# Threading and Gauging of Rotary Shouldered Connections

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## Introduction

This standard is based on API Specification 7, *Specification for Rotary Drill Stem Elements*.

The function of this part of this standard is to define the connections design and the gauging required for rotary drill stem elements. It also defines the testing required to verify compliance with these requirements. As rotary drill stem elements are very mobile, moving from rig to rig, design control is an important element required to ensure the interchangeability and performance of product manufactured by different sources.

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# Threading and Gauging of Rotary Shouldered Connections

## 1 Scope

### 1.1 Coverage

This standard specifies the following requirements on rotary shouldered connections for use in petroleum and natural gas industries: dimensional requirements on threads and thread gauges, stipulations on gauging practice and gauge specifications, as well as instruments and methods for inspection of thread connections. These connections are intended primarily for use in drill-string components.

Other supplementary specifications can be agreed between interested parties for special tolerance requirements, qualification, testing, inspection, and finishing. This standard applies both to newly manufactured connections and connections that are recut after service. It should be realized that recut connections are subject to additional inspection and testing—the user is referred to API 7G-2 for such information.

This standard is applicable to the following preferred rotary shouldered connection designs. These are traceable to an internationally supported system of gauges and calibration that can be described as number (NC) style, regular (REG) style, or full-hole (FH) style.

#### 1.2 Application of the API Monogram

If the product (gauge) is manufactured at a facility licensed by API and, it is intended to be supplied bearing the API Monogram, the requirements of Annex A apply.

## 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.

API Specification 5DP, *Specification for Drill Pipe*

API Specification 7-1, *Specification for Rotary Drill Stem Elements*

ISO 1302 [1], *Geometrical Product Specifications (GPS)—Indication of surface texture in technical product documentation*

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

ISO 11961, *Petroleum and natural gas industries—Steel drill pipe*

ISO/IEC [2] 17025, *General requirements for the competence of testing and calibration laboratories*

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[1] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org.

[2] International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland, www.iec.ch.

# 3 Terms, Definitions, Symbols, and Abbreviations

## 3.1 Terms and Definitions

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

**3.1.1**
**bevel diameter**
Outside diameter of the contact face of the rotary shouldered connection.

**3.1.2**
**box connection**
**box end**
Threaded connection on oil country tubular goods with internal (female) threads.

**3.1.3**
**box thread**
Internal (female) threads of a rotary shouldered connection.

**3.1.4**
**break-in**
Procedure applied to newly manufactured threads to assure correct mating.

**3.1.5**
**calibration system**
Documented system of gauge calibration and control.

**3.1.6**
**cold rolling**
**(cold working)**
Plastic deformation of the surface of the connection at a temperature low enough to induce strain hardening.

**3.1.7**
**first perfect thread**
Thread furthest from the sealing face on a pin, or closest to the sealing face on a box, where both the crest and the root are fully formed.

**3.1.8**
**full depth thread**
Thread in which the thread root lies on the minor cone of an external thread or lies on the major cone of an internal thread.

**3.1.9**
**full-hole (FH) style**
Type and size of rotary shouldered connection, covered by this standard, having thread form of V-040 or V-050.

NOTE The number relates to a historical drill pipe size.

**3.1.10**
**gauge point**
Imaginary plane, perpendicular to the thread axis of rotary shouldered connections at which, $C$, the pitch diameter at gauge point is measured.

NOTE This plane is located 15.875 mm (0.625 in.) from the makeup shoulder of the pin or box connection (pin or box end), except on Working plug gauges, where it is located 34.925 mm (1.375 in.) from the reference face.

**3.1.11**
**GOST Z style**
Type and size of the rotary shouldered connection, covered by a Russian standard, having the V-038R, V-040, or V-050 thread form.

NOTE The number designation is the pin-base diameter, rounded to units of millimeters.

**3.1.12**
**H90 style**
Type and size of rotary shouldered connection, having a 90° thread (90-V-050) form.

NOTE The number relates to a historical drill pipe size.

**3.1.13**
**IF style**
Type and size of the rotary shouldered connection, having the V-038R thread form.

NOTE The number relates to a historical drill pipe size; the thread form was historically V-065.

**3.1.14**
**interchange standoff**
Standoff between each member of a gauge set and a corresponding gauge higher in the ranking scheme: Grand Master or Regional Master, Reference Master, and Working gauge.

**3.1.15**
**last engaged thread**
Last thread of the pin near the makeup shoulder that is engaged with the box threads or the box thread farthest from the shoulder that is engaged with the pin threads.

**3.1.16**
**lead**
Distance parallel to the thread axis from a point on a thread turn and the corresponding point on the next turn, i.e. the axial displacement of a point following the helix one turn around the thread axis.

**3.1.17**
**length of box threads**
Length of threads in the box measured from the makeup shoulder to the last thread with full thread depth, measured at the intersection of the thread flank closest to the makeup shoulder with the crest of the thread.

**3.1.18**
**makeup shoulder**
Shoulder on a rotary shouldered connection carrying load when assembled.

**3.1.19**
**manufacturer**
Firm, company, or corporation that operates facilities capable of cutting the threads and is responsible for compliance with all the applicable provisions of this standard.

**3.1.20**
**master gauge**
Gauges used for calibration of other gauges.

NOTE These include Reference Master, Regional Master, and Grand Master gauges.

**3.1.21**
**mating standoff**
Standoff between the plug and ring members of a gauge set.

NOTE Interchange standoff is the standoff between each member and a gauge higher in the ranking scheme.

**3.1.22**
**number connection (NC) style**
Type and size of the rotary shouldered connection, having the V-038R thread form.

NOTE The number in the connection number is the first two digits of the pitch diameter of the pin thread at the gauge point, expressed in units of 2.54 mm (0.1 in.).

**3.1.23**
**open-hole (OH) style**
Type and size of rotary shouldered connection, having the V-076 thread form.

NOTE The number relates to a historical drill pipe size.

**3.1.24**
**PAC style**
Type and size of rotary shouldered connection, having the V-076 thread form.

NOTE The number relates to a historical drill pipe size.

**3.1.25**
**pin connection**
**pin end**
Threaded connection on oil country tubular goods with external (male) threads.

**3.1.26**
**pin thread**
External (male) threads of a rotary shouldered connection.

**3.1.27**
**pitch**
Axial distance between successive threads, which, in a single start thread, is equivalent to lead.

**3.1.28**
**pitch cone**
An imaginary cone of such apex angle and location of its vertex and axis that its surface would pass through a taper thread in such a manner as to make the axially measured widths of the thread ridge and the thread groove equal.

**3.1.29**
**pitch diameter at gauge point**
Diameter of the pitch cone at the gauge point.

**3.1.30**
**product**
Drill string component with rotary shouldered connection in accordance with this standard.

**3.1.31**
**reference dimension**
Dimension that is a result of two or more other dimensions.

**3.1.32**
**regular (REG) style**
Type and size of rotary shouldered connection, having thread forms of V-040, V-050, or V-055.

NOTE The number relates to a historical drill pipe size.

**3.1.33**
**rotary shouldered connection**
Thread connection used on drill stem elements that has coarse, tapered threads, and sealing shoulders.

**3.1.34**
**SL H90 style**
Type and size of rotary shouldered connection, having a 90° (90-V-084) thread form and heavy truncation.

NOTE The number relates to a historical drill pipe size.

**3.1.35**
**standoff**
Distance between faces of gauges, or gauge and product when mated.

**3.1.36**
**stress-relief groove (or feature)**
Modification performed on rotary shouldered connections that removes a certain length of the unengaged threads of the pin or box.

NOTE This process reduces the likelihood of fatigue cracking in the highly stressed area both for box and pin threads due to a reduction of stress concentration.

**3.1.37**
**taper**
Increase or decrease in the diameter of the pitch cone with length.

NOTE The taper is expressed in millimeters per millimeter (inch per foot) of thread length.

**3.1.38**
**thread form**
Thread profile in an axial plane for a length of one pitch.

**3.1.39**
**thread height**
Distance between the crest and root, normal to the axis of the thread.

**3.1.40**
**tolerance**
Amount of variation permitted.

**3.1.41**
**Working gauges**
Gauges used for gauging rotary shouldered connections.

## 3.2 Symbols

$A$ depth of the pin stress-relief groove below the thread root at the gauge point

$B$ depth of box stress-relief groove, measured from the minor thread cone

$C$ pitch diameter of thread at gauge point

$C_{\mathrm{GP}}$ pitch diameter at Working gauge point

$D_{\mathrm{BG}}$ diameter of box member at stress-relief groove

$D_{\mathrm{CB}}$ diameter of cylinder of boreback stress-relief contour

$D_{\mathrm{FG}}$ diameter of face groove and box counterbore in low-torque feature

$D_{\mathrm{FP}}$ diameter of plug fitting plate

$D_{\mathrm{L}}$ large diameter of pin at the intersection of the major cone and the pin shoulder

$D_{\mathrm{LF}}$ diameter of cylindrical feature at the pin base on pin

$D_{\mathrm{MP}}$ major diameter of plug gauge at gauge point

$D_{MR}$ minor diameter of ring gauge at gauge point

$D_R$ outside diameter of ring gauge

$D_{PT}$ diameter of optional pin ID taper

$D_S$ diameter of major diameter cone at the small end of the pin

$D_{SRG}$ diameter of pin stress-relief groove

$d_b$ diameter of ball for lead and taper gauges

$d_{bh}$ diameter of ball for thread height gauge

$F_c$ width of crest flat, product thread

$F_r$ width of root flat, product thread

$f_c$ crest truncation, product thread

$f_{cg}$ crest truncation, gauge thread

$f_r$ root truncation, product thread

$f_{rg}$ root truncation, gauge thread

$H$ reference thread height not truncated

$h$ product thread height truncated

$h_{bg}$ depth of box stress-relief groove, measured normal to taper cone

$h_{cn}$ height of product thread, compensated for taper

$h_g$ reference gauge thread height truncated

$L_{BC}$ depth of box

$L_{BG}$ length, shoulder face to groove of box member

$L_{BT}$ depth of box threads at last full depth thread

$L_{CB}$ boreback length

$L_{CYL}$ depth of cylinder of boreback contour

$L_{GP}$ distance from shoulder to gauge point

$L_{PC}$ length of pin

$L_{Qc}$ depth of box counterbore

$L_{SRG}$ length of relief groove on pin

$L_X$ length from shoulder to last thread scratch on boreback cylinder

$L_{ct}$ length of setting standard for thread lead, compensated for taper

$L_{ft}$ distance from shoulder to first full-depth pin thread

$L_{pg}$ total length of plug gauge

$L_{rg}$ total length of ring gauge

$n$ number of threads in 25.4 mm (1.0 in.)

$p$ pitch of thread (used also for lead, since all threads referenced are single-start)

$Q$ diameter of ring gauge counterbore

$Q_c$ diameter of product box counterbore

$R$ root radius, product thread

$R_{FG}$ radius at corners of low-torque grooves

$R_{LF}$ radius at end of pin-base cylinder feature

$R_{bg}$ radius at corners of box stress-relief groove

$r_c$ radius at corners of crest flat

$r_r$ radius at corners of root flat

$S$ mating standoff of gauges

$S_0$ standoff of certified Reference Master gauges

$S_1$ standoff of the Working plug gauge on a Reference Master gauge

$S_2$ standoff of the Working ring gauge on a Reference Master gauge

$T$ taper, millimeters of diameter per millimeter of length or inches of diameter per foot of length

$T_{FP}$ thickness of gauge fitting plate

$\varphi$ half of the included angle of the taper cone

$\theta$ angle between the thread flank and the normal to the thread axis

### 3.3 Abbreviations

c/bore counterbore

CW cold (working) rolling: used as a marking

FF full-face

FH full-hole (style)

GOST (Russian: ГОСТ) historical Soviet Standards institution

ID inside diameter

IF internal flush (style)

LH left-hand

LT low-torque modification

NC numbered connection (style)

OD outside diameter

OH open-hole (style)

PAC Phillip A Cornell (style)

ref reference (dimension)

REG regular (style)

RH right-hand

SMYS specified minimum yield stress

SRG stress-relief groove

## 4 General Information

### 4.1 General

In this standard, data are expressed in both the International System (SI) of units and the U.S. customary (USC) system of units. Separate tables for data expressed in SI units and USC units are given in Annex B and Annex C, respectively. Figures express data in both SI and USC units. For a specific order item, it is intended that only one system of units be used, without combining data expressed in the other system.

Products manufactured to specifications expressed in either of these unit systems shall be considered equivalent and totally interchangeable. Consequently, compliance with the requirements of this standard as expressed in one system provides compliance with requirements expressed in the other system.

Some of the dimensions in USC units have been converted from traditional fractional measurements. Depending on the rounding conventions used, tabulated dimensions and/or tolerances may differ by up to

0.002 in. from some existing manufacturing documents. These differences are to be considered acceptable and in compliance and shall not be cause of rejection. See Annex D for guidance on unit conversion and rounding.

NOTE Any style of rotary shouldered connection can be made in right-hand (RH) or left-hand (LH) versions; right-hand is assumed unless otherwise designated as LH; left-hand threads are not supported by the international system of gauges and calibration, except in the REG style.

## 4.2 Purchaser Supplied Information

In placing orders for equipment to be manufactured with rotary shouldered connections in accordance with this standard, the purchaser shall specify the following on the purchase order:

a) number of this standard;

b) thread style and size; and

c) if necessary, supplementary requirements as detailed in Section 6, which are optional with the purchaser.

# 5 Threading

## 5.1 Thread Profile and Dimensions

### 5.1.1 Overall Dimensions

Rotary shouldered connections shall be furnished in the sizes and styles shown in Figures 1 and 2 and Table B.1. Dimensions of rotary shouldered connections shall conform to Table B.1, with the thread forms defined in Table B.2. The dimensions shown in Tables B.1 and B.2 that have no specified tolerance and do not have tolerances defined below, shall be considered reference dimensions. Deviations from these dimensions shall not be cause for rejection. The extent of the bevel of the small end of the pin is optional with the manufacturer.

Right-hand threads shall be considered standard. Left-hand threads may be made using this standard, but traceable gauging following this standard exists only in the REG style.

### 5.1.2 Pin Dimensions

The pin dimensions in Table B.1 shall be interpreted using Figures 1 and 2.

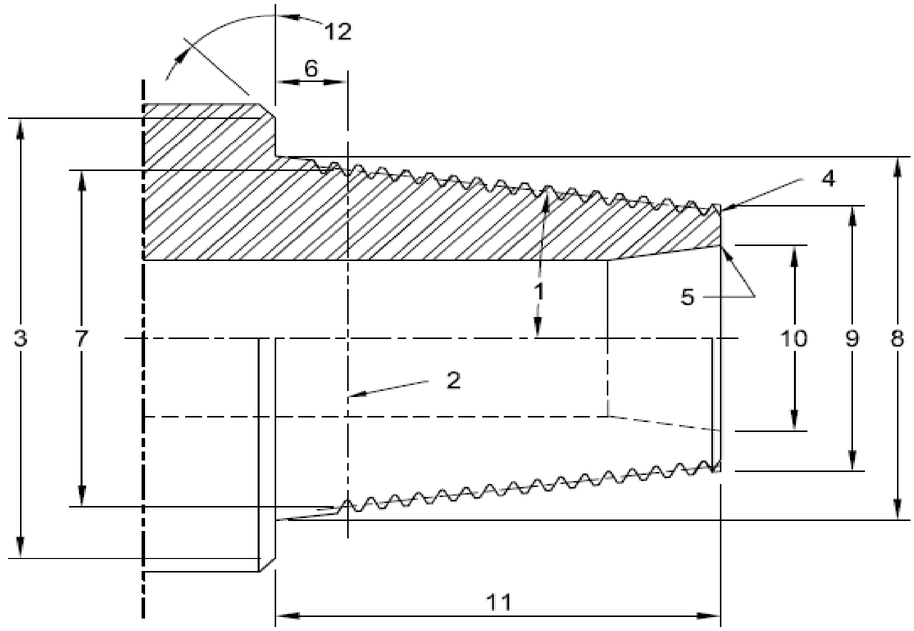
### 5.1.3 Pin Base Diameter

Pin base diameter dimensional requirements shall be as follows.

Rotary shouldered connections on drill collars shall have a cylindrical region at the base conforming to the dimension $D_{\mathrm{LF}}$ of Table B.1 and shall have a radius $R_{\mathrm{LF}}$ 1.6 mm ±0.4 mm (0.063 in. ±0.016 in.) at the pin base as shown in Figure 2, except when a stress-relief groove is used.

This feature reduces the stress concentration factor in this area. Rotary shouldered connections on products other than drill collars, such as tool joints, may have a tapered region at the pin base rather than a cylindrical region. In this case the radius at the intersection of the taper and the sealing face shall be 0.78 mm ±0.12 mm (0.031 in. ±0.005 in.), as shown in Figure 2.

The distance between the pin shoulder and the intersection of the pin base diameter or thread major cone with the thread flank at the first point of full thread depth shall not exceed $L_{\mathrm{ft}}$ (see Figure 2).

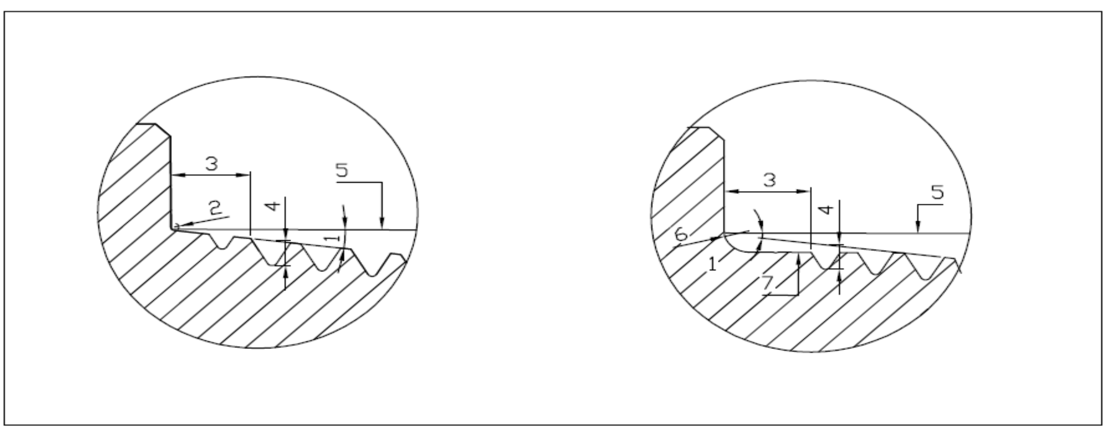



**Key**

1 taper half-angle, $\varphi$
2 plane of gauge point
*3* connection bevel diameter; see 5.2
4 outside bevel angle optional to manufacturer
5 optional inside bevel (see 6.3.2)
6 location of gauge plane 15.875 mm (0.625 in.) from shoulder
7 pitch diameter at gauge point, C
8 large diameter, $D_L$
9 small diameter, $D_S$
10 diameter of optional tapered inside bevel $D_{PT}$ (see 6.3.2)
11 pin length, $L_{PC}$
12 connection bevel angle

NOTE See Table B.1 (C.1) for dimensions.

**Figure 1—Pin Connection (Pin End)**




**(a) Tapered Pin Base** **(b) Cylindrical Pin Base**

**Key**

1 taper half-angle, $\varphi$
2 internal radius with tapered base 0.79 mm (0.031 in.) min
3 distance from shoulder to first full-depth pin thread, $L_{FT}$
4 first point of full thread depth
5 large diameter, $D_L$
6 internal radius, $R_{LF}$, with cylinder base
7 pin cylinder diameter, $D_{LF}$

**Figure 2—Tapered and Cylindrical Pin Bases**

### 5.1.4 Shoulder Contact Face

Shoulder contact faces of rotary shouldered connections shall be plane, and square with the thread axis, within 0.05 mm (0.002 in.). The surface finish of the contact face, before any surface treatment, shall be 5 µm (125 µin.) $R_a$ or better, so as to assure a reliable sealing surface.

### 5.1.5 Standoff

Rotary shouldered connections shall be produced with standoff tolerances as specified in 7.2.

### 5.1.6 Lead Tolerance

The lead tolerance of rotary shouldered connections shall be as follows:

a) ±0.038 mm per 25.4 mm (0.0015 in. per in.) for any 25.4 mm (1.0 in.) between first and last full depth threads; and

b) ±0.114 mm (0.0045 in.) between first and last full depth threads, or the sum of 0.0254 mm (0.001 in.) for each 25.4 mm (1 in.) between first and last full depth threads, whichever is greater.

The method for determining lead is described in 7.4.

### 5.1.7 Taper Tolerance

The taper tolerance of rotary shouldered connections shall be as follows:

a) pin thread: +0.0025 mm/mm to 0 mm/mm (+0.030 in./ft to 0 in./ft) average taper between first and last full depth threads; and

b) box thread: 0 mm/mm to −0.0025 mm/mm (0 in./ft to −0.030 in./ft) average taper between first and last full depth threads.

The method for determining taper is described in 7.5.

### 5.1.8 Box Counterbore

The box counterbore shall have the diameter, $Q_c$, specified in Table B.1, and taper, $T$, as shown in the detail of Figure 3. The depth of the counterbore shall be $L_{Qc}$ as specified in Table B.1. The angle of the bevel at the intersection of the counterbore and the first threads is optional to the manufacturer but is typically 25° to 45°.

### 5.1.9 Thread Form

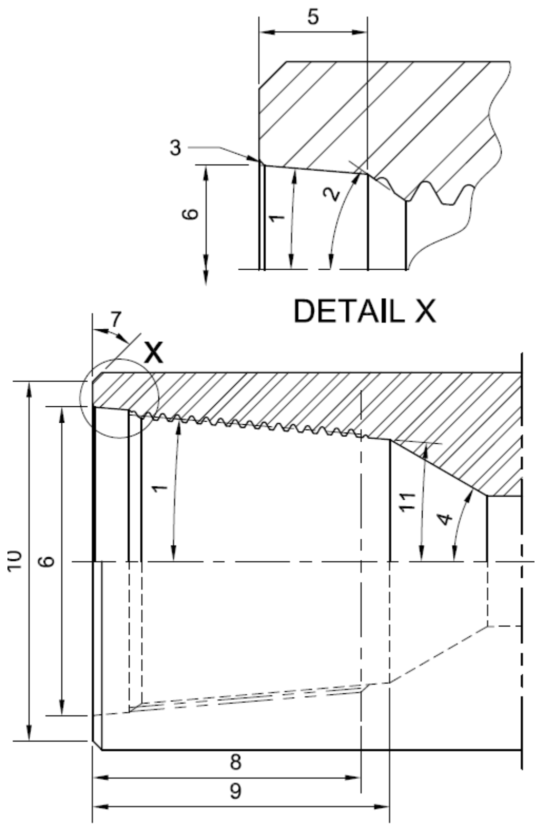
The thread form shall be as defined in Table B.2 and shown in Figures 4 and 5. The surface finish of the thread flanks and root before any surface treatment shall be 2.5 µm (63 µin.) $R_a$ or better in order to maximize the fatigue life of the connection. This may be demonstrated using a sacrificial test piece on a process qualification basis.

The design intent for root radius, $R$, in Figure 4 is a tolerance of ±0.025 mm (±0.001 in.); this is not an auditable dimension but it is indirectly verified through the truncated thread height.

## 5.2 Bevels for Drill Collars and Tools that Mate Directly with Drill Collars

### 5.2.1 General

All connections shall have bevels on the outside surface with diameters detailed below. The bevel design is based on an angle of 45°.




**Key**

1 taper half-angle, $\varphi$

2 chamfer angle, typically 25° to 45°

3 break edge or radius 0.8 mm (0.031 in.) max

4 30° maximum taper

5 counterbore depth, $L_{Qc}$ +2.4/–0.81 mm (+0.094/–0.031 in.)

6 counterbore diameter, $Q_c$

7 bevel angle, 45° ±10°

8 depth of box threads, $L_{BT}$

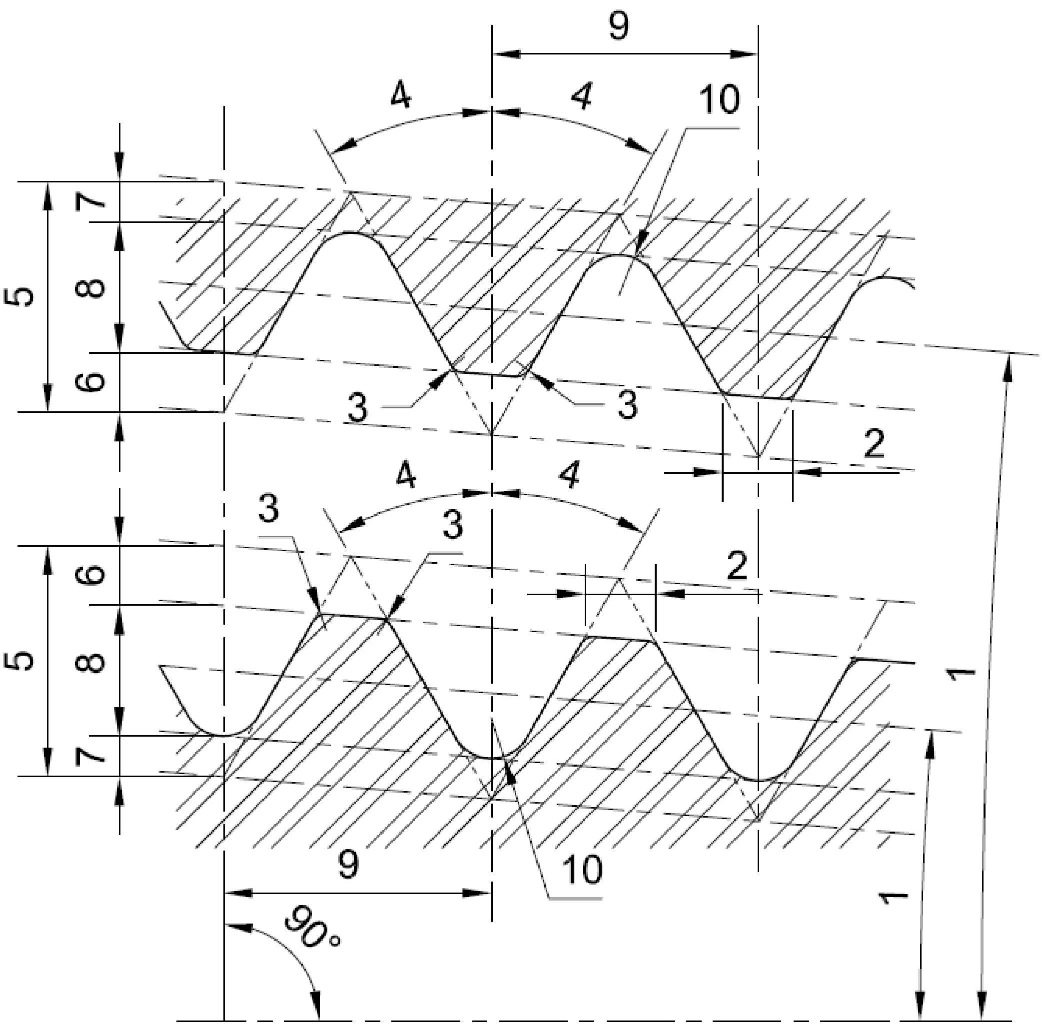
9 box depth, $L_{BC}$

10 connection bevel diameter

11 bore detail (see 6.3.3)

NOTE See Table B.1 (C.1) for dimensions.

**Figure 3—Box Connection (Box End)**




**Key**

1 taper half-angle, $\varphi$

2 crest flat, $F_c$

3 crest corner radius, $r_c$

4 thread half-angle, $\Theta$

5 thread height not truncated, $H$

6 crest truncation, $f_c$

7 root truncation, $f_r$

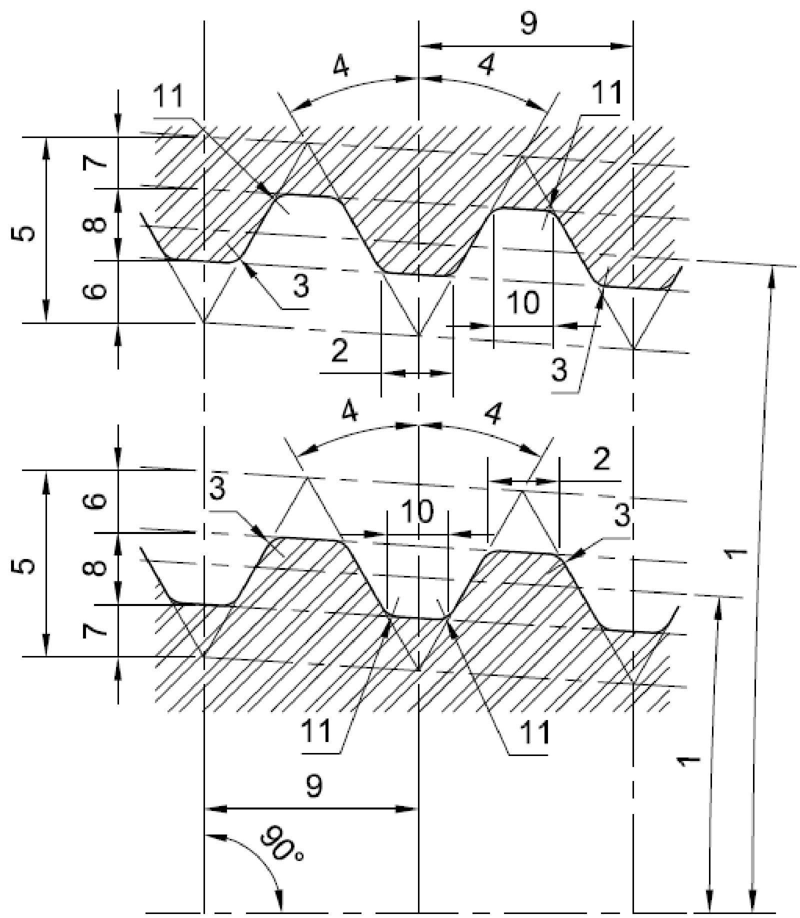
8 truncated thread height, $h$

9 lead, $p$

10 root radius, $R$

NOTE See Table B.2 (C.2) for dimensions.

**Figure 4—Thread Forms V-038R, V-050, V-040**




**Key**

1 taper half-angle, $\varphi$
2 crest flat, $F_c$
3 crest corner radius, $r_c$
4 thread half-angle, $\Theta$
5 thread height not truncated, $H$
6 crest truncation, $f_c$
7 root truncation, $f_r$
8 truncated thread height, $h$
9 lead, $p$
10 root flat, $F_r$
11 root corner radius, $r_r$

NOTE See Table B.2 (C.2) for dimensions.

**Figure 5—Product Thread Form V-055 (also V-065 and V-076)**

### 5.2.2 Purpose of Bevels

Bevels on connections serve two purposes. The first is to protect the outer edge of the sealing face from deformation in the form of mashes and fins. The second is to increase the contact pressure on the sealing face so as to minimize leaking and separation due to downhole bending.

Bevel diameters on the same ODs should be of equal size, within manufacturing tolerances, on mating pins and boxes to minimize the formation of grooves on the sealing faces. When mismatches of ODs greater than 6.35 mm (0.250 in.) occur, mismatches of bevel diameters will also occur.

Historically bevel diameters have been calculated every 6.35 mm (0.250 in.) based on 75 % of the shoulder width. This basic calculation is simple and depends only on the outside diameter and counter bore of the connection.

Effort has been made to preserve these historical bevel diameters because they are easy to calculate and have worked very well in most cases.

#### 5.2.3 Methods to Calculate Bevel Diameters

The process is fully described in Annex E.

#### 5.2.4 Other Considerations

Table B.3 has bevel diameters that cover a range from a suggested minimum OD to a maximum OD. For an OD falling between two listed values, the bevel diameter corresponding to the smaller OD shall be used. Table B.3 also contains a reference ID. The purpose of the reference ID is to be able to calculate shoulder loads that will not cause the seal face stress on mismatched ODs to exceed the SMYS of the product material.

When the ID of the pin connection (pin end) that mates directly with it is equal to or greater than the reference ID, the minimum OD listed for each connection in Table B.3 can be mated with the largest OD listed (or any OD in between) for that same connection in Table B.3 and the stress on the seal face will not exceed 100 % of SMYS.

The smallest bevel diameter shown in Table B.3 is the smallest bevel diameter recommended for each connection to avoid the risk that seal face stress generated by mismatches of ODs may exceed the SMYS. If a rotary shouldered connection is used on a product with smaller outside diameter than is listed in the table, the bevel diameter shall be set by agreement between the manufacturer and the purchaser.

Unless otherwise specified, bevel diameter tolerances shall be ±0.4 mm (±0.016 in.).

Bevel diameters in Table B.3 shall not apply to products that have specific requirements in API 5DP, API 7-1, ISO 10424-1, and ISO 11961, such as tool joints for drill pipe and HWDP, bits, or boxes that mate with bits.

For drilling equipment outside the scope of these standards, the manufacturer may specify a bevel diameter other than that listed in Table B.3.

### 5.3 Low-torque Feature

Several connections in larger sizes shall have modified bevel diameters and enlarged face counterbores when used on products with a large outside diameter. This allows the makeup torque to achieve adequate compressive stress on the sealing face while maintaining bending stiffness. These features are shown in Figure 6, and dimensions in Table B.4. These features shall be mandatory above the product diameter indicated in Table B.4.

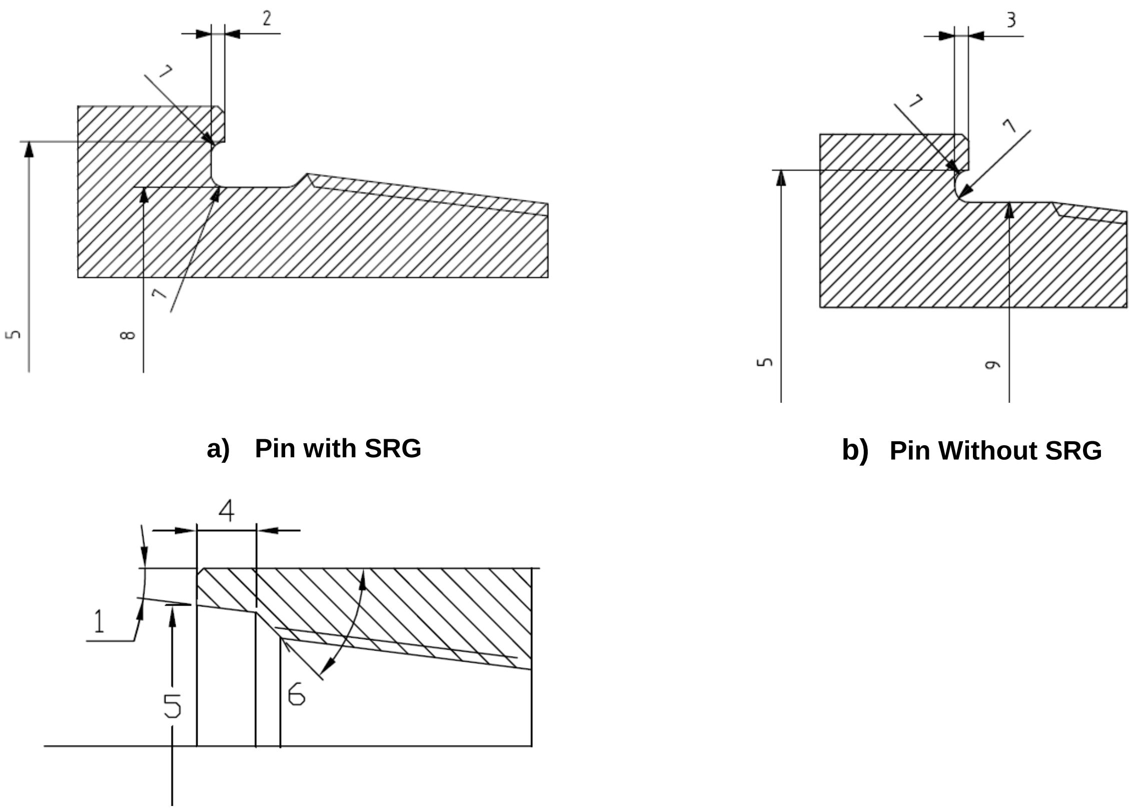
## 6 Product Optional Features

### 6.1 General

These features are required only if specified by the product specification (API 5DP or 7-1, ISO 10424-1 or ISO 11961), or on the product order. Some of the features noted below may be applied at the manufacturer's option.

### 6.2 Stress-relief Features

If fatigue failures in connections can be a problem, stress-relief features may be specified. Stress-relief features are of two basic designs: (1) a groove on the pin and a boreback contour for boxes or (2) a groove on both the pins and boxes. The boreback stress-relief contour is the recommended design for the box connection (box end). However, the box relief groove also has been shown to provide beneficial effects.




**a) Pin with SRG**

**b) Pin Without SRG**

**c) Box**

**Key**

1 taper half-angle, $\varphi$

2 face groove depth with stress relief groove, 6.4 mm +1.6/0 mm (0.25 in. +0.063/0 in.)

3 face groove depth with pin cylinder [1.6 mm +0.8/0 mm (0.063 in. +0.031/0 in.)]

4 counterbore depth, 9.5 mm 0/−1.6 mm (0.375 in. 0/−0.063 in.)

5 groove diameter, $D_{FG}$

6 45° ±1°

7 face groove radius, $R_{FG}$

8 stress relief groove diameter, $D_{SRG}$

9 pin cylinder diameter, $D_{LF}$

NOTE See Table B.4 (C.4) for dimensions.

**Figure 6—Low-torque Feature for Certain Connections with Large ODs**

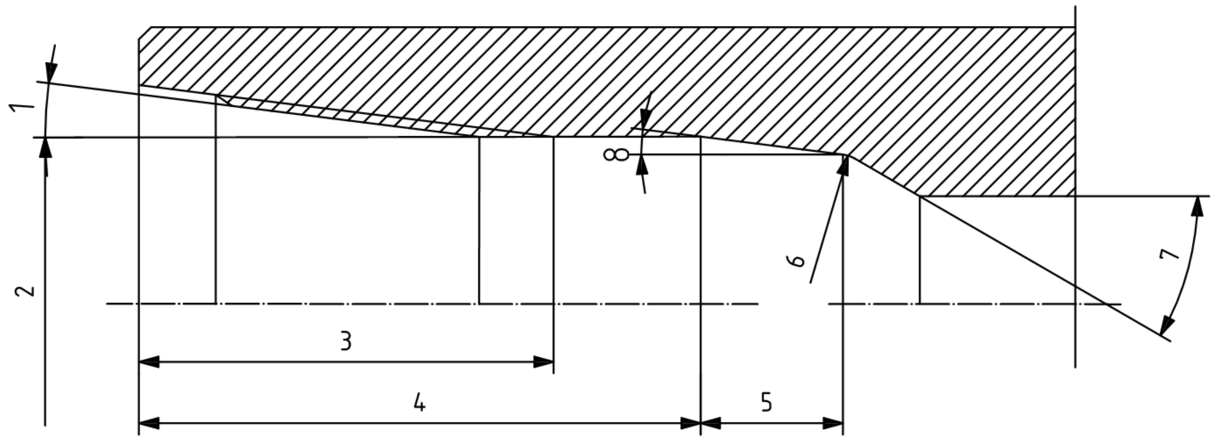
These features are shown in Figures 7 through 9. The dimensions for connections not listed here may be calculated according to the equations in Annex E. Stress-relief grooves at the pin shoulder and stress-relief grooves or borebacks at the base of the box thread shall conform to the dimensions shown in Table B.6.

Stress-relief grooves are recommended for use only on pin threads with pitch diameter, $C$, at gauge point greater than 89 mm (3.5 in.) so as to limit the reduction in cross section to less than 12.5 %

The boreback contour is recommended for use only on threads with pin length ($L_{PC}$) greater than 89 mm (3.5 in.).

Stress-relief grooves on pins cause a slight reduction in the tensile strength and section modulus of the connection. However, under most conditions this reduction in cross-sectional area is more than offset by the reduction in fatigue failures. If high tensile loads are expected, or if the pin inside diameter is larger than the inside taper dimension listed in Table B.5, calculations of this effect should be made.

Any transition radius to the stress-relief feature shall be smoothly blended to the groove.




**Key**

1 thread taper half-angle, $\varphi$, reference

2 boreback cylinder diameter, $D_{CB}$,
3 µm (125 µin.) $R_a$ finish

3 depth to last scratch of thread, $L_X$

4 depth of boreback cylinder, $L_{CYL}$

5 length of taper section, 50 mm ±6 mm (2 in. ±0.25 in.)

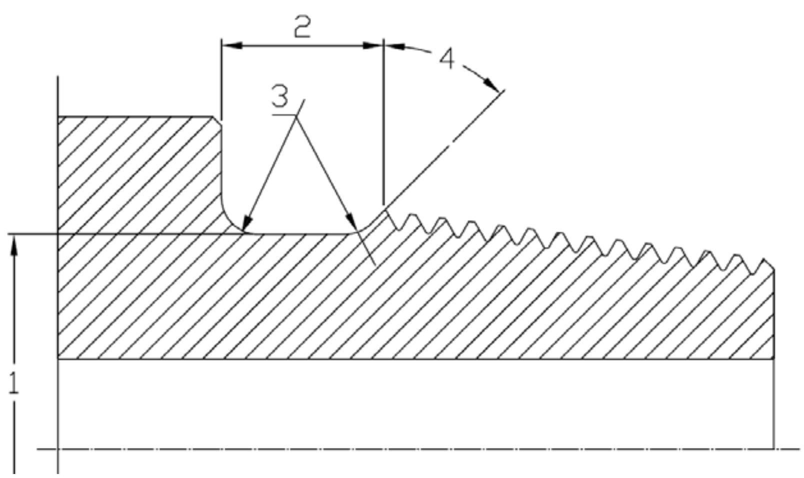
6 transition radius, 25 mm (1.0 in.)

7 transition cone, 30° maximum

8 transition taper equal to thread taper

NOTE See Table B.6 (C.6) for dimensions.

**Figure 7—Box Boreback Feature**




**Key**

1 stress-relief groove diameter, $D_{SRG}$,
1.5 µm (63 µin.) $R_a$ finish

2 groove length, $L_{SRG}$,
18.26 to 26.19 mm (0.719 to 1.031 in.)

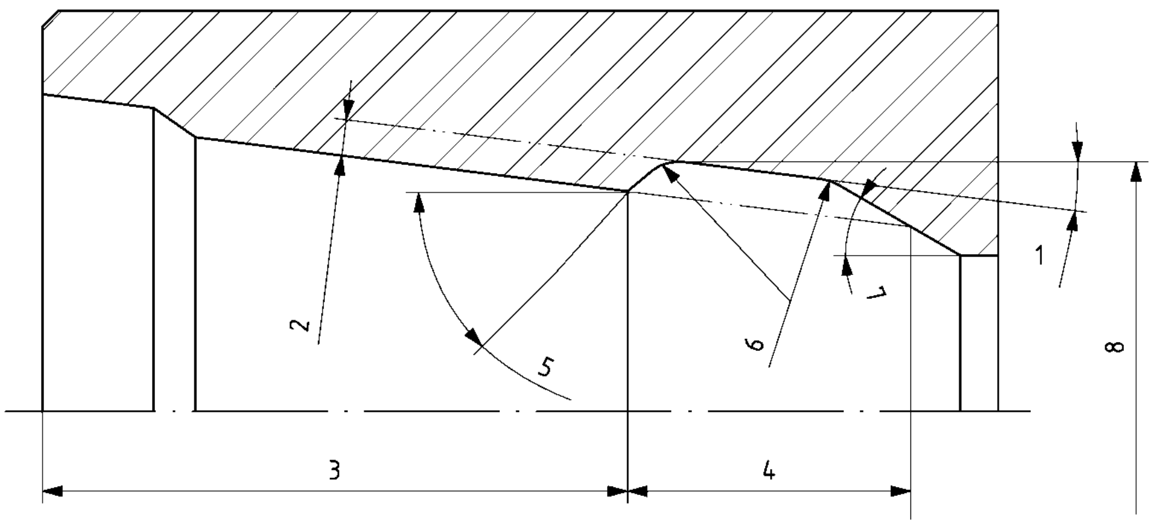
3 radius 6.4 ±0.4 mm (0.25 in. ±0.016 in.),
1.5 µm (63 µin.) $R_a$ finish, blended with $D_{SRG}$

4 45° ref

NOTE 1 The radius of Key 3 may undercut the shoulder if it does not reduce the area of the sealing face.

NOTE 2 See Table B.6 (C.6) for dimensions.

**Figure 8—Pin Stress-relief Groove**




**Key**

1 taper equal to thread taper half-angle, $\varphi$

2 box groove depth, $h_{bg}$

3 length, face to groove of box member, $L_{BG}$, 5.16 mm +0.4/0 mm (0.203 in. +0.016/0 in.)

4 groove length, 38.1 mm ±3.2 mm (1.5 in. ±0.125 in.), 1.5 (63) finish

5 groove edge angle, 45° ±2°

6 groove radius, 6.35 mm ±0.4 mm (0.25 in. ±0.016 in.), 3 µm (125 µin.) $R_a$ finish, blended to box groove, Key 2

7 transition cone angle, 30° maximum

8 box groove major diameter, $D_{BG}$

NOTE See Table B.6 (C.6) for dimensions.

**Figure 9—Box Stress-relief Groove**

## 6.3 Optional Profile Features

### 6.3.1 General

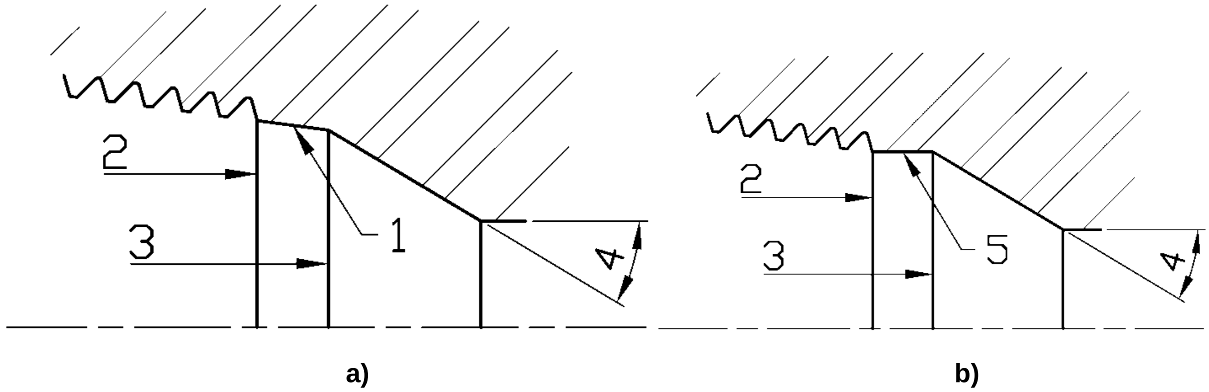
Several optional features have historically been used by some producers and are acceptable, but not required.

### 6.3.2 Inside Taper on Pin

An internal taper as shown in Key 10 of Figure 1 may be used on the end of pin connections (pin ends) unless otherwise specified, to ease the passage of service tools and reduce flow discontinuities. In this case, the internal diameter at the end of the pin shall be as listed in Table B.5 and shall be concentric to the axis of the connection. The taper angle shall be 10° to 30°. The diameter is based solely on historical practice. When this feature is not used there shall be a bevel at the end of the pin ID, with dimensions to be determined by the producer.

### 6.3.3 Unthreaded Area on Box

The unthreaded area on the box between $L_{BT}$ and $L_{BC}$ is most commonly finished as a continuation of the minor diameter of the box threads with the thread taper—this is shown in Figure 10a. At the producer's option, a cylindrical bore may be substituted as in Figure 10b. Threading may continue beyond the $L_{BT}$ length.




**Key**

1 tapered bore with taper $T$

2 end of full depth threads, $L_{BT}$

3 total box depth, $L_{BC}$

4 transition angle to box ID, 30° max

5 optional cylindrical bore

**Figure 10—Unthreaded Area of Box Connection**

## 6.4 Benchmarks

### 6.4.1 General

At the manufacturer's option, or if specified by the customer, a benchmark may be used on both box and pin to serve as a witness of the original dimensions. This permits the evaluation of any rework of the shoulder face to repair damage in service. The benchmark shall be applied 3.18 mm (0.125 in.) from the face, on the pin base or on the box counterbore, and shall not be remarked unless the threads are remachined.

Benchmarks are commonly used on drill pipe tool joints. They shall not be used on pin connections (pin ends) with stress-relief grooves.

Two types of benchmarks are used, the cylinder benchmark and the stamped benchmark. Both are described below under 6.4.2 and 6.4.3, respectively.

### 6.4.2 Cylinder Benchmark

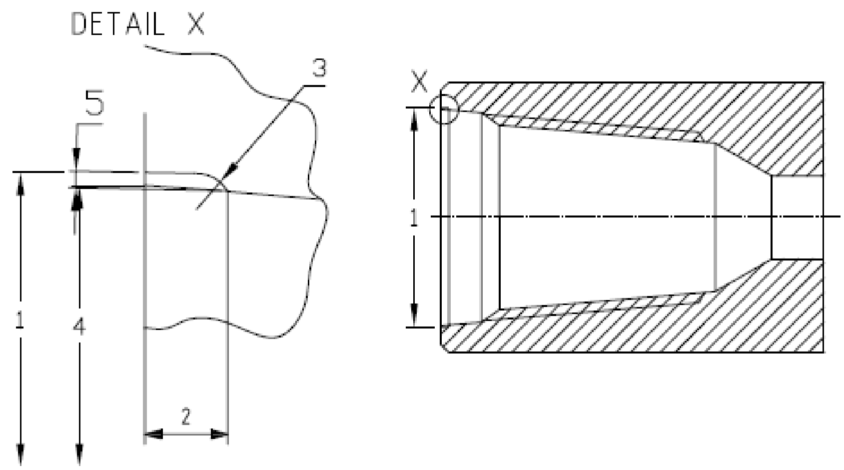
The cylinder benchmark consists of a turned cylinder in the box counterbore or a raised cylinder on the pin base, 3.18 mm (0.125 in.) long, as shown in Figures 11 and 12.

The diameter of the cylinder benchmark feature in the box is the counterbore diameter, $Q_c$, plus 0.4 mm (0.016 in.), tabulated as $D_{PB}$ in Table B.5.

The diameter of the cylinder benchmark feature on the box (Key 1 of Figure 11) and the projected diameter of the counterbore (Key 4) shall both fall within the tolerance for $Q_c$ in Table B.1.

### 6.4.3 Stamped Benchmark

The stamped benchmark consists of a 4.77 mm (0.188 in.) diameter circle with a bar tangent to the circle. The bar is located to the side of the circle nearest the makeup shoulder. The benchmark is stamped on the product so that the bar is parallel to the makeup shoulder and positioned 3.18 mm (0.125 in.) from the shoulder face as shown in Figure 13.




**Key**

1 benchmark diameter

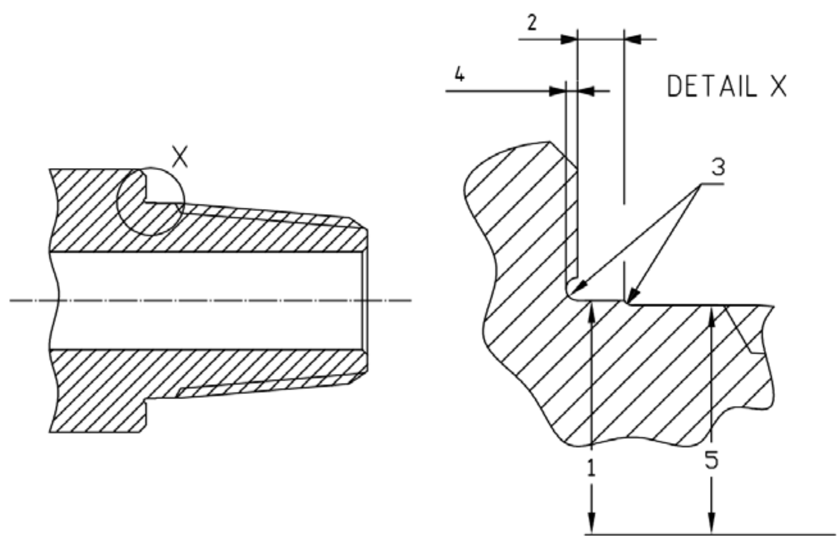
2 benchmark depth
3.18 mm 0/−0.25 mm (0.125 in. 0/−0.010 in.)

3 radius 0.8 mm ±0.25 mm (0.031 in. ±0.010 in.)

4 projected counterbore diameter

5 benchmark height 0.4 mm (0.016 in.) minimum

**Figure 11—Cylinder Benchmark (Box)**




**Key**

1 benchmark cylinder diameter; $D_{PB}$, see 6.4.2

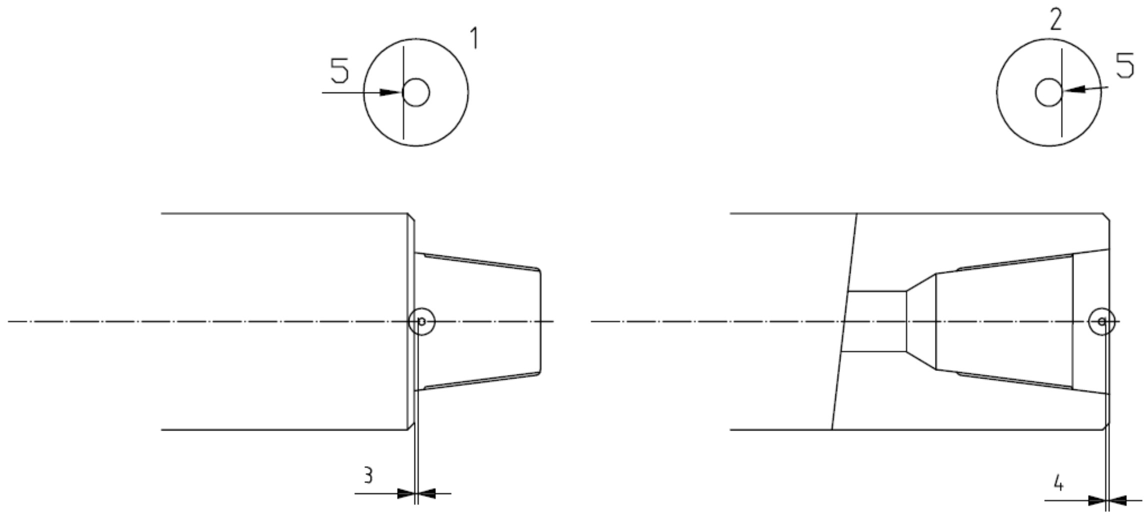
2 benchmark cylinder length, 3.18 mm +0.25/0 mm (0.125 in. +0.010/0 in.)

3 groove radius, 0.8 mm. ±0.1 mm (0.031 ±0.004 in.)

4 groove depth, 0.65 mm ±0.15 mm (0.026 in. ±0.006 in.)

5 pin cylinder diameter, $D_{LF}$

**Figure 12—Cylinder Benchmark (Pin)**




**Key**

1 benchmark orientation (pin)

2 benchmark orientation (box)

3 benchmark location (pin), 3.18 mm (0.125 in.) from shoulder

4 benchmark location (box), 3.18 mm (0.125 in.) from shoulder

5 benchmark diameter, 4.77 mm (0.188 in.)

**Figure 13—Stamped Benchmark**

## 6.5 Surface Treatment

Surface treatment is required by API 5DP and API 7-1 and is not otherwise required by this standard. All gauging shall be done before surface treatment.

## 6.6 Cold Rolling

If so specified, or at the producer's option the roots of threads may be cold rolled after gauging. A connection shall be considered to conform to this specification if it meets the requirements of this standard before cold rolling. In such event, the connection shall also be stamped with a circle enclosing CW (an old symbol) to indicate cold rolling after gauging. A pin connection (pin end) shall be so marked on the end of the pin. A box connection (box end) shall be marked in the box counterbore.

NOTE 1 Gauge standoff changes after cold working of threads; therefore, cold rolling of gauged connections can result in connections that do not fall within the gauge standoff of this standard. This does not affect the interchangeability of connections and improves the performance of connections in fatigue.

NOTE 2 Improper cold rolling can be damaging to the connection; cold rolling procedures are outside the scope of this document and are discussed in API 7-1 and ISO 10424-1.

## 6.7 Break-in

If so specified, the connection may be "broken-in" by repeated make and break of the connection before being placed in service. This shall be performed following a documented procedure. All gauging shall be done, before break-in.

# 7 Product Gauging

## 7.1 Gauging

### 7.1.1 General

Any manufacturer who desires to produce drill stem members utilizing rotary shouldered connections conforming to this specification shall own or have access to calibrated Reference Master gauges, consisting of mated sets of Reference Master plug(s) and Reference Master ring gauge(s) conforming to the requirements in 8.2.2.

All threads of rotary shouldered connections shall comply with the gauging requirements specified herein. These requirements are not intended in any way to restrict the use of any other instruments or methods to control manufacturing operations. In case of dispute, acceptance and rejection of the product shall be governed by the use of instruments for determining standoff, lead, taper and thread form described in this standard. The intent of this standard is that any thread element of the product shall be acceptable if any measurement of that element, measured as defined in 7.1.2 to 7.6, is found to be in conformance. That is, the variation of gauges, within tolerances, shall not be a reason for rejection.

The gauging elements of new rotary shouldered connections are described in Annex F.

#### 7.1.2 Precautions

##### 7.1.2.1 Temperature

All instruments shall be exposed to the same temperature conditions as the product to be inspected, for a time sufficient to eliminate any temperature difference.

Some materials used to make rotary shouldered connections, notably on non-magnetic drill collars, have thermal expansion coefficients significantly different from the steel used to make gauges. This effect can impact the measurement of standoff if the temperature is far from 20 °C (68 °F) and shall be taken into account.

NOTE Taking this into account can help in cases of dispute on the measurement.

##### 7.1.2.2 Care of Instruments

The instruments described herein are precision instruments and shall be handled in a careful and intelligent manner, commensurate with the maintenance of the high accuracy and precision required for inspection under the requirements of this gauging practice, as described in Annexes G, H, and I. If any instrument is damaged, for instance inadvertently dropped or severely shocked, it shall not be used for inspection purposes until its accuracy has been reestablished.

##### 7.1.2.3 Cleaning the Threads

All threads shall be cleaned thoroughly before gauging. If the gauging is made after shipment, the thread compound shall be removed with a brush having stiff bristles, using a suitable solvent.

### 7.2 Standoff Measurement

#### 7.2.1 Standoff

The standoff of the Working gauge is intended as a method to locate the plane of the pitch diameter in relation to the sealing shoulder of the connection. It is dependent on the other elements of the thread, notably lead and taper. The effect of taper error is small when it is in conformance with the specification. The effect of lead error, even within tolerance, can be as large as that of the tolerance on pitch diameter at the gauge point, and lead must therefore be measured as well as standoff.

#### 7.2.2 Working Gauges

The manufacturer shall have available Working gauges, as defined in Section 8 of this standard, to gauge product threads and shall maintain all Working gauges in such condition as to ensure that product threads, gauged as required herein, are acceptable (see Annex G for recommended practice for care and use of Working gauges). The Working gauges shall comply with all the stipulations on calibration and retest as specified in Section 9. The use of Reference Master gauges in checking product threads should be minimized. Such use should be confined to cases of dispute that cannot be settled by rechecking the

Working gauges against the Reference Master. Good care should be exercised when the Reference Master gauge is assembled on a product thread. The purchaser of Reference Master gauges shall comply with all the stipulations on calibration and retest as given in Section 9.

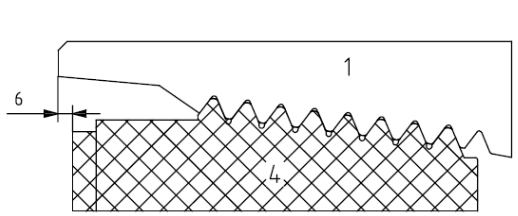
### 7.2.3 Standoff Tolerances

Tolerances on standoff values shall be as shown in Figure 14 and the following shall also apply.

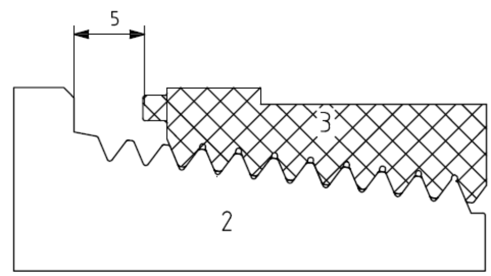
a) Standoff of the Working ring gauge to the product pin: $S_2$ +0.25/−0.13 mm ($S_2$ +0.010/−0.005 in.).

b) Standoff of the Working plug gauge to the product box: ($S - S_1$) + 0.25/0 mm [($S - S_1$) +0.010/0 in.].

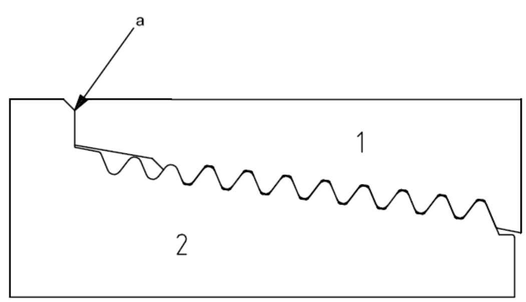
The standoffs, $S_1$ and $S_2$, of the Working gauges are defined in 8.1. These tolerances shall apply after the connection is finish-machined and before any anti-galling or cold-working surface treatment is applied to the pin or box connection (pin or box end). Gauge standoff may change after the application of surface treatment and may cause the standoff to exceed the limits specified for the connection and shall not constitute a cause for rejection. It is, therefore, permissible for a connection to be referenced to this standard if it meets its requirements before the application of the surface treatment.




**a) Gauging of Box**




**b) Gauging of Pin**




**c) Mating of Product Threads**

**Key**

1 product box
2 product pin
3 Working ring gauge
4 Working plug gauge
5 ring gauge standoff, $S_2$ +0.25/–0.13 mm ($S_2$ +0.010/−0.005 in.) [b]
6 plug gauge sits in ($S - S_1$) +0.25/0 mm [($S - S_1$) +0.010/0 in.]

[a] At hand tight condition, a gap may exist at the face.

[b] For drill bit pins only, standoff may be $S_2$ +0.25/−0.79 mm ($S_2$ +0.010/−0.031 in.).

**Figure 14—Gauging Practice**

## 7.3 Gauge Contact Points

The measurement of lead and taper shall be made as close as practical to the pitch cone of the thread. Contact points of lead and taper gauges shall, therefore, be of the ball-point type and should preferably be made of tungsten carbide or tantalum carbide. The dimensions of the ball-point contacts shall be such that they contact the thread flanks rather than the thread root. The ball-point diameters, $d_b$, meeting flank contact requirements are specified in Table B.7 (column 5). The contact point diameters, $d_{bh}$, for thread height gauges should be ball type with a diameter as specified in Table B.7 (column 7) and shall not contact the thread flank.

## 7.4 Lead Measurement

### 7.4.1 Lead Tolerances

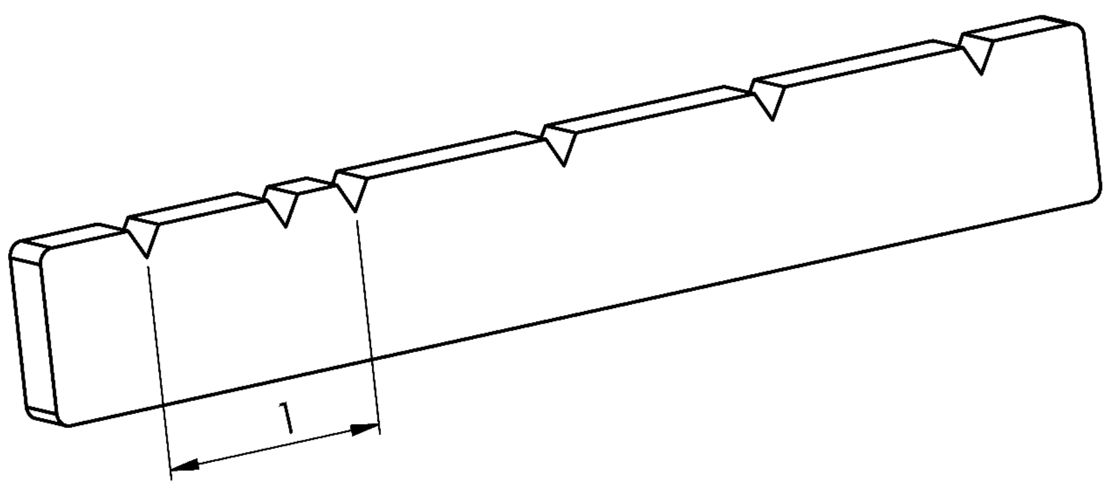
Lead tolerances shall be expressed in terms of mm per 25.4 mm (in. per 1 in.) of threads and cumulative error and lead errors shall be determined accordingly. For interval measurements over lengths other than 25.4 mm (1 in.), the observed errors shall be calculated to the basis of mm per 25.4 mm (in. per 1 in.). The cumulative error shall be made using the longest available setting length for the lead gauge.

The lead of threads shall be gauged with a lead gauge. The precision of the measuring mechanism shall be 0.013 mm (0.0005 in.) or smaller.

### 7.4.2 Lead Gauge Setting Standard

Lead gauge setting standards, similar to Figure 15, shall be so constructed as to compensate for the error in measuring lead parallel to the taper cone instead of parallel to the thread axis, according to the $L_{ct}$ values shown in Table B.7.

The distance between any two adjacent notches of the template shall be a multiple of the thread lead compensated for taper, $L_{ct}$, within a tolerance of ±0.003 mm (±0.0001 in.), and between any two non-adjacent notches within a tolerance of ±0.005 mm (±0.0002 in.). The notches shall cover a span of at least 102 mm (4 in.) and shall include at least one interval corresponding to the thread lead.




**Key**

1 multiple of compensated thread lead, $L_{ct}$

**Figure 15—Standard Lead Template**

## 7.5 Taper Measurement

### 7.5.1 Taper Errors

For all threads of rotary shouldered connections, taper tolerances shall be expressed in terms of millimeters per millimeter (inches per foot) of thread and taper errors shall be determined accordingly. The measurements are made for a suitable interval of thread length and the observed errors shall be calculated to the millimeters per millimeter (inches per foot) basis.

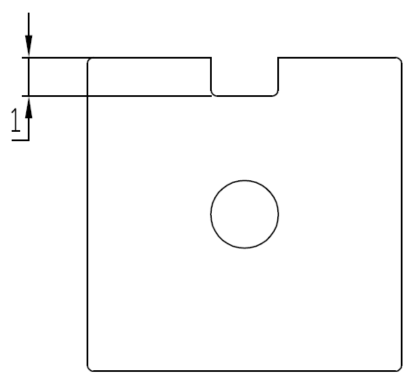
### 7.5.2 Taper Calipers

The taper of threads shall be measured with an instrument having a precision of 0.025 mm (0.001 in.) or less within the measurement range used.

## 7.6 Thread Height Measurement and Gauges

Thread height shall be measured with an instrument having a precision of 0.013 mm (0.0005 in.) or better within the measurement range used.

A standard template as shown in Figure 16 shall be provided for standardizing the height gauge. The standard templates shall be so constructed as to compensate for the error in measuring height normal to the taper cone instead of normal to the thread axis. For the U-groove on standard templates, the depth of the groove shall conform to the dimensions $h_{cn}$ shown in Table B.7 (column 6) within a tolerance of ±0.005 mm (±0.0002 in.).




**Key**

1 compensated thread height, $h_{cn}$

**Figure 16—Thread Height Setting Standard**

# 8 Gauges for Rotary Shouldered Connections

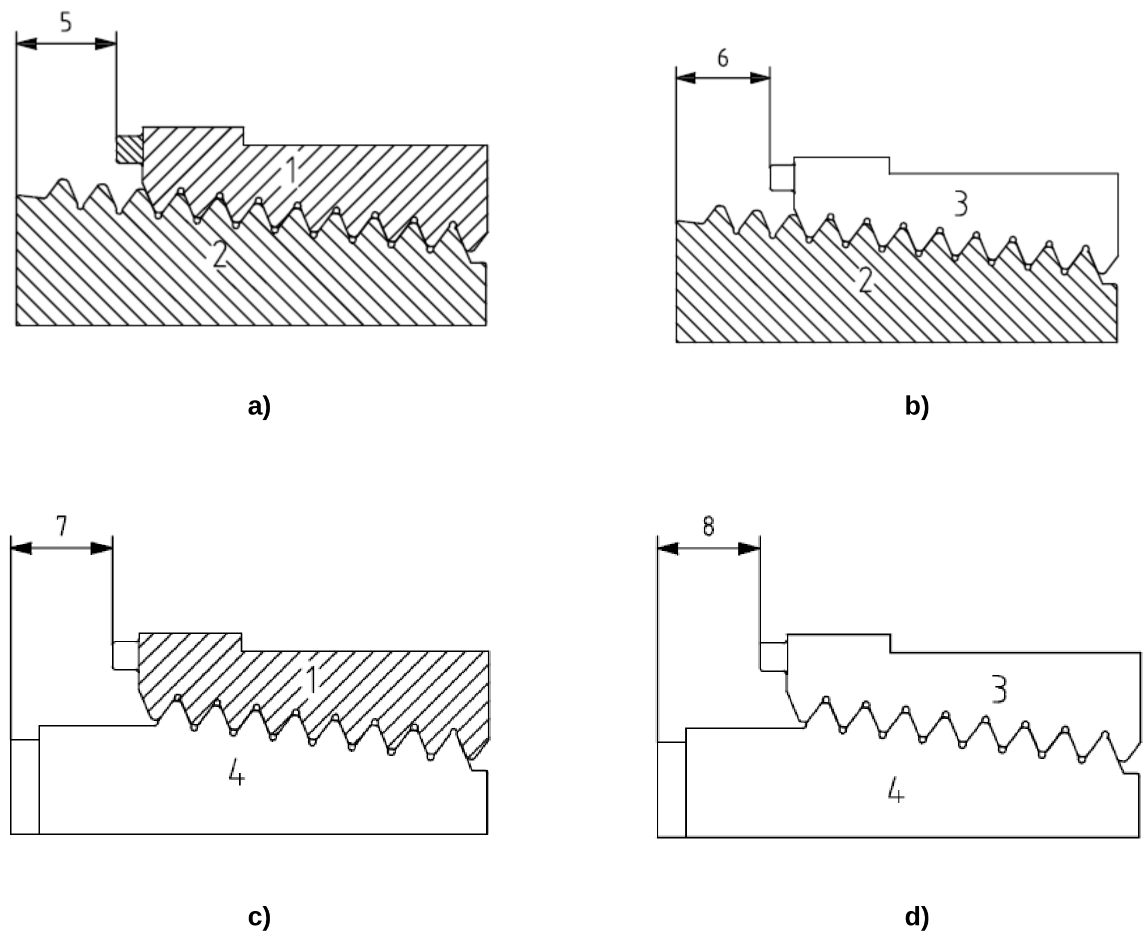
## 8.1 Gauge Relationship

The relationship between Reference Master gauges and Working gauges shall be as shown in Figure 17 wherein the certified Reference Master plug gauge is shown as the standard and the certified Reference Master ring gauge as the transfer standard. The standoff value, $S_0$, of certified Reference Master gauges is the distance from the plane of the rotary shoulder on the plug gauge to the plane of the gauge point on the ring gauge. The certified Reference Master ring gauge is used to establish the standoff value, $S_1$, of the Working plug gauge. The certified Reference Master plug gauge is used to establish the standoff value, $S_2$, of the Working ring gauge. $S_1$ and $S_2$ are measured values that the Working gauges stand off from their certified Reference Master gauges and may be greater or less than $S$, up to the interchange limits of

Table B.12. These values shall be recorded for each Working gauge member, together with the identification number of the Reference Master set from which they were derived.

The standoff value, $S_0$, of certified Reference Master gauges (Figure 17a) shall be measured at 20 °C ±1 °C (68 °F ±2 °F). Verifications of Working gauges (Figures 17b to 17d) may be at any temperature as long as both the master and Working gauges have normalized to the same temperature.

The mating standoff of the Reference Master ring gauge against the Reference Master plug gauge as marked on the ring gauge is intended primarily as the basis for establishing the limits of wear or secular change in the Reference Master gauges.




**Key**

1 certified Reference Master ring gauge

2 certified Reference Master plug gauge

3 Working ring gauge

4 Working plug gauge

5 $S_0 = S$ ±0.025 mm ($S$ ±0.001 in.)

6 Ring Gauge Interchange Standoff, $S_2$

7 Plug Gauge Interchange Standoff, $S_1$

8 $S$ ±0.025 mm ($S$ ±0.001 in.)

**Figure 17—Gauge Relationships**

## 8.2 Gauge Specifications

### 8.2.1 Specifications

The gauge specifications in this standard derive from API 7. All gauges manufactured before December 1, 2008 and conforming to the requirements of the 40th Edition of API 7 shall be considered to conform to this standard.

### 8.2.2 Master Gauges

Grand, Regional and Reference Master gauges shall conform to the dimensions specified in Tables B.8 to B.10 and Figures 18 and 19. For Master gauges, the gauge point for pitch diameter is located 15.875 mm (0.625 in.) from the measuring face. The major diameter of the plug gauge and the minor diameter of the ring gauge at this gauge point are listed in Table B.9 for reference.

Grand and Regional Master gauges shall conform to the tolerances specified in Table B.11. Reference Master gauges shall conform to the tolerances specified in Table B.12. Prior to use, all Regional and Reference Master gauges shall be calibrated as required in Section 9.

The same gauging principles and tolerances can be applied to the connections listed in Annexes J, K, and L and all thread dimensions can be calculated from the thread elements.

### 8.2.3 Working Gauges

Working gauges shall conform to the dimensions specified in Tables B.8 to B.10 and Figures 18 and 20, and to the tolerances specified in Table B.13. All Working plug gauges shall have the unused threads removed from the large end, except for gauges with mating standoff of 9.525 mm (0.375 in.) such as 1 and $1^{1}/_{2}$ REG. To assure removal of the unused threads, the start of the first thread on the large end of the Working plug shall be located within the limits of 27.43 mm to 28.45 mm (1.080 in. to 1.120 in.) from the surface used to determine standoff.

For Working gauges, the gauge point for pitch diameter is located 34.925 mm (1.375 in.) from the measuring face.

### 8.2.4 General Design

Plug and ring gauges shall be through-hardened and ground. Hardness shall be a minimum of Rockwell C55, or equivalent hardness on a superficial scale.

Thread gauges may be specified as right-hand or left-hand. However, as of 2016, left-hand Reference Master gauges exist only for threads in the REG style. Imperfect threads at ends of plug and ring gauges shall be reduced to a blunt start.

Gauges shall be furnished with fitting plates as illustrated in Figures 19 and 20 except for gauges with mating standoff of 9.53 mm (0.375 in.) such as 1 and $1^{1}/_{2}$ REG. These fitting plates, or the faces of gauges without fitting plates, shall be flat, and square to the axis of the pitch-cone, within 0.010 mm (0.0004 in.).

### 8.2.5 Root Form

The roots of gauge threads shall be sharp with a radius of truncation not to exceed 0.25 mm (0.01 in.), or undercut to a maximum width equivalent to the basic root truncation values given in Table B.2. The undercut shall be of such depth as to clear the basic sharp thread; otherwise, the shape of the undercut is not important.

### 8.2.6 Initial Standoff

New and reconditioned plug and ring gauges shall conform to the mating standoff dimension, specified in Table B.9, and the mating standoff tolerances specified in Tables B.11 to B.13.

The interchange standoff for plug and ring gauges against Grand, Regional, and Reference Master gauges shall conform to the nominal standoff of Table B.9 and the interchange standoff tolerances specified in Tables B.11 to B.13.

NOTE The requirements for interchange standoff place a restriction on the magnitude of the thread-element errors that can be present in gauges that meet both the mating and interchange standoff requirements. If the errors in certain thread elements are at or near the maximum limits allowed by Tables B.11 to B.13, then the errors on other thread elements need to be well within the limits to compensate. Differences in lead in mated gauges can be partially or completely compensated by difference in taper.

### 8.2.7 External Elements

Dimensions $L_{\mathrm{pg}}$, $L_{\mathrm{rg}}$, $D_{\mathrm{R}}$, $Q$, and fitting plate diameter, $D_{\mathrm{FP}}$, shall conform to the dimensions given in Table B.10 and the tolerances given in Tables B.11 to B.13. The length of the controlled outside dimension, $D_{\mathrm{R}}$, of the ring gauge is optional to the manufacturer. The fitting plate thickness, $T_{\mathrm{FP}}$, shall not exceed 9.53 mm (0.375 in.) for connections with pitch diameter ($C$) 142.24 mm (5.6 in.) or smaller, and 11.1 mm (0.437 in.) for larger connections.

### 8.2.8 Surface Condition

The thread surfaces of gauges shall be ground to a surface roughness of 0.8 µm (32 µin.) $R_{\mathrm{a}}$ or better as defined in ISO 1302, and shall be free of surface imperfections (such as cracks) capable of damaging the mating surface.

### 8.2.9 Marking

#### 8.2.9.1 General

Plug and ring gauges shall be permanently marked by the gauge manufacturer with the markings given in 8.2.9.2 through 8.2.9.7. The marking location on plug gauges shall be on the body, although marking on the handle is acceptable on gauges in small sizes when the handle is integral with the body. Any markings that are considered necessary by the gauge manufacturer may be added.

#### 8.2.9.2 Size

The size or number of the gauge shall be as given in Table B.9, column 1.

#### 8.2.9.3 Style

Style of connection shall be as given in Table B.9, column 1 with left-hand indication, if applicable, followed by the designation ROTARY.

EXAMPLES—NC ROTARY and REG LH ROTARY.

#### 8.2.9.4 Class

The classes of gauges are one of the following:

— Working,

— Reference Master,

— Regional Master,

— Grand Master.

#### 8.2.9.5 Manufacturer

The manufacturer shall assign an identification number to each gauge, unique for that manufacturer. The name or identifying mark of the gauge maker, together with the identification shall be placed on both plug and ring gauge. In the case of API gauges in the API Monogram program, the certifying agency shall assign a unique number, and this shall also be marked.

#### 8.2.9.6 Date

The date of certification shall be marked on Master gauges. In recertifying reconditioned gauges, the previous certification date shall be replaced with the date of recertification. Dates of retest, as required by 9.3.1.5, shall not be marked on master gauges.

#### 8.2.9.7 Standoff

The initial mating standoff of Master gauges and Working gauges shall be marked on the ring gauge only. Mating standoff values determined by periodic retest as specified in 9.3.1.6 shall not be marked on Reference Master or Working gauges.

EXAMPLE 1

A certified Regional Master NC56 rotary gauge marked as follows:

— NC56 ROTARY REGIONAL MASTER,

— A B Company (or Mark) Identification Number,

— Date of Certification,

— Initial Mating Standoff,

— API Monogram.

EXAMPLE 2

An NC56 Working gauge marked as follows:

— NC56 ROTARY WORKING,

— A B Company (or Mark) Identification Number,

— Initial Mating Standoff,

— API Monogram (if applicable).

EXAMPLE 3

A certified Reference Master $4^1/_2$ REG rotary gauge marked as follows:

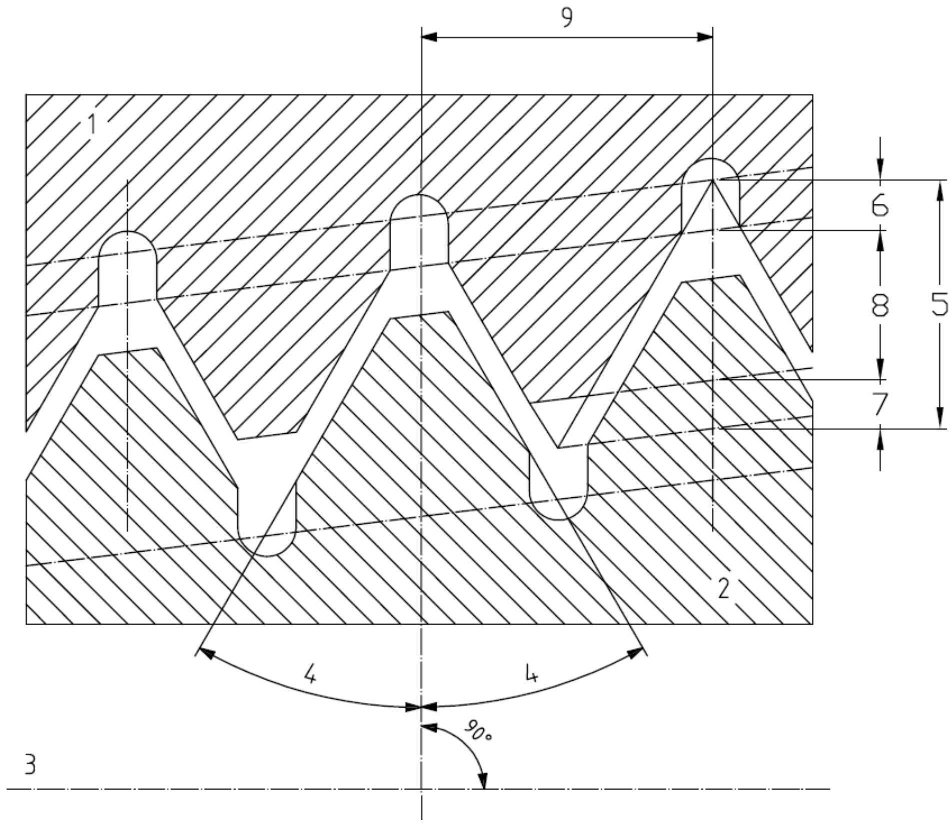
— $4^1/_2$ REG ROTARY REFERENCE MASTER,

— A B Company (or Mark) Identification Number,

— Date of Certification,

— Initial Mating Standoff,

— API Monogram (if applicable).




**Key**

1 ring gauge threads

2 plug gauge threads

3 axis of thread

4 thread half-angle, $\varphi$

5 thread height not truncated, $H$

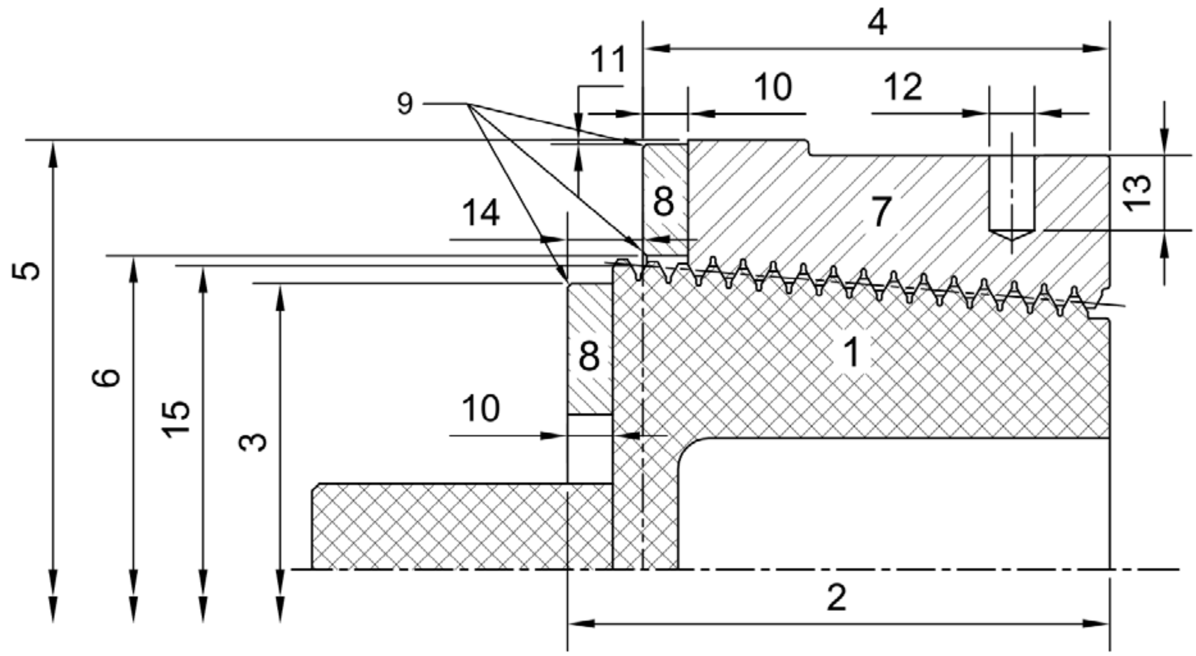
6 gauge root truncation, $f_{rg}$

7 gauge crest truncation, $f_{cg}$

8 gauge truncated thread height, $h_g$

9 lead, $p$

**Figure 18—Gauge Thread Form**




**Key**

1 master plug gauge

2 length of plug gauge, $L_{pg}$

3 plug fitting plate diameter, $D_{FP}$

4 length of ring gauge, $L_{rg}$

5 outside diameter of ring gauge, $D_r$

6 diameter of ring gauge counterbore, $Q$, and ID of fitting plate

7 Master ring gauge

8 fitting plate

9 chamfer fitting plates where shown, 0.8 mm (0.03 in.) × 45° typical

10 fitting plate thickness, $T_{fp}$

11 ring fitting plate relief from gauge diameter, 0.8 mm (0.03 in.) minimum

12 torque hammer hole diameter, 15.9 mm +0.4/0 mm (0.63 in. +0.016/0 in.) (Note 2)

13 torque hammer hole depth, 15.9 mm ±3.2 mm (0.63 in. ±0.13 in.)

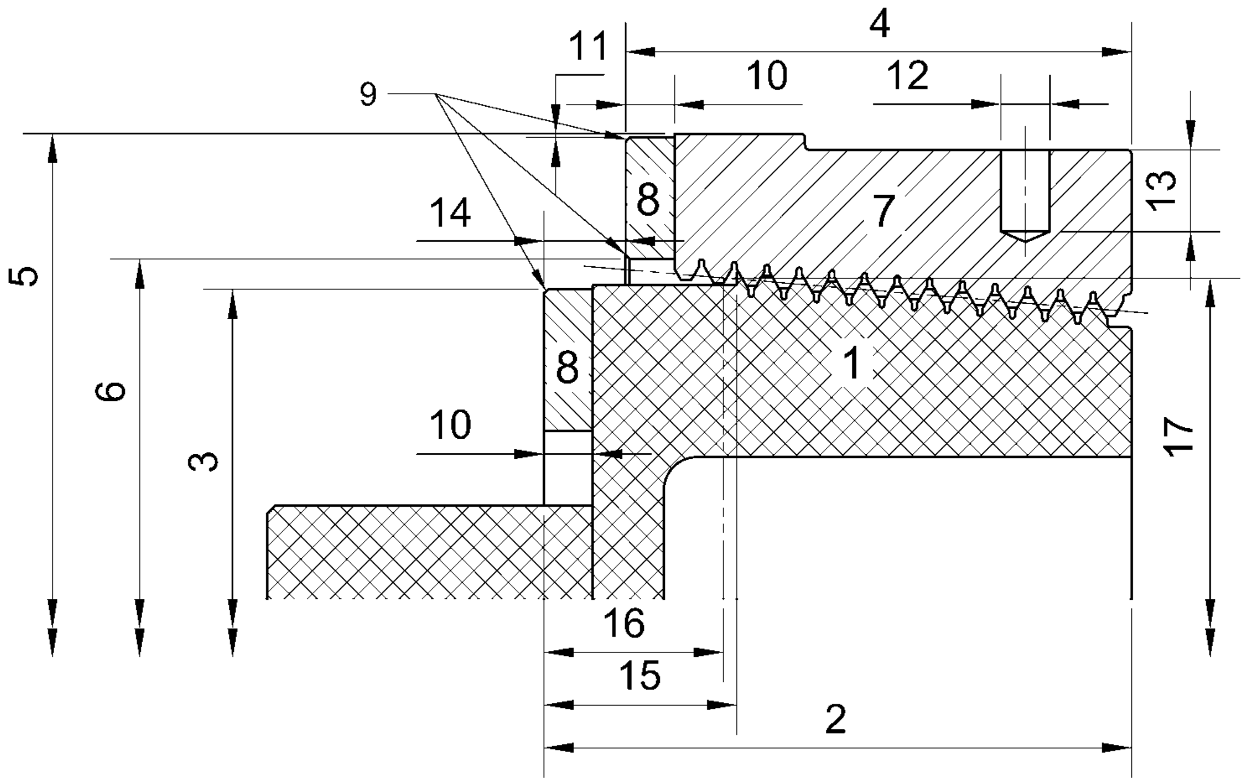
14 standoff, $S_0$

15 pitch diameter at gauge point

NOTE1 See Tables B.9 and B.10 (C.9 and C.10) for dimensions.

NOTE 2 For gauges with pitch diameter < 50 mm (2.0 in.), the hole diameter shall be 9.53 mm +0.25/0 mm (0.38 in. +0.01/0 in.).

**Figure 19—Grand, Regional, and Reference Master Thread Gauges**




**Key**

| | | | |
|---|---|---|---|
| 1 | Working plug gauge | 10 | fitting plate thickness, $T_{fp}$ |
| 2 | length of plug gauge, $L_{pg}$ | 11 | ring fitting plate clearance, 0.8 mm (0.03 in.) minimum |
| 3 | plug fitting plate diameter, $D_{FP}$ | 12 | torque hammer hole diameter, 15.9 mm +0.4/0 mm (0.625 in. +0.016/0 in.); see Note 2 |
| 4 | length of ring gauge, $L_{rg}$ | 13 | torque hammer hole depth, 15.9 mm ±3.2 mm (0.63 in. ±0.13 in.) |
| 5 | outside diameter of ring gauge, $D_r$ | 14 | standoff, $S$ |
| 6 | diameter of ring gauge counterbore, $Q$, and ID of fitting plate | 15 | gauge point for work gauge; see 8.2.3 |
| 7 | Working ring gauge | 16 | length of removed thread of plug gauge; see 8.2.3 |
| 8 | fitting plate | 17 | pitch diameter at work gauge point, $C_{GP}$ |
| 9 | chamfer fitting plates where shown, 0.8 mm (0.03 in.) × 45° | | |

NOTE 1 See Tables B.9 and B.10 (C.9 and C.10) for dimensions.

NOTE 2 For gauges with pitch diameter <50 mm (2.0 in.), the hole diameter shall be 9.53 mm +0.25/0 mm (0.38 in. +0.01/0 in.).

**Figure 20—Working Thread Gauges**

# 9 Gauge Calibration

## 9.1 Calibration System

Owners and users of Reference Master and Working gauges shall establish and document a system of gauge calibration and control. Records shall be maintained which show conformance of gauges to the design and calibration requirements of 8.2.2 and 8.2.3, including the originally certified (initial) standoff values. The calibration system shall establish the frequency of retest in conformance with 9.3.1.5 and 9.3.1.6. Records of calibration shall show the last calibration date, identity of the individual who performed the calibration, and calibration history. When Reference Master gauges are not on the site of the gauge user, copies of the Reference Master gauges' calibration certificate shall be maintained at the user site.

All gauges shall be calibrated and maintained in sets of corresponding ring and plug elements. A single Working gauge may be certified only if accompanied by a previously certified mating gauge (e.g. a manufacturer may need several ring gauges, but only one plug gauge for standoff verification; in this case, each of the ring gauges shall record standoff against the identified plug gauge and this plug gauge shall be used for periodic reverification).

All instruments shall be exposed to the same temperature conditions as the gauge to be inspected, for a time sufficient to eliminate any temperature difference. All measurements of gauges shall be made at 20 °C ± 1°C (68 °F ± 2 °F), except as noted below for pitch diameter at gauge point.

## 9.2 Acceptance Criteria

Any gauge thread element in this standard shall meet the following two conditions in order to be considered acceptable.

a) The uncertainty of the measurement is less than or equal to the greater of 25 % of the tolerance range and 0.0025 mm (0.0001 in.) for linear measurement or 0.1° for angular measurements.

b) The value measured is within the limits specified plus the measurement uncertainty.

## 9.3 Gauge Measurement Methods

### 9.3.1 Determination of Standoff

#### 9.3.1.1 Mating and Interchange Standoff

Mating and interchange standoff (see Figure 17) shall be determined as specified in 9.3.1.2 through 9.3.1.6. During the test, all pieces entering into the measurement shall be stabilized at the same temperature.

#### 9.3.1.2 Cleanliness

Gauges shall be free of visible evidence of contaminants before mating. A thin film of medicinal mineral oil shall be wiped on the threads with a suitable tool such as a clean chamois skin or bristle brush.

#### 9.3.1.3 Torque

The pair shall be mated hand tight without spinning into place and a complete register shall be accomplished with the torque hammer specified for each size (see Figure 21). Torque-hammer masses are as follows.

a) 0.45 kg (1 lb) for gauges with pitch diameter up to 50 mm (1.97 in.).

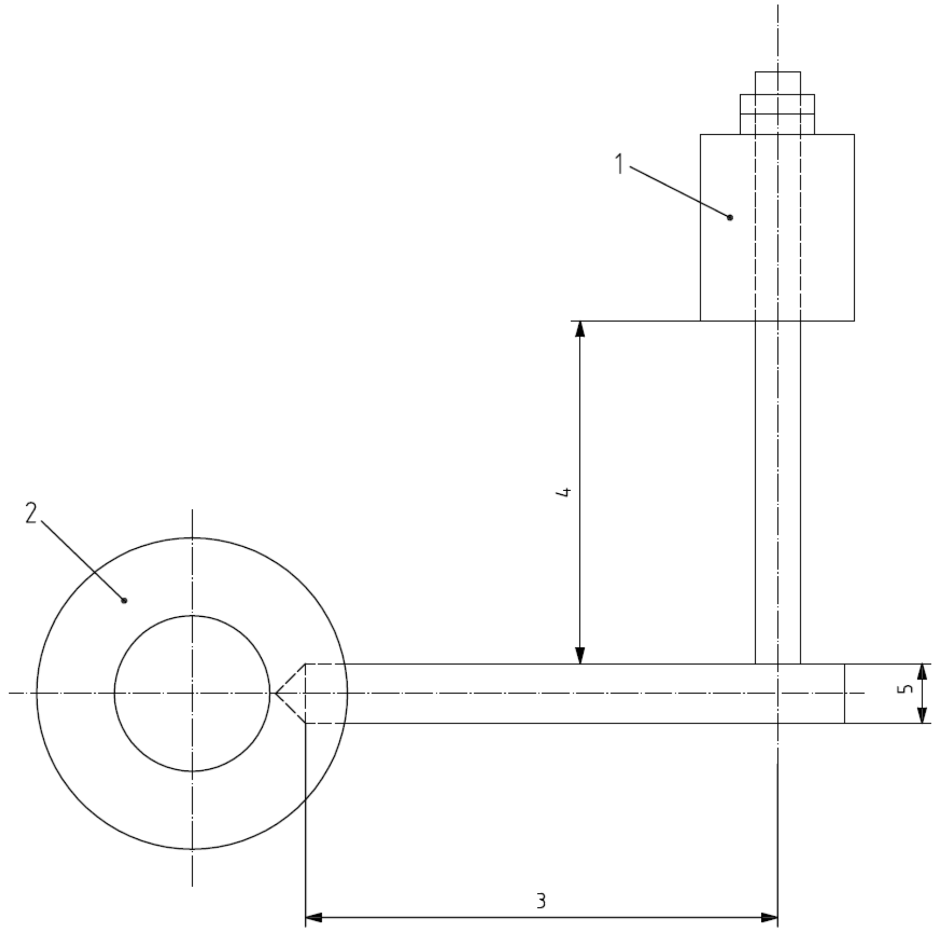
b) 0.91 kg (2 lb) for gauges with pitch diameter over 50 mm (1.98 in.) to 81 mm (3.19 in.).

c) 1.36 kg (3 lb) for gauges with pitch diameter over 81 mm (3.19 in.) to 130 mm (5.12 in.).

d) 1.82 kg (4 lb) for gauges with pitch diameter over 130 mm (5.12 in.) to 166 mm (6.54 in.).

e) 2.27 kg (5 lb) for gauges with pitch diameter over 166 mm (6.54 in.) to 180 mm (7.09 in.).

f) 2.72 kg (6 lb) for gauges with pitch diameter greater than 180 mm (7.09 in.).




**Key**

1 weight

2 ring gauge

3 torque arm length, 171.4 mm ±3 mm (6.75 in. ±0.12 in.)

4 drop height, 152.4 mm ±3 mm (6.0 in. ±0.12 in.)

5 torque arm diameter, 15.88 mm 0/−0.4 mm (0.625 in. 0/−0.016 in.)

**Figure 21—Torque Hammer**

Regarding Figure 21, use with gauges with pitch diameter <50 mm (2.0 in.), the diameter of the torque arm shall be 9.50 mm 0/–0.025 mm (0.374 in. 0/–0.010 in.).

#### 9.3.1.4 Torqueing Method

A sufficient number of torque-hammer blows shall be made so that continued hammering does not move the ring relative to the plug. When testing, the plug gauge shall be rigidly held, preferably in a vice mounted on a rigid work bench. When so held, 12 torque-hammer blows should be sufficient to make a complete register.

#### 9.3.1.5 Periodic Retest

##### 9.3.1.5.1 General

Plug and ring gauges shall be periodically retested according to the schedule specified in 9.3.1.5.2 and 9.3.1.5.3 to ensure the gauges remain within the standoff limits specified in 9.3.1.6.

#### 9.3.1.5.2 Master Gauges

Regional and Reference Master gauges shall be retested for mating and interchange standoff at least once each 7 years, and certified on a certificate of retest as being acceptable for further use. The certificate of retest shall also report the mating and interchange standoff of the gauges. Regional Master gauges shall be retested against Grand Master gauges at the recognized certifying metrology agency. Reference Master gauges shall be retested against certified Regional Master or Grand Master gauges. These agencies are listed in the API Composite list, at the web location in 9.4.

#### 9.3.1.5.3 Working Gauges

Working gauges shall be retested periodically for mating and interchange standoff against certified Reference Masters. The frequency at which Working gauges should be retested depends entirely upon the amount of use. Guidance may be found in ILAC-G24 by the International Laboratory Accreditation Cooperation. Frequency of retest shall ensure that mating and interchange standoff is maintained within the requirements of 9.3.1.6. A calibration system as specified in 9.1 shall be used to establish frequency of retest.

### 9.3.1.6 Retest Standoff

Mating standoff of gauges (plugs and rings) on periodic retest shall conform to the following wear limit tolerances from the originally established mating values.

a) Regional Master gauges: −0.0330/+0.0127 mm (−0.0013/+0.0005 in.).

b) Reference Master gauges: −0.0584/+0.0127 mm (−0.0023/+0.0005 in.).

c) Working gauges: −0.0584/+0.0127 mm (−0.0023/+0.0005 in.).

The interchange standoff of Regional and Reference Master gauges on retest against Grand Master or Regional Master gauges respectively shall conform to the nominal standoff ±0.102 mm (0.004 in.).

The interchange standoff of Working gauges on retest against Reference Master gauges shall conform to the nominal standoff ±0.102 mm (0.004 in.).

Any gauges not conforming to these axial limit tolerances shall be removed from service or reconditioned as described in 9.3.1.7.

### 9.3.1.7 Reconditioning

Plug and ring gauges reported as in non-conformance with the standoff requirements of 9.3.1.6, or as otherwise unsuitable for further use, shall be removed from service. Regional Master, Reference Master, and Working gauges found to be in non-conformance may be reconditioned. Grand Master gauges shall not be reconditioned. Reconditioned Regional Master and reconditioned Reference Master gauges shall be resubmitted for initial certification in accordance with the requirements of 9.4 before returning to service. Reconditioned Working gauges shall be inspected for compliance with all the thread element requirements of 8.2.

## 9.3.2 Measurement of Elements

### 9.3.2.1 Taper

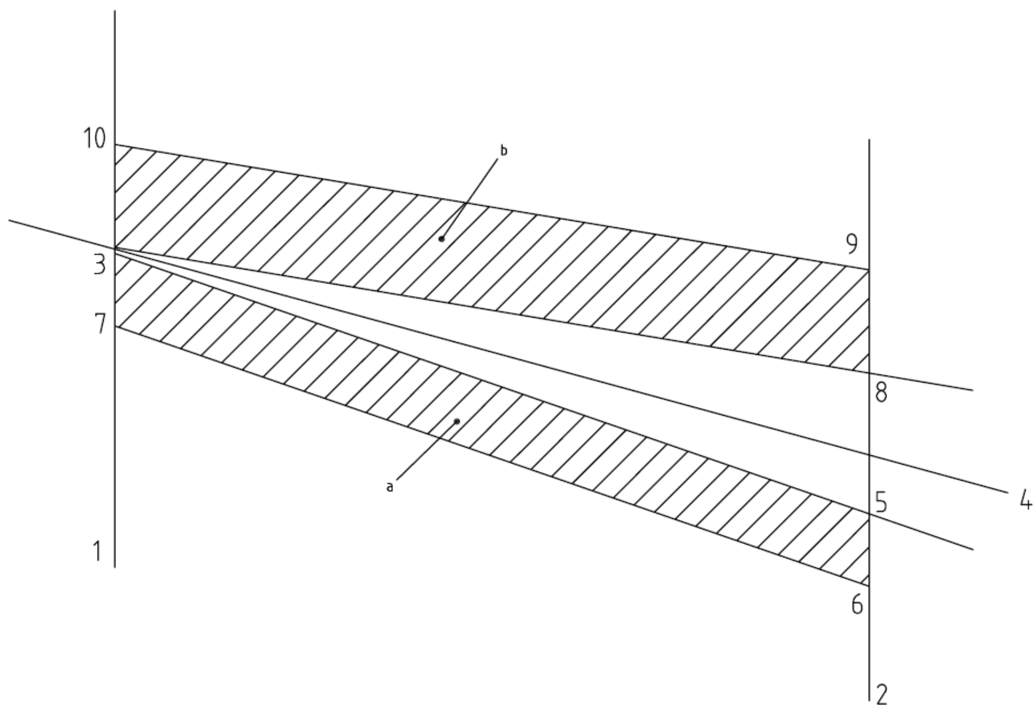
The taper tolerances are defined over the full ring gauge length, $L_{\mathrm{rg}}$.

The included taper shall be measured on the diameter along the pitch line over the full threaded length, omitting one full thread from each end, and shall conform to the basic taper within the tolerance specified in Tables B.11 to B.13. The taper over lengths less than the full threaded length shall be such that the pitch diameter at any intermediate thread falls within the limits illustrated in Figure 22.

The limits are defined by:

a) a cone passing through a point one full thread from the large end of the gauge, and having the minimum specified taper for the plug, or maximum specified taper for the ring, and

b) a parallel cone offset by the range between minimum and maximum taper, to a smaller diameter for the plug and to a larger diameter for the ring.




**Key**

| | | | |
|---|---|---|---|
| 1 | large end of gauge, less one full thread | 6 | tolerance limit for plug gauge at maximum taper |
| 2 | small end of gauge | 7 | point for taper tolerance of plug gauge |
| 3 | base point for taper tolerance | 8 | tolerance limit for ring gauge at maximum taper |
| 4 | basic taper cone | 9 | tolerance limit for ring gauge at minimum taper |
| 5 | tolerance limit for plug gauge at minimum taper | 10 | point for taper tolerance of ring gauge |

[a] Volume 3-5-6-7 defines the geometric tolerance for the plug.

[b] Volume 3-8-9-10 defines the geometric tolerance for the ring.

[c] The figure illustrates a Regional Master gauge to show a minimum taper not equal to the nominal taper.

**Figure 22—Tolerance Bands for Taper on Gauges**

EXAMPLE

For a Regional Master plug gauge, NC50, for which $L_{rg}$ is 98.4 mm (3.875 in.)

If the pitch diameter measured one full thread from the large end is 129.124 mm (5.0836 in.).

The tolerance range for the pitch diameter, six threads down is:

1) Compute effect of nominal taper (the intersection with line 3-4):

   $T$ × (6 threads × $p$) = −1/6 mm/mm × (6 × 6.35 mm) = −6.350 mm

   −2 in./ft × (6 × 0.25 in.) = −0.250 in.

2) Compute effect of minimum taper tolerance over the full length of threads (the intersection with line 3-5):

   (0.003 mm/98.4 mm) × (6 threads × 6.35 mm) = −0.001 mm

   (0.0001 in./3.875 in.) × (6 threads × 0.25 in.) = −0.00004 in.

   NOTE Result is negative because taper is in diminishing direction.

   So the limit dimension at minimum taper is 129.124 mm − 6.350 mm − 0.001 mm = 122.773 mm

   5.0836 in. − 0.250 in. − 0.00004 in. = 4.83356 in.

3) Compute the limit at maximum taper (the intersection with line 7-6):

   Diameter is reduced by the difference between maximum and minimum taper, over 6 threads:

   (0.010 mm − 0.003 mm)/98.4 mm) × (6 threads × 6.35 mm) = 0.0027 mm

   (0.0004 in. − 0.0001 in.) 3.875 in.) × (6 threads × 0.25 in.) = 0.00012 in.)

4) Resulting in an allowable range of pitch diameter at this location of:

   122.773 mm 0/−0.003 mm (4.83356 in. 0/−0.00012 in.)

#### 9.3.2.2 Lead

The lead of plug and ring gauges shall be measured parallel to the thread axis along the pitch line, over the full threaded length, omitting one full thread from each end. The lead error between any two threads shall not exceed the tolerance specified in Tables B.11 to B.13.

If necessary, lead may be measured parallel to the taper, as described in 7.4, and reported as the equivalent lead parallel to the thread axis.

#### 9.3.2.3 Flank Angle

The flank angle shall be considered to be the best-fit over the full thread height. A measurement using an optical comparator is acceptable.

The flank angle is defined with respect to the axis of the pitch-cone of the gauge, which is sometimes difficult to determine. It is acceptable to measure the flank angle using the pitch-line of the threads on the same side as a reference, taking account of the taper half-angle.

#### 9.3.2.4 Pitch Diameter at Gauge Point

The pitch diameter at gauge point shall be measured on plug gauges at 20 °C ±1 °C (68 °F ±1.8 °F).

## 9.4 Gauge Certification

New and reconditioned Master gauges, prior to use, shall be submitted to one of the certification agencies for certification to be in accordance with the stipulations given in this standard. These metrology laboratories and accreditation bodies shall operate according with ISO/IEC 17025 or equivalent standards.

The American Petroleum Institute maintains a certification program for where certified gauges are listed with their holders—*Thread Gauge Certification Agencies*—in the *API Composite List* (www.api.org/compositelist). Questions about the listing of agencies should be directed to API Monogram/APIQR Programs (certification@api.org).

Application to become an API Thread Gauge Certification Agency is open to any nationally recognized independent metrology laboratory capable of demonstrating compliance to API policy and specified requirements. Interested parties should contact API Monogram/APIQR Programs.

# Annex A
(informative)

# API Monogram Program
# Use of the API Monogram by Licensees

## A.1 Scope

### A.1.1 Applicability

This annex is normative (mandatory) for products supplied bearing the API Monogram and manufactured at a facility licensed by API; for all other instances it is not applicable.

### A.1.2 General

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

## A.2 Normative References

In addition to the referenced standards listed earlier in this document, this annex references the following standard:

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

## A.3 API Monogram Program: Licensee Responsibilities

### A.3.1 Monogram Program Requirements

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) the quality management system requirements of API Q1;

b) the API Monogram Program requirements of API Q1, Annex A;

c) the requirements contained in the API product specification(s) to which the organization is licensed; and

d) the requirements contained in the API Monogram Program License Agreement.

### A.3.2 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following:

a) products that do not conform to API specified requirements shall not bear the API Monogram;

b) each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram and license number;

   2) define the method(s) used to apply the Monogram and license number;

   3) identify the location on the product where the API Monogram and license number are to be applied;

   4) require the application of the date of manufacture of the product in conjunction with the use of the API Monogram and license number;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) define the application of all other required API product specification(s) and/or standard(s) marking requirements.

c) only an API licensee shall apply the API Monogram and its designated license number to API monogrammable products;

d) the API Monogram and license number, when issued, are site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location; and

e) the API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the, *API Monogram*

*Program Alternative Marking of Products License Agreement*, available on the API Monogram Program website at http://www.api.org/alternative-marking.

### A.3.3 Design and Design Documentation

Each licensee and/or applicant for licensing shall maintain current design documentation as identified in API Q1 for all of the applicable products that fall under the scope of each Monogram license. The design document information shall provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s) and/or standard(s). The design documentation shall be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in Advisory # 6, available on API Monogram Program website at http://www.api.org/advisories.

### A.3.4 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that an additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their conformance with the requirements of the applicable API product specification(s) and/or standard(s).

### A.3.5 Use of the API Monogram in Advertising

An API Monogram licensee shall not use the API Monogram and/or license number on letterheads, buildings or other structures, websites or in any advertising without an express statement of fact describing the scope of Licensee's authorization (license number and product specification). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

## A.4 Product Marking Requirements

### A.4.1 General

These marking requirements shall apply only to those API Licensees wishing to mark applicable products in conjunction with the requirements of the API Monogram Program.

### A.4.2 Product Specification Identification

Manufacturers shall mark products as specified by the applicable API specifications or standards. Marking shall include reference to the applicable API specification and/or standard. Unless otherwise specified, reference to the API specifications and/or standards shall be, as a minimum, "API [Document Number]" (e.g. API 6A, or API 600). Unless otherwise specified, when space allows, the marking may include use of "Spec" or "Std," as applicable (e.g. API Spec 6A or API Std 600).

### A.4.3 Units

Products shall be marked with units as specified in the API specification and/or standard. If not specified, equipment shall be marked with U.S. customary (USC) units. Use of dual units [USC units and metric (SI) units] may be acceptable, if such units are allowed by the applicable product specification and/or standard.

### A.4.4 Nameplates

Nameplates, when applicable, shall be made of a corrosion-resistant material unless otherwise specified by the API specification and/or standard. Nameplate shall be located as specified by the API specification and/or standard. If the location is not specified, then the licensee shall develop and maintain a procedure detailing the location to which the nameplate shall be applied. Nameplates may be attached at any time during the manufacturing process.

The API Monogram and license number shall be marked on the nameplate, in addition to the other product marking requirements specified by the applicable product specification and/or standard.

### A.4.5 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram. The license number shall be used in close proximity to the API Monogram.

## A.5 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification and/or standard deficiencies or nonconformities against API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.aspx.

# Annex B
(informative)

# Tables in SI Units

### Table B.1—Product Thread Dimensions for Preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper** [a] | **Threads per 25.4 mm** | **Pitch Diameter at Gauge Point** | **Large Diameter of Pin** | **Pin Cylinder Diameter** | **Small Diameter of Pin** | **Pin Length** [b] | **Depth of Box Threads** | **Total Box Depth** | **Box c/bore Diameter** | **Depth of Box c/bore** | **Last Full Depth Thread** |
| | | $T$ | $n$ | $C$ | $D_L$ | $D_{LF}$ | $D_S$ | $L_{PC}$ | $L_{BT}$ | $L_{BC}$ | $Q_c$ | $L_{Qc}$ | $L_{ft}$ [c] |
| | | mm/mm | | | ref | ±0.4 | ref | 0<br>−3.18 | min | +9.5<br>0 | +0.8<br>−0.4 | +2.4<br>−0.8 | max |
| NC23 | V-038R | 1/6 | 4 | 59.8170 | 65.10 | 61.90 | 52.40 | 76.21 | 79.38 | 92.08 | 66.68 | 15.875 | 12.70 |
| NC26 | V-038R | 1/6 | 4 | 67.7672 | 73.05 | 69.85 | 60.35 | 76.21 | 79.38 | 92.08 | 74.63 | 15.875 | 12.70 |
| NC31 | V-038R | 1/6 | 4 | 80.8482 | 86.13 | 82.96 | 71.32 | 88.91 | 92.08 | 104.78 | 87.71 | 15.875 | 12.70 |
| NC35 | V-038R | 1/6 | 4 | 89.6874 | 94.97 | 92.08 | 79.09 | 95.26 | 98.43 | 111.13 | 96.82 | 15.875 | 12.70 |
| NC38 | V-038R | 1/6 | 4 | 96.7232 | 102.01 | 98.83 | 85.06 | 101.61 | 104.78 | 117.48 | 103.58 | 15.875 | 12.70 |
| NC40 | V-038R | 1/6 | 4 | 103.4288 | 108.71 | 105.56 | 89.66 | 114.31 | 117.48 | 130.18 | 110.34 | 15.875 | 12.70 |
| NC44 | V-038R | 1/6 | 4 | 112.1918 | 117.48 | 114.27 | 98.42 | 114.31 | 117.48 | 130.18 | 119.08 | 15.875 | 12.70 |
| NC46 | V-038R | 1/6 | 4 | 117.5004 | 122.78 | 119.61 | 103.73 | 114.31 | 117.48 | 130.18 | 124.61 | 15.875 | 12.70 |
| NC50 | V-038R | 1/6 | 4 | 128.0592 | 133.35 | 130.43 | 114.30 | 114.31 | 117.48 | 130.18 | 134.95 | 15.875 | 12.70 |
| NC56 | V-038R | 1/4 | 4 | 142.6464 | 149.25 | 144.86 | 117.50 | 127.01 | 130.18 | 142.88 | 150.83 | 15.875 | 12.70 |
| NC61 | V-038R | 1/4 | 4 | 156.9212 | 163.53 | 159.16 | 128.60 | 139.71 | 142.88 | 155.58 | 165.10 | 15.875 | 12.70 |
| NC70 | V-038R | 1/4 | 4 | 179.1462 | 185.75 | 181.38 | 147.65 | 152.41 | 155.58 | 168.28 | 187.33 | 15.875 | 12.70 |
| 1 REG | V-055 | 1/8 | 6 | 29.3116 | 32.54 | 31.32 | 27.78 | 38.11 | 50.81 | 53.98 | 33.05 | 11.125 | 10.16 |
| 1 1/2 REG | V-055 | 1/8 | 6 | 39.1414 | 42.37 | 41.17 | 36.01 | 50.81 | 53.98 | 66.68 | 42.88 | 11.125 | 10.16 |
| 2 3/8 REG | V-040 | 1/4 | 5 | 60.0804 | 66.68 | 63.88 | 47.62 | 76.21 | 79.38 | 92.08 | 68.28 | 15.875 | 12.70 |
| 2 7/8 REG | V-040 | 1/4 | 5 | 69.6054 | 76.20 | 73.41 | 53.97 | 88.91 | 92.08 | 104.78 | 77.80 | 15.875 | 12.70 |
| 3 1/2 REG | V-040 | 1/4 | 5 | 82.2927 | 88.90 | 86.11 | 65.07 | 95.26 | 98.43 | 111.13 | 90.50 | 15.875 | 12.70 |
| 4 1/2 REG | V-040 | 1/4 | 5 | 110.8677 | 117.48 | 114.68 | 90.47 | 107.96 | 111.13 | 123.83 | 119.08 | 15.875 | 12.70 |
| 5 1/2 REG | V-050 | 1/4 | 4 | 132.9441 | 140.18 | 137.41 | 110.03 | 120.66 | 123.83 | 136.53 | 141.68 | 15.875 | 12.70 |
| 6 5/8 REG | V-050 | 1/6 | 4 | 146.2481 | 152.20 | 149.40 | 131.01 | 127.01 | 130.18 | 142.88 | 154.00 | 15.875 | 12.70 |
| 7 5/8 REG | V-050 | 1/4 | 4 | 170.5491 | 177.80 | 175.01 | 144.47 | 133.36 | 136.53 | 149.23 | 180.19 | 15.875 | 12.70 |
| 8 5/8 REG | V-050 | 1/4 | 4 | 194.7311 | 201.98 | 199.14 | 167.84 | 136.53 | 139.71 | 152.40 | 204.39 | 15.875 | 12.70 |
| 5 1/2 FH | V-050 | 1/6 | 4 | 142.0114 | 147.96 | 145.16 | 126.77 | 127.01 | 130.18 | 142.88 | 150.01 | 15.875 | 12.70 |
| 6 5/8 FH | V-050 | 1/6 | 4 | 165.5978 | 171.53 | 168.73 | 150.36 | 127.01 | 130.18 | 142.88 | 173.84 | 15.875 | 12.70 |

NOTE See Figures 1, 2, and 3.

[a] FOOTNOTE 1 Taper ($T$) 1/6 mm/mm corresponds to a half-angle of $\varphi = 4.764°$.
1/4 mm/mm corresponds to a half-angle of $\varphi = 7.125°$.
1/8 mm/mm corresponds to a half-angle of $\varphi = 3.576°$.

[b] FOOTNOTE 2 For roller cone drill bits only, the pin length may vary by 0/−5 mm.

[c] FOOTNOTE 3 Length to flank of first full depth pin thread.

## Table B.2—Product Thread Form Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Thread Form** | | **V-038R** | **V-038R** | **V-040** | **V-050** | **V-050** | **V-055** |
| threads per 25.4 mm | $n$ | 4 | 4 | 5 | 4 | 4 | 6 |
| lead, ref | | 6.35 | 6.35 | 5.08 | 6.35 | 6.35 | 4.23334 |
| half angle | $\theta$, deg ±0.75 | 30 | 30 | 30 | 30 | 30 | 30 |
| taper | $T$, mm/mm | 1/6 | 1/6 | 1/6 | 1/6 | 1/4 | 1/8 |
| crest flat width | $F_c$ | 1.65 | 1.65 | 1.02 | 1.27 | 1.27 | 1.397 |
| root radius | $R$ | 0.97 | 0.97 | 0.51 | 0.64 | 0.64 | N/A |
| root flat width | $F_r$ | — | — | — | — | — | 1.19 |
| root flat corner radius | $r_r$ ±0.2 | — | — | — | — | — | 0.38 |
| thread height, not truncated | $H$, ref | 5.48627 | 5.470627 | 4.376496 | 5.486527 | 5.470627 | 3.661410 |
| crest truncation | $f_c$ ref | 1.426489 | 1.422349 | 0.875309 | 1.097305 | 1.094130 | 1.208253 |
| root truncation | $f_r$ ref | 0.96520 | 0.96520 | 0.50800 | 0.63 500 | 0.63500 | 1.03251 |
| thread height truncated | $h + 0.025 - 0.076$ | 3.10 | 3.08 | 2.99 | 3.75 | 3.74 | 1.42 |
| crest flat corner radius | $r_c$ ±0.2 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |

NOTE 1 See Figures 4 and 5 for meaning of dimensions.

NOTE 2 Dimensions without tolerances are design elements and are not auditable.

## Table B.3—Bevel Diameters for Preferred Connections When Used on Drill Collars

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NC23 | 28.58 | OD | 79.38 | — | — | — | — | — | — | — |
| | | BD | 76.20 | — | — | — | — | — | — | — |
| NC26 | 38.10 | OD | 85.72 | 88.90 | 92.08 | 95.25 | 98.42 | — | — | — |
| | | BD | 84.53 [e] | 84.53 [e] | 87.71 | 87.71 | 92.47 | — | — | — |
| NC31 | 38.10 | OD | 104.78 | 107.95 | 111.12 | — | — | — | — | — |
| | | BD | 101.60 [e] | 101.60 [e] | 105.17 | — | — | — | — | — |
| NC35 | 50.80 | OD | 114.30 | 117.48 | 120.65 | — | — | — | — | — |
| | | BD | 110.33 | 110.33 | 114.70 | — | — | — | — | — |
| NC38 | 57.15 | OD | 120.65 | 123.82 | 127.00 | 130.18 | 133.35 | — | — | — |
| | | BD | 117.87 [e] | 117.87 [e] | 121.05 | 121.05 | 125.81 | — | — | — |
| NC40 | 50.80 | OD | 133.35 | 136.52 | 139.70 | 142.88 | 146.05 | — | — | — |
| | | BD | 128.19 [e] | 128.19 [e] | 132.16 | 132.16 | 136.92 | — | — | — |
| NC44 | 57.15 | OD | 139.70 | 142.88 | 146.05 | 149.22 | 152.40 | 155.58 | 158.75 | — |
| | | BD | 138.13 [e] | 138.13 [e] | 139.70 | 139.70 | 144.46 | 144.46 | 149.22 | — |
| NC46 | 57.15 | OD | 152.40 | 155.58 | 158.75 | 161.92 | 165.10 | 168.28 | 171.45 | 174.62 |
| | | BD | 145.25 [e] | 145.25 [e] | 150.02 | 150.02 | 154.78 | 154.78 | 159.54 | 159.54 |
| NC50 | 57.15 | OD | 161.92 | 165.10 | 168.28 | 171.45 | 174.62 | 177.80 | 180.98 | 184.15 |
| | | BD | 161.14 [e] | 161.14 [e] | 161.14 [e] | 161.14 [e] | 164.70 | 164.70 | 169.46 | 169.46 |
| NC56 | 63.50 | OD | 184.15 | 187.32 | 190.50 | 193.68 | 196.85 | 200.02 | 203.20 | — |
| | | BD | 179.78 [e] | 179.78 [e] | 180.58 | 180.58 | 185.34 | 185.34 | 190.10 | — |
| NC61 | 71.42 | OD | 203.20 | 209.55 | 212.72 | 215.90 | 219.08 | 222.25 | 225.42 | 228.60 |
| | | BD | 197.25 [e] | 198.42 | 198.42 | 203.20 | 203.20 | 207.96 | 207.96 | 212.72 |
| NC70 | 71.42 | OD | 234.95 | 238.12 | 241.30 | 244.48 | 247.65 | 250.82 | 254.00 | — |
| | | BD | 226.62 [e] | 226.62 [e] | 227.80 | 227.80 | 232.57 | 232.57 | 237.33 | — |
| 1 REG | 12.70 | OD | 39.70 | 42.88 | — | — | — | — | — | — |
| | | BD | 38.50 | 38.50 | — | — | — | — | — | — |
| 1 1/2 REG | 12.70 | OD | 52.40 | 55.58 | — | — | — | — | — | — |
| | | BD | 50.80 | 50.80 | — | — | — | — | — | — |

## Table B.3—Bevel Diameters for Preferred Connections When Used on Drill Collars *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 3/8 REG | 36.53 | OD | 79.38 | 82.55 | 85.72 | 88.90 | — | — | — | — |
| | | BD | 76.61 | 76.61 | 81.36 | 81.36 | — | — | — | — |
| 2 7/8 REG | 33.32 | OD | 98.42 | — | — | — | — | — | — | — |
| | | BD | 90.88 | — | — | — | — | — | — | — |
| 3 1/2 REG | 38.10 | OD | 111.12 | 114.30 | — | — | — | — | — | — |
| | | BD | 104.78 [e] | 108.35 | — | — | — | — | — | — |
| 4 1/2 REG | 57.15 | OD | 139.70 | 142.88 | 146.05 | 149.22 | 152.40 | — | — | — |
| | | BD | 137.71 [e] | 137.71 [e] | 139.30 | 139.30 | 144.06 | — | — | — |
| 5 1/2 REG | 63.50 | OD | 171.45 | 174.62 | 177.80 | 180.98 | 184.15 | 187.32 | 190.50 | — |
| | | BD | 167.48 [e] | 167.48 [e] | 169.062 | 169.062 | 173.84 | 173.84 | 178.59 | — |
| 6 5/8 REG | 71.42 | OD | 190.50 | 193.68 | 196.85 | 200.02 | 203.20 | 206.38 | 209.55 | — |
| | | BD | 184.94 [e] | 184.94 [e] | 186.13 | 186.13 | 190.90 | 190.90 | 195.66 | — |
| 7 5/8 REG FF | 71.42 | OD | 225.42 | 228.60 | 231.78 | 234.95 | 238.12 | 241.30 | — | — |
| | | BD | 215.90 [e] | 215.90 [e] | 219.08 | 219.08 | 223.84 | 223.84 | — | — |
| 7 5/8 REG LT | 63.50 | OD | 241.30 | 244.48 | 247.65 | 250.82 | 254.00 | — | — | — |
| | | BD | 234.95 | 234.95 | 234.95 | 234.95 | 234.95 | — | — | — |
| 8 5/8 REG FF | 76.20 | OD | 254.00 | 257.18 | 260.35 | 263.52 | 266.70 | 269.88 | — | — |
| | | BD | 246.86 [e] | 246.86 [e] | 246.86 [e] | 246.86 [e] | 251.22 | 251.22 | — | — |
| 8 5/8 REG LT | 76.20 | OD | 269.88 | 273.05 | 276.22 | 279.40 | — | — | — | — |
| | | BD | 266.70 | 266.70 | 266.70 | 266.70 | — | — | — | — |
| 5 1/2 FH | 63.50 | OD | 184.15 | 187.32 | 190.50 | 193.68 | 196.85 | 200.02 | 203.20 | — |
| | | BD | 178.99 [e] | 178.99 [e] | 180.18 | 180.18 | 184.94 | 184.94 | 189.70 | — |
| 6 5/8 FH | 71.42 | OD | 215.90 | 219.08 | 222.25 | 225.42 | 228.60 | 231.78 | 234.95 | — |
| | | BD | 208.36 [e] | 208.36 [e] | 209.95 | 209.95 | 214.71 | 214.71 | 219.47 | — |

NOTE See Figures 1 and 3.

[a] FOOTNOTE 1 Tolerance on bevel diameters is ±0.40 mm.

[b] FOOTNOTE 2 See table '*Drill collar OD tolerances*' in API 7-1 (ISO 10424-1).

[c] FOOTNOTE 3 When drill collars and tools of the same OD listed in the table above are mated, the maximum seal stress will be less than 100 % of SMYS when torqued to the recommended torque value.

[d] FOOTNOTE 4 See 5.2.4.

[e] FOOTNOTE 5 These bevel diameters are not calculated using 75 % of the face width.

## Table B.4—Low-torque Feature

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Connection Size and Style** | **Required for OD Greater than:** | **Face Groove Diameter** $D_{FG}$ $^{+0.8}_{-0.4}$ | **Face Groove Radius** $R_{FG}$ ±0.4 |
| 7 5/8 REG LT | 241.3 | 196.85 | 6.35 |
| 8 5/8 REG LT | 266.7 | 228.6 | 6.35 |
| NOTE See Figure 6. | | | |

## Table B.5—Optional Feature Dimensions

| 1 | 2 | 3 |
|---|---|---|
| **Connection Size and Style** | **Pin ID Taper Diameter** $D_{PT}$ $^{+0.8}_{-0.8}$ See Figure 1 | **Pin Benchmark Diameter** $D_{PB}$ $^{+0.4}_{0}$ See Figure 12 |
| NC23 | — | 62.69 |
| NC26 | — | 70.64 |
| NC31 | 50.80 | 83.75 |
| NC35 | 58.72 | 92.87 |
| NC38 | 63.50 | 99.62 |
| NC40 | 66.68 | 106.35 |
| NC44 | 73.03 | 115.07 |
| NC46 | 76.20 | 120.40 |
| NC50 | 82.55 | 131.22 |
| NC56 | 82.55 | 145.65 |
| NC61 | 82.55 | 159.95 |
| NC70 | 104.78 | 182.17 |
| 1 REG | — | — |
| 1 1/2 REG | — | — |
| 2 3/8 REG | — | 64.67 |
| 2 7/8 REG | — | 74.20 |
| 3 1/2 REG | 50.80 | 86.90 |
| 4 1/2 REG | 66.68 | 115.47 |
| 5 1/2 REG | 76.20 | 138.21 |
| 6 5/8 REG | 85.73 | 150.20 |
| 7 5/8 REG | 101.60 | 175.80 |
| 8 5/8 REG | 111.13 | 199.93 |
| 5 1/2 FH | 88.90 | 145.95 |
| 6 5/8 FH | 104.78 | 169.52 |

## Table B.6—Stress-relief Groove and Boreback Contour Dimensions for Preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Connection Size and Style | **Box Boreback Contour** | | | **Box Groove** | | Diameter of Pin Groove |
| | Cylinder Diameter | Depth to Last Thread Scratch | Depth to End of Cylinder | Diameter of Box Groove | Depth to Start of Box Groove | |
| | $D_{CB}$ | $L_X$ | $L_{CYL}$ | $D_{BG}$ | $L_{BG}$ | $D_{SRG}$ |
| | $^{+0.40}_{0}$ | reference | ±6.25 | $^{+0.79}_{0}$ | $^{0}_{-3.18}$ | $^{0}_{-0.79}$ |
| NC35 | 82.15 | 82.55 | 133.36 | 84.54 | 85.85 | 82.06 |
| NC38 | 88.12 | 88.90 | 139.71 | 90.48 | 91.94 | 89.10 |
| NC40 | 92.87 | 101.60 | 152.41 | 94.85 | 104.64 | 95.80 |
| NC44 | 101.61 | 101.60 | 152.41 | 103.59 | 104.64 | 104.57 |
| NC46 | 106.76 | 101.60 | 152.41 | 109.15 | 104.64 | 109.88 |
| NC50 | 117.48 | 101.60 | 152.41 | 119.46 | 104.64 | 120.44 |
| NC56 | 121.85 | 114.30 | 165.11 | 123.04 | 117.34 | 134.03 |
| NC61 | 132.95 | 127.00 | 177.81 | 134.14 | 130.04 | 148.31 |
| NC70 | 152.00 | 139.70 | 190.51 | 153.19 | 142.74 | 170.53 |
| 3 1/2 REG | — | — | — | — | — | — |
| 4 1/2 REG | 94.47 | 95.25 | 146.06 | 96.04 | 98.55 | 101.93 |
| 5 1/2 REG | 114.31 | 107.95 | 158.76 | 114.31 | 111.25 | 123.67 |
| 6 5/8 REG | 134.14 | 114.30 | 165.11 | 134.93 | 117.34 | 137.59 |
| 7 5/8 REG | 148.82 | 120.65 | 171.46 | 148.82 | 123.95 | 161.26 |
| 8 5/8 REG | 172.24 | 123.95 | 174.76 | 172.24 | 127.00 | 185.44 |
| 5 1/2 FH | 129.77 | 114.30 | 165.11 | 130.97 | 117.34 | 133.35 |
| 6 5/8 FH | 153.60 | 114.30 | 165.11 | 154.39 | 117.34 | 156.94 |

NOTE See Figures 7, 8, and 9 for meaning of dimensions.

## Table B.7—Compensated Thread Lengths, Thread Heights, and Ball-point Diameters

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | **Taper**<br>$T$<br>mm/mm | **Threads per 25.4 mm**<br>$n$ | **Compensated Lead Parallel to Taper** [a]<br>$L_{ct}$ | **Ball-point Diameter for Taper and Lead**<br>$d_b$<br>±0.05 | **Thread Height Compensated for Taper** [b]<br>$h_{cn}$ | **Ball-point Diameter for Thread Height**<br>$d_{bh}$<br>±0.05 |
| V-038R | 1/6 | 4 | 6.3729 | 3.658 | 3.0886 | 1.829 |
| V-038R | 1/4 | 4 | 6.3983 | 3.658 | 3.0658 | 1.829 |
| V-040 | 1/4 | 5 | 5.1206 | 2.921 | 2.9743 | 0.864 |
| V-050 | 1/4 | 4 | 6.3983 | 3.658 | 3.7186 | 1.118 |
| V-050 | 1/6 | 4 | 6.3729 | 3.658 | 3.7440 | 1.118 |
| V-055 | 1/8 | 6 | 4.2418 | 2.438 | 1.4173 | 1.829 |

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] FOOTNOTE 1 Compensated thread length ($L_{ct}$) is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] FOOTNOTE 2 Compensated thread height ($h_{cn}$) is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

## Table B.8—Gauge Thread Form Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Form of Thread** | **Threads per 25.4 mm**<br>$n$ | **Lead** | **Half-angle**<br>$\theta$<br>degree | **Taper**<br>$T$<br>mm/mm | **Thread Height not Truncated**<br>$H$<br>reference | **Gauge Root Truncation**<br>$F_{rg}$<br>max | **Gauge Crest Truncation**<br>$f_{cg}$ | **Gauge Thread Height Truncated**<br>$h_g$<br>reference |
| V-038R | 4 | 6.35000 | 30 | 1/6 | 5.486527 | 1.355979 | 1.6510 | 2.4790 |
| V-038R | 4 | 6.35000 | 30 | 1/4 | 5.470627 | 1.355979 | 1.6510 | 2.4638 |
| V-040 | 5 | 5.08000 | 30 | 1/4 | 4.376496 | 1.002284 | 1.0023 | 2.3724 |
| V-050 | 4 | 6.35000 | 30 | 1/4 | 5.470627 | 1.221232 | 1.2212 | 3.0277 |
| V-050 | 4 | 6.35000 | 30 | 1/6 | 5.486527 | 1.224280 | 1.2243 | 3.0378 |
| V-055 | 6 | 4.23333 | 30 | 1/8 | 3.66141 | 1.39954 | 1.39954 | 0.86233 |

NOTE 1 In computing thread height and truncation, account has been taken of the effect of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 2 See Tables B.11 to B.13 for tolerances on columns 3, 4, 5, and 8.

NOTE 3 Prior to March 2005, the Crest truncation for V-038R gauges with 1/6 taper was 1.42649, and with 1/4 taper was 1.42235. These values are still acceptable for existing gauges made prior to this date.

NOTE 4 See Figure 18 for meaning of dimensions.

## Table B.9—Gauge Thread Dimensions for Preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Style and Size** | **Thread Form** | **Taper**<br>$T$<br>mm/mm | **Threads per 25.4 mm**<br>$n$ | **Pitch Diameter at Gauge Point** [a]<br>$C$ | **Major (Plug) Reference** [a]<br>$D_{MP}$ | **Minor (Ring) Reference** [b]<br>$D_{MR}$ | **Pitch Diameter at Working Gauge Point** [c]<br>$C_{GP}$ | **Gauge Standoff**<br>$S$ |
| NC23 | V-038R | 1/6 | 4 | 59.817000 | 62.00165 | 57.63260 | 56.64200 | 15.875 |
| NC26 | V-038R | 1/6 | 4 | 67.767200 | 69.95185 | 65.58280 | 64.59220 | 15.875 |
| NC31 | V-038R | 1/6 | 4 | 80.848200 | 83.03285 | 78.66380 | 77.67320 | 15.875 |
| NC35 | V-038R | 1/6 | 4 | 89.687400 | 91.87205 | 87.50300 | 86.51240 | 15.875 |
| NC38 | V-038R | 1/6 | 4 | 96.723200 | 98.90785 | 94.53880 | 93.54820 | 15.875 |
| NC40 | V-038R | 1/6 | 4 | 103.428800 | 105.61345 | 101.24440 | 100.25380 | 15.875 |
| NC44 | V-038R | 1/6 | 4 | 112.191800 | 114.37645 | 110.00740 | 109.01680 | 15.875 |
| NC46 | V-038R | 1/6 | 4 | 117.500400 | 119.68505 | 115.31600 | 114.32540 | 15.875 |
| NC50 | V-038R | 1/6 | 4 | 128.059180 | 130.24383 | 125.87478 | 124.88418 | 15.875 |
| NC56 | V-038R | 1/4 | 4 | 142.646400 | 144.81505 | 140.47775 | 137.88390 | 15.875 |
| NC61 | V-038R | 1/4 | 4 | 156.921200 | 159.08985 | 154.75255 | 152.15870 | 15.875 |
| NC70 | V-038R | 1/4 | 4 | 179.146200 | 181.31485 | 176.97755 | 174.38370 | 15.875 |
| 1 REG | V-055 | 1/8 | 6 | 29.311600 | 30.17393 | 28.44927 | 26.93035 | 9.525 |
| 1 1/2 REG | V-055 | 1/8 | 6 | 39.141400 | 40.00373 | 38.27907 | 36.76015 | 9.525 |
| 2 3/8 REG | V-040 | 1/4 | 5 | 60.080398 | 62.45225 | 57.70855 | 55.31790 | 15.875 |
| 2 7/8 REG | V-040 | 1/4 | 5 | 69.605398 | 71.97725 | 67.23355 | 64.84290 | 15.875 |
| 3 1/2 REG | V-040 | 1/4 | 5 | 82.292698 | 84.66455 | 79.92085 | 77.53020 | 15.875 |
| 4 1/2 REG | V-040 | 1/4 | 5 | 110.867698 | 113.23955 | 108.49585 | 106.10520 | 15.875 |
| 5 1/2 REG | V-050 | 1/4 | 4 | 132.944108 | 135.97230 | 129.91592 | 128.18161 | 15.875 |
| 6 5/8 REG | V-050 | 1/6 | 4 | 146.248120 | 149.28596 | 143.21028 | 143.07312 | 15.875 |
| 7 5/8 REG | V-050 | 1/4 | 4 | 170.549062 | 173.57725 | 167.52087 | 165.78656 | 15.875 |
| 8 5/8 REG | V-050 | 1/4 | 4 | 194.731132 | 197.75932 | 191.70294 | 189.96863 | 15.875 |
| 5 1/2 FH | V-050 | 1/6 | 4 | 142.011400 | 145.04924 | 138.97356 | 138.83640 | 15.875 |
| 6 5/8 FH | V-050 | 1/6 | 4 | 165.597840 | 168.63568 | 162.56000 | 162.42284 | 15.875 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE 1 The values in columns 5 and 6 apply only to Grand, Regional, and Reference Master plug gauges.

[b] FOOTNOTE 2 The values in column 7 apply only to ring gauges.

[c] FOOTNOTE 3 The values in column 8 apply only to Working plug gauges.

**Table B.10—Gauge External Dimensions for Preferred Connections**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length** $L_{pg}$ | **Fitting Plate [b] Diameter** $D_{FP}$ | **Ring Gauge Length** $L_{rg}$ | **Ring Gauge Outside Diameter** $D_R$ | **Diameter of Ring Gauge Counterbore** $Q$ |
| NC23 | 76.200 | 52.222 | 60.325 | 98.425 | 64.033 |
| NC26 | 76.200 | 60.173 | 60.325 | 106.350 | 71.984 |
| NC31 | 88.900 | 73.254 | 73.025 | 130.175 | 85.065 |
| NC35 | 95.250 | 82.093 | 79.375 | 133.350 | 93.904 |
| NC38 | 101.600 | 89.129 | 85.725 | 142.875 | 100.940 |
| NC40 | 114.300 | 95.834 | 98.425 | 149.225 | 107.671 |
| NC44 | 114.300 | 104.597 | 98.425 | 161.925 | 116.408 |
| NC46 | 114.300 | 109.906 | 98.425 | 165.100 | 121.717 |
| NC50 | 114.300 | 120.472 | 98.425 | 180.975 | 132.283 |
| NC56 | 127.000 | 135.077 | 111.125 | 200.025 | 146.863 |
| NC61 | 139.700 | 149.352 | 123.825 | 215.900 | 161.138 |
| NC70 | 152.400 | 171.577 | 136.525 | 238.125 | 183.363 |
| 1 REG | 38.100 | [a] | 28.575 | 63.500 | 34.544 |
| 1 1/2 REG | 50.800 | [a] | 41.275 | 73.025 | 42.875 |
| 2 3/8 REG | 76.200 | 54.127 | 60.325 | 95.250 | 64.287 |
| 2 7/8 REG | 88.900 | 63.652 | 73.025 | 107.950 | 73.812 |
| 3 1/2 REG | 95.250 | 76.327 | 79.375 | 127.000 | 86.512 |
| 4 1/2 REG | 107.950 | 104.902 | 92.075 | 158.750 | 115.087 |
| 5 1/2 REG | 120.650 | 125.882 | 104.775 | 190.500 | 137.846 |
| 6 5/8 REG | 127.000 | 138.379 | 111.125 | 209.550 | 151.105 |
| 7 5/8 REG | 133.350 | 163.093 | 117.475 | 241.300 | 175.412 |
| 8 5/8 REG | 136.525 | 187.274 | 120.650 | 273.050 | 199.593 |
| 5 1/2 FH | 127.000 | 134.417 | 111.125 | 196.850 | 146.914 |
| 6 5/8 FH | 127.000 | 157.734 | 111.125 | 228.600 | 170.459 |

NOTE See Figures 19 and 20 for meaning of dimension.

[a] FOOTNOTE 1 There is no fitting plate on 1 REG and 1 1/2 REG.

[b] FOOTNOTE 2 The thickness of fitting plates, $T_{FP}$, shall be 9.53 mm maximum for all gauge sizes with pitch diameter, $C$, less than 142.24 mm and 11.10 mm maximum for all larger gauge sizes.

## Table B.11—Tolerances on Gauge Dimensions for Regional and Grand Master Gauges

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| **Element** | **Tolerances** | | | |
| | **Plug** | | **Ring** | |
| pitch diameter at gauge point [a] | ±0.005 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 99 | ±0.005 | | ±0.008 | |
| pitch diameter > 99 | ±0.008 | | ±0.010 | |
| taper limits [c]: | min | max | min | max |
| all | 0.003 | 0.010 | –0.030 | –0.015 |
| half-angle of thread, degrees | ±0.083 | | ±0.167 | |
| mating standoff, $S$ | | | ±0.025 | |
| interchange standoff, Regional Master against Grand Master | ±0.102 | | ±0.102 | |
| crest truncation, $f_{cg}$ | ±0.0284 | | ±0.0279 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±2.4 | | ± 2.4 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.4 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.4 | |
| ring gauge counterbore, $Q$ | — | | ±0.4 | |

NOTE See Figure 19.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads, whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

**Table B.12—Tolerances on Gauge Dimensions for Reference Master Gauges**

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| Element | Tolerances | | | |
| | Plug | | Ring | |
| pitch diameter at gauge point [a]: | | | — | |
| pitch diameter ≤ 152 [d] | ±0.010 | | — | |
| Pitch diameter > 152 | ±0.013 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 152 [e] | ±0.010 | | ±0.015 | |
| pitch diameter > 152 | ±0.013 | | ±0.018 | |
| taper limits [c]: | min | max | min | max |
| $L_{rg}$ 89 and shorter | 0 | 0.010 | −0.030 | −0.010 |
| $L_{rg}$ 90 through 102 | 0 | 0.013 | −0.036 | −0.010 |
| $L_{rg}$ 103 through 114 | 0 | 0.015 | −0.041 | −0.010 |
| $L_{rg}$ 115 through 127 | 0 | 0.018 | −0.046 | −0.010 |
| $L_{rg}$ 128 through 140 | 0 | 0.020 | −0.051 | −0.010 |
| $L_{rg}$ 141 and larger | 0 | 0.023 | −0.056 | −0.010 |
| half-angle of thread, degrees | ±0.117 | | ±0.25 | |
| mating standoff, $S_0$ | — | | ±0.025 | |
| interchange standoff, Reference Master against Regional Master or Grand Master | ±0.102 | | ±0.102 | |
| crest truncation, $f_{cg}$ | ±0.0318 | | ±0.0318 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±2.4 | | ±2.4 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.4 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.4 | |
| ring gauge counterbore, $Q$ | — | | ±0.4 | |

NOTE See Figure 19.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads, whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 $L_{rg}$ values are listed in Table 9, column 4. The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

[d] FOOTNOTE 4 The tolerance for pitch diameter for NC56 was historically ±0.013. This shall remain acceptable for gauges made before December 2008.

[e] FOOTNOTE 5 The tolerance for lead for NC56 was historically ±0.013 on the plug and ±0.018 on the ring. This shall remain acceptable for gauges made before December 2008.

## Table B.13—Tolerances on Gauge Dimensions for Working Gauges

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| **Element** | **Tolerances** | | | |
| | **Plug** | | **Ring** | |
| pitch diameter at gauge point [a]: | — | | — | |
| pitch diameter ≤ 152 [d] | ±0.010 | | — | |
| pitch diameter > 152 | ±0.013 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 152 [e] | ±0.010 | | ±0.015 | |
| pitch diameter > 152 | ±0.013 | | ±0.018 | |
| taper [c]: | min | max | min | max |
| $L_{rg}$ 89 and shorter | 0 | 0.015 | –0.036 | –0.010 |
| $L_{rg}$ 90 through 102 | 0 | 0.018 | –0.041 | –0.010 |
| $L_{rg}$ 103 through 114 | 0 | 0.020 | –0.046 | –0.010 |
| $L_{rg}$ 115 through 127 | 0 | 0.023 | –0.051 | –0.010 |
| $L_{rg}$ 128 through 140 | 0 | 0.025 | –0.056 | –0.010 |
| $L_{rg}$ 141 and larger | 0 | 0.028 | –0.061 | –0.010 |
| half-angle of thread, degrees | ±0.117 | | ±0.25 | |
| mating standoff, $S$ | — | | ±0.025 | |
| interchange standoff, Working gauge against Reference Master | ±0.102 | | ±0.102 | |
| crest truncation, $f_{cg}$ | ±0.0318 | | ±0.0318 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±2.4 | | ±2.4 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.4 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.4 | |
| ring gauge counterbore, $Q$ | — | | ±0.4 | |

NOTE See Figure 20 for meaning of dimension.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations. The gauge point for Working gauges is 34.925 mm from the measurement face.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads, whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 $L_{rg}$ values are listed in Table B.9, column 4. The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

[d] FOOTNOTE 4 The tolerance for pitch diameter for NC56 was historically ±0.013. This shall remain acceptable for gauges made before December 2008.

[e] FOOTNOTE 5 The tolerance for lead for NC56 was historically ±0.013 on the plug and ±0.018 on the ring. This shall remain acceptable for gauges made before December 2008.

# Annex C
(informative)

# Tables in USC Units

## Table C.1—Product Thread Dimensions for Preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper [a]** | **Threads per Inch** | **Pitch Diameter at Gauge Point** | **Large Diameter of Pin** | **Pin Cylinder Diameter** | **Small Diameter of Pin** | **Pin Length [b]** | **Depth of Box Threads** | **Total Box Depth** | **Box c/bore Diameter** | **Depth of Box c/bore** | **Last Full Depth Thread** |
| | | $T$ | $n$ | $C$ | $D_L$ | $D_{LF}$ | $D_S$ | $L_{PC}$ | $L_{BT}$ | $L_{BC}$ | $Q_c$ | $L_{Qc}$ | $L_{ft}$ [c] |
| | | in./ft | | | reference | ±0.016 | reference | $^{0}_{-0.125}$ | min | $^{+0.38}_{0}$ | $^{+0.031}_{-0.016}$ | $^{+0.094}_{-0.031}$ | max |
| NC23 | V-038R | 2.0 | 4.0 | 2.35500 | 2.563 | 2.437 | 2.063 | 3.000 | 3.125 | 3.625 | 2.625 | 0.625 | 0.50 |
| NC26 | V-038R | 2.0 | 4.0 | 2.66800 | 2.876 | 2.750 | 2.376 | 3.000 | 3.125 | 3.625 | 2.938 | 0.625 | 0.50 |
| NC31 | V-038R | 2.0 | 4.0 | 3.18300 | 3.391 | 3.266 | 2.808 | 3.500 | 3.625 | 4.125 | 3.453 | 0.625 | 0.50 |
| NC35 | V-038R | 2.0 | 4.0 | 3.53100 | 3.739 | 3.625 | 3.114 | 3.750 | 3.875 | 4.375 | 3.812 | 0.625 | 0.50 |
| NC38 | V-038R | 2.0 | 4.0 | 3.80800 | 4.016 | 3.891 | 3.349 | 4.000 | 4.125 | 4.625 | 4.078 | 0.625 | 0.50 |
| NC40 | V-038R | 2.0 | 4.0 | 4.07200 | 4.280 | 4.156 | 3.530 | 4.500 | 4.625 | 5.125 | 4.344 | 0.625 | 0.50 |
| NC44 | V-038R | 2.0 | 4.0 | 4.41700 | 4.625 | 4.499 | 3.875 | 4.500 | 4.625 | 5.125 | 4.688 | 0.625 | 0.50 |
| NC46 | V-038R | 2.0 | 4.0 | 4.62600 | 4.834 | 4.709 | 4.084 | 4.500 | 4.625 | 5.125 | 4.906 | 0.625 | 0.50 |
| NC50 | V-038R | 2.0 | 4.0 | 5.04170 | 5.250 | 5.135 | 4.500 | 4.500 | 4.625 | 5.125 | 5.313 | 0.625 | 0.50 |
| NC56 | V-038R | 3.0 | 4.0 | 5.61600 | 5.876 | 5.703 | 4.626 | 5.000 | 5.125 | 5.625 | 5.938 | 0.625 | 0.50 |
| NC61 | V-038R | 3.0 | 4.0 | 6.17800 | 6.438 | 6.266 | 5.063 | 5.500 | 5.625 | 6.125 | 6.500 | 0.625 | 0.50 |
| NC70 | V-038R | 3.0 | 4.0 | 7.05300 | 7.313 | 7.141 | 5.813 | 6.000 | 6.125 | 6.625 | 7.375 | 0.625 | 0.50 |
| 1 REG | V-055 | 1.5 | 6.0 | 1.15400 | 1.281 | 1.233 | 1.094 | 1.500 | 2.000 | 2.125 | 1.301 | 0.438 | 0.40 |
| 1 1/2 REG | V-055 | 1.5 | 6.0 | 1.54100 | 1.668 | 1.621 | 1.418 | 2.000 | 2.125 | 2.625 | 1.688 | 0.438 | 0.40 |
| 2 3/8 REG | V-040 | 3.0 | 5.0 | 2.36537 | 2.625 | 2.515 | 1.875 | 3.000 | 3.125 | 3.625 | 2.688 | 0.625 | 0.50 |
| 2 7/8 REG | V-040 | 3.0 | 5.0 | 2.74037 | 3.000 | 2.890 | 2.125 | 3.500 | 3.625 | 4.125 | 3.063 | 0.625 | 0.50 |
| 3 1/2 REG | V-040 | 3.0 | 5.0 | 3.23987 | 3.500 | 3.390 | 2.562 | 3.750 | 3.875 | 4.375 | 3.563 | 0.625 | 0.50 |
| 4 1/2 REG | V-040 | 3.0 | 5.0 | 4.36487 | 4.625 | 4.515 | 3.562 | 4.250 | 4.375 | 4.875 | 4.688 | 0.625 | 0.50 |
| 5 1/2 REG | V-050 | 3.0 | 4.0 | 5.23402 | 5.519 | 5.410 | 4.332 | 4.750 | 4.875 | 5.375 | 5.578 | 0.625 | 0.50 |
| 6 5/8 REG | V-050 | 2.0 | 4.0 | 5.75780 | 5.992 | 5.882 | 5.158 | 5.000 | 5.125 | 5.625 | 6.063 | 0.625 | 0.50 |
| 7 5/8 REG | V-050 | 3.0 | 4.0 | 6.71453 | 7.000 | 6.890 | 5.688 | 5.250 | 5.375 | 5.875 | 7.094 | 0.625 | 0.50 |
| 8 5/8 REG | V-050 | 3.0 | 4.0 | 7.66658 | 7.952 | 7.840 | 6.608 | 5.375 | 5.500 | 6.000 | 8.047 | 0.625 | 0.50 |
| 5 1/2 FH | V-050 | 2.0 | 4.0 | 5.59100 | 5.825 | 5.715 | 4.991 | 5.000 | 5.125 | 5.625 | 5.906 | 0.625 | 0.50 |
| 6 5/8 FH | V-050 | 2.0 | 4.0 | 6.51960 | 6.753 | 6.643 | 5.920 | 5.000 | 5.125 | 5.625 | 6.844 | 0.625 | 0.50 |

NOTE See Figures 1, 2, and 3.

[a] FOOTNOTE 1 Taper ($T$) 2 in./ft corresponds to a half-angle of $\varphi = 4.764°$;
3 in./ft corresponds to a half-angle of $\varphi = 7.125°$; and
1.5 in./ft corresponds to a half-angle of $\varphi = 3.576°$.

[b] FOOTNOTE 2 For roller cone drill bits only, the pin length may vary by 0/–0.2 in.

[c] FOOTNOTE 3 Length to flank of first full depth pin thread.

## Table C.2—Product Thread Form Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Thread Form** | | **V-038R** | **V-038R** | **V-040** | **V-050** | **V-050** | **V-055** |
| threads per inch | $n$ | 4 | 4 | 5 | 4 | 4 | 6 |
| lead, ref | | 0.25 | 0.25 | 0.2 | 0.25 | 0.25 | 0.166667 |
| half-angle, of thread | $\theta$, deg ±0.75 | 30 | 30 | 30 | 30 | 30 | 30 |
| taper | $T$, in./ft | 2 | 3 | 3 | 2 | 3 | 1.5 |
| crest flat width | $F_c$ | 0.065 | 0.065 | 0.04 | 0.05 | 0.05 | 0.055 |
| root radius | $R$ | 0.038 | 0.038 | 0.02 | 0.025 | 0.025 | N/A |
| root flat width | $F_r$ | — | — | — | — | — | 0.047 |
| root flat corner radius | $r_r$ ±0.008 | — | — | — | — | — | 0.015 |
| thread height, not truncated | $H$, ref | 0.216005 | 0.215379 | 0.172303 | 0.216005 | 0.215379 | 0.144150 |
| crest truncation | $f_{c,}$ ref | 0.056161 | 0.055998 | 0.034461 | 0.043201 | 0.043076 | 0.047569 |
| root truncation | $f_r$ ref | 0.038000 | 0.038000 | 0.020000 | 0.025000 | 0.025000 | 0.040650 |
| thread height truncated | $h\ ^{+0.001}_{-0.003}$ | 0.122 | 0.121 | 0.118 | 0.148 | 0.147 | 0.056 |
| crest flat corner radius | $r_c$ ±0.008 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |

NOTE 1 See Figures 3 and 4 for meaning of dimensions.

NOTE 2 Dimensions without tolerances are design elements and are not auditable.

## Table C.3—Bevel Diameters for Preferred Connections When Used on Drill Collars in USC Units

| Connection Style and Size | Ref. ID [d] | Bevel Diameters for Various ODs [a,b,c] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NC23 | 1.125 | OD | 3.125 | — | — | — | — | — | — | — |
| | | BD | 3.000 | — | — | — | — | — | — | — |
| NC26 | 1.500 | OD | 3.375 | 3.500 | 3.625 | 3.750 | 3.875 | — | — | — |
| | | BD | 3.328 [e] | 3.328 [e] | 3.453 | 3.453 | 3.641 | — | — | — |
| NC31 | 1.500 | OD | 4.125 | 4.250 | 4.375 | — | — | — | — | — |
| | | BD | 4.000 [e] | 4.000 [e] | 4.141 | — | — | — | — | — |
| NC35 | 2.000 | OD | 4.500 | 4.625 | 4.750 | — | — | — | — | — |
| | | BD | 4.344 | 4.344 | 4.516 | — | — | — | — | — |
| NC38 | 2.250 | OD | 4.750 | 4.875 | 5.000 | 5.125 | 5.250 | — | — | — |
| | | BD | 4.641 [e] | 4.641 [e] | 4.766 | 4.766 | 4.953 | — | — | — |
| NC40 | 2.000 | OD | 5.250 | 5.375 | 5.500 | 5.625 | 5.750 | — | — | — |
| | | BD | 5.047 [e] | 5.047 [e] | 5.203 | 5.203 | 5.391 | — | — | — |
| NC44 | 2.250 | OD | 5.500 | 5.625 | 5.750 | 5.875 | 6.000 | 6.125 | 6.250 | — |
| | | BD | 5.438 [e] | 5.438 [e] | 5.500 | 5.500 | 5.688 | 5.688 | 5.875 | — |
| NC46 | 2.250 | OD | 6.000 | 6.125 | 6.250 | 6.375 | 6.500 | 6.625 | 6.750 | 6.875 |
| | | BD | 5.719 [e] | 5.719 [e] | 5.906 | 5.906 | 6.094 | 6.094 | 6.281 | 6.281 |
| NC50 | 2.250 | OD | 6.375 | 6.500 | 6.625 | 6.750 | 6.875 | 7.000 | 7.125 | 7.250 |
| | | BD | 6.344 [e] | 6.344 [e] | 6.344 [e] | 6.344 [e] | 6.484 | 6.484 | 6.672 | 6.672 |
| NC56 | 2.500 | OD | 7.250 | 7.375 | 7.500 | 7.625 | 7.750 | 7.875 | 8.000 | — |
| | | BD | 7.078 [e] | 7.078 [e] | 7.109 | 7.109 | 7.297 | 7.297 | 7.484 | — |
| NC61 | 2.812 | OD | 8.000 | 8.250 | 8.375 | 8.500 | 8.625 | 8.750 | 8.875 | 9.000 |
| | | BD | 7.766 [e] | 7.812 | 7.812 | 8.000 | 8.000 | 8.188 | 8.188 | 8.375 |
| NC70 | 2.812 | OD | 9.250 | 9.375 | 9.500 | 9.625 | 9.750 | 9.875 | 10.000 | — |
| | | BD | 8.922 [e] | 8.922 [e] | 8.969 | 8.969 | 9.156 | 9.156 | 9.344 | — |
| 1 REG | 0.500 | OD | 1.563 | 1.688 | — | — | — | — | — | — |
| | | BD | 1.516 | 1.516 | — | — | — | — | — | — |
| $1^1/2$ REG | 0.500 | OD | 2.063 | 2.188 | — | — | — | — | — | — |
| | | BD | 2.000 | 2.000 | — | — | — | — | — | — |

**Table C.3—Bevel Diameters for Preferred Connections When Used on Drill Collars in USC Units** *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters for Various ODs [a,b,c] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 3/8 REG | 1.438 | OD | 3.125 | 3.250 | 3.375 | 3.500 | — | — | — | — |
| | | BD | 3.016 | 3.016 | 3.203 | 3.203 | — | — | — | — |
| 2 7/8 REG | 1.312 | OD | 3.875 | — | — | — | — | — | — | — |
| | | BD | 3.578 | — | — | — | — | — | — | — |
| 3 1/2 REG | 1.500 | OD | 4.375 | 4.500 | — | — | — | — | — | — |
| | | BD | 4.125 [e] | 4.266 | — | — | — | — | — | — |
| 4 1/2 REG | 2.250 | OD | 5.500 | 5.625 | 5.750 | 5.875 | 6.000 | — | — | — |
| | | BD | 5.422 [e] | 5.422 [e] | 5.484 | 5.484 | 5.672 | — | — | — |
| 5 1/2 REG | 2.500 | OD | 6.750 | 6.875 | 7.000 | 7.125 | 7.250 | 7.375 | 7.500 | — |
| | | BD | 6.594 [e] | 6.594 [e] | 6.656 | 6.656 | 6.844 | 6.844 | 7.031 | — |
| 6 5/8 REG | 2.812 | OD | 7.500 | 7.625 | 7.750 | 7.875 | 8.000 | 8.125 | 8.250 | — |
| | | BD | 7.281 [e] | 7.281 [e] | 7.328 | 7.328 | 7.516 | 7.516 | 7.703 | — |
| 7 5/8 REG FF | 2.812 | OD | 8.875 | 9.000 | 9.125 | 9.250 | 9.375 | 9.500 | — | — |
| | | BD | 8.500 [e] | 8.500 [e] | 8.625 | 8.625 | 8.813 | 8.813 | — | — |
| 7 5/8 REG LT | 2.500 | OD | 9.500 | 9.625 | 9.750 | 9.875 | 10.000 | — | — | — |
| | | BD | 9.250 | 9.250 | 9.250 | 9.250 | 9.250 | — | — | — |
| 8 5/8 REG FF | 3.000 | OD | 10.000 | 10.125 | 10.250 | 10.375 | 10.500 | 10.625 | — | — |
| | | BD | 9.719 [e] | 9.719 [e] | 9.719 [e] | 9.719 [e] | 9.891 | 9.891 | — | — |
| 8 5/8 REG LT | 3.000 | OD | 10.625 | 10.750 | 10.875 | 11.000 | — | — | — | — |
| | | BD | 10.500 | 10.500 | 10.500 | 10.500 | — | — | — | — |
| 5 1/2 FH | 2.500 | OD | 7.250 | 7.375 | 7.500 | 7.625 | 7.750 | 7.875 | 8.000 | — |
| | | BD | 7.047 [e] | 7.047 [e] | 7.094 | 7.094 | 7.281 | 7.281 | 7.469 | — |
| 6 5/8 FH | 2.812 | OD | 8.500 | 8.625 | 8.750 | 8.875 | 9.000 | 9.125 | 9.250 | — |
| | | BD | 8.203 [e] | 8.203 [e] | 8.266 | 8.266 | 8.453 | 8.453 | 8.641 | — |

NOTE See Figures 1 and 3.

[a] FOOTNOTE 1 Tolerance on bevel diameters is ±0.016 in.

[b] FOOTNOTE 2 See table '*Drill collar OD tolerances*' in API 7-1 (ISO 10424-1).

[c] FOOTNOTE 3 When drill collars and tools of the same OD listed in the table above are mated, the maximum seal stress will be less than 100 % of SMYS when torqued to the recommended torque value.

[d] FOOTNOTE 4 See 5.2.4.

[e] FOOTNOTE 5 These bevel diameters are not calculated using 75 % of the face width.

## Table C.4—Low-torque Feature

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Connection Size and Style** | **Required for OD Greater than:** | **Face Groove Diameter** $D_{FG}{}^{+0.032}_{-0.016}$ | **Face Groove Radius** $R_{FG} \pm 0.016$ |
| 7 5/8 REG LT | 9.50 | 7.75 | 0.25 |
| 8 5/8 REG LT | 10.50 | 9.00 | 0.25 |
| NOTE See Figure 6. | | | |

## Table C.5—Optional Feature Dimensions

| 1 | 2 | 3 |
|---|---|---|
| **Connection Size and Style** | **Pin ID Taper Diameter** $D_{PT}{}^{+0.031}_{-0.031}$ See Figure 1 | **Pin Benchmark Diameter** $D_{PB}{}^{+0.016}_{0}$ See Figure 12 |
| NC23 | — | 2.468 |
| NC26 | — | 2.781 |
| NC31 | 2.000 | 3.297 |
| NC35 | 2.312 | 3.656 |
| NC38 | 2.500 | 3.922 |
| NC40 | 2.625 | 4.187 |
| NC44 | 2.875 | 4.531 |
| NC46 | 3.000 | 4.740 |
| NC50 | 3.250 | 5.166 |
| NC56 | 3.250 | 5.734 |
| NC61 | 3.250 | 6.297 |
| NC70 | 4.125 | 7.172 |
| 1 REG | — | — |
| 1 1/2 REG | — | — |
| 2 3/8 REG | — | 2.546 |
| 2 7/8 REG | — | 2.921 |
| 3 1/2 REG | 2.000 | 3.421 |
| 4 1/2 REG | 2.625 | 4.546 |
| 5 1/2 REG | 3.000 | 5.441 |
| 6 5/8 REG | 3.375 | 5.913 |
| 7 5/8 REG | 4.000 | 6.921 |
| 8 5/8 REG | 4.375 | 7.871 |
| 5 1/2 FH | 3.500 | 5.746 |
| 6 5/8 FH | 4.125 | 6.674 |

**Table C.6—Stress-relief Groove and Boreback Contour Dimensions for Preferred Connections**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Connection Size and Style | Box Boreback Contour | | | Box Groove | | Diameter of Pin Groove |
| | Cylinder Diameter | Depth to Last Thread Scratch | Depth to End of Cylinder | Diameter of Box Groove | Depth to Start of Box Groove | |
| | $D_{CB}$ | $L_X$ | $L_{CYL}$ | $D_{BG}$ | $L_{BG}$ | $D_{SRG}$ |
| | $^{+0.016}_{0}$ | reference | ±0.25 | $^{+0.031}_{0}$ | $^{0}_{-0.125}$ | $^{0}_{-0.031}$ |
| NC35 | 3.234 | 3.25 | 5.25 | 3.328 | 3.38 | 3.231 |
| NC38 | 3.469 | 3.50 | 5.50 | 3.562 | 3.62 | 3.508 |
| NC40 | 3.656 | 4.00 | 6.00 | 3.734 | 4.12 | 3.772 |
| NC44 | 4.000 | 4.00 | 6.00 | 4.078 | 4.12 | 4.117 |
| NC46 | 4.203 | 4.00 | 6.00 | 4.297 | 4.12 | 4.326 |
| NC50 | 4.625 | 4.00 | 6.00 | 4.703 | 4.12 | 4.742 |
| NC56 | 4.797 | 4.50 | 6.50 | 4.844 | 4.62 | 5.277 |
| NC61 | 5.234 | 5.00 | 7.00 | 5.281 | 5.12 | 5.839 |
| NC70 | 5.984 | 5.50 | 7.50 | 6.031 | 5.62 | 6.714 |
| 3 1/2 REG | — | — | — | — | — | — |
| 4 1/2 REG | 3.719 | 3.75 | 5.75 | 3.781 | 3.88 | 4.013 |
| 5 1/2 REG | 4.500 | 4.25 | 6.25 | 4.500 | 4.38 | 4.869 |
| 6 5/8 REG | 5.281 | 4.50 | 6.50 | 5.312 | 4.62 | 5.417 |
| 7 5/8 REG | 5.859 | 4.75 | 6.75 | 5.859 | 4.88 | 6.349 |
| 8 5/8 REG | 6.781 | 4.88 | 6.88 | 6.781 | 5.00 | 7.301 |
| 5 1/2 FH | 5.109 | 4.50 | 6.50 | 5.156 | 4.62 | 5.250 |
| 6 5/8 FH | 6.047 | 4.50 | 6.50 | 6.078 | 4.62 | 6.179 |

NOTE See Figures 7, 8, and 9 for meaning of dimensions.

### Table C.7—Compensated Thread Lengths, Thread Heights, and Ball-point Diameters

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | **Taper**<br>$T$<br>in./ft | **Threads per Inch**<br>$n$ | **Compensated Lead Parallel to Taper** [a]<br>$L_{ct}$ | **Ball-point Diameter for Taper and Lead**<br>$d_b$<br>±0.002 | **Thread Height Compensated for Taper** [b]<br>$h_{cn}$ | **Ball-point Diameter for Thread Height**<br>$d_{bh}$<br>±0.002 |
| V-038R | 2 | 4 | 0.2509 | 0.144 | 0.1216 | 0.072 |
| V-038R | 3 | 4 | 0.2519 | 0.144 | 0.1207 | 0.072 |
| V-040 | 3 | 5 | 0.2016 | 0.115 | 0.1171 | 0.034 |
| V-050 | 3 | 4 | 0.2519 | 0.144 | 0.1464 | 0.044 |
| V-050 | 2 | 4 | 0.2509 | 0.144 | 0.1474 | 0.044 |
| V-055 | 1.5 | 6 | 0.1670 | 0.096 | 0.0558 | 0.072 |

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] FOOTNOTE 1 Compensated thread length ($L_{ct}$) is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] FOOTNOTE 2 Compensated thread height ($h_{cn}$) is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

### Table C.8—Gauge Thread Form Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Form of Thread** | **Threads per Inch**<br>$n$ | **Lead** | **Half-angle**<br>$\theta$<br>degrees | **Taper**<br>$T$<br>in./ft | **Thread Height Not Truncated**<br>$H$<br>reference | **Gauge Root Truncation**<br>$f_{rg}$<br>max | **Gauge Crest Truncation**<br>$f_{cg}$ | **Thread Height Truncated**<br>$h_g$<br>reference |
| V-038R | 4 | 0.250000 | 30 | 2 | 0.216005 | 0.053385 | 0.065000 | 0.0976 |
| V-038R | 4 | 0.250000 | 30 | 3 | 0.215379 | 0.053385 | 0.065000 | 0.0970 |
| V-040 | 5 | 0.200000 | 30 | 3 | 0.172303 | 0.039460 | 0.039460 | 0.0934 |
| V-050 | 4 | 0.250000 | 30 | 3 | 0.215379 | 0.048080 | 0.048080 | 0.1192 |
| V-050 | 4 | 0.250000 | 30 | 2 | 0.216005 | 0.048200 | 0.048200 | 0.1196 |
| V-055 | 6 | 0.166667 | 30 | 1.5 | 0.144150 | 0.055100 | 0.055100 | 0.03395 |

NOTE 1 In computing thread height and truncation, account has been taken of the effect of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 2 See Tables C.11 through C.13 for tolerances on columns 3, 4, 5, and 8.

NOTE 3 Prior to March 2005 the Crest truncation for V-038R gauges with 2 in./ft taper was 0.061161, and with 3 in./ft taper was 0.060998. These values are still acceptable for existing gauges made prior to this date.

NOTE 4 See Figure 18 for meaning of dimensions.

## Table C.9—Gauge Thread Dimensions for Preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Style and Size** | **Thread Form** | **Taper** $T$ in./ft | **Threads per Inch** $n$ | **Pitch Diameter at Gauge Point** [a] $C$ | **Major (Plug) Reference** [a] $D_{MP}$ | **Minor (Ring) Reference** [b] $D_{MR}$ | **Pitch Diameter at Working Gauge Point** [c] $C_{GP}$ | **Gauge Standoff** $S$ |
| NC23 | V-038R | 2.0 | 4 | 2.35500 | 2.44101 | 2.26900 | 2.23000 | 0.6250 |
| NC26 | V-038R | 2.0 | 4 | 2.66800 | 2.75401 | 2.58200 | 2.54300 | 0.6250 |
| NC31 | V-038R | 2.0 | 4 | 3.18300 | 3.26901 | 3.09700 | 3.05800 | 0.6250 |
| NC35 | V-038R | 2.0 | 4 | 3.53100 | 3.61701 | 3.44500 | 3.40600 | 0.6250 |
| NC38 | V-038R | 2.0 | 4 | 3.80800 | 3.89401 | 3.72200 | 3.68300 | 0.6250 |
| NC40 | V-038R | 2.0 | 4 | 4.07200 | 4.15801 | 3.98600 | 3.94700 | 0.6250 |
| NC44 | V-038R | 2.0 | 4 | 4.41700 | 4.50301 | 4.33100 | 4.29200 | 0.6250 |
| NC46 | V-038R | 2.0 | 4 | 4.62600 | 4.71201 | 4.54000 | 4.50100 | 0.6250 |
| NC50 | V-038R | 2.0 | 4 | 5.04170 | 5.12771 | 4.95570 | 4.91670 | 0.6250 |
| NC56 | V-038R | 3.0 | 4 | 5.61600 | 5.70138 | 5.53062 | 5.42850 | 0.6250 |
| NC61 | V-038R | 3.0 | 4 | 6.17800 | 6.26338 | 6.09262 | 5.99050 | 0.6250 |
| NC70 | V-038R | 3.0 | 4 | 7.05300 | 7.13838 | 6.96762 | 6.86550 | 0.6250 |
| 1 REG | V-055 | 1.5 | 6 | 1.15400 | 1.18795 | 1.12005 | 1.06025 | 0.3750 |
| 1 1/2 REG | V-055 | 1.5 | 6 | 1.54100 | 1.57495 | 1.50705 | 1.44725 | 0.3750 |
| 2 3/8 REG | V-040 | 3.0 | 5 | 2.36537 | 2.45875 | 2.27199 | 2.17787 | 0.6250 |
| 2 7/8 REG | V-040 | 3.0 | 5 | 2.74037 | 2.83375 | 2.64699 | 2.55287 | 0.6250 |
| 3 1/2 REG | V-040 | 3.0 | 5 | 3.23987 | 3.33325 | 3.14649 | 3.05237 | 0.6250 |
| 4 1/2 REG | V-040 | 3.0 | 5 | 4.36487 | 4.45825 | 4.27149 | 4.17737 | 0.6250 |
| 5 1/2 REG | V-050 | 3.0 | 4 | 5.23402 | 5.35324 | 5.11480 | 5.04652 | 0.6250 |
| 6 5/8 REG | V-050 | 2.0 | 4 | 5.75780 | 5.87740 | 5.63820 | 5.63280 | 0.6250 |
| 7 5/8 REG | V-050 | 3.0 | 4 | 6.71453 | 6.83375 | 6.59531 | 6.52703 | 0.6250 |
| 8 5/8 REG | V-050 | 3.0 | 4 | 7.66658 | 7.78580 | 7.54736 | 7.47908 | 0.6250 |
| 5 1/2 FH | V-050 | 2.0 | 4 | 5.59100 | 5.71060 | 5.47140 | 5.46600 | 0.6250 |
| 6 5/8 FH | V-050 | 2.0 | 4 | 6.51960 | 6.63920 | 6.40000 | 6.39460 | 0.6250 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE 1 The values in columns 5 and 6 apply only to Grand, Regional, and Reference Master plug gauges.

[b] FOOTNOTE 2 The values in column 7 apply only to ring gauges.

[c] FOOTNOTE 3 The values in column 8 apply only to Working plug gauges.

**Table C.10—Gauge External Dimensions for Preferred Connections**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length** $L_{pg}$ | **Fitting Plate [b] Diameter** $D_{FP}$ | **Ring Gauge Length** $L_{rg}$ | **Ring Gauge Outside Diameter** $D_R$ | **Diameter of Ring Gauge Counterbore** $Q$ |
| NC23 | 3.000 | 2.056 | 2.375 | 3.875 | 2.521 |
| NC26 | 3.000 | 2.369 | 2.375 | 4.187 | 2.834 |
| NC31 | 3.500 | 2.884 | 2.875 | 5.125 | 3.349 |
| NC35 | 3.750 | 3.232 | 3.125 | 5.250 | 3.697 |
| NC38 | 4.000 | 3.509 | 3.375 | 5.625 | 3.974 |
| NC40 | 4.500 | 3.773 | 3.875 | 5.875 | 4.239 |
| NC44 | 4.500 | 4.118 | 3.875 | 6.375 | 4.583 |
| NC46 | 4.500 | 4.327 | 3.875 | 6.500 | 4.792 |
| NC50 | 4.500 | 4.743 | 3.875 | 7.125 | 5.208 |
| NC56 | 5.000 | 5.318 | 4.375 | 7.875 | 5.782 |
| NC61 | 5.500 | 5.880 | 4.875 | 8.500 | 6.344 |
| NC70 | 6.000 | 6.755 | 5.375 | 9.375 | 7.219 |
| 1 REG | 1.500 | a | 1.125 | 2.500 | 1.360 |
| 1 1/2 REG | 2.000 | a | 1.625 | 2.875 | 1.688 |
| 2 3/8 REG | 3.000 | 2.131 | 2.375 | 3.750 | 2.531 |
| 2 7/8 REG | 3.500 | 2.506 | 2.875 | 4.250 | 2.906 |
| 3 1/2 REG | 3.750 | 3.005 | 3.125 | 5.000 | 3.406 |
| 4 1/2 REG | 4.250 | 4.130 | 3.625 | 6.250 | 4.531 |
| 5 1/2 REG | 4.750 | 4.956 | 4.125 | 7.500 | 5.427 |
| 6 5/8 REG | 5.000 | 5.448 | 4.375 | 8.250 | 5.949 |
| 7 5/8 REG | 5.250 | 6.421 | 4.625 | 9.500 | 6.906 |
| 8 5/8 REG | 5.375 | 7.373 | 4.750 | 10.750 | 7.858 |
| 5 1/2 FH | 5.000 | 5.292 | 4.375 | 7.750 | 5.784 |
| 6 5/8 FH | 5.000 | 6.210 | 4.375 | 9.000 | 6.711 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE There is no fitting plate on 1 REG and 1 1/2 REG.

[b] FOOTNOTE The thickness of fitting plates, $T_{FP}$, shall be 0.375 in. maximum for all gauge sizes with pitch diameter ($C$) of 5.6 in. or smaller and 0.437 in. maximum for all larger gauge sizes.

**Table C.11—Tolerances on Gauge Dimensions for Regional and Grand Master Gauges**

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| **Element** | **Tolerances** | | | |
| | **Plug** | | **Ring** | |
| pitch diameter at gauge point [a]: | ±0.0002 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 3.90 | ±0.0002 | | ±0.0003 | |
| pitch diameter > 3.90 | ±0.0003 | | ±0.0004 | |
| taper limits [c]: | min | max | min | max |
| all | 0.0001 | 0.0004 | − 0.0012 | − 0.0006 |
| half-angle of thread, degrees | ±0.083 | | ±0.167 | |
| mating standoff, $S$ | — | | ±0.001 | |
| interchange standoff, Regional Master against Grand Master | ±0.004 | | ±0.004 | |
| crest truncation, $f_{cg}$ | ±0.00112 | | ±0.00110 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±0.093 | | ±0.093 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.015 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.015 | |
| ring gauge counterbore, $Q$ | — | | ±0.015 | |

NOTE See Figure 19.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads, whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

## Table C.12—Tolerances on Gauge Dimensions for Reference Master Gauges

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| **Element** | **Tolerances** | | | |
| | **Plug** | | **Ring** | |
| pitch diameter at gauge point [a]: | — | | — | |
| pitch diameter ≤ 5.98 [d] | ±0.0004 | | — | |
| pitch diameter > 5.98 | ±0.0005 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 5.98 [e] | ±0.0004 | | ±0.0006 | |
| pitch diameter > 5.98 | ±0.0005 | | ±0.0007 | |
| taper limits[c]: | min | max | min | max |
| $L_{rg}$ 3.5 and shorter | 0 | 0.0004 | −0.0012 | −0.0004 |
| $L_{rg}$ 3.56 through 4 | 0 | 0.0005 | −0.0014 | −0.0004 |
| $L_{rg}$ 4.06 through 4.5 | 0 | 0.0006 | −0.0016 | −0.0004 |
| $L_{rg}$ 4.56 through 5 | 0 | 0.0007 | −0.0018 | −0.0004 |
| $L_{rg}$ 5.06 through 5.5 | 0 | 0.0008 | −0.0020 | −0.0004 |
| $L_{rg}$ 5.56 and longer | 0 | 0.0009 | −0.0022 | −0.0004 |
| half-angle of thread, degrees | ±0.117 | | ±0.25 | |
| mating standoff, $S_0$ | — | | ±0.001 | |
| interchange standoff, Reference Master against Regional Master or Grand Master | ±0.004 | | ±0.004 | |
| crest truncation, $f_{cg}$ | ±0.00125 | | ±0.00125 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±0.093 | | ±0.093 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.015 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.015 | |
| ring gauge counterbore, $Q$ | — | | ±0.015 | |

NOTE See Figure 19.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 $L_{rg}$ values are listed in Table B.9, column 4. The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

[d] FOOTNOTE 4 The tolerance for pitch diameter for NC56 was historically ±0.0005. This shall remain acceptable for gauges made before December 2008.

[e] FOOTNOTE 5 The tolerance for lead for NC56 was historically ±0.0005 on the plug and ±0.0007 on the ring. This shall remain acceptable for gauges made before December 2008.

**Table C.13—Tolerances on Gauge Dimensions for Working Gauges**

| 1 | 2 | | 3 | |
|---|---|---|---|---|
| **Element** | **Tolerances** | | | |
| | **Plug** | | **Ring** | |
| pitch diameter at gauge point [a]: | — | | — | |
| pitch diameter ≤ 5.98 [d] | ±0.0004 | | — | |
| pitch diameter > 5.98 | ±0.0005 | | — | |
| lead [b]: | — | | — | |
| pitch diameter ≤ 5.98 [e] | ±0.0004 | | ±0.0006 | |
| pitch diameter > 5.98 | ±0.0005 | | ±0.0007 | |
| taper limits [c]: | min | max | min | max |
| $L_{rg}$ 3.5 and shorter | 0 | 0.0006 | –0.0014 | –0.0004 |
| $L_{rg}$ 3.56 through 4 | 0 | 0.0007 | –0.0016 | –0.0004 |
| $L_{rg}$ 4.06 through 4.5 | 0 | 0.0008 | –0.0018 | –0.0004 |
| $L_{rg}$ 4.56 through 5 | 0 | 0.0009 | –0.0020 | –0.0004 |
| $L_{rg}$ 5.06 through 5.5 | 0 | 0.0010 | –0.0022 | –0.0004 |
| $L_{rg}$ 5.56 and longer | 0 | 0.0011 | –0.0024 | –0.0004 |
| half-angle of thread, degrees | ±0.117 | | ±0.25 | |
| mating standoff, $S$ | — | | ±0.001 | |
| interchange standoff, Working gauge against Reference Master | ±0.004 | | ±0.004 | |
| crest truncation, $f_{cg}$ | ±0.00125 | | ±0.00125 | |
| gauge lengths, $L_{pg}$ and $L_{rg}$ | ±0.093 | | ±0.093 | |
| plug fitting plate diameter, $D_{FP}$ | ±0.015 | | — | |
| ring gauge outside diameter, $D_R$ | — | | ±0.015 | |
| ring gauge counterbore, $Q$ | — | | ±0.015 | |

NOTE See Figure 20.

[a] FOOTNOTE 1 Helix angle correction shall be disregarded in pitch diameter determinations. The gauge point for Working gauges is 1.375 from the measurement face.

[b] FOOTNOTE 2 Maximum allowable error in lead between any two threads whether adjacent or separated by any amount not exceeding the full length of thread less one full thread at each end.

[c] FOOTNOTE 3 $L_{rg}$ values are listed in Table B.9, column 4. The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange standoff due to lead errors. See Figure 22 for meaning of taper limits.

[d] FOOTNOTE 4 The tolerance for pitch diameter for NC56 was historically ±0.0005. This shall remain acceptable for gauges made before December 2008.

[e] FOOTNOTE 5 The tolerance for lead for NC56 was historically ±0.0005 on the plug and ±0.0007 on the ring. This shall remain acceptable for gauges made before December 2008.

# Annex D
(informative)

# USC Units Conversion Table

## D.1 Conversion Table

The factors that should be used for conversion of metric units to USC values are given in Table D.1.

**Table D.1—Conversions Factors for Metric to USC Units**

| | |
|---|---|
| 1 mm (millimeter) | = 1/25.4 in. |
| 1 mm/mm (millimeters per millimeter)<br>= 1000 mm/m (millimeters per meter) | = 12 in./ft (inches per foot)<br>= 1 in./in. (inch per inch) |
| 1 thread per 25.4 mm | = 1 thread per 1 in. |
| 1 kg (kilogram) | = 2.2046 lb (pounds) |

Equation (D.1) should be used to convert the temperature in degrees Celsius ($t_C$) to the temperature in degrees Fahrenheit ($t_F$):

$$t_F = (1.8 \times t_C) + 32 \quad \text{(D.1)}$$

## D.2 Rounding

The majority of dimensions in this standard were defined in USC units in API 7. The values used here in SI units are converted using the following rules.

a) Dimensions that define threads are converted exactly. This requires one more decimal place than the original USC units, which is not consistent with ISO standard practice.

b) These values include $C$, $f_c$, $f_r$, and $R$.

c) Lead and taper are expressed using exact conversions.

d) Three place decimals in inch units become 2 place decimals in millimeters. Rounding may be up or down so that the mm dimension falls within the inch tolerances.

e) All other dimensions are converted to the same number of decimal place as the original USC units. The conversion to SI units is made so that when reconverted to USC units, and rounded, the result is equal to the historical USC value.

# Annex E
(informative)

# Calculations

## E.1 Thread Dimensions

The thread dimensions listed in the tables below shall be composed of primary dimensions (Tables E.1 and E.2), derived dimensions that may be computed from the primary dimensions, and auxiliary dimensions (Table E.3) that have been defined by the designers of the connection or the feature.

## E.2 Primary Dimensions

The primary dimensions represent a design decision for the connection and thread form.

**Table E.1—Primary Dimensions for Connection**

| | |
|---|---|
| pitch diameter at gauge point dimension, $L_{GP}$ | $C$ |
| taper | $T$ |
| pin length | $L_{PC}$ |
| gauge point from shoulder | $L_{GP}$ |

**Table E.2—Primary Dimensions for Thread Form**

| | |
|---|---|
| threads per 25.4 mm (1 in.) | $n$ |
| half angle between thread flanks | $\theta$ |
| crest flat width | $F_c$ |
| root flat width | $F_r$ |
| root radius | $R$ |

## E.3 Derived Dimensions

These relations follow from the thread definitions and are used throughout this document.

a) Lead, $P$ (see Figure 4):

$$P = 25.4\ \text{mm}/n\ (1\ \text{in.}/n) \quad \text{(E.1)}$$

b) Thread height, $H$, before truncation (see Figure 4):

$$H = P[1 - (T \tan\theta/2)^2]/(2\tan\theta) \quad \text{(E.2)}$$

c) Cone half-angle, $\varphi$ (see Figure 1):

$$\varphi = \arctan(T/2) \quad \text{(E.3)}$$

d) Crest truncation, $f_c$ (see Figure 4):

$$f_c = F_c[1 - (T \tan\theta/2)^2]/(2 \tan\theta) \quad \text{(E.4)}$$

e) Root truncation, $f_r$, when there is a root flat (see Figure 5):

$$f_r = F_r[1 - (T \tan\theta/2)^2]/(2\tan\theta) \quad \text{(E.5)}$$

f) Root truncation when there is not a root flat (see Figure 4):

$$f_r = R(1 - \sin\theta) / \sin\theta \quad \text{(E.6)}$$

g) Truncated thread height (see Figures 4 and 5):

$$h = H - f_c - f_r \quad \text{(E.7)}$$

h) Compensated thread height when there is a root flat:

$$h_{cn} = h\cos\varphi \quad \text{(E.8)}$$

i) Compensated thread height when there is not a root flat:

$$h_{cn} = (h - R)\cos\varphi + R \quad \text{(E.9)}$$

j) Major cone diameter, $D_L$, at pin base (see Figure 1):

$$D_L = C + L_{GP}T + H - 2f_c \quad \text{(E.10)}$$

k) Major diameter, $D_S$, at small end of pin (see Figure 1):

$$D_S = D_L - TL_{PC} \quad \text{(E.11)}$$

## E.4 Design Rules

### E.4.1 General

These relations are the result of design choices and do not necessarily agree with the values defined as standards in this standard. In particular, some of the computed dimensions have historically been rounded in inch units; they have been used to generate dimensions in this standard when authoritative historical values were not available.

### E.4.2 Box Depth

Box depth, $L_{BC}$ (see Figure 2):

$$L_{BC} = L_{PC} + 15.875 \text{ mm (0.625 in.)} \quad \text{(E.12)}$$

### E.4.3 Box Thread Depth

Box thread depth, $L_{BT}$ (see Figure 2):

$$L_{BT} = L_{PC} + 3.175 \text{ mm (0.125 in.)} \quad \text{(E.13)}$$

### E.4.4 Bevel Diameters

#### E.4.4.1 General

Refer to Figures 1 and 3 for bevel diameters.

#### E.4.4.2 Calculation

Calculation of the correct bevel diameter (BD) requires a two-part approach. Bevel diameters shall be calculated every 6.35 mm (0.250 in.) starting at the reference OD regardless of the method used except as noted in E.4.4.5. Bevel diameters have traditionally been calculated in USC units and then converted to the metric system. In USC units the data for bevel diameters is recorded in divisions of $^{1}/_{64}$ in. (0.0156 in.) for defining the mathematical scale used in the tables.

#### E.4.4.3 Bevel Diameters by the 75 % Shoulder Width Method

##### E.4.4.3.1 General

The bevel diameter calculated by this method is a nominal bevel diameter. Tables B.3, C.3, K.4, and L.4 contain reference ODs and corresponding bevel diameter. By default, the bevel diameters are calculated by the 75 % shoulder width method; exceptions are marked by a footnote.

The reference OD is the recommended minimum OD where the bevel diameter can be calculated by the 75 % shoulder width method. Use of ODs smaller than the reference OD can lead to seal face stresses greater than the SMYS of the material.

##### E.4.4.3.2 Basic 75 % Shoulder Width Formula

The basic 75 % shoulder width formula is given by:

$$\text{BD1} = (\text{OD} - Q_\text{c})(0.75) + Q_\text{c} \qquad \text{(E.14)}$$

where

$Q_\text{c}$ is the nominal counter bore dimension from Table B.1 (C.1);

OD is the outside diameter of the product; and

BD1 is the bevel diameter by the 75 % shoulder width method.

##### E.4.4.3.3 Alternate 75 % Shoulder Width Method

For ODs larger than the reference OD add 4.76 mm (0.1875 in.) to BD1 for each 6.35 mm (0.250 in.) increase in OD.

The alternate 75 % shoulder width method to obtain BD2, the bevel diameter from this alternate method, for the respective unit system is given by:

Metric units:

$$\text{BD2} = \text{BD1} + (4.76\ \text{mm})(\text{number of 6.35 mm increases in OD}) \qquad \text{(E.15)}$$

USC units:

$$\text{BD2} = \text{BD1} + (0.1875\ \text{in.})(\text{number of 0.250 in. increases in OD}) \qquad \text{(E.16)}$$

The seal face stress for bevel diameters calculated by the 75 % method increases as the OD of the connection decreases. At some small OD the seal face stress will exceed the SMYS.

### E.4.4.4 Mismatched Outside Diameters

#### E.4.4.4.1 General

There is a minimum bevel diameter required for mismatched ODs to keep the stress level on seal face below SMYS.

To calculate the required bevel diameter, the largest OD in the table and the reference ID are used to calculate the maximum torsional load from the makeup torque. Table B.3 (Table C.3) lists the reference ID used in these tables.

#### E.4.4.4.2 Calculate the Seal Face Load

Calculate the seal face load from the makeup torque of the largest OD of the connection in the table and the reference ID from:

$$\text{Load1} = (S_{\text{mu}})(\text{A1}) \tag{E.17}$$

where

$S_{\text{mu}}$ is 431 MPa (62,500 psi) for preferred connections in Table B.3 (C.3);

A1 is the torsional area of pin ($A_{\text{p}}$) (see API 7G);

Load1 is the load generated by makeup torque.

Use the reference ID shown in Table B.3 (C.3) to calculate the torsional area of the pin. The formulas to calculate the torsional areas of the pin or box are found in API 7G or ISO 10407.

#### E.4.4.4.3 Calculate Required Area of Seal Face

Calculate the required area of seal face to keep seal stress below SMYS from:

$$\text{A2} = (\text{L1})/\text{SMYS} \tag{E.18}$$

where

A2 is the area of seal face required to support the load from the makeup torque.

#### E.4.4.4.4 Calculate the New Bevel Diameter

Calculate the new bevel diameter to support the load and not exceed SMYS from:

$$\text{BD3} = (\text{CB}^{\mathbf{2}} + 4A^{2}/\pi)^{0.5} \tag{E.19}$$

where

BD3 is the minimum bevel diameter (OD of the area) required to support the load generated by makeup torque and the reference ID.

#### E.4.4.4.5 Interpretation of Calculations

The interpretation of calculations can be done by the following.

a) Compare the bevel diameters found in E.4.4.3 and E.4.4.4 for each OD in the table for that connection.

b) Select the larger of these diameters for each OD as the bevel diameter for that OD.

c) The smallest OD and bevel diameter in Table B.3 (C.3) is the smallest OD and bevel diameter recommended for each connection regardless of the calculation method used. The use of smaller bevel diameters will result in a stress level in the seal face stress that is above the SMYS of the product material when a mismatch with the largest OD and reference ID occurs. If ODs smaller than those in the tables are used, the smallest bevel in the tables shall be used until the bevel diameter becomes larger than the tool OD. At this point, each further reduction of 6.35 mm (0.250 in.) in OD, the new bevel diameter shall be determined by subtracting 1.587 mm (0.0625 in.) from the reduced OD.

d) Bevel diameters are calculated every 6.35 mm (0.250 in.). For ODs between the 6.35 mm (0.250 in.) intervals, the bevels are the same as the bevel diameter of the smaller OD.

EXAMPLE

For the NC46 connection, one of the calculation points is at 165.10 mm (6.500 in.) OD with a bevel diameter of 154.79 mm (6.094 in.). The next calculation point occurs at 171.45 mm (6.750 in.) OD. For the interval between 165.10 and 154.79 mm (6.500 and 6.750 in.), the bevel diameter remains 154.79 mm (6.094 in.).

That is:

1) the bevel diameter for 166.6 mm (6.562 in.) OD is 154.79 mm (6.094 in.),

2) for 168.28 mm (6.625 in.) OD it is 154.79 mm (6.094 in.),

3) for 169.8 mm (6.687 in.) OD it is still 154.79 mm (6.094 in.), and

4) at 171.45 mm (6.750 in.) OD the bevel diameter is recalculated.

e) For ODs larger than the largest OD currently in Table B.3 (C.3), the bevel diameter shall be determined by adding 4.76 mm (0.188 in.) to the largest bevel diameter in the table for each 6.35 mm (0.250 in.) of OD increase.

f) The ID of the connection cannot be smaller than the reference ID if all seal faces in Table B.3 (C.3) are to have stress levels less than the SMYS when the ODs are mismatched.

NOTE Bevel diameters calculated in E.4.4.3 are nominal and are rounded up or down to the nearest 1/64 in. Bevel diameters calculated by E.4.4.4 are minimum and are rounded up to the nearest 1/64 in. and then increased in size by 0.40 mm (0.016 in.) to become the nominal values in the tables.

### E.4.5 Boreback Diameter and Boreback Length

Boreback diameter, $D_{CB}$, and boreback length, $L_X$ (see Figure 7):

$$L_X = L_{PC} - 12.7 \text{ mm (0.5 in.)} \tag{E.20}$$

$$D_{CB} = C + L_{GP}\, T + H - 2f_r - L_X\, T \tag{E.21}$$

### E.4.6 Box Groove Diameter and Box Groove Length

Box groove diameter, $D_{BG}$, and box groove length, $L_{BG}$ [Equations (E.22) through (E.27); see Figure 9]:

$$L_{BG} = L_P - 9.52 \text{ mm} \tag{E.22}$$

$$(L_{BG} = L_P - 0.375 \text{ in.}) \tag{E.23}$$

$$h_{bg} = 5.16 \text{ mm (0.203 in.)} \tag{E.24}$$

$$R_{bg} = 6.35 \text{ mm (0.250 in.)} \tag{E.25}$$

$$D_{BG} = C - T(L_{BG} - L_{GP}) + 2B \tag{E.26}$$

$$B = \left\{ h_{BG} - R_{bg}\left[1-\cos\left(45^\circ+\varphi\right)\right]\right\}\left[\frac{\sin\left(45^\circ\right)}{\sin\left(45^\circ+\varphi\right)}\right] + R_{bg}\left(1-\cos 45^\circ\right) - \left(H/2 - f_c\right) \quad \text{(E.27)}$$

Values of $B$ are listed in Table E.3.

### E.4.7 Pin Stress Relief Groove

Pin stress-relief groove, $D_{SRG}$ (see Figure 8):

$$D_{SRG} = C - H + 2f_r - A \quad \text{(E.28)}$$

$A$ is the depth of the groove below the thread root at the gauge point and depends on the thread form. Values are listed in Table E.3.

**Table E.3—Auxiliary Design Dimensions**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | **Taper, $T$** | **$\theta$** | **Pin SRG clearance, $A$** | | **Box SRG Addendum, $B$** | |
| | | degrees ±0.75 | mm | (in.) | mm | (in.) |
| V-038R | 1/6 | 30 | 4.064 | (0.160) | 3.24 | (0.128) |
| V-038R | 1/4 | 30 | 5.080 | (0.200) | 2.97 | (0.117) |
| V-040 | 1/4 | 30 | 5.588 | (0.220) | 2.97 | (0.117) |
| V-050 | 1/4 | 30 | 5.080 | (0.200) | 2.64 | (0.104) |
| V-050 | 1/6 | 30 | 4.445 | (0.175) | 2.91 | (0.115) |
| V-055 | 1/8 | 30 | — | — | 4.08 | (0.160) |
| V-076 | 1/8 | 30 | 3.810 | (0.150) | 3.62 | (0.143) |
| 90-V-050 | 1/6 | 45 | 4.572 | (0.180) | 3.39 | (0.133) |
| 90-V-050 | 1/4 | 45 | 5.080 | (0.200) | 3.12 | (0.123) |
| 90-V-084 | 5/48 | 45 | 4.826 | (0.190) | 3.73 | (0.147) |

## E.5 Gauge Dimensions

Gauge dimensions can be calculated by the following.

a) Major diameter of plug gauge at gauge point, $D_{MP}$, for distance from shoulder at gauge point, $L_{GP}$:

$$D_{MP} = C + (H - 2f_{cg}) \quad \text{(E.29)}$$

b) Minor diameter of plug gauge at gauge point, $D_{MR}$, for distance from shoulder at gauge point, $L_{GP}$:

$$D_{MR} = C - (H - 2f_{cg}) \quad \text{(E.30)}$$

c) Pitch diameter at Working gauge point, $C_{GP}$, [E.31 (SI units); E.32 (USC units)]:

$$C_{GP} = C - 19.05\,T \text{ mm} \quad \text{(E.31)}$$

$$C_{GP} = C - 0.75\,(T/12) \text{ in.} \quad \text{(E.32)}$$

d) Length of setting standard for thread lead, compensated taper, $L_{ct}$ [Equations (E.33) (SI units) and (E.34) (USC units)]:

$$L_{ct} = 25.4 \text{ mm}/\cos\varphi \tag{E.33}$$

$$L_{ct} = 1.0 \text{ in.}/\cos\varphi \tag{E.34}$$

e) Diameter of ball for thread height gauge, $d_b$:

$$d_b = P/(2\cos\theta) \tag{E.35}$$

f) Reference gauge thread height truncated, $h_g$:

$$h_g = H - f_{cg} - f_{rg} \tag{E.36}$$

g) Gauge thread with crest truncation, $f_{cg}$ [Equation (E.37)], for thread forms (V-038R, V-040, V-050) with full root radius, $R$:

$$f_{cg} = R\cos\theta\,(\tan\varphi + \cot\theta) \text{ plus an allowance of 0.01 to 0.012 mm (0.004 to 0.005 in.)} \tag{E.37}$$

h) Gauge thread with crest truncation, $f_{cg}$, for thread forms (V-055, V-076, 90-V-050, 90-V-084) with root flat radius, $r_r$:

$$f_{cg} = f_r + r_r \cdot (1/\cos\varphi - \sin\theta - \cos\theta \cdot \tan\varphi) \text{ plus an allowance of 0.01 to 0.012 mm (0.004 to 0.005 in.)} \tag{E.38}$$

# Annex F
(informative)

# Gauging Elements of New Rotary Shouldered Connections

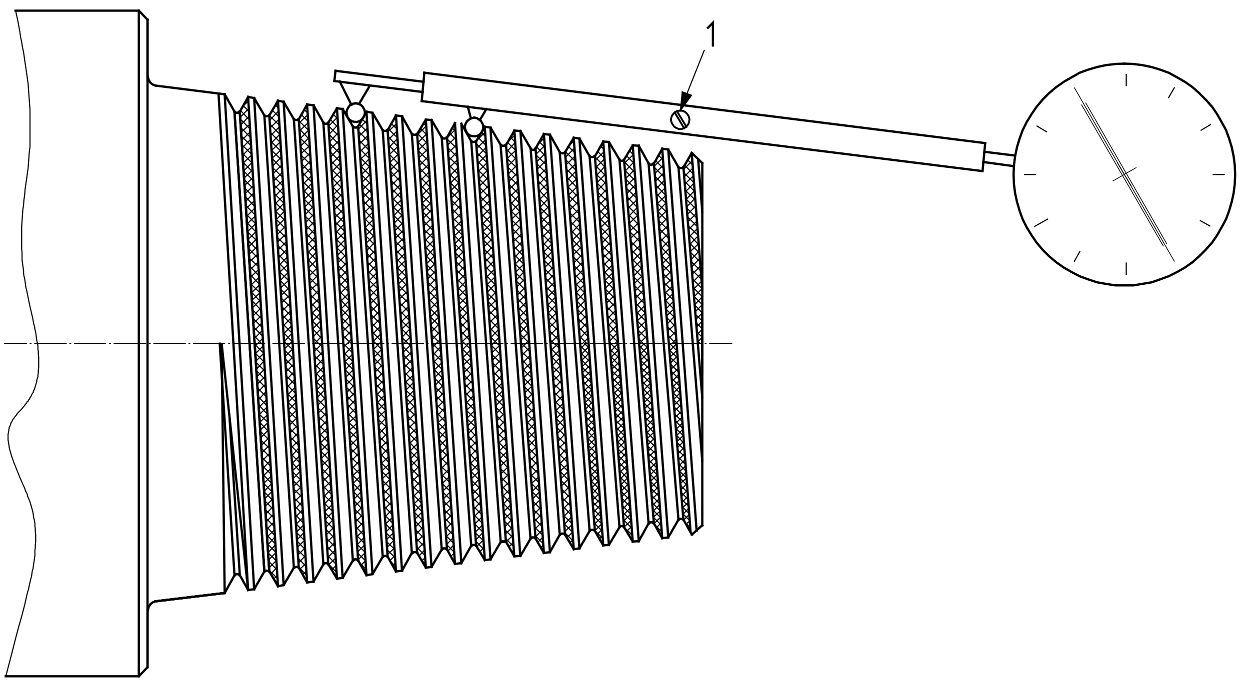
## F.1 General

This annex describes typical instruments for measuring thread elements, and their use. The representation of the instrument is not intended to imply a preference for a particular manufacturer or construction.

## F.2 Lead Gauges

### F.2.1 General

The lead of threads should be gauged with a lead gauge, one type of which is illustrated in Figure F.1. A gauge of similar principle should be used for internal threads. Lead gauges shall be constructed so that the measuring mechanism is under strain when the indicator hand is adjusted to zero by means of the standard template (see Figure 15). The precision of the measuring instrument shall be 0.013 mm (0.0005 in.) or better.




**Key**

1 adjusting mechanism

**Figure F.1—External Lead Measurement**

### F.2.2 Adjustment of Gauges

Before use, the appropriate ball-points should be installed in accordance with Table B.7, and the movable ball-point should be set to provide a distance between points equal to the interval of threads to be gauged (see Table B.7) and the dial gauge indicator set to zero position when the gauge is applied to the standard template. If the gauge does not register zero, adjust it until it registers zero on the template.

### F.2.3 Procedure for Lead Measurement

The ball-points of the gauge should be placed in the proper thread grooves and the gauge shall be pivoted upon the fixed ball-point through a small arc on either side of the correct line of measurement. The minimum plus reading or maximum minus reading on the indicator shall be taken as the lead error.

## F.3 Taper Measurement

### F.3.1 Taper Calipers

The taper of threads should be measured with an instrument having a dial-gauge caliper similar to that illustrated in Figures F.2 and F.3. The caliper shall have a precision of 0.025 mm (0.001 in.) or better within the measurement range used.

### F.3.2 Procedure for Taper Measurements

Before use, the appropriate ball-points should be installed in accordance with Table B.7. With the adjustable arm of the caliper set to accommodate the size of thread to be inspected, the contact on the fixed arm of the caliper shall be placed in the first perfect thread position and the contact on the movable arm of the caliper in position in the same thread, 180° opposite. The fixed contact shall be held firmly in position, the movable contact oscillated through a small arc, and the dial gauge set so that the zero position coincides with the maximum indication. Similarly, successive measurements, at the same radial position relative to the axis of the thread, shall then be taken at suitable intervals for the length of perfect threads. A line scribed on the thread crests parallel to the thread axis can be used to align the fixed contact for maintaining the same radial position. The difference between successive measurements shall be the taper in the interval of threads.

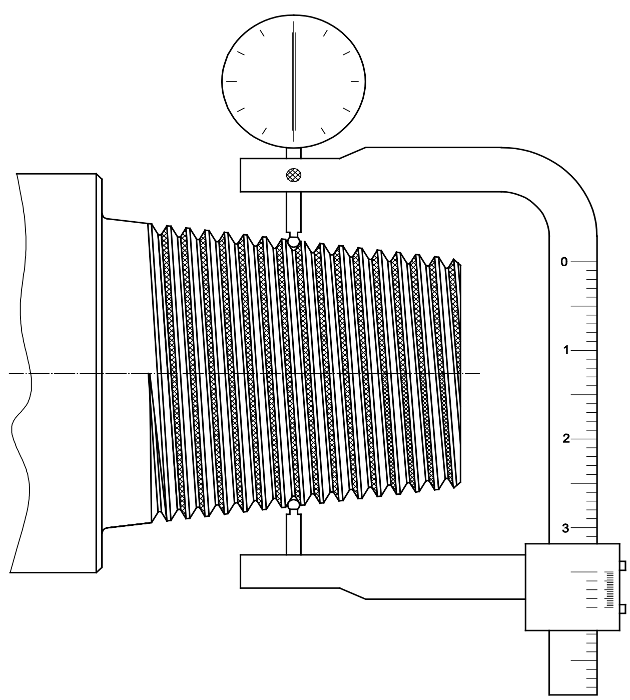



**Figure F.2—External Taper Measurement (Pin)**

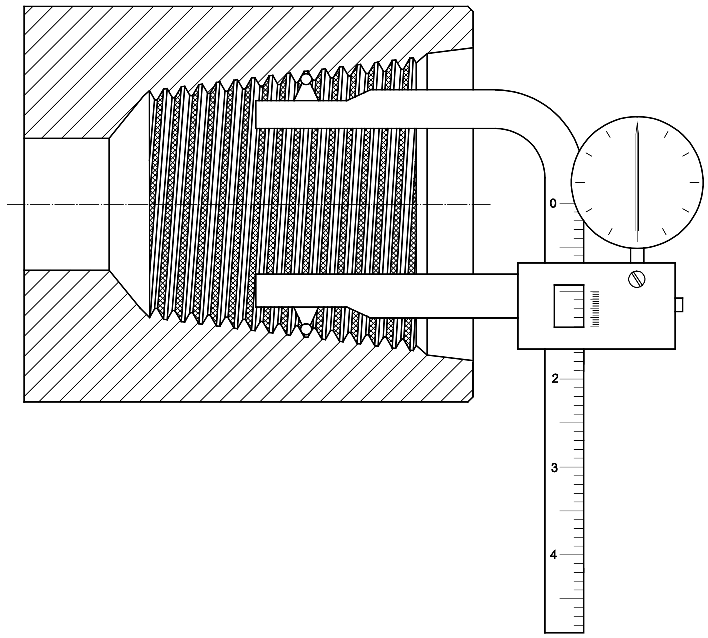



**Figure F.3—Internal Taper Measurement (Box)**

## F.4 Thread Height Measurement

### F.4.1 Thread Height Gauges

Thread height should be measured with gauges similar to the type illustrated in Figure F.4 for external threads and internal threads as size permits, or the type illustrated in Figure F.5 for small internal threads. Such gauges shall have indicators graduated to register the deviation in thread height, as illustrated in Figure F.6 and shall be equipped with appropriate ball-point, in accordance with Table B.7. The height gauge shall have a measurement precision not larger than 0.013 mm (0.000 5 in.).

Alternatively, the thread height may be measured with a gauge indicator equipped with a dial capable of registering the actual thread height. The contact points shall be conical in shape, with an included angle of 50° and a 0.006 in. radius. The thread height indicator is set to register zero when placed on a flat surface.

### F.4.2 Adjustment

When applied to the U-groove for the type of thread to be measured, gauges shall be adjusted to the proper register. Gauges having indicators for determining deviation in thread height shall be adjusted to register zero when applied to the applicable groove. Gauges with indicators for determining the actual thread height shall be adjusted to register the proper thread height when applied to the applicable groove. For thread height gauges of the type illustrated in Figure F.5, if the standard template cannot be positioned flat on the anvil with the pressure arm applied, the arm shall be moved to prevent contact with the standard template during adjustment.

### F.4.3 Procedure

The contact ball shall be placed in the proper thread groove with the anvil in a line parallel to the axis of the thread and resting on the crests of the adjacent threads. For gauges of the type illustrated in Figure F.4, the gauge shall be oscillated through a small arc on each side of the position normal to the taper cone. For gauges graduated to measure the actual thread height, the minimum plus reading or maximum minus reading on the indicator shall be taken as the thread height error. For balanced dial height gauges the reading at the point or needle reversal shall be taken as the height error. For gauges of the type illustrated in Figure F.6, the gauge cannot be oscillated. Confirm that the gauge is well seated and properly centered in the groove before taking reading.

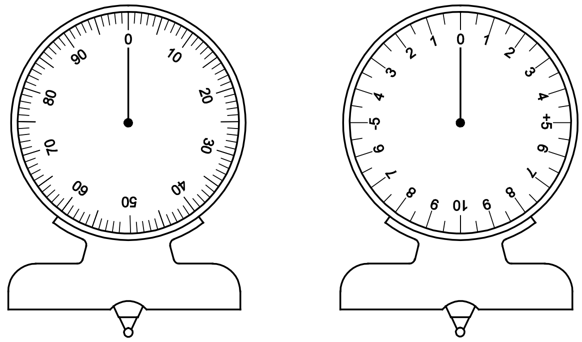



**Figure F.4—Thread-height Gauge**

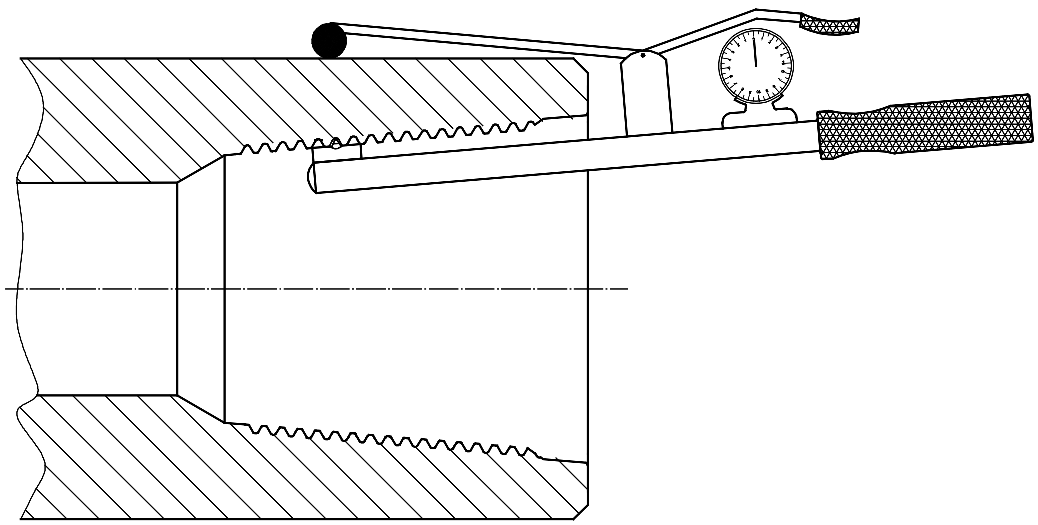


**Figure F.5—Thread-height Measurement (Box)**

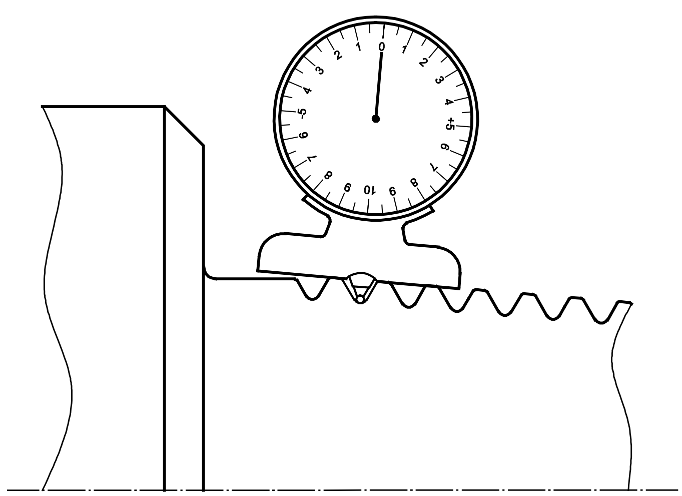


**Figure F.6—Thread-height Measurement (Pin)**

# Annex G
(normative)

# Care and Use of Working Gauges

## G.1 Gauge Wear

A reduction in mating standoff of used Working gauges is not serious providing the wear on thread elements has been uniform and that correction in gauging standoff, as shown by comparison with the Reference Masters, is applied when gauging product threads.

## G.2 Handling

Because of their extreme accuracy, gauges represent a considerable investment. They should be handled with care. A gauge that is abused or allowed to deteriorate quickly loses its value for gauging purposes.

## G.3 Protection

Gauges should be kept free from dirt and grit. It is important that a suitable place be provided for storage. It is advisable that plug and ring gauges be stored separately and not made up in pairs. They should be coated with a good grade of slushing oil when not in use.

## G.4 Inspection and Deburring

Before use, the gauges should be examined for burrs on the thread. Burrs or other rough spots should be removed with a medium-fine stone or with a fine file. Gauges should be given a periodic visual examination for pick-up of slivers on the gauging surfaces. Those observed should be removed with a fine file or stone.

## G.5 Handling

In gauging product threads, the gauges should be handled with care. Clean both gauge and product thoroughly before assembling. A light film of thin oil will protect the gauge when in use and increase the life of the gauge. Dry surfaces when set up under pressure have a tendency to seize and pick up metal. Such spots cause inaccuracies in gauging if not removed. Gauges should be set up firmly on the product. A rod about 150 mm (6 in.) long may be used for this purpose. Loose gauging produces loose joints.

# Annex H
(informative)

# Care and Use of Master Gauges

## H.1 Protective Coating

The gauging surfaces of Master gauges should be protected with a coating of petrolatum brushed into the threads. In cold weather, it is advisable to heat the petrolatum slightly so that it flows easily. If gauges are not used for a 6-month period, they should be thoroughly cleaned and a fresh coating of petrolatum applied.

A neutral oil is effective in protecting gauges for only a short period of time, a few days to 2 weeks depending on atmospheric conditions. In warm weather, the oil flows off the surface much faster than in cold weather. Eventually, dust particles settling on an oil-protected gauge will penetrate the gauge surface and cause small rust spots. Since the custodian might not know when the Regional Masters will be used again, the use of petrolatum as protection is advised in all cases.

## H.2 Storage

Gauges should be stored unassembled in a well-controlled temperature environment. When gauges are stored with plug and ring assembled, with or without a protective coating, there is a tendency for electrolytic corrosion to develop, appearing as a discoloration of the surface in contact. If left assembled for a long period, the surfaces can actually rust together. The ideal storage arrangement for Master gauges is a case or cupboard with wood shelves provided with a door with lock and key to prevent unauthorized use of the gauges. Shelves should be partitioned with wood spacers to provide a separate compartment for each size plug gauge. This prevents damage to the thread surface in storing. Compartments for rings are not required, but rings should not be stacked. Shelving should be covered with waxed paper to protect end surfaces of plugs and rings.

## H.3 Cleaning

In the determination of standoff values, Master gauges should be thoroughly cleaned before assembly. This can be done most efficiently by immersing the gauges (plug and ring) in a suitable solvent and brushing the thread surface with a stiff brush. After cleaning, the Master gauges should be inspected for damaged threads, rust, etc. Gauges with burrs or rough threads that can damage the Master gauges should not be assembled with those gauges. With regard to discoloration on the thread surfaces, the custodian should use his judgement. The coefficient of friction between smooth and bright steel surfaces is less that between rough and discolored surfaces. It is apparent that the friction factor enters into the determination of standoff values. A gummy oil deposit on the gauge seriously adds to the friction. It is inadvisable to determine standoff on gauges with such a deposit.

## H.4 Lubrication

For the standoff determination, the thread surfaces of the gauges should be completely, but lightly covered with medicinal mineral oil. Excess oil should be avoided since the excess would flow out of the ends of the gauge and, if trapped, can affect the standoff value.

## H.5 Torqueing Conditions

In the assembling operation, the plug gauge should be held rigidly in a vice. The vice should be of a heavy type and firmly fastened to a rigid bench. This is of importance as standoff values, especially on the larger sizes, can be affected by the rigidity of the holding device. When the hammer is used, the lever arm should be approximately horizontal (see Figure 21). Standoff should be measured at four points around the fitting plates, avoiding contact with any raised points caused by the stamping of serial numbers on the plates. The mean of the four readings should be taken as the standoff value to be reported.

# Annex I
(informative)

# Shipment of Reference Master Gauges

## I.1 General Precautions

Reference Master gauges should ordinarily remain in good condition for years if properly cared for and used only for the purpose intended, namely, the checking of Working gauges with smooth, clean threads. If the gauges become dirty they shall be cleaned by the gauge owner before shipment to the custodian for standoff determinations.

## I.2 Cleaning

Oily deposits or discolorations may sometimes be removed with a pointed soft wood stick. To do this, the gauge (plug or ring) should be chucked in a lathe and rotated slowly while the stick is pressed into the thread with equal bearing on both flanks. A large portion of such deposits can usually be removed by this method, but it can sometimes be necessary to charge the stick with oil and a fine grade of emery. A coarse or quick-cutting abrasive shall not be used.

## I.3 Retouching

Burrs or small scored places on the threads can be eliminated by fine-grade stoning. The stoning of scored places extending all the way around the gauge is not approved as the accuracy of the gauges can be seriously affected by extensive stoning. For severe cases of pitting or scoring, re-grinding by the gauge maker is advisable.

## I.4 Coating

After drying, the plug and ring gauge shall be thoroughly covered with medicinal mineral oil, assembled in mating pairs, then wrapped in oil paper.

## I.5 Packing

Each mating pair of gauges shall be boxed separately for shipment, using waste or similar packing.

## I.6 Crating

Shipping boxes shall be securely made and the material shall be heavy enough to prevent damage to the gauges during shipment; wood 50 mm (2 in.) thick is recommended. If gauges are received by custodian in boxes inadequate for return shipment, the custodian shall repair or replace shipping containers and add the cost to the inspection fee. The gauges shall be held rigidly in place in the box by a follower block with a hole through the middle that fits the handle of the plug gauge snugly. This follower block should be fastened with wood screws through the outside of the box. The tops of the shipping boxes shall be screwed on, not nailed, with the return address affixed securely on the reverse side, so that the top can be reversed by the custodian for return shipment to the owner.

## I.7 Shipping

All carriage charges shall be prepaid. Shipment to custodians should preferably be by express, which is faster in transit and delivery. When returning gauges, custodians will ship collect. Owners should indicate to the custodian whether gauges are to be returned by freight or express.

## I.8 Gauging Rules

Custodians are not permitted to assemble Grand or Regional Master gauges with Reference Master gauges that have dirty or damaged threads. If cleaning is required, other than that required to remove the protective coating, the testing agency will charge for the extra work. If the gauge is rusted or scored to the extent that it requires reconditioning, the gauge owner will be so notified. Failure to recondition such gauges is considered as justification for cancellation of their status as authorized Reference Master gauges.

## I.9 Customs Requirements and Shipping

Owners of gauges that are to be transported by ship abroad for test should make prior arrangements with a customs broker, either in the country of origin or in another country, for entry of the gauges to the destination country, with or without bond as is necessary, and prepaid transportation to and from the ports of entry and exit. If arrangements are made with a broker in the country of origin, that broker should, in turn, have a customs broker in or near the port of entry arrange for entry of the gauges and prepaid transportation to the certification laboratory.

An alternative method of shipment, which eliminates the need for the services of a customs broker, is by air freight. When shipment is made by this method, the certification laboratory picks up the gauges at the airport and arrange for entry in bond if required. After test, the laboratory obtains the release from bond, if required, and delivers the gauges to the airport for return shipment. The gauges are returned collect with transportation charges payable at destination.

Transportation by air is much more expensive than by ship, but the difference is largely offset by the customs broker's charges. Added advantages of air transportation are the very great decrease in the time the gauges are away from the owner's factory and traceability during transport.

# Annex J
(informative)

# Other Rotary Shouldered Connections

## J.1 Interchangeable Connections

Connections defined in the main body of this standard are considered preferred. They include NC23 to NC70, 1 to $8^5/8$ REG, $5^1/2$ and $6^5/8$ FH. Connections in the NC style (column 1 of Table J.1) are interchangeable with several obsolete connections. When the obsolete connections are requested, they shall be replaced with the equivalent NC connections. Other non-preferred connections are also interchangeable; these are defined only once in the sections that follow.

**Table J.1—Interchangeable Connections**

| NC | IF | FH | XH | SH | DSL | WO |
|---|---|---|---|---|---|---|
| **Numbered Connection** | **Internal Flush** | **Full-hole** | **eXtra-hole** | **Slim-hole** | **Double Stream Line** | **Wide-open** |
| NC26 | $2^3/8$ IF | — | — | $2^7/8$ SH | — | — |
| NC31 | $2^7/8$ IF | — | — | $3^1/2$ SH | — | — |
| NC38 | $3^1/2$ IF | — | — | $4^1/2$ SH | — | — |
| NC40 | — | 4 FH | — | — | $4^1/2$ DSL | — |
| NC46 | 4 IF | — | $4^1/2$ XH | — | — | 4 WO |
| NC50 | $4^1/2$ IF | — | 5 XH | — | $5^1/2$ DSL | $4^1/2$ WO |
| — | — | — | $2^7/8$ XH | — | $3^1/2$ DSL | — |
| — | — | — | $3^1/2$ XH | 4 SH | — | — |

## J.2 GOST Connections

The majority of connections specified by GOST are interchangeable with connections in this standard. The equivalence is listed below, in Table J.2. The tolerances are slightly different between these standards.

**Table J.2—Equivalences for GOST Connections**

| GOST | ISO | GOST | ISO | GOST | ISO |
|---|---|---|---|---|---|
| Z-30 | NC10 | Z-94 | NC35 | Z-147 | $5^1/2$ FH |
| Z-35 | NC12 | Z-101 | $3^1/2$ FH | Z-149 | NC56 |
| Z-38 | NC13 | Z-102 | NC38 | Z-152 | $6^5/8$ REG |
| Z-44 | NC16 | Z-108 | NC40 | Z-163 | NC61 |
| Z-65 | NC23 | Z-117 | $4^1/2$ REG | Z-171 | $6^5/8$ FH |
| Z-66 | $2^3/8$ REG | Z-118 | NC44 | Z-177 | $7^5/8$ REG |
| Z-73 | NC26 | Z-121 | $4^1/2$ FH | Z-185 | NC70 |
| Z-76 | $2^7/8$ REG | Z-122 | NC46 | Z-201 | $8^5/8$ REG |
| Z-86 | NC31 | Z-133 | NC50 | Z-203 | NC77 |
| Z-88 | $3^1/2$ REG | Z-140 | $5^1/2$ REG | — | — |

## J.3 Non-interchangeable Connections

Certain connections have thread elements close enough to others that they can be mated, but without creating a connection of adequate strength. They are given in points a) through c):

a) different pin length:
   1) NC38 and $3^1/_2$ WO,
   2) $2^7/_8$ OH SW and $2^7/_8$ OH LW,
   3) 4 OH SW and 4 OH LW;

b) different taper: NC44 and 4 OH;

c) pitch diameter within 1.5 mm (0.06 in.):
   1) NC26 and $2^3/_8$ WO,
   2) NC31 and $2^7/_8$ XH or $2^7/_8$ WO, and
   3) NC35 and 4 SH.

## J.4 Product Threads for Non-preferred Connections

There are many rotary shouldered connections other than those defined as preferred above. Their thread elements are listed in Tables K.1 and K.2 and in Tables L.1 and L.2. The dimensions are derived from API 7G, 16th Edition whenever possible.

The pin cylinder radius, $R_{\mathrm{LF}}$ of some of these connections differs from the definition in Section 5 of this standard. The differences are shown in the notes of Tables K.1 and L.1.

## J.5 Product Thread Dimensions

There are several thread forms in use other than those specified in Tables B.2 and K.2. They conform either to Figures 4 and 5 or to Figure J.1, and the dimensions are given in Tables B.2 and K.2.

## J.6 Connection Features for Non-preferred Connections

### J.6.1 General

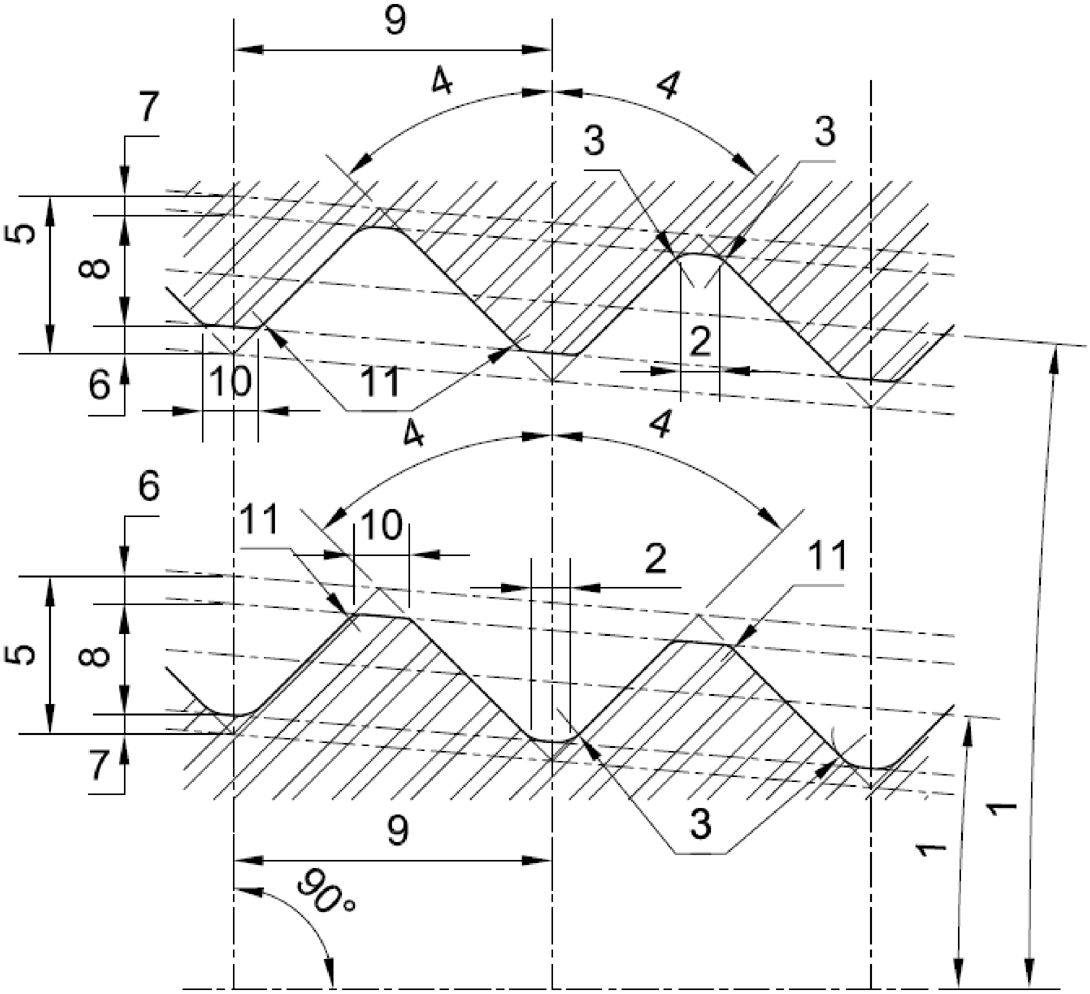
A number of connections have historically been used in drill collar sizes that would require excessively large bevels. To alleviate the problems, low-torque counterbores were designed. They shall be used on drill collars exceeding the diameter(s) indicated in Table K.4 (L.4). The bevel diameter shall be as indicated, regardless of increase in collar diameter beyond these limits.

### J.6.2 Bevel Diameters

Bevel diameters for non-preferred connections are listed in Table K.3 (L.3).

### J.6.3 Stress-relief Features for Non-preferred Connections

Stress-relief features are defined in the same way for all connections. They are optional. When such features are used, the dimensions shall be as defined in Table K.6 (L.6). They shall not be used on connections smaller than those indicated in the tables.




**Key**

1 taper half-angle, $\varphi$

2 root flat, $F_r$

3 root corner radius, $r_r$

4 thread half angle, $\Theta$

5 thread height not truncated, $H$

6 crest truncation, $f_c$

7 root truncation, $f_r$

8 truncated thread height, $h$

9 lead, $p$

10 crest flat, $F_c$

11 crest corner radius, $r_c$

NOTE See Table K.2 (L.2) for dimensions.

**Figure J.1—Thread Form (with 90° Included Angle)**

## J.7 Gauge Dimensions for Non-preferred Connections

### J.7.1 General

Gauges for the connections listed in Table K.1 (L.1) shall be made to follow Figures 19 to 20 with dimensions listed in Table K.8 through Table K.10 (L.8 through L.10).

### J.7.2 Dimensions for Gauging Thread Elements

The ball diameters for gauging of thread elements, and the compensated length for lead measurement shall be as defined in Table K.7 (L.7).

# Annex K
(informative)

# Dimensions for Non-preferred Connections in SI Units

## Table K.1—Product Dimensions for Non-preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper [a]** | **Threads per 25.4 mm** | **Pitch Diameter at Gauge Point** | **Large Diameter of Pin** | **Pin Cylinder Diameter** | **Small Diameter of Pin** | **Pin Length [b]** | **Depth of Box Threads** | **Total Box [d] Depth** | **Box c/bore Diameter** | **Depth of Box c/bore** | **Last Full Depth Thread** |
| | | $T$ | $n$ | $C$ | $D_L$ | $D_{LF}$ | $D_S$ | $L_{PC}$ | $L_{BT}$ | $L_{BC}$ | $Q_c$ | $L_{Qc}$ | $L_{ft}$ [c] |
| | | mm/mm | | | ref | ±0.4 | ref | 0<br>−318 | min | +9<br>0 | +0.8<br>−0.4 | +2.4<br>−0.8 | max |
| NC10 | V-055 | 1/8 | 6 | 27.00 | 30.23 | 29.03 | 25.47 | 38.11 | 41.28 | 53.98 | 30.58 | 11.13 | 10.16 |
| NC12 | V-055 | 1/8 | 6 | 32.13 | 35.36 | 34.16 | 29.79 | 44.45 | 47.63 | 60.33 | 35.71 | 11.13 | 10.16 |
| NC13 | V-055 | 1/8 | 6 | 35.33 | 38.56 | 37.36 | 32.99 | 44.45 | 47.63 | 60.33 | 38.91 | 11.13 | 10.16 |
| NC16 | V-055 | 1/8 | 6 | 40.87 | 44.09 | 42.90 | 38.53 | 44.45 | 47.63 | 60.33 | 44.48 | 11.13 | 10.16 |
| NC77 | V-038R | 1/4 | 4 | 196.62 | 203.23 | 198.83 | 161.95 | 165.10 | 168.28 | 180.98 | 204.77 | 15.88 | 12.70 |
| 2 7/8 FH [h] | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 1/2 FH | V-040 | 1/4 | 5 | 94.84 | 101.45 | 98.65 | 77.62 | 95.25 | 98.43 | 111.13 | 102.79 | 15.88 | 12.70 |
| 4 1/2 FH | V-040 | 1/4 | 5 | 115.11 | 121.72 | 118.92 | 96.32 | 101.60 | 104.78 | 117.48 | 123.83 | 15.88 | 12.70 |
| 5 1/2 IF | V-038R [g] | 1/6 | 4 | 157.20 | 162.48 | 159.54 | 141.33 | 127.00 | 130.18 | 142.88 | 163.91 | 15.88 | 12.70 |
| 6 5/8 IF | V-038R [g] | 1/6 | 4 | 184.18 | 189.46 | 186.54 | 168.30 | 127.00 | 130.18 | 142.88 | 190.91 | 15.88 | 12.70 |
| 2 3/8 OH LW | V-076 | 1/8 | 4 | 65.74 | 69.88 | 67.46 | 62.33 | 60.33 | 63.50 | 76.20 | 71.04 | 12.70 | 7.95 |
| 2 3/8 OH SW | V-076 | 1/8 | 4 | 65.74 | 69.88 | 69.28 [e] | 62.33 | 60.33 | 63.50 | 76.20 | 71.04 | 12.70 | 7.95 |
| 2 7/8 OH LW | V-076 | 1/8 | 4 | 75.79 | 79.93 | 77.39 | 71.98 | 63.50 | 66.68 | 79.38 | 81.36 | 12.70 | 7.95 |
| 2 7/8 OH SW | V-076 | 1/8 | 4 | 75.79 | 79.93 | 78.33 [e] | 70.79 | 73.03 | 76.20 | 88.90 | 81.36 | 12.70 | 7.95 |
| 3 1/2 OH LW | V-076 | 1/8 | 4 | 94.69 | 98.83 | 96.44 | 88.52 | 82.55 | 85.73 | 98.43 | 100.41 | 15.88 | 12.70 |
| 3 1/2 OH SW | V-076 | 1/8 | 4 | 94.69 | 98.83 | 96.44 [e] | 88.52 | 82.55 | 85.73 | 98.43 | 100.41 | 15.88 | 12.70 |
| 4 OH LW | V-076 | 1/8 | 4 | 112.17 | 116.31 | 113.89 | 105.18 | 88.90 | 92.08 | 104.78 | 117.88 | 15.88 | 12.70 |
| 4 OH SW | V-076 | 1/8 | 4 | 112.17 | 116.31 | 113.89 [e] | 103.61 | 101.60 | 104.78 | 117.48 | 117.88 | 15.88 | 12.70 |
| 4 1/2 OH LW | V-076 | 1/8 | 4 | 120.70 | 124.84 | 122.63 | 112.93 | 95.25 | 98.43 | 111.13 | 125.81 | 15.88 | 12.70 |
| 4 1/2 OH SW | V-076 | 1/8 | 4 | 120.70 | 124.84 | 122.63 [e] | 112.93 | 95.25 | 98.43 | 111.13 | 125.81 | 15.88 | 12.70 |
| 2 3/8 PAC | V-076 | 1/8 | 4 | 55.96 | 60.10 | 58.50 [e] | 52.55 | 60.33 | 63.50 | 76.20 | 61.11 | 9.53 | 6.35 |
| 2 7/8 PAC | V-076 | 1/8 | 4 | 60.17 | 64.31 | 62.71 [e] | 56.77 | 60.33 | 63.50 | 76.20 | 65.48 | 9.53 | 6.35 |
| 3 1/2 PAC | V-076 | 1/8 | 4 | 73.25 | 77.39 | 76.200 [e] | 67.08 | 82.55 | 85.73 | 98.43 | 78.97 | 9.53 | 6.35 |

## Table K.1—Product Dimensions for Non-preferred Connections (*continued*)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper** [a] | **Threads per 25.4 mm** | **Pitch Diameter at Gauge Point** | **Large Diameter of Pin** | **Pin Cylinder Diameter** | **Small Diameter of Pin** | **Pin Length** [b] | **Depth of Box Threads** | **Total Box** [d] **Depth** | **Box c/bore Diameter** | **Depth of Box c/bore** | **Last Full Depth Thread** |
| | | $T$ | $n$ | $C$ | $D_L$ | $D_{LF}$ | $D_S$ | $L_{PC}$ | $L_{BT}$ | $L_{BC}$ | $Q_c$ | $L_{Qc}$ | $L_{ft}$ [c] |
| | | mm/mm | | | ref | ±0.4 | ref | 0 −318 | min | +9 0 | +0.8 −0.4 | +2.4 −0.8 | max |
| 2 3/8 SH | V-038R [g] | 1/6 | 4 | 56.64 | 61.93 | 58.80 | 49.76 | 73.03 | 79.38 | 92.08 | 63.50 | 15.88 | 12.70 |
| 2 3/8 WO | V-038R [g] | 1/6 | 4 | 66.17 | 71.45 | 68.63 | 61.39 | 60.33 | 63.50 | 76.20 | 72.62 | 15.88 | 12.70 |
| 2 7/8 WO | V-038R [g] | 1/6 | 4 | 79.27 | 84.56 | 81.71 | 71.86 | 76.20 | 79.38 | 92.08 | 85.73 | 15.88 | 12.70 |
| 3 1/2 WO | V-038R [g] | 1/6 | 4 | 96.72 | 102.01 | 99.21 | 87.20 | 88.90 | 92.08 | 104.78 | 103.58 | 15.88 | 12.70 |
| 2 7/8 XH | V-038R [g] | 1/6 | 4 | 79.22 | 84.51 | 81.30 | 67.56 | 101.60 | 104.78 | 117.48 | 85.32 | 15.88 | 9.65 |
| 3 1/2 XH | V-038R [g] | 1/6 | 4 | 91.54 | 96.82 | 94.03 | 82.02 | 88.90 | 92.08 | 104.78 | 98.43 | 15.88 | 12.70 |
| 3 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 99.79 | 104.78 | 99.62 [f] | 87.83 | 101.60 | 104.78 | 117.48 | 106.38 | 15.88 | 12.70 |
| 4 H90 | 90-V-050 | 1/6 | 3.5 | 109.31 | 114.30 | 109.14 [f] | 96.32 | 107.95 | 111.13 | 123.83 | 115.90 | 15.88 | 12.70 |
| 4 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 117.80 | 122.78 | 117.65 [f] | 103.73 | 114.30 | 117.48 | 130.18 | 124.23 | 15.88 | 12.70 |
| 5 H90 | 90-V-050 | 1/6 | 3.5 | 124.67 | 129.64 | 124.64 [f] | 109.55 | 120.65 | 123.83 | 136.53 | 131.37 | 15.88 | 12.70 |
| 5 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 131.54 | 136.53 | 131.39 [f] | 116.41 | 120.65 | 123.83 | 136.53 | 138.13 | 15.88 | 12.70 |
| 6 5/8 H90 | 90-V-050 | 1/6 | 3.5 | 147.41 | 152.40 | 147.27 [f] | 131.24 | 127.00 | 130.18 | 142.88 | 154.00 | 15.88 | 12.70 |
| 7 H90 FF | 90-V-050 | 1/4 | 3.5 | 158.81 | 165.10 | 159.97 [f] | 130.18 | 139.70 | 142.88 | 155.58 | 166.70 | 15.88 | 12.70 |
| 7 H90 LT | 90-V-050 | 1/4 | 3.5 | 158.81 | 165.10 | 160.35 | 130.18 | 139.70 | 142.88 | 155.58 | 180.85 | 9.53 | 12.70 |
| 7 5/8 H90 FF | 90-V-050 | 1/4 | 3.5 | 181.38 | 187.68 | 182.55 [f] | 148.77 | 155.58 | 158.75 | 171.45 | 189.31 | 15.88 | 12.70 |
| 7 5/8 H90 LT | 90-V-050 | 1/4 | 3.5 | 181.38 | 187.68 | 182.93 | 148.77 | 155.58 | 158.75 | 171.45 | 203.20 | 9.53 | 12.70 |
| 8 5/8 H90 FF | 90-V-050 | 1/4 | 3.5 | 203.61 | 209.91 | 204.77 [f] | 167.82 | 168.28 | 171.45 | 184.15 | 211.53 | 15.88 | 12.70 |
| 8 5/8 H90 LT | 90-V-050 | 1/4 | 3.5 | 203.61 | 209.91 | 205.16 | 167.82 | 168.28 | 171.45 | 184.15 | 212.85 | 9.53 | 12.70 |
| 2 3/8 SL H90 | 90-V-084 | 5/48 | 3 | 65.48 | 69.22 | 67.87 | 61.62 | 73.03 [d] | 76.21 | 88.90 | 70.26 | 15.88 | 12.70 |
| 2 7/8 SL H90 | 90-V-084 | 5/48 | 3 | 77.44 | 81.18 | 80.19 | 73.25 | 76.20 [d] | 79.38 | 92.08 | 82.14 | 15.88 | 12.70 |
| 3 1/2 SL H90 | 90-V-084 | 5/48 | 3 | 93.68 | 97.41 | 96.01 | 88.82 | 82.55 [d] | 85.73 | 98.43 | 98.43 | 15.88 | 12.70 |
| GOST Z-161 | V-050 | 1/6 | 4 | 155.96 | 161.90 | 159.13 | 140.74 | 127.00 | 130.18 | 142.88 | 163.93 | 15.88 | 12.70 |
| GOST Z-189 | V-050 | 1/6 | 4 | 183.46 | 189.41 | 186.61 | 168.22 | 127.00 | 130.18 | 142.88 | 191.77 | 15.88 | 12.70 |

NOTE See Figures 1, 2, and 3 for meaning of dimensions.

[a] FOOTNOTE 1 Taper ($T$) 1/6 mm/m corresponds to a half-angle of $\varphi = 4.764°$.
1/4 mm/mm corresponds to a half-angle of $\varphi = 7.125°$.
1/8 mm/mm corresponds to a half-angle of $\varphi = 3.576°$.
5/48 mm/mm corresponds to a half-angle of $\varphi = 2.981°$.

[b] FOOTNOTE 2 For roller cone drill bits only, the pin length may vary by +0/−5 mm.

[c] FOOTNOTE 3 Length to flank of first full depth pin thread (see Figure 1).

[d] FOOTNOTE 4 Pin Length Tolerance for SL H90 style connections is +0/−1.59 mm.

[e] FOOTNOTE 5 For OH SW and PAC styles, the radius $R_{LF}$ at the pin cylinder is 0.8 mm +0.4/−0 mm (see Figure 2).

[f] FOOTNOTE 6 For the H90 style, the radius $R_{LF}$ at the pin cylinder is 3.18 mm ±0.4 mm (see Figure 2).

[g] FOOTNOTE 7 Prior to 2010, these connections were made with the V-065 thread form, which is interchangeable with V-038R.

[h] FOOTNOTE 8 2 7/8 FH has been removed since several incompatible connections have used this designation.

## Table K.2—Thread Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | | **90-V-050** | **90-V-050** | **V-065** [a] | **V-076** | **90-V-084** |
| threads per 25.4 mm | $n$ | 3.5 | 3.5 | 4 | 4 | 3 |
| lead, ref | — | 7.257136 | 7.257 136 | 6.350000 | 6.350000 | 8.466658 |
| half-angle | $\theta$, deg ±0.75 | 45 | 45 | 30 | 30 | 45 |
| taper, mm/mm | $T$ | 1/6 | 1/4 | 1/6 | 1/8 | 5/48 |
| crest flat width | $F_c$ | 1.27 | 1.27 | 1.65 | 1.93 | 2.13 |
| root radius | $R$ | N/A | N/A | N/A | N/A | N/A |
| root flat width | $F_r$ | 0.86 | 0.86 | 1.42 | 1.70 | 1.73 |
| root flat corner radius | $r_r$ ±0.2 | 0.76 | 0.76 | 0.38 | 0.38 | 0.76 |
| thread height, not truncated | $H$, ref | 3.603371 | 3.571875 | 5.486527 | 5.492090 | 4.221861 |
| crest truncation | $f_c$ ref | 0.630580 | 0.625069 | 1.426489 | 1.669593 | 1.063904 |
| root truncation | $f_r$ ref | 0.428803 | 0.425044 | 1.228979 | 1.471879 | 0.861263 |
| thread height truncated | $h^{+0.025}_{-0.076}$ | 2.55 | 2.52 | 2.83 | 2.35 | 2.30 |
| crest flat corner radius | $r_c$ ±0.2 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |

NOTE 1 See Figures 4, 5, and J.1.

NOTE 2 Dimensions without tolerances are design elements and are not auditable.

[a] FOOTNOTE The V-065 thread form has been replaced by V-038R, but has been listed for historical purposes.

## Table K.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle)

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NC10 | 18.26 | OD | 34.93 | — | — | — | — | — | — |
| | | BD | 34.53 | — | — | — | — | — | — |
| NC12 | 23.02 | OD | 41.28 | — | — | — | — | — | — |
| | | BD | 40.08 | — | — | — | — | — | — |
| NC13 | 23.81 | OD | 46.04 | — | — | — | — | — | — |
| | | BD | 44.84 | — | — | — | — | — | — |
| NC16 | 25.40 | OD | 53.98 | — | — | — | — | — | — |
| | | BD | 52.78 | — | — | — | — | — | — |
| NC77 | 71.44 | OD | 266.70 | 269.88 | 273.05 | 276.23 | 279.40 | 282.58 | — |
| | | BD | 251.23 | 251.23 | 255.98 | 255.98 | 260.75 | 260.75 | — |
| 3 1/2 FH | 50.80 | OD | 123.83 | 127.00 | 130.18 | 133.35 | — | — | — |
| | | BD | 120.65 | 120.65 | 123.43 | 123.43 | — | — | — |
| 4 1/2 FH | 63.50 | OD | 146.05 | 149.23 | 152.40 | 155.58 | 158.75 | — | — |
| | | BD | 142.08 [e] | 142.08 [e] | 145.26 | 145.26 | 150.02 | — | — |
| 5 1/2 IF | 57.15 | OD | 206.38 | 209.55 | 212.72 | 215.90 | 219.08 | 222.25 | 225.42 |
| | | BD | 199.24 [e] | 199.24 [e] | 200.42 | 200.42 | 205.18 | 205.18 | 209.95 |
| 6 5/8 IF | 57.15 | OD | 247.65 | 250.82 | 254.00 | 257.18 | 260.35 | 263.52 | — |
| | | BD | 234.54 | 234.54 | 238.12 | 238.12 | 243.28 | 243.28 | — |
| 2 3/8 OH LW | 49.21 | OD | 79.38 | 82.55 | 85.73 | 88.90 | — | — | — |
| | | BD | 77.79 [e] | 77.79 [e] | 82.14 | 82.14 | — | — | — |
| 2 3/8 OH SW | 49.21 | OD | 79.38 | 82.55 | 85.73 | 88.90 | — | — | — |
| | | BD | 77.79 [e] | 77.79 [e] | 82.14 | 82.14 | — | — | — |
| 2 7/8 OH LW | 44.45 | OD | 95.25 | 98.42 | 101.60 | 104.78 | — | — | — |
| | | BD | 93.66 [e] | 93.66 [e] | 95.25 | 95.25 | — | — | — |
| 2 7/8 OH SW | 44.45 | OD | 95.25 | 98.42 | 101.60 | 104.78 | — | — | — |
| | | BD | 93.66 [e] | 93.66 [e] | 95.25 | 95.25 | — | — | — |
| 3 1/2 OH LW | 53.98 | OD | 123.82 | 127.00 | 130.18 | 133.35 | — | — | — |
| | | BD | 117.87 | 117.87 | 123.04 | 123.04 | — | — | — |
| 3 1/2 OH SW | 53.98 | OD | 123.82 | 127.00 | 130.18 | 133.35 | — | — | — |
| | | BD | 117.87 | 117.87 | 123.04 | 123.04 | — | — | — |

**Table K.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle)** *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 OH LW | 63.50 | OD | 142.88 | 146.05 | 149.22 | 152.40 | — | — | — |
| | | BD | 136.53 | 136.53 | 141.29 | 141.29 | — | — | — |
| 4 OH SW | 63.50 | OD | 142.88 | 146.05 | 149.22 | 152.40 | — | — | — |
| | | BD | 136.53 | 136.53 | 141.29 | 141.29 | — | — | — |
| 4 1/2 OH LW | 53.98 | OD | 161.93 | 165.10 | 168.28 | 171.45 | — | — | — |
| | | BD | 153.19 | 153.19 | 157.96 | 157.96 | — | — | — |
| 4 1/2 OH SW | 53.98 | OD | 161.93 | 165.10 | 168.28 | 171.45 | — | — | — |
| | | BD | 153.19 | 153.19 | 157.96 | 157.96 | — | — | — |
| 2 3/8 PAC | 34.93 | OD | 69.85 | 73.03 | 76.20 | — | — | — | — |
| | | BD | 68.66 | 68.66 | 69.85 | — | — | — | — |
| 2 7/8 PAC | 38.10 | OD | 79.38 | — | — | — | — | — | — |
| | | BD | 76.20 | — | — | — | — | — | — |
| 3 1/2 PAC | 38.10 | OD | 95.25 | 98.42 | — | — | — | — | — |
| | | BD | 91.28 | 91.28 | — | — | — | — | — |
| 2 3/8 SH | 36.51 | OD | 76.20 | 77.79 | 79.38 | 80.96 | — | — | — |
| | | BD | 73.03 | 73.03 | 75.41 | 75.41 | — | — | — |
| 2 3/8 WO | 46.02 | OD | 82.550 | 85.725 | 88.900 | — | — | — | — |
| | | BD | 79.78 [e] | 82.550 | 82.550 | — | — | — | — |
| 2 7/8 WO | 38.10 | OD | 101.60 | 104.78 | — | — | — | — | — |
| | | BD | 98.42 [e] | 98.42 [e] | — | — | — | — | — |
| 3 1/2 WO | 46.04 | OD | 127.00 | 130.18 | — | — | — | — | — |
| | | BD | 121.44 | 121.44 | — | — | — | — | — |
| 2 7/8 XH | 38.10 | OD | 104.78 | 107.95 | 111.13 | — | — | — | — |
| | | BD | 100.01 | 100.01 | 102.39 | — | — | — | — |
| 3 1/2 XH | 41.28 | OD | 120.65 | 123.82 | 127.00 | — | — | — | — |
| | | BD | 115.09 | 115.09 | 119.86 | — | — | — | — |

**Table K.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle)** *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $3^1/_2$ H-90 | 50.80 | OD | 127.00 | 130.18 | 133.35 | 136.53 | 139.70 | — | — |
| | | BD | 122.22 | 122.22 | 127.00 | 127.00 | 127.00 | — | — |
| 4 H-90 | 50.80 | OD | 139.70 | 142.88 | 146.05 | 149.23 | 152.40 | 155.58 | 158.75 |
| | | BD | 134.95 | 134.95 | 139.70 | 139.70 | 139.70 | 146.05 | 146.05 |
| $4^1/_2$ H-90 | 50.80 | OD | 152.40 | 155.58 | 158.75 | 161.92 | 165.10 | 168.28 | 171.45 |
| | | BD | 146.05 | 146.05 | 152.40 | 152.40 | 152.40 | 158.75 | 158.75 |
| 5 H-90 | 63.50 | OD | 165.10 | 168.28 | 171.45 | 174.63 | 177.80 | — | — |
| | | BD | 155.58 | 155.58 | 161.92 | 161.92 | 161.92 | — | — |
| $5^1/_2$ H-90 | 57.15 | OD | 171.45 | 174.62 | 177.80 | 180.98 | 184.15 | 187.33 | 190.50 |
| | | BD | 165.66 [e] | 168.28 | 168.28 | 168.28 | 168.28 | 168.28 | 168.28 |
| $6^5/_8$ H-90 | 71.44 | OD | 193.68 | 196.85 | 200.03 | 203.20 | 206.38 | 209.55 | — |
| | | BD | 184.15 | 190.50 | 190.50 | 190.50 | 190.50 | 190.50 | — |
| 7 H-90 FF | 63.50 | OD | 209.55 | 212.73 | 215.90 | — | — | — | — |
| | | BD | 203.20 | 203.20 | 209.55 | — | — | — | — |
| 7 H-90 LT | 63.50 | OD | 219.08 | 222.25 | 225.42 | 228.60 | — | — | — |
| | | BD | 209.55 | 209.55 | 219.08 | 219.08 | — | — | — |
| $7^5/_8$ H-90 FF | 71.44 | OD | 238.13 | 241.30 | 244.48 | — | — | — | — |
| | | BD | 227.02 | 234.95 | 234.95 | — | — | — | — |
| $7^5/_8$ H-90 LT | 71.44 | OD | 247.65 | 250.82 | 254.00 | 257.18 | 260.35 | — | — |
| | | BD | 240.89 [e] | 244.48 | 244.48 | 244.48 | 244.48 | — | — |
| $8^5/_8$ H-90 FF | 71.44 | OD | 266.70 | 269.88 | — | — | — | — | — |
| | | BD | 254.00 | 254.00 | — | — | — | — | — |
| $8^5/_8$ H-90 LT | 71.44 | OD | 273.05 | 276.23 | 279,4. | 282.58 | 285.75 | 288.92 | 292.10 |
| | | BD | 271.48 [e] | 271.48 [e] | 271.48 [e] | 273.05 | 273.05 | 273.05 | 275.03 |
| $2^3/_8$ SL H-90 | 31.75 | OD | 82.55 | 85.73 | — | — | — | — | — |
| | | BD | 79.38 | 79.38 | — | — | — | — | — |
| $2^7/_8$ SL H-90 | 38.10 | OD | 101.60 | 104.78 | 107.95 | 120.65 | — | — | — |
| | | BD | 98.42 | 98.42 | 104.78 | 104.78 | — | — | — |
| $3^1/_2$ SL H-90 | 47.62 | OD | 120.65 | 123.83 | 127.00 | 130.18 | 133.35 | — | — |
| | | BD | 117.48 | 117.48 | 123.82 | 123.82 | 124.61 | — | — |

[a] FOOTNOTE 1 Tolerance on bevel diameters is ±0.40 mm.

[b] FOOTNOTE 2 See table '*Drill collar OD tolerances*' in API 7-1 (ISO 10424-1).

[c] FOOTNOTE 3 When drill collars and tools of the same OD listed in the table above are mated, the maximum seal stress will be less than 100 % of SMYS for the ODs listed.

[d] FOOTNOTE 4 See 5.2.4.

[e] FOOTNOTE 5 These bevel diameters are not calculated using 75 % of the face width.

**Table K.4—Low-torque Feature**

| Connection Size and Style | Required for OD Greater Than | Face Groove Diameter $D_{FG+-0.8/-0.4}$ |
|---|---|---|
| 7 H90 LT | 215.90 | 180.85 |
| 7 5/8 H90 LT | 244.47 | 203.20 |
| 8 5/8 H90 LT | 269.87 | 238.25 |
| NOTE See Figure 6. | | |

**Table K.5—Optional Feature Dimensions**

| 1 | 2 | 3 |
|---|---|---|
| **Connection Size and Style** | **Pin ID Taper Diameter** $D_{PT}$ $^{+0.8}_{-0.8}$ (See Figure 1) | **Pin Benchmark Diameter** $D_{PB}$ $^{+0.4}_{0}$ (See Figure 12) |
| NC10 | — | 29.82 |
| NC12 | — | 34.96 |
| NC13 | — | 38.16 |
| NC16 | — | 43.69 |
| NC77 | 107.95 | 199.62 |
| 3 1/2 FH | 60.33 | 99.45 |
| 4 1/2 FH | 73.03 | 119.72 |
| 5 1/2 IF | 95.25 | 160.10 |
| 6 5/8 IF | 101.60 | 187.08 |
| 2 3/8 OH LW | — | 68.25 |
| 2 3/8 OH SW | — | 69.07 |
| 2 7/8 OH LW | — | 78.19 |
| 2 7/8 OH SW | — | 79.13 |
| 3 1/2 OH LW | — | 97.24 |
| 3 1/2 OH SW | — | 97.24 |
| 4 OH LW | — | 114.69 |
| 4 OH SW | — | 114.69 |
| 4 1/2 OH LW | — | 123.42 |
| 4 1/2 OH SW | — | 123.42 |
| 2 3/8 PAC | — | 59.29 |
| 2 7/8 PAC | — | 63.51 |
| 3 1/2 PAC | — | 76.99 |
| 2 3/8 SH | — | 59.54 |
| 2 3/8 WO | — | 82.50 |
| 2 7/8 WO | — | 100.00 |
| 3 1/2 WO | — | 82.10 |
| 2 7/8 XH | — | 94.42 |

**Table K.5—Optional Feature Dimensions** *(continued)*

| 1 | 2 | 3 |
|---|---|---|
| **Connection Size and Style** | **Pin ID Taper Diameter**<br>$D_{PT}$ $^{+0.8}_{-0.8}$<br>(See Figure 1) | **Pin Benchmark Diameter**<br>$D_{PB}$ $^{+0.4}_{0}$<br>(See Figure 12) |
| 3 1/2 XH | 47.63 | 29.82 |
| 3 1/2 H90 | 60.33 | 100.41 |
| 4 H90 | 63.50 | 109.94 |
| 4 1/2 H90 | 73.03 | 118.45 |
| 5 H90 | 76.20 | 125.43 |
| 5 1/2 H90 | 82.55 | 132.19 |
| 6 5/8 H90 | 82.55 | 148.06 |
| 7 H90 | 88.90 | 160.76 |
| 7 5/8 H90 | 95.25 | 183.34 |
| 8 5/8 H90 | 104.78 | 205.57 |
| 2 3/8 SL H90 | — | 67.42 |
| 2 7/8 SL H90 | — | 79.38 |
| 3 1/2 SL H90 | — | 95.66 |
| GOST Z-161 | — | 160.84 |
| GOST Z-189 | — | 188.35 |

**Table K.6—Stress-relief Grooves and Features Dimensions for Non-preferred Connections**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Connection Size and Style | Box Boreback Contour | | | Box Groove | | Diameter of Pin Groove |
| | Cylinder Diameter | Depth to Last Thread Scratch | Depth to End of Cylinder | Diameter of Box Groove | Depth to Start of Box Groove | |
| | $D_{CB}{}^{+0.4}_{0}$ | $L_X$ ref | $L_{CYL}$ ±6.35 | $D_{BG}{}^{+0.79}_{0}$ | $L_{BG}{}^{0}_{-3.18}$ | $D_{SRG}{}^{0}_{-0.79}$ |
| NC77 | 166.30 | 152.40 | 203.20 | 167.49 | 155.58 | 188.01 |
| 3 1/2 FH | 81.77 | 82.55 | 133.35 | 83.34 | 85.72 | 85.90 |
| 4 1/2 FH | 100.41 | 88.90 | 139.70 | 102.01 | 92.07 | 106.17 |
| 5 1/2 IF | 144.48 | 114.30 | 165.10 | 146.46 | 117.47 | 149.58 |
| 6 5/8 IF | 171.46 | 114.30 | 165.10 | 173.44 | 117.47 | 176.55 |
| 4 OH SW | 105.57 | 88.90 | 139.70 | 109.88 | 92.07 | 105.81 |
| 4 1/2 OH LW | 115.09 | 82.55 | 133.35 | 119.23 | 85.72 | 114.35 |
| 4 1/2 OH SW | 115.09 | 82.55 | 133.350 | 119.23 | 85.72 | 114.35 |
| 3 1/2 XH | — | — | — | 87.33 | 79.37 | 83.92 |
| 3 1/2 H90 | 90.48 | 88.90 | 139.70 | 93.68 | 92.07 | 92.48 |
| 4 H90 | 98.43 | 95.25 | 146.05 | 102.39 | 98.42 | 102.00 |
| 4 1/2 H90 | 106.38 | 101.60 | 152.40 | 109.53 | 104.77 | 110.49 |
| 5 H90 | 111.92 | 107.95 | 158.75 | 115.50 | 111.12 | 117.34 |
| 5 1/2 H90 | 119.08 | 107.95 | 158.75 | 122.23 | 111.12 | 124.23 |
| 6 5/8 H90 | 133.76 | 114.30 | 165.10 | 137.32 | 117.47 | 140.10 |
| 7 H90 | 133.76 | 127.00 | 177.80 | 136.53 | 130.17 | 151.00 |
| 7 5/8 H90 | 152.41 | 142.88 | 193.68 | 154.79 | 146.05 | 173.58 |
| 8 5/8 H90 | 171.46 | 155.58 | 206.38 | 173.84 | 158.75 | 195.80 |
| 3 1/2 SL H90 | — | — | — | 95.36 | 71.42 | 86.36 |
| GOST Z-161 | 143.77 | 114.30 | 165.10 | 144.86 | 117.47 | 147.29 |
| GOST Z-189 | 171.28 | 114.30 | 165.10 | 172.34 | 117.47 | 174.80 |

NOTE See Figures 7, 8, and 9 for meaning of dimensions.

**Table K.7—Compensated Thread Lengths, Thread Heights, and Ball-point Diameters**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | **Taper**<br>$T$<br>mm/mm | **Threads per 25.4 mm**<br>$n$ | **Compensated Lead Parallel to Taper** [a]<br>$L_{ct}$ | **Ball-point Diameter for Taper and Lead**<br>$d_b$<br>±0.05 | **Thread Height Compensated for Taper** [b]<br>$h_{cn}$ | **Ball-point Diameter for Thread Height**<br>$D_{bh}$<br>±0.05 |
| 90-V-050 | 1/6 | 3.5 | 7.2822 | 5.131 | 2.5324 | 1.829 |
| 90-V-050 | 1/4 | 3.5 | 7.3127 | 5.131 | 2.5019 | 1.829 |
| V-065 | 1/6 | 4.0 | 6.3729 | 3.658 | 2.8219 | 1.829 |
| V-076 | 1/8 | 4.0 | 6.3627 | 3.658 | 2.3444 | 1.829 |
| 90-V-084 | 5/48 | 3.0 | 8.4785 | 5.994 | 2.2835 | 1.829 |

NOTE 1 See Figures 15 and 16 for meaning of dimensions.

NOTE 2 For thread forms not included in this table, different ball-point diameters may be required.

[a] FOOTNOTE 1 Compensated thread length ($L_{ct}$) is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] FOOTNOTE 2 Compensated thread height ($h_{cn}$) is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

**Table K.8—Gauge Thread Form Dimensions for Non-preferred Thread Forms**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Form of Thread** | **Threads per 25.4 mm**<br>$n$ | **Lead** | **Half-angle**<br>$\theta$<br>degrees | **Taper**<br>$T$<br>mm/mm | **Thread Height Not Truncated**<br>$H$<br>reference | **Gauge Root Truncation**<br>$f_{rg}$<br>max | **Gauge Crest Truncation**<br>$f_{cg}$ | **Thread Height Truncated**<br>$h_g$<br>reference |
| 90-V-050 | 3.5 | 7.257136 | 45 | 1/6 | 3.603371 | 0.732358 | 0.732358 | 2.1387 |
| 90-V-050 | 3.5 | 7.257136 | 45 | 1/4 | 3.571875 | 0.726770 | 0.726770 | 2.1184 |
| V-065 | 4.0 | 6.350000 | 30 | 1/6 | 5.486527 | 1.553489 | 1.553489 | 2.3800 |
| V-076 | 4.0 | 6.350000 | 30 | 1/8 | 5.492090 | 1.796542 | 1.796542 | 1.8974 |
| 90-V-084 | 3.0 | 8.466658 | 45 | 5/48 | 4.221861 | 1.171143 | 1.171143 | 1.8796 |

NOTE 1 In computing thread height and truncation, account has been taken of the effect of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 2 See Tables B.11 through B.13 for tolerances on columns.

NOTE 3 Prior to March 2005, the Crest truncation for V-065 gauges with 1/6 taper was 1.42649, and with 1/4 taper was 1.42235. These values are still acceptable for existing gauges made prior to this date.

NOTE 4 See Figure 18 for meaning of dimensions.

## Table K.9—Gauge Thread Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Diameter at Gauge Point** | | | |
| **Style and Size** | **Thread Form** | **Taper**<br>$T$<br>mm/mm | **Threads per 25.4 mm**<br>$n$ | **Pitch Diameter at Gauge Point** [a]<br>$C$ | **Major (Plug)** [a] **Reference**<br>$D_{MP}$ | **Minor (Ring)** [b] **Reference**<br>$D_{MR}$ | **Pitch Diameter at Working Gauge Point** [c]<br>$C_{GP}$ | **Gauge Standoff**<br>$S$ |
| NC10 | V-055 | 1/8 | 6 | 27.00020 | 27.86380 | 26.13914 | 24.61895 | 9.525 |
| NC12 | V-055 | 1/8 | 6 | 32.13100 | 32.99460 | 31.26994 | 29.74975 | 9.525 |
| NC13 | V-055 | 1/8 | 6 | 35.33140 | 36.19500 | 34.47034 | 32.95015 | 9.525 |
| NC16 | V-055 | 1/8 | 6 | 40.86860 | 41.73220 | 40.00754 | 38.48735 | 9.525 |
| NC77 | V-038R | 1/4 | 4 | 196.62140 | 198.79056 | 194.45224 | 191.85890 | 15.875 |
| 3 1/2 FH | V-040 | 1/4 | 5 | 85.44560 | 87.81796 | 83.07324 | 80.68310 | 15.875 |
| 4 1/2 FH | V-040 | 1/4 | 5 | 94.84360 | 97.21596 | 92.47124 | 90.08110 | 15.875 |
| 5 1/2 IF | V-038R | 1/6 | 4 | 115.11280 | 117.48516 | 112.74044 | 110.35030 | 15.875 |
| 6 5/8 IF | V-038R | 1/6 | 4 | 157.20060 | 159.38500 | 155.01620 | 154.02560 | 15.875 |
| 2 3/8 OH LW | V-076 | 1/8 | 4 | 184.17540 | 186.35980 | 181.99100 | 181.00040 | 15.875 |
| 2 7/8 OH LW | V-076 | 1/8 | 4 | 65.73520 | 67.63258 | 63.83782 | 63.35395 | 15.875 |
| 2 7/8 OH SW | V-076 | 1/8 | 4 | 75.79360 | 77.69098 | 73.89622 | 73.41235 | 15.875 |
| 3 1/2 OH SW | V-076 | 1/8 | 4 | 75.79360 | 77.69098 | 73.89622 | 73.41235 | 15.875 |
| 4 OH LW | V-076 | 1/8 | 4 | 94.69120 | 96.58858 | 92.79382 | 92.30995 | 15.875 |
| 4 OH SW | V-076 | 1/8 | 4 | 112.16640 | 114.06378 | 110.26902 | 109.78515 | 15.875 |
| 4 1/2 OH SW | V-076 | 1/8 | 4 | 112.16640 | 114.06378 | 110.26902 | 109.78515 | 15.875 |
| 2 3/8 PAC | V-076 | 1/8 | 4 | 120.70080 | 122.59818 | 118.80342 | 118.31955 | 15.875 |
| 2 7/8 PAC | V-076 | 1/8 | 4 | 55.95620 | 57.85358 | 54.05882 | 53.57495 | 15.875 |
| 3 1/2 PAC | V-076 | 1/8 | 4 | 60.1760 | 62.06998 | 58.27522 | 57.79135 | 15.875 |
| 2 3/8 SH | V-038R | 1/6 | 4 | 73.25360 | 75.15098 | 71.35622 | 70.87235 | 15.875 |

## Table K.9—Gauge Thread Dimensions *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Diameter at Gauge Point** | | | |
| **Style and Size** | **Thread Form** | **Taper** $T$ mm/mm | **Threads per 25.4 mm** $n$ | **Pitch Diameter at Gauge Point** [a] $C$ | **Major (Plug)** [a] **Reference** $D_{MP}$ | **Minor (Ring)** [b] **Reference** $D_{MR}$ | **Pitch Diameter at Working Gauge Point** [c] $C_{GP}$ | **Gauge Standoff** $S$ |
| 2 3/8 WO | V-038R | 1/6 | 4 | 66.167 | 68.3514 | 63.9826 | 62.992 | 15.875 |
| 2 7/8 WO | V-038R | 1/6 | 4 | 79.2734 | 81.4578 | 77.089 | 76.0984 | 15.875 |
| 3 1/2 WO | V-038R | 1/6 | 4 | 96.7232 | 98.9076 | 94.5388 | 93.5482 | 15.875 |
| 2 7/8 XH | V-038R | 1/6 | 4 | 79.2226 | 81.407 | 77.0382 | 76.0476 | 15.875 |
| 3 1/2 XH | V-038R | 1/6 | 4 | 91.5416 | 93.726 | 89.3572 | 88.3666 | 15.875 |
| 3 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 99.78644 | 101.92512 | 97.64776 | 96.61144 | 15.875 |
| 4 H90 | 90-V-050 | 1/6 | 3.5 | 109.31144 | 111.45012 | 107.1728 | 106.1364 | 15.875 |
| 4 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 117.79504 | 119.93372 | 115.6564 | 114.62 | 15.875 |
| 5 H90 | 90-V-050 | 1/6 | 3.5 | 124.66574 | 126.80442 | 122.5271 | 121.4907 | 15.875 |
| 5 1/2 H90 | 90-V-050 | 1/6 | 3.5 | 131.53644 | 133.67512 | 129.3978 | 128.3614 | 15.875 |
| 6 5/8 H90 | 90-V-050 | 1/6 | 3.5 | 147.41144 | 149.55012 | 145.2728 | 144.2364 | 15.875 |
| 7 H90 | 90-V-050 | 1/4 | 3.5 | 158.80842 | 160.92678 | 156.6901 | 154.0459 | 15.875 |
| 7 5/8 H90 | 90-V-050 | 1/4 | 3.5 | 181.38394 | 183.5023 | 179.2656 | 176.6214 | 15.875 |
| 8 5/8 H90 | 90-V-050 | 1/4 | 3.5 | 203.60894 | 205.7273 | 201.4906 | 198.8464 | 15.875 |
| 2 3/8 SL H90 | 90-V-084 | 5/48 | 3 | 79.2734 | 81.4578 | 77.089 | 76.0984 | 15.875 |
| 2 7/8 SL H90 | 90-V-084 | 5/48 | 3 | 96.7232 | 98.9076 | 94.5388 | 93.5482 | 15.875 |
| 3 1/2 SL H90 | 90-V-084 | 5/48 | 3 | 79.2226 | 81.407 | 77.0382 | 76.0476 | 15.875 |
| GOST Z-161 | V-050 | 1/6 | 4 | 91.5416 | 93.726 | 89.3572 | 88.3666 | 15.875 |
| GOST Z-189 | V-050 | 1/6 | 4 | 99.78644 | 101.92512 | 97.64776 | 96.61144 | 15.875 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE 1 The values in columns 5 and 6 apply only to Grand, Regional, and Reference Master plug gauges.

[b] FOOTNOTE 2 The values in column 7 apply only to ring gauges.

[c] FOOTNOTE 3 The values in column 8 apply only to Working plug gauges.

# Table K.10—Gauge External Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length**<br>$L_{pg}$ | **Fitting Plate [a,b] Diameter**<br>$D_{FP}$<br>max | **Ring Gauge Length**<br>$L_{rg}$ | **Ring Gauge Outside Diameter**<br>$D_R$<br>reference | **Diameter of Ring Gauge Counterbore**<br>$Q$<br>min |
| NC10 | 38.100 | — | 28.575 | 52.629 | 29.845 |
| NC12 | 44.450 | — | 34.925 | 58.801 | 34.976 |
| NC13 | 44.450 | — | 34.925 | 62.636 | 38.176 |
| NC16 | 44.450 | — | 34.925 | 69.291 | 43.713 |
| NC77 | 165.100 | 190.703 | 149.225 | 257.835 | 200.838 |
| 3 1/2 FH | 88.900 | 79.553 | 73.025 | 124.485 | 89.713 |
| 4 1/2 FH | 95.250 | 88.925 | 79.375 | 135.712 | 99.060 |
| 5 1/2 IF | 101.600 | 109.195 | 85.725 | 160.020 | 119.329 |
| 6 5/8 IF | 127.000 | 151.257 | 111.125 | 210.541 | 161.442 |
| 2 3/8 OH LW | 127.000 | 178.232 | 111.125 | 242.926 | 188.417 |
| 2 7/8 OH LW | 60.325 | 60.223 | 44.450 | 100.279 | 69.545 |
| 2 7/8 OH SW | 63.500 | 70.282 | 47.625 | 112.344 | 79.604 |
| 3 1/2 OH SW | 73.025 | 70.282 | 57.150 | 112.344 | 79.604 |
| 4 OH LW | 82.550 | 89.179 | 66.675 | 135.026 | 98.501 |
| 4 OH SW | 88.900 | 106.655 | 73.025 | 155.981 | 115.976 |
| 4 1/2 OH SW | 101.600 | 106.655 | 85.725 | 155.981 | 115.976 |
| 2 3/8 PAC | 95.250 | 115.189 | 79.375 | 166.218 | 124.511 |
| 2 7/8 PAC | 60.325 | 50.495 | 44.450 | 88.468 | 59.715 |
| 3 1/2 PAC | 60.325 | 54.712 | 44.450 | 93.523 | 63.932 |
| 2 3/8 SH | 82.550 | 67.793 | 66.675 | 109.220 | 77.013 |
| 2 3/8 WO | 60.325 | 60.173 | 44.450 | 101.371 | 70.460 |

## Table K.10—Gauge External Dimensions *(continued)*

| D1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length**<br>$L_{pg}$ | **Fitting Plate Diameter** [a,b]<br>$D_{FP}$<br>max | **Ring Gauge Length**<br>$L_{rg}$ | **Ring Gauge Outside Diameter**<br>$D_R$<br>reference | **Diameter of Ring Gauge Counterbore**<br>$Q$<br>min |
| 2 7/8 WO | 60.325 | 60.173 | 44.450 | 101.371 | 70.460 |
| 3 1/2 WO | 88.900 | 73.279 | 73.025 | 117.094 | 83.566 |
| 2 7/8 XH | 88.900 | 90.729 | 73.025 | 138.024 | 101.016 |
| 3 1/2 XH | 101.600 | 73.228 | 85.725 | 117.043 | 83.515 |
| 3 1/2 H90 | 88.900 | 85.547 | 73.025 | 131.826 | 95.834 |
| 4 H90 | 101.600 | 94.082 | 85.725 | 141.351 | 103.784 |
| 4 1/2 H90 | 107.950 | 103.607 | 92.075 | 152.781 | 113.309 |
| 5 H90 | 114.300 | 112.090 | 98.425 | 162.966 | 121.793 |
| 5 1/2 H90 | 120.650 | 118.974 | 104.775 | 171.221 | 128.651 |
| 6 5/8 H90 | 120.650 | 125.832 | 104.775 | 179.451 | 135.534 |
| 7 H90 | 127.000 | 141.707 | 111.125 | 198.501 | 151.409 |
| 7 5/8 H90 | 139.700 | 153.137 | 123.825 | 212.166 | 162.789 |
| 8 5/8 H90 | 155.575 | 175.717 | 139.700 | 239.243 | 185.369 |
| 2 3/8 SL H90 | 168.275 | 197.942 | 152.400 | 265.913 | 207.594 |
| 2 7/8 SL H90 | 71.425 | 60.046 | 55.550 | 99.873 | 69.215 |
| 3 1/2 SL H90 | 74.600 | 72.009 | 58.725 | 114.249 | 81.178 |
| GOST Z-161 | 80.975 | 88.240 | 65.100 | 133.706 | 97.409 |
| GOST Z-189 | 127.000 | 149.377 | 111.125 | 209.855 | 160.858 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE There is no fitting plate on NC10 through NC16.

[b] FOOTNOTE The thickness of fitting plates, $T_{FP}$, shall be 9.53 mm maximum for all gauge sizes with pitch diameter less than 158.5 mm and 11.10 mm maximum for all larger gauge sizes.

# Annex L
(informative)

# Dimensions for Non-preferred Connections in USC Units

## Table L.1—Product Dimensions for Non-preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper** [a] $T$ in./ft | **Threads per Inch** $n$ | **Pitch Diameter at Gauge Point** $C$ | **Large Diameter of Pin** $D_L$ ref | **Pin Cylinder Diameter** $D_{LF}$ ±0.016 | **Small Diameter of Pin** $D_S$ ref | **Pin Length** [b] $L_{PC}$ $^{0}_{-0.125}$ | **Depth of Box Threads** $L_{BT}$ min | **Total Box Depth** $L_{BC}$ $^{+0.38}_{0}$ | **Box c/bore Diameter** $Q_c$ $^{+0.031}_{-0.016}$ | **Depth of Box c/bore** $L_{Qc}$ $^{+0.094}_{-0.031}$ | **Last Full Depth Thread** $L_{FT}$ [c] max |
| NC10 | V-055 | 1.5 | 6 | 1.06300 | 1.190 | 1.143 | 1.003 | 1.500 | 1.625 | 2.125 | 1.204 | 0.438 | 0.40 |
| NC12 | V-055 | 1.5 | 6 | 1.26500 | 1.392 | 1.345 | 1.173 | 1.750 | 1.875 | 2.375 | 1.406 | 0.438 | 0.40 |
| NC13 | V-055 | 1.5 | 6 | 1.39100 | 1.518 | 1.471 | 1.299 | 1.750 | 1.875 | 2.375 | 1.532 | 0.438 | 0.40 |
| NC16 | V-055 | 1.5 | 6 | 1.60900 | 1.736 | 1.689 | 1.517 | 1.750 | 1.875 | 2.375 | 1.751 | 0.438 | 0.40 |
| NC77 | V-038R | 3 | 4 | 7.74100 | 8.001 | 7.828 | 6.376 | 6.500 | 6.625 | 7.125 | 8.062 | 0.625 | 0.50 |
| $2^7/_8$ FH [h] | — | — | — | — | — | — | — | — | — | — | — | — | — |
| $3^1/_2$ FH | V-040 | 3 | 5 | 3.73400 | 3.994 | 3.884 | 3.056 | 3.750 | 3.875 | 4.375 | 4.047 | 0.625 | 0.50 |
| $4^1/_2$ FH | V-040 | 3 | 5 | 4.53200 | 4.792 | 4.682 | 3.792 | 4.000 | 4.125 | 4.625 | 4.875 | 0.625 | 0.50 |
| $5^1/_2$ IF | V-038R [g] | 2 | 4 | 6.18900 | 6.397 | 6.272 | 5.564 | 5.000 | 5.125 | 5.625 | 6.453 | 0.625 | 0.50 |
| $6^5/_8$ IF | V-038R [g] | 2 | 4 | 7.25100 | 7.459 | 7.334 | 6.626 | 5.000 | 5.125 | 5.625 | 7.516 | 0.625 | 0.50 |
| $2^3/_8$ OH LW | V-076 | 1.5 | 4 | 2.58800 | 2.751 | 2.656 | 2.454 | 2.375 | 2.500 | 3.000 | 2.797 | 0.5 | 0.313 |
| $2^3/_8$ OH SW | V-076 | 1.5 | 4 | 2.58800 | 2.751 | 2.688 [e] | 2.454 | 2.375 | 2.500 | 3.000 | 2.797 | 0.5 | 0.313 |
| $2^7/_8$ OH LW | V-076 | 1.5 | 4 | 2.98400 | 3.147 | 3.047 | 2.834 | 2.500 | 2.625 | 3.125 | 3.203 | 0.5 | 0.313 |
| $2^7/_8$ OH SW | V-076 | 1.5 | 4 | 2.98400 | 3.147 | 3.084 [e] | 2.787 | 2.875 | 3.000 | 3.500 | 3.203 | 0.5 | 0.313 |
| $3^1/_2$ OH LW | V-076 | 1.5 | 4 | 3.72800 | 3.891 | 3.797 | 3.485 | 3.250 | 3.375 | 3.875 | 3.953 | 0.625 | 0.50 |
| $3^1/_2$ OH SW | V-076 | 1.5 | 4 | 3.72800 | 3.891 | 3.797 [e] | 3.485 | 3.250 | 3.375 | 3.875 | 3.953 | 0.625 | 0.50 |
| 4 OH LW | V-076 | 1.5 | 4 | 4.41600 | 4.579 | 4.484 | 4.141 | 3.500 | 3.625 | 4.125 | 4.641 | 0.625 | 0.50 |
| 4 OH SW | V-076 | 1.5 | 4 | 4.41600 | 4.579 | 4.484 [e] | 4.079 | 4.000 | 4.125 | 4.625 | 4.641 | 0.625 | 0.50 |
| $4^1/_2$ OH LW | V-076 | 1.5 | 4 | 4.75200 | 4.915 | 4.828 | 4.446 | 3.750 | 3.875 | 4.375 | 4.953 | 0.625 | 0.50 |
| $4^1/_2$ OH SW | V-076 | 1.5 | 4 | 4.75200 | 4.915 | 4.828 [e] | 4.446 | 3.750 | 3.875 | 4.375 | 4.953 | 0.625 | 0.50 |
| $2^3/_8$ PAC | V-076 | 1.5 | 4 | 2.20300 | 2.366 | 2.303 [e] | 2.069 | 2.375 | 2.500 | 3.000 | 2.406 | 0.375 | 0.25 |
| $2^7/_8$ PAC | V-076 | 1.5 | 4 | 2.36900 | 2.532 | 2.469 [e] | 2.235 | 2.375 | 2.500 | 3.000 | 2.578 | 0.375 | 0.25 |
| $3^1/_2$ PAC | V-076 | 1.5 | 4 | 2.88400 | 3.047 | 3.000 [e] | 2.641 | 3.250 | 3.375 | 3.875 | 3.109 | 0.375 | 0.25 |

## Table L.1—Product Dimensions for Non-preferred Connections *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connection Style and Size** | **Thread Form** | **Taper** [a]<br>$T$<br>in./ft | **Threads per Inch**<br>$n$ | **Pitch Diameter at Gauge Point**<br>$C$ | **Large Diameter of Pin**<br>$D_L$<br>ref | **Pin Cylinder Diameter**<br>$D_{LF}$<br>±0.016 | **Small Diameter of Pin**<br>$D_S$<br>ref | **Pin Length** [b]<br>$L_{PC}$<br>0 / −0.125 | **Depth of Box Threads**<br>$L_{BT}$<br>min | **Total Box Depth**<br>$L_{BC}$<br>+0.38 / 0 | **Box c/bore Diameter**<br>$Q_c$<br>+0.031 / −0.016 | **Depth of Box c/bore**<br>$L_{Qc}$<br>+0.094 / −0.031 | **Last Full Depth Thread**<br>$L_{FT}$ [c]<br>max |
| 2 3/8 SH | V-038R [g] | 2 | 4 | 2.23000 | 2.438 | 2.312 | 1.959 | 2.875 | 3.125 | 3.625 | 2.500 | 0.625 | 0.50 |
| 2 3/8 WO | V-038R [g] | 2 | 4 | 2.60600 | 2.814 | 2.703 | 2.418 | 2.375 | 2.500 | 3.000 | 2.859 | 0.625 | 0.50 |
| 2 7/8 WO | V-038R [g] | 2 | 4 | 3.12100 | 3.329 | 3.217 | 2.829 | 3.000 | 3.125 | 3.625 | 3.375 | 0.625 | 0.50 |
| 3 1/2 WO | V-038R [g] | 2 | 4 | 3.80800 | 4.016 | 3.906 | 3.433 | 3.500 | 3.625 | 4.125 | 4.078 | 0.625 | 0.50 |
| 2 7/8 XH | V-038R [g] | 2 | 4 | 3.11900 | 3.327 | 3.201 | 2.660 | 4.000 | 4.125 | 4.625 | 3.359 | 0.625 | 0.38 |
| 3 1/2 XH | V-038R [g] | 2 | 4 | 3.60400 | 3.812 | 3.686 | 3.229 | 3.500 | 3.625 | 4.125 | 3.875 | 0.625 | 0.50 |
| 3 1/2 H90 | 90-V-050 | 2 | 3.5 | 3.92860 | 4.125 | 3.922 [f] | 3.458 | 4.000 | 4.125 | 4.625 | 4.188 | 0.625 | 0.50 |
| 4 H90 | 90-V-050 | 2 | 3.5 | 4.30360 | 4.500 | 4.297 [f] | 3.792 | 4.250 | 4.375 | 4.875 | 4.563 | 0.625 | 0.50 |
| 4 1/2 H90 | 90-V-050 | 2 | 3.5 | 4.63760 | 4.834 | 4.632 [f] | 4.084 | 4.500 | 4.625 | 5.125 | 4.891 | 0.625 | 0.50 |
| 5 H90 | 90-V-050 | 2 | 3.5 | 4.90810 | 5.104 | 4.907 [f] | 4.313 | 4.750 | 4.875 | 5.375 | 5.172 | 0.625 | 0.50 |
| 5 1/2 H90 | 90-V-050 | 2 | 3.5 | 5.17860 | 5.375 | 5.173 [f] | 4.583 | 4.750 | 4.875 | 5.375 | 5.438 | 0.625 | 0.50 |
| 6 5/8 H90 | 90-V-050 | 2 | 3.5 | 5.80360 | 6.000 | 5.798 [f] | 5.167 | 5.000 | 5.125 | 5.625 | 6.063 | 0.625 | 0.50 |
| 7 H90 FF | 90-V-050 | 3 | 3.5 | 6.25230 | 6.500 | 6.298 [f] | 5.125 | 5.500 | 5.625 | 6.125 | 6.563 | 0.625 | 0.50 |
| 7 H90 LT | 90-V-050 | 3 | 3.5 | 6.25230 | 6.500 | 6.313 | 5.125 | 5.500 | 5.625 | 6.125 | 7.120 | 0.375 | 0.50 |
| 7 5/8 H90 FF | 90-V-050 | 3 | 3.5 | 7.14110 | 7.389 | 7.187 [f] | 5.857 | 6.125 | 6.250 | 6.750 | 7.453 | 0.625 | 0.50 |
| 7 5/8 H90 LT | 90-V-050 | 3 | 3.5 | 7.14110 | 7.389 | 7.202 | 5.857 | 6.125 | 6.250 | 6.750 | 8.000 | 0.375 | 0.50 |
| 8 5/8 H90 FF | 90-V-050 | 3 | 3.5 | 8.01610 | 8.264 | 8.062 [f] | 6.607 | 6.625 | 6.750 | 7.250 | 8.328 | 0.625 | 0.50 |
| 8 5/8 H90 LT | 90-V-050 | 3 | 3.5 | 8.01610 | 8.264 | 8.077 | 6.607 | 6.625 | 6.750 | 7.250 | 8.380 | 0.375 | 0.50 |
| 2 3/8 SL H90 | 90-V-084 | 1.25 | 3 | 2.57800 | 2.725 | 2.623 | 2.426 | 2.875 [d] | 3.000 | 3.500 | 2.766 | 0.625 | 0.50 |
| 2 7/8 SL H90 | 90-V-084 | 1.25 | 3 | 3.04900 | 3.196 | 3.094 | 2.884 | 3.000 [d] | 3.125 | 3.625 | 3.234 | 0.625 | 0.50 |
| 3 1/2 SL H90 | 90-V-084 | 1.25 | 3 | 3.68800 | 3.835 | 3.735 | 3.497 | 3.250 [d] | 3.375 | 3.875 | 3.875 | 0.625 | 0.50 |
| GOST Z-161 | V-050 | 2 | 4 | 6.14025 | 6.374 | 6.265 | 5.541 | 5.000 | 5.125 | 5.625 | 6.454 | 0.625 | 0.50 |
| GOST Z-189 | V-050 | 2 | 4 | 7.22292 | 7.457 | 7.347 | 6.623 | 5.000 | 5.125 | 5.625 | 7.550 | 0.625 | 0.50 |

NOTE See Figures 1, 2, and 3 for meaning of dimensions.

[a] FOOTNOTE 1 Taper ($T$) 2 in./ft corresponds to a half-angle of $\varphi = 4.764°$.
3 in./ft corresponds to a half-angle of $\varphi = 7.125°$.
1.5 in./ft corresponds to a half-angle of $\varphi = 3.576°$.
1.25 in./ft corresponds to a half-angle of $\varphi = 2.981°$.

[b] FOOTNOTE 2 For roller cone drill bits only, the pin length may vary by +0/–0.19 in.

[c] FOOTNOTE 3 Length to flank of first full depth pin thread (see Figure 1).

[d] FOOTNOTE 4 Pin Length Tolerance for SL H90 style connections is +0/–0.063 in..

[e] FOOTNOTE 5 For OH SW and PAC styles, the radius $R_{LF}$ at the pin cylinder is 0.031 in. +0.016/−0 in. (see Figure 2).

[f] FOOTNOTE 6 For the H90 style, the radius $R_{LF}$ at the pin cylinder is 0.125 in. ±0.016 in. (see Figure 2).

[g] FOOTNOTE 7 Prior to 2010, these connections were made with the V-065 thread form, which is interchangeable with V-038R.

[h] FOOTNOTE 8 2 7/8 FH has been removed since several incompatible connections have used this designation.

**Table L.2—Thread Dimensions**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | | **90-V-050** | **90-V-050** | **V-065**[a] | **V-076** | **90-V-084** |
| threads per inch | $n$ | 3.5 | 3.5 | 4 | 4 | 3 |
| lead, ref | | 0.285714 | 0.285714 | 0.25 | 0.25 | 0.333333 |
| half-angle | $\theta$, deg ±0.75 | 45 | 45 | 30 | 30 | 45 |
| taper | $T$, in./ft | 2 | 3 | 2 | 1.5 | 1.25 |
| crest flat width | $F_c$ | 0.05 | 0.05 | 0.065 | 0.076 | 0.084 |
| root radius | $R$ | N/A | N/A | N/A | N/A | N/A |
| root flat width | $F_r$ | 0.034 | 0.034 | 0.056 | 0.067 | 0.068 |
| root flat corner radius | $r_r$ ±0.008 | 0.03 | 0.03 | 0.015 | 0.015 | 0.03 |
| thread height, not truncated | $H$, ref | 0.141865 | 0.140625 | 0.216005 | 0.216224 | 0.166215 |
| crest truncation | $f_c$ ref | 0.024826 | 0.024609 | 0.056161 | 0.065732 | 0.041886 |
| root truncation | $f_r$ | 0.016882 | 0.016734 | 0.048385 | 0.057948 | 0.033908 |
| thread height truncated | $h\ ^{+0.001}_{-0.003}$ | 0.100 | 0.099 | 0.111 | 0.092 | 0.090 |
| crest flat corner radius | $r_c$ ±0.008 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |

NOTE 1 See Figures 4, 5, and J.1.

NOTE 2 Dimensions without tolerances are design elements and are not auditable.

[a] FOOTNOTE The V-065 thread form has been replaced by V-038R, but is listed for historical purposes.

## Table L.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle)

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NC10 | 0.719 | OD | 1.375 | — | — | — | — | — | — |
| | | BD | 1.359 | — | — | — | — | — | — |
| NC12 | 0.906 | OD | 1.625 | — | — | — | — | — | — |
| | | BD | 1.578 | — | — | — | — | — | — |
| NC13 | 0.938 | OD | 1.812 | — | — | — | — | — | — |
| | | BD | 1.766 | — | — | — | — | — | — |
| NC16 | 1.000 | OD | 2.125 | — | — | — | — | — | — |
| | | BD | 2.078 | — | — | — | — | — | — |
| NC77 | 2.812 | OD | 10.500 | 10.625 | 10.750 | 10.875 | 11.000 | 11.125 | — |
| | | BD | 9.891 | 9.891 | 10.078 | 10.078 | 10.266 | 10.266 | — |
| 3 1/2 FH | 2.000 | OD | 4.875 | 5.000 | 5.125 | 5.250 | — | — | — |
| | | BD | 4.672 | 4.672 | 4.859 | 4.859 | — | — | — |
| 4 1/2 FH | 2.500 | OD | 5.750 | 5.875 | 6.000 | 6.125 | 6.250 | — | — |
| | | BD | 5.594 [e] | 5.594 [e] | 5.719 | 5.719 | 5.906 | — | — |
| 5 1/2 IF | 2.125 | OD | 8.125 | 8.250 | 8.375 | 8.500 | 8.625 | 8.750 | 8.875 |
| | | BD | 7.844 [e] | 7.844 [e] | 7.891 | 7.891 | 8.078 | 8.078 | 8.266 |
| 6 5/8 IF | 2.250 | OD | 9.750 | 9.875 | 10.000 | 10.125 | 10.250 | 10.375 | — |
| | | BD | 9.234 [e] | 9.234 [e] | 9.375 | 9.375 | 9.578 | 9.578 | — |
| 2 3/8 OH LW | 1.938 | OD | 3.125 | 3.250 | 3.375 | 3.500 | — | — | — |
| | | BD | 3.062 [e] | 3.062 [e] | 3.234 | 3.234 | — | — | — |
| 2 3/8 OH SW | 1.938 | OD | 3.125 | 3.250 | 3.375 | 3.500 | — | — | — |
| | | BD | 3.062 [e] | 3.062 [e] | 3.234 | 3.234 | — | — | — |
| 2 7/8 OH LW | 1.750 | OD | 3.750 | 3.875 | 4.000 | 4.125 | — | — | — |
| | | BD | 3.641 [e] | 3.641 [e] | 3.750 | 3.750 | — | — | — |
| 2 7/8 OH SW | 1.750 | OD | 3.750 | 3.875 | 4.000 | 4.125 | — | — | — |
| | | BD | 3.641 [e] | 3.641 [e] | 3.750 | 3.750 | — | — | — |
| 3 1/2 OH LW | 2.125 | OD | 4.875 | 5.000 | 5.125 | 5.250 | — | — | — |
| | | BD | 4.641 | 4.641 | 4.844 | 4.844 | — | — | — |
| 3 1/2 OH SW | 2.125 | OD | 4.875 | 5.000 | 5.125 | 5.250 | — | — | — |
| | | BD | 4.641 | 4.641 | 4.844 | 4.844 | — | — | — |

## Table L.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle) *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 OH LW | 2.500 | OD | 5.625 | 5.750 | 5.875 | 6.000 | — | — | — |
| | | BD | 5.375 | 5.375 | 5.562 | 5.562 | — | — | — |
| | | | | | | | | | |
| 4 OH SW | 2.500 | OD | 5.625 | 5.750 | 5.875 | 6.000 | — | — | — |
| | | BD | 5.375 | 5.375 | 5.562 | 5.562 | — | — | — |
| | | | | | | | | | |
| 4 1/2 OH LW | 2.125 | OD | 6.375 | 6.500 | 6.625 | 6.750 | — | — | — |
| | | BD | 6.031 | 6.031 | 6.219 | 6.219 | — | — | — |
| | | | | | | | | | |
| 4 1/2 OH SW | 2.125 | OD | 6.375 | 6.500 | 6.625 | 6.750 | — | — | — |
| | | BD | 6.031 | 6.031 | 6.219 | 6.219 | — | — | — |
| | | | | | | | | | |
| 2 3/8 PAC | 1.375 | OD | 2.750 | 2.875 | 3.000 | — | — | — | — |
| | | BD | 2.703 | 2.703 | 2.750 | — | — | — | — |
| | | | | | | | | | |
| 2 7/8 PAC | 1.500 | OD | 3.125 | — | — | — | — | — | — |
| | | BD | 3.000 | — | — | — | — | — | — |
| | | | | | | | | | |
| 3 1/2 PAC | 1.500 | OD | 3.750 | 3.875 | — | — | — | — | — |
| | | BD | 3.594 | 3.594 | — | — | — | — | — |
| | | | | | | | | | |
| 2 3/8 SH | 1.438 | OD | 3.000 | 3.063 | 3.125 | — | — | — | — |
| | | BD | 2.875 | 2.875 | 2.969 | — | — | — | — |
| | | | | | | | | | |
| 2 3/8 WO | 1.812 | OD | 3.250 | 3.375 | 3.500 | — | — | — | — |
| | | BD | 3.141 [e] | 3.250 | 3.250 | — | — | — | — |
| | | | | | | | | | |
| 2 7/8 WO | 1.500 | OD | 4.000 | 4.125 | 4.250 | — | — | — | — |
| | | BD | 3.875 [e] | 3.875 [e] | 4.031 | — | — | — | — |
| | | | | | | | | | |
| 3 1/2 WO | 1.812 | OD | 5.000 | 5.125 | — | — | — | — | — |
| | | BD | 4.781 | 4.781 | — | — | — | — | — |
| | | | | | | | | | |
| 2 7/8 XH | 1.500 | OD | 4.125 | 4.250 | 4.375 | — | — | — | — |
| | | BD | 3.938 | 3.938 | 4.031 | — | — | — | — |
| | | | | | | | | | |
| 3 1/2 XH | 1.625 | OD | 4.750 | 4.875 | 5.000 | — | — | — | — |
| | | BD | 4.531 | 4.531 | 4.719 | — | — | — | — |

**Table L.3—Bevel Diameters for Non-preferred Connections When Used on Drill Collars (60° Included Thread Angle)** *(continued)*

| Connection Style and Size | Ref. ID [d] | Bevel Diameters [a] for Various ODs [b,c] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 1/2 H-90 | 2.000 | OD | 5.000 | 5.125 | 5.250 | 5.375 | 5.500 | — | — |
| | | BD | 4.812 | 4.812 | 5.000 | 5.000 | 5.000 | — | — |
| 4 H-90 | 2.000 | OD | 5.500 | 5.625 | 5.750 | 5.875 | 6.000 | 6.125 | 6.250 |
| | | BD | 5.312 | 5.312 | 5.500 | 5.500 | 5.500 | 5.750 | 5.750 |
| 4 1/2 H-90 | 2.000 | OD | 6.000 | 6.125 | 6.250 | 6.375 | 6.500 | 6.625 | 6.750 |
| | | BD | 5.750 | 5.750 | 6.000 | 6.000 | 6.000 | 6.250 | 6.250 |
| 5 H-90 | 2.250 | OD | 6.500 | 6.625 | 6.750 | 6.875 | 7.000 | — | — |
| | | BD | 6.125 | 6.125 | 6.375 | 6.375 | 6.375 | — | — |
| 5 1/2 H-90 | 2.250 | OD | 6.750 | 6.875 | 7.000 | 7.125 | 7.250 | 7.375 | 7.500 |
| | | BD | 6.531 [e] | 6.625 | 6.625 | 6.625 | 6.625 | 6.625 | 6.625 |
| 6 5/8 H-90 | 2.812 | OD | 7.625 | 7.750 | 7.875 | 8.000 | 8.125 | 8.250 | — |
| | | BD | 7.250 | 7.500 | 7.500 | 7.500 | 7.500 | 7.500 | — |
| 7 H-90 FF | 2.500 | OD | 8.250 | 8.375 | 8.500 | — | — | — | — |
| | | BD | 8.000 | 8.000 | 8.250 | — | — | — | — |
| 7 H-90 LT | 2.500 | OD | 8.625 | 8.750 | 8.875 | 9.000 | — | — | — |
| | | BD | 8.281 [e] | 8.281 [e] | 8.625 | 8.625 | — | — | — |
| 7 5/8 H-90 FF | 2.812 | OD | 9.375 | 9.500 | 9.625 | — | — | — | — |
| | | BD | 8.938 [e] | 9.250 | 9.250 | — | — | — | — |
| 7 5/8 H-90 LT | 2.812 | OD | 9.750 | 9.875 | 10.000 | 10.125 | 10.250 | — | — |
| | | BD | 9.484 [e] | 9.625 | 9.625 | 9.625 | 9.625 | — | — |
| 8 5/8 H-90 FF | 2.812 | OD | 10.500 | 10.625 | — | — | — | — | — |
| | | BD | 10.000 | 10.000 | — | — | — | — | — |
| 8 5/8 H-90 LT | 2.812 | OD | 10.750 | 10.875 | 11.000 | 11.125 | 11.250 | 11.375 | 11.500 |
| | | BD | 10.688 [e] | 10.688 [e] | 10.688 [e] | 10.750 | 10.750 | 10.750 | 10.828 |
| 2 3/8 SL H-90 | 1.250 | OD | 3.250 | 3.375 | — | — | — | — | — |
| | | BD | 3.125 | 3.125 | — | — | — | — | — |
| 2 7/8 SL H-90 | 1.500 | OD | 4.000 | 4.125 | 4.250 | 4.375 | — | — | — |
| | | BD | 3.875 | 3.875 | 4.125 | 4.125 | — | — | — |
| 3 1/2 SL H-90 | 1.875 | OD | 4.750 | 4.875 | 5.000 | 5.125 | 5.250 | — | — |
| | | BD | 4.625 | 4.625 | 4.875 | 4.875 | 4.906 | — | — |

[a] FOOTNOTE 1 Tolerance on bevel diameters is ±0.016 in.

[b] FOOTNOTE 2 See table '*Drill collar OD tolerances*' in API 7-1 (ISO 10424-1).

[c] FOOTNOTE 3 When drill collars and tools of the same OD listed in the table above are mated, the maximum seal stress will be less than 100 % of SMYS when made up to the recommended torque value.

[d] FOOTNOTE 4 See 5.2.4.

[e] FOOTNOTE 5 These bevel diameters are not calculated using 75 % of the face width.

**Table L.4—Low-torque Feature**

| Connection Size and Style | Required for OD Greater Than | Face Groove Diameter $D_{FG+0.032/-0.016}$ |
|---|---|---|
| 7 H90 LT | 8.5 | 7.12 |
| 7 5/8 H90 LT | 9.625 | 8.0 |
| 8 5/8 H90 LT | 10.625 | 9.38 |
| NOTE See Figure 6. | | |

**Table L.5—Optional Feature Dimension for Non-preferred Connections**

| 1 | 2 | 3 |
|---|---|---|
| Connection Size and Style | Pin ID Taper Diameter $D_{PT}$ ±0.031 (See Figure 1) | Pin Benchmark Diameter $D_{PB}$ +0.016/0 (See Figure 12) |
| NC10 | — | 1.174 |
| NC12 | — | 1.376 |
| NC13 | — | 1.502 |
| NC16 | — | 1.72 |
| NC77 | 4.25 | 7.859 |
| 3 1/2 FH | 2.375 | 3.915 |
| 4 1/2 FH | 2.875 | 4.713 |
| 5 1/2 IF | 3.75 | 6.303 |
| 6 5/8 IF | 4.0 | 7.365 |
| 2 3/8 OH LW | — | 2.687 |
| 2 3/8 OH SW | — | 2.719 |
| 2 7/8 OH LW | — | 3.078 |
| 2 7/8 OH SW | — | 3.115 |
| 3 1/2 OH LW | — | 3.828 |
| 3 1/2 OH SW | — | 3.828 |
| 4 OH LW | — | 4.515 |
| 4 OH SW | — | 4.515 |
| 4 1/2 OH LW | — | 4.859 |
| 4 1/2 OH SW | — | 4.859 |
| 2 3/8 PAC | — | 2.334 |
| 2 7/8 PAC | — | 2.5 |
| 3 1/2 PAC | — | 3.031 |
| 2 3/8 SH | — | 2.344 |
| 2 7/8 WO | — | 3.248 |
| 3 1/2 WO | — | 3.937 |
| 2 7/8 XH | 1.875 | 3.232 |
| 3 1/2 XH | 2.375 | 3.717 |

**Table L.5—Optional Feature Dimension for Non-preferred Connections** *(continued)*

| 1 | 2 | 3 |
|---|---|---|
| **Connection Size and Style** | **Pin ID Taper Diameter**<br>$D_{PT}$<br>±0.031<br>(See Figure 1) | **Pin Benchmark Diameter**<br>$D_{PB}$<br>+0.016/0<br>(See Figure 12) |
| 3 1/2 H90 | 2.5 | 3.953 |
| 4 H90 | 2.875 | 4.328 |
| 4 1/2 H90 | 3 | 4.663 |
| 5 H90 | 3.25 | 4.938 |
| 5 1/2 H90 | 3.25 | 5.204 |
| 6 5/8 H90 | 3.5 | 5.829 |
| 7 H90 | 3.75 | 6.329 |
| 7 5/8 H90 | 4.125 | 7.218 |
| 8 5/8 H90 | 4.375 | 8.093 |
| 2 3/8 SL H90 | — | 2.654 |
| 2 7/8 SL H90 | — | 3.125 |
| 3 1/2 SL H90 | — | 3.766 |
| GOST Z-161 | — | 6.332 |
| GOST Z-189 | — | 7.415 |

## Table L.6—Stress-relief Grooves and Features Dimensions for Non-preferred Connections

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Connection Size and Style | Box Boreback Contour | | | Box Groove | | Pin Groove |
| | Cylinder Diameter | Depth to Last Thread Scratch | Depth to End of Cylinder | Diameter of Box Groove | Depth to Start of Box Groove | Diameter of Pin Groove |
| | $D_{CB}{}^{+0.016}_{0}$ | $L_X$ ref | $L_{CYL}$ ±0.25 | $D_{BG}{}^{+0.031}_{0}$ | $L_{BG}{}^{0}_{-0.125}$ | $D_{SRG}{}^{0}_{-0.031}$ |
| NC77 | 6.547 | 6.000 | 8.000 | 6.594 | 6.125 | 7.402 |
| 3 1/2 FH | 3.219 | 3.250 | 5.250 | 3.281 | 3.375 | 3.382 |
| 4 1/2 FH | 3.953 | 3.500 | 5.500 | 4.016 | 3.625 | 4.180 |
| 5 1/2 IF | 5.688 | 4.500 | 6.500 | 5.766 | 4.625 | 5.889 |
| 6 5/8 IF | 6.750 | 4.500 | 6.500 | 6.828 | 4.625 | 6.951 |
| 4 OH SW | 4.156 | 3.500 | 5.500 | 4.326 | 3.625 | 4.166 |
| 4 1/2 OH LW | 4.531 | 3.250 | 5.250 | 4.694 | 3.375 | 4.502 |
| 4 1/2 OH SW | 4.531 | 3.250 | 5.250 | 4.694 | 3.375 | 4.502 |
| 3 1/2 XH | — | — | — | 3.438 | 3.125 | 3.304 |
| 3 1/2 H90 | 3.562 | 3.500 | 5.500 | 3.688 | 3.625 | 3.641 |
| 4 H90 | 3.875 | 3.750 | 5.750 | 4.031 | 3.875 | 4.016 |
| 4 1/2 H90 | 4.188 | 4.000 | 6.000 | 4.312 | 4.125 | 4.350 |
| 5 H90 | 4.406 | 4.250 | 6.250 | 4.547 | 4.375 | 4.620 |
| 5 1/2 H90 | 4.688 | 4.250 | 6.250 | 4.812 | 4.375 | 4.891 |
| 6 5/8 H90 | 5.266 | 4.500 | 6.500 | 5.406 | 4.625 | 5.516 |
| 7 H90 | 5.266 | 5.000 | 7.000 | 5.375 | 5.125 | 5.945 |
| 7 5/8 H90 | 6.000 | 5.625 | 7.625 | 6.094 | 5.750 | 6.834 |
| 8 5/8 H90 | 6.750 | 6.125 | 8.125 | 6.844 | 6.250 | 7.709 |
| 3 1/2 SL H90 | — | — | — | 3.754 | 2.812 | 3.400 |
| GOST Z-161 | 5.660 | 4.500 | 6.500 | 5.703 | 4.625 | 5.799 |
| GOST Z-189 | 6.743 | 4.500 | 6.500 | 6.785 | 4.625 | 6.882 |

NOTE See Figures 7, 8, and 9 for meaning of dimensions.

## Table L.7—Compensated Thread Lengths, Thread Heights, and Ball-point Diameters

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Thread Form** | **Taper**<br>$T$<br>in./ft | **Threads per Inch**<br>$n$ | **Compensated Lead Parallel to Taper** [a]<br>$L_{ct}$ | **Ball-point Diameter for Taper and Lead**<br>$d_b$<br>±0.002 | **Thread Height Compensated for Taper** [b]<br>$h_{cn}$ | **Ball-point Diameter for Thread Height**<br>$d_{bh}$<br>±0.002 |
| 90-V-050 | 2 | 3.5 | 0.2867 | 0.202 | 0.0997 | 0.072 |
| 90-V-050 | 3 | 3.5 | 0.2879 | 0.202 | 0.0985 | 0.072 |
| V-065 | 2 | 4.0 | 0.2509 | 0.144 | 0.1111 | 0.072 |
| V-076 | 1.5 | 4.0 | 0.2505 | 0.144 | 0.0923 | 0.072 |
| 90-V-084 | 1.25 | 3.0 | 0.3338 | 0.236 | 0.0899 | 0.072 |

NOTE 1 See Figures 15 and 16 for meaning of dimensions.

NOTE 2 For thread forms not included in this table, different ball-point diameters may be required.

[a] FOOTNOTE 1 Compensated thread length ($L_{ct}$) is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] FOOTNOTE 2 Compensated thread height ($h_{cn}$) is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

## Table L.8—Gauge Thread Form Dimensions for Non-preferred Thread Forms

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Form of Thread** | **Threads per Inch**<br>$n$ | **Lead** | **Half-angle**<br>$\theta$<br>degrees | **Taper**<br>$T$<br>in./ft | **Thread Height Not Truncated**<br>$H$<br>reference | **Gauge Root Truncation**<br>$f_{rg}$<br>max | **Gauge Crest Truncation**<br>$f_{cg}$ | **Thread Height Truncated**<br>$h_g$<br>reference |
| 90-V-050 | 3.5 | 0.285714 | 45 | 2 | 0.141865 | 0.028833 | 0.028833 | 0.0842 |
| 90-V-050 | 3.5 | 0.285714 | 45 | 3 | 0.140625 | 0.028613 | 0.028613 | 0.0834 |
| V-065 | 4 | 0.250000 | 30 | 2 | 0.216005 | 0.061161 | 0.061161 | 0.0937 |
| V-076 | 4 | 0.250000 | 30 | 1.5 | 0.216224 | 0.070730 | 0.070730 | 0.0747 |
| 90-V-084 | 3 | 0.333333 | 45 | 1.25 | 0.166215 | 0.046108 | 0.046108 | 0.0740 |

NOTE 1 In computing thread height and truncation, account has been taken of the effect of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 2 See Tables C.11 through C.13 for tolerances on columns 3, 4, 5, and 8.

NOTE 3 Prior to March 2005 the Crest truncation for V-065 gauges with 2 in./ft taper was 0.061161, and with 3 in./ft taper was 0.060998. These values are still acceptable for existing gauges made prior to this date.

NOTE 4 See Figure 18 for meaning of dimensions.

## Table L.9—Gauge Thread Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter at Gauge Point | | | |
| **Style and Size** | **Thread Form** | **Taper** | **Threads per Inch** | **Pitch Diameter at Gauge Point** [a] | **Major (Plug)** [a] **Reference** | **Minor (Ring)** [b] **Reference** | **Pitch Diameter at Working Gauge Point** [c] | **Gauge Standoff** |
| | | $T$ | $n$ | $C$ | $D_{MP}$ | $D_{MR}$ | $C_{GP}$ | $S$ |
| | | in./ft | | | | | | |
| NC10 | V-055 | 1.5 | 6 | 1.06300 | 1.0970 | 1.0291 | 0.96925 | 0.375 |
| NC12 | V-055 | 1.5 | 6 | 1.26500 | 1.2990 | 1.2311 | 1.17125 | 0.375 |
| NC13 | V-055 | 1.5 | 6 | 1.39100 | 1.4250 | 1.3571 | 1.29725 | 0.375 |
| NC16 | V-055 | 1.5 | 6 | 1.60900 | 1.6430 | 1.5751 | 1.51525 | 0.375 |
| NC77 | V-038R | 3 | 4 | 7.74100 | 7.8264 | 7.6556 | 7.55350 | 0.625 |
| 3 1/2 FH | V-040 | 3 | 5 | 3.73400 | 3.8274 | 3.6406 | 3.54650 | 0.625 |
| 4 1/2 FH | V-040 | 3 | 5 | 4.53200 | 4.6254 | 4.4386 | 4.34450 | 0.625 |
| 5 1/2 IF | V-038R | 2 | 4 | 6.18900 | 6.2750 | 6.1030 | 6.06400 | 0.625 |
| 6 5/8 IF | V-038R | 2 | 4 | 7.25100 | 7.3370 | 7.1650 | 7.12600 | 0.625 |
| 2 3/8 OH LW | V-076 | 1.5 | 4 | 2.58800 | 2.6627 | 2.5133 | 2.49425 | 0.625 |
| 2 7/8 OH LW | V-076 | 1.5 | 4 | 2.98400 | 3.0587 | 2.9093 | 2.89025 | 0.625 |
| 2 7/8 OH SW | V-076 | 1.5 | 4 | 2.98400 | 3.0587 | 2.9093 | 2.89025 | 0.625 |
| 3 1/2 OH SW | V-076 | 1.5 | 4 | 3.72800 | 3.8027 | 3.6533 | 3.63425 | 0.625 |
| 4 OH LW | V-076 | 1.5 | 4 | 4.41600 | 4.4907 | 4.3413 | 4.32225 | 0.625 |
| 4 OH SW | V-076 | 1.5 | 4 | 4.41600 | 4.4907 | 4.3413 | 4.32225 | 0.625 |
| 4 1/2 OH SW | V-076 | 1.5 | 4 | 4.75200 | 4.8267 | 4.6773 | 4.65825 | 0.625 |
| 2 3/8 PAC | V-076 | 1.5 | 4 | 2.20300 | 2.2777 | 2.1283 | 2.10925 | 0.625 |
| 2 7/8 PAC | V-076 | 1.5 | 4 | 2.36900 | 2.4437 | 2.2943 | 2.27525 | 0.625 |
| 3 1/2 PAC | V-076 | 1.5 | 4 | 2.88400 | 2.9587 | 2.8093 | 2.79025 | 0.625 |
| 2 3/8 SH | V-038R | 2 | 4 | 2.23000 | 2.3160 | 2.1440 | 2.10500 | 0.625 |

## Table L.9—Gauge Thread Dimensions *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter at Gauge Point | | | |
| **Style and Size** | **Thread Form** | **Taper** $T$ in./ft | **Threads per Inch** $n$ | **Pitch Diameter at Gauge Point** [a] $C$ | **Major (Plug)** [a] **Reference** $D_{MP}$ | **Minor (Ring)** [b] **Reference** $D_{MR}$ | **Pitch Diameter at Working Gauge Point** [c] $C_{GP}$ | **Gauge Standoff** $S$ |
| 2 3/8 WO | V-038R | 2 | 4 | 2.60500 | 2.6910 | 2.5190 | 2.48000 | 0.625 |
| 2 7/8 WO | V-038R | 2 | 4 | 3.12100 | 3.2070 | 3.0350 | 2.99600 | 0.625 |
| 3 1/2 WO | V-038R | 2 | 4 | 3.80800 | 3.8940 | 3.7220 | 3.68300 | 0.625 |
| 2 7/8 XH | V-038R | 2 | 4 | 3.11900 | 3.2050 | 3.0330 | 2.99400 | 0.625 |
| 3 1/2 XH | V-038R | 2 | 4 | 3.60400 | 3.6900 | 3.5180 | 3.47900 | 0.625 |
| 3 1/2 H90 | 90-V-050 | 2 | 3.5 | 3.92860 | 4.0128 | 3.8444 | 3.80360 | 0.625 |
| 4 H90 | 90-V-050 | 2 | 3.5 | 4.30360 | 4.3878 | 4.2194 | 4.17860 | 0.625 |
| 4 1/2 H90 | 90-V-050 | 2 | 3.5 | 4.63760 | 4.7218 | 4.5534 | 4.51260 | 0.625 |
| 5 H90 | 90-V-050 | 2 | 3.5 | 4.90810 | 4.9923 | 4.8239 | 4.78310 | 0.625 |
| 5 1/2 H90 | 90-V-050 | 2 | 3.5 | 5.17860 | 5.2628 | 5.0944 | 5.05360 | 0.625 |
| 6 5/8 H90 | 90-V-050 | 2 | 3.5 | 5.80360 | 5.8878 | 5.7194 | 5.67860 | 0.625 |
| 7 H90 | 90-V-050 | 3 | 3.5 | 6.25230 | 6.3357 | 6.1689 | 6.06480 | 0.625 |
| 7 5/8 H90 | 90-V-050 | 3 | 3.5 | 7.14110 | 7.2245 | 7.0577 | 6.95360 | 0.625 |
| 8 5/8 H90 | 90-V-050 | 3 | 3.5 | 8.01610 | 8.0995 | 7.9327 | 7.82860 | 0.625 |
| 2 3/8 SL H90 | 90-V-084 | 1.25 | 3 | 2.57800 | 2.6520 | 2.5040 | 2.49988 | 0.625 |
| 2 7/8 SL H90 | 90-V-084 | 1.25 | 3 | 3.04900 | 3.1230 | 2.9750 | 2.97088 | 0.625 |
| 3 1/2 SL H90 | 90-V-084 | 1.25 | 3 | 3.68800 | 3.7620 | 3.6140 | 3.60988 | 0.625 |
| GOST Z-161 | V-050 | 2 | 4 | 6.14025 | 6.2599 | 6.0206 | 6.01525 | 0.625 |
| GOST Z-189 | V-050 | 2 | 4 | 7.22292 | 7.3425 | 7.1033 | 7.09792 | 0.625 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE 1 The values in columns 5 and 6 apply only to Grand, Regional, and Reference Master plug gauges.

[b] FOOTNOTE 2 The values in column 7 apply only to ring gauges.

[c] FOOTNOTE 3 The values in column 8 apply only to Working plug gauges.

### Table L.10—Gauge External Dimensions

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length**<br>$L_{pg}$ | **Fitting Plate Diameter** [a,b]<br>$D_{FP}$<br>max | **Ring Gauge Length**<br>$L_{rg}$ | **Ring Gauge Outside Diameter**<br>$D_R$<br>reference | **Diameter of Ring Gauge Counterbore**<br>$Q$<br>min |
| NC10 | 1.500 | — | 1.125 | 2.072 | 1.175 |
| NC12 | 1.750 | — | 1.375 | 2.315 | 1.377 |
| NC13 | 1.750 | — | 1.375 | 2.466 | 1.503 |
| NC16 | 1.750 | — | 1.375 | 2.728 | 1.721 |
| NC77 | 6.500 | 7.508 | 5.875 | 10.151 | 7.907 |
| 3 1/2 FH | 3.750 | 3.501 | 3.125 | 5.343 | 3.900 |
| 4 1/2 FH | 4.000 | 4.299 | 3.375 | 6.300 | 4.698 |
| 5 1/2 IF | 5.000 | 5.955 | 4.375 | 8.289 | 6.356 |
| 6 5/8 IF | 5.000 | 7.017 | 4.375 | 9.564 | 7.418 |
| 2 3/8 OH LW | 2.375 | 2.371 | 1.750 | 3.948 | 2.738 |
| 2 7/8 OH LW | 2.500 | 2.767 | 1.875 | 4.423 | 3.134 |
| 2 7/8 OH SW | 2.875 | 2.767 | 2.250 | 4.423 | 3.134 |
| 3 1/2 OH SW | 3.250 | 3.511 | 2.625 | 5.316 | 3.878 |
| 4 OH LW | 3.500 | 4.199 | 2.875 | 6.141 | 4.566 |
| 4 OH SW | 4.000 | 4.199 | 3.375 | 6.141 | 4.566 |
| 4 1/2 OH SW | 3.750 | 4.535 | 3.125 | 6.544 | 4.902 |
| 2 3/8 PAC | 2.375 | 1.988 | 1.750 | 3.483 | 2.351 |
| 2 7/8 PAC | 2.375 | 2.154 | 1.750 | 3.682 | 2.517 |
| 3 1/2 PAC | 3.250 | 2.669 | 2.625 | 4.300 | 3.032 |
| 2 3/8 SH | 2.875 | 1.996 | 2.250 | 3.538 | 2.397 |

**Table L.10—Gauge External Dimensions** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Style and Size** | **Plug Gauge Length**<br>$L_{pg}$ | **Fitting Plate [a,b] Diameter**<br>$D_{FP}$<br>max | **Ring Gauge Length**<br>$L_{rg}$ | **Ring Gauge Outside Diameter**<br>$D_R$<br>reference | **Diameter of Ring Gauge Counterbore**<br>$Q$<br>min |
| $2^3/8$ WO | 2.375 | 2.369 | 1.750 | 3.991 | 2.774 |
| $2^7/8$ WO | 3.500 | 2.885 | 2.875 | 4.610 | 3.290 |
| $3^1/2$ WO | 3.500 | 3.572 | 2.875 | 5.434 | 3.977 |
| $2^7/8$ XH | 4.000 | 2.883 | 3.375 | 4.608 | 3.288 |
| $3^1/2$ XH | 3.500 | 3.368 | 2.875 | 5.190 | 3.773 |
| $3^1/2$ H90 | 4.000 | 3.704 | 3.375 | 5.565 | 4.086 |
| 4 H90 | 4.250 | 4.079 | 3.625 | 6.015 | 4.461 |
| $4^1/2$ H90 | 4.500 | 4.413 | 3.875 | 6.416 | 4.795 |
| 5 H90 | 4.750 | 4.684 | 4.125 | 6.741 | 5.065 |
| $5^1/2$ H90 | 4.750 | 4.954 | 4.125 | 7.065 | 5.336 |
| $6^5/8$ H90 | 5.000 | 5.579 | 4.375 | 7.815 | 5.961 |
| 7 H90 | 5.500 | 6.029 | 4.875 | 8.353 | 6.409 |
| $7^5/8$ H90 | 6.125 | 6.918 | 5.500 | 9.419 | 7.298 |
| $8^5/8$ H90 | 6.625 | 7.793 | 6.000 | 10.469 | 8.173 |
| $2^3/8$ SL H90 | 2.812 | 2.364 | 2.187 | 3.932 | 2.725 |
| $2^7/8$ SL H90 | 2.937 | 2.835 | 2.312 | 4.498 | 3.196 |
| $3^1/2$ SL H90 | 3.188 | 3.474 | 2.563 | 5.264 | 3.835 |
| GOST Z-161 | 5.000 | 5.881 | 4.375 | 8.262 | 6.333 |
| GOST Z-189 | 5.000 | 6.963 | 4.375 | 9.561 | 7.416 |

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] FOOTNOTE There is no fitting plate on NC10 through NC16.

[b] FOOTNOTE The thickness of fitting plates, $T_{FP}$, shall be 0.375 in. maximum for all gauge sizes with pitch diameter less than 6.24 in. and 0.437 in. maximum for all larger gauge sizes.

# Bibliography

[1] API Specification 7, *Specification for Rotary Drill Stem Elements*

[2] API Recommended Practice 7G, *Recommended Practice for Drill Stem Design and Operating Limits*

[3] API Recommended Practice 7G-2, *Recommended Practice for Inspection and Classification of Used Drill Stem Elements*

[4] ILAC G-24 [3], *Guidelines for the determination of calibration intervals of measuring instruments*

[5] ISO 10407 [4], *Petroleum and natural gas industries—Drilling and production equipment—Drill stem design and operating limits*

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[3] ILAC, 7 Leeds Street, Rhodes, NSW 2138 Australia, www.ilac.org

[4] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org.

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