical increments (i.e. 5/64, 6/64, 7/64, 8/64, etc.). b) Production beans The orifice size of any individual production bean and the increment between sizes are optional with the manufacturer."
10.16.3.4	Replace in the sentence "class" with "classes".
10.20	Add to the end of the title "for offshore service"
10.20.1	Replace in the first sentence "surface" with "offshore surface".
10.20.1 a)	Add at the end of the first sentence ", as a minimum".
10.20.2.2	Add before the first sentence "This section covers flanged end valves, or valves with other industry non-threaded end connections, and multiple completion of block type valves used as wellhead surface safety valves."
10.20.2.3	Replace in the first bullet point "flanges and ring joints" with "end connections".
10.20.4.3	Add the following requirements at the end of the subclause: "c) Test Agency To verify a specific Class II SSV/USV design, the manufacturer must submit an SSV/USV of the same basic design and materials of construction to a Test Agency, as defined below. Verification testing at a Test Agency is not required for SSV/USV equipment other than valve bore sealing mechanisms, PR2 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 Table 84."
Table 83	Replace in **SSV/USV valve data** section "Temperature rating" with "Temperature class". Replace in **SSV/USV actuator data** section "Valve catalog or model no." with "Actuator catalog or model no." Replace in **SSV/USV actuator data** section "Valve bore material class" with "Material class".
Table 83	Add to the title "(minimum data required)".
10.20.7.4	Add the following new subclause at the end of this subclause: "10.20.7.4 Failure Reporting After receiving a failure report from the Operator, the Manufacturer of SSV/USV equipment shall respond within 6 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. Copies of all reports to the Operator shall also be sent to the Manager, API Quality Program."

10.21.1 Replace the sentence with "Bull plugs shall meet applicable requirements for loose connectors".

10.24.1 Replace the sentence with "Back pressure valves shall meet applicable requirements for tubing hangers".

Annex A Add the following at the end of the annex:
"A.6 Chokes
Orders for chokes shall specify the size and pressure rating of the inlet connection as well as size, type and pressure rating of the outlet connection, first listing the inlet connection and then the outlet connection, the working pressure, and type, i.e. adjustable or positive. Orders for adjustable chokes should specify the maximum orifice diameter. Orders for positive chokes should specify the type of flow bean together with its maximum orifice size."

Table B.54 Add the following dimension for Nominal size 7 1/16 x 6 5/8 under Face-to-face valve length, Full-bore gate valves: 22,12 in

Table B.55 Add the following dimension for Nominal size 7 1/16 x 6 5/8 under Face-to-face valve length, Full-bore gate valves: 24,12 in

Annex J Annex J (normative) "Repair and remanufacture requirements" from ISO 10423 is withdrawn, including all references to Annex J in the body of the standard.

Table K.2 Replace Table K.2 with the following:

Replacement Table K.2

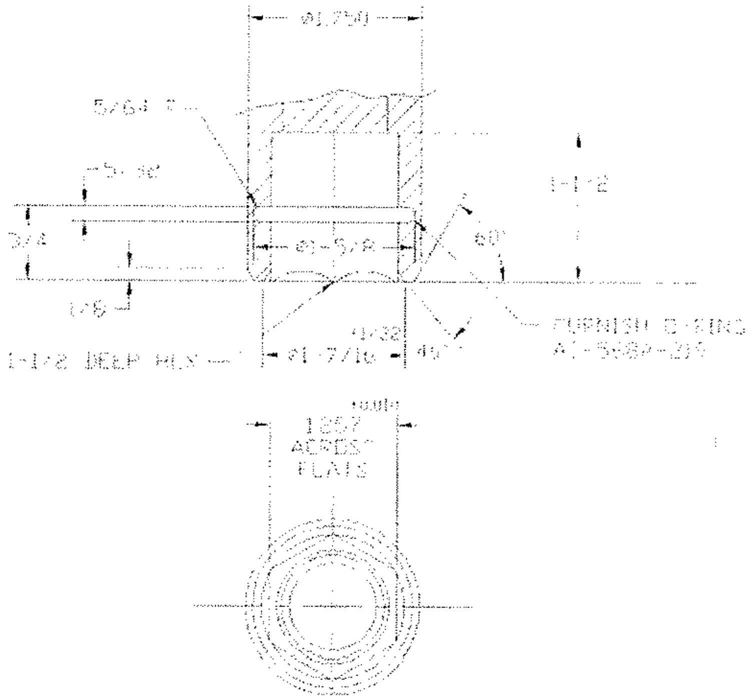
Nominal Size Tree Cap		Rated Working Pressure		Maximum Bore[a]		Minimum Boss Outside Diameter	
(in)	(mm)	Mpa	(psi)	(mm)	(in)	(mm)	(in)
2 9/16	65	103,5	15 000	66,6	2,62	109,0	4,29
2 9/16	65	138,0	20 000	66,6	2,62	144,5	5,69
3	76	34,5	5 000	76,7	3,02	94,5	3,72
3	76	69,0	10 000	76,7	3,02	104,6	4,12
3	76	103,5	15 000	76,7	3,02	126,7	4,99
4	102	34,5	5 000	102,1	4,02	125,7	4,95
4	102	69,0	10 000	102,1	4,02	139,2	5,48
4	102	103,5	15 000	102,1	4,02	166,4	6,55
5	127	34,5	5 000	127,5	5,02	157,0	6,18
5	127	69,0	10 000	127,5	5,02	174,0	6,85
5	127	103,5	15 000	127,5	5,02	212,1	8,35
6 3/8	162	34,5	5 000	162,6	6,4	200,2	7,88
6 3/8	162	69,0	10 000	162,6	6,4	221,7	8,73

[a] See Figure K.1 and Figure K.2.

(the drawing and footnotes in the original Table K.2 will be retained as is)

L.3.5 Add the following new clause after L.3.4:
"L.3.5 The Running/Retrieval Socket Tool should be in accordance with Figure L.11."

Add Figure L.11:



Annex M.2 Add the following note:
"Note: Reference to previous edition of API Spec 6A (17th Edition)"

Annex M.3 Add the following note:
"Note: Reference to previous edition of API Spec 6A (17th Edition)"

Annex M.4 Table M.3 Add the following at the end of the table:
"Figure L.11 Running/retrieval socket tool"

O.2 Editorial Modifications to ISO 10423

The following editorial changes are made to the document.

[Editorial errors, if any, found in the document will be placed here.]

Date of Issue: September 1, 2004
Affected Publication: API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*, Nineteenth Edition, July 2004

ERRATA 1

Changes are shown in **bold** text.

Page 62, Table 11, change the second line as follows:

Impact testing	7.4.2.1.2	**7.4.2.2.2**	**7.4.2.3.2**	**7.4.2.3.2**

Page 151, Table 51, change the line for Ring Number RX 47 as follows:

RX 47	228,60	245,26	19,84	10,34	6,88	41,28	2,3	12,7	19,84	1,5	**18,3**

Page 273, Table B.51, change the line for Ring Number RX 47 as follows:

RX 47	9,000	9,656	0,781	0,407	0,271	1,625	0,09	0,50	0,781	0,06	**0,72**

Bibliography

[1] ISO 31 (all parts), *Quantities and units*

[2] ISO 10419, *Petroleum and natural gas industries — Drilling and production equipment — Installation, maintenance and repair of surface safety valves and underwater safety valves offshore*

[3] ISO 10433, *Petroleum and natural gas industries — Drilling and production equipment — Specification for wellhead surface safety valves and underwater safety valves for offshore service*

[4] ISO 13628-3, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 3: Through flowline (TFL) systems*

[5] API Bul 5A: *Information on dimensional data for sharp-thread casing and tubing*, second edition, 1944

[6] API Spec 5CT, *Specification for casing and tubing (U.S. customary units)*, sixth edition, October 1998, errata May 1999, and previous editions

[7] API Spec 6A, *Specification for wellhead and christmas tree equipment*, seventeenth edition, February 1996, errata and Supplement December 1996

[8] API TR 6AF, *Technical report on capabilities of API flanges under combinations of load*

[9] API TR 6AF1, *Technical report on temperature derating of API flanges under combination of loading*

[10] API TR 6AF2, *Technical report on capabilities of API integral flanges under combination of loading*

[11] API Spec 6AV1, *Specification for verification test of wellhead surface safety valves and underwater safety valves for offshore service*, first edition, February 1996

[12] API Spec 6FA, *Specification for fire test for valves*

[13] API Spec 14D, *Specification for wellhead surface safety valves and underwater safety valves for offshore services*, ninth edition, June 1994

[14] API RP 14H, *Recommended practice for installation, maintenance, and repair of surface safety valves and underwater safety valves offshore*, fourth edition, July 1994

[15] ASME B1.5, *ACME screw threads*

[16] ASME B16.5, *Pipe flanges and flanged fittings NPS $^1/_2$ through NPS 24*

[17] ASME B16.34, *Valves — Flanged, threaded, and welding end*

[18] ASME B18.2.2, *Square and hex nuts (inch series)*

[19] ASME, Boiler and Pressure Vessel Code:1998, Section II, *Materials*

[20] ASME SPPE 1, *Quality assurance and certification of safety and pollution prevention equipment used in offshore oil and gas operations*

[21] ASTM E 21, *Standard test methods for elevated temperature tension tests of metallic materials*

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