INTERNATIONAL STANDARD

ISO 10424-2

First edition
2007-11-15

Petroleum and natural gas industries — Rotary drilling equipment —

Part 2: **Threading and gauging of rotary shouldered thread connections**

Industries du pétrole et du gaz naturel — Équipements de forage rotary —

Partie 2: Filetage et calibrage des connexions rotary filetées à épaulement

Reference number
ISO 10424-2:2007(E)

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Foreword

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

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

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

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

ISO 10424-2 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

ISO 10424 consists of the following parts, under the general title *Petroleum and natural gas industries — Rotary drilling equipment*:

— *Part 1: Rotary drill stem elements*

— *Part 2: Threading and gauging of rotary shouldered thread connections*

Introduction

This International Standard is based on API Spec 7, *Specification for rotary drill stem elements*.

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

Petroleum and natural gas industries — Rotary drilling equipment —

Part 2: Threading and gauging of rotary shouldered thread connections

1 Scope

This part of ISO 10424 specifies requirements on rotary shouldered connections for use in petroleum and natural gas industries, including dimensional requirements on threads and thread gauges, stipulations on gauging practice, 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 part of ISO 10424 is applicable to the following preferred rotary shouldered connection designs:

a) number (NC) style;

b) regular (REG) style;

c) full hole (FH) style.

These are traceable to an internationally supported system of gauges and calibration

2 Conformance — Units of measurement

In this part of ISO 10424, data are expressed in both the International System (SI) of units and the United States Customary (USC) system of units. Separate tables for data expressed in SI units and USC units are given in the body of this part of ISO 10424 and Annex A, 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. Annex G provides the conversion between SI and USC units used in this part of ISO 10424.

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 part of ISO 10424 as expressed in one system provides compliance with requirements expressed in the other system. For data expressed in the SI system, a comma is used as the decimal separator and a space as the thousands separator. For data expressed in the USC system, a dot (on the line) is used as the decimal separator and a space as the thousands separator.

In the text, data in SI units are followed by data in USC units in brackets.

3 Normative references

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

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

ISO 11961[1)], *Petroleum and natural gas industries — Steel drill pipe*

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

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

4 Terms, abbreviated terms, definitions and symbols

4.1 Terms and definitions

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

4.1.1
bevel diameter
outside diameter of the contact face of the rotary shouldered connection

4.1.2
box connection
box end
threaded connection on oil country tubular goods with internal (female) threads

4.1.3
box thread
internal (female) threads of a rotary shouldered connection

4.1.4
break-in
procedure applied to newly manufactured threads to assure correct mating

4.1.5
calibration system
documented system of gauge calibration and control

4.1.6
cold working
plastic deformation of the surface of the connection at a temperature low enough to induce strain hardening

4.1.7
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

4.1.8
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

1) To be published. (Revision of ISO 11961:1996)

4.1.9
gauge point
imaginary plane, perpendicular to the thread axis of rotary shouldered connections at which the pitch diameter, C, at gauge point is measured

NOTE This plane is located 15,875 mm (0.625 0 in) from the make-up shoulder of the pin thread.

4.1.10
interchange stand-off
stand-off between each member of a gauge set and a corresponding gauge next higher in the ranking scheme: grand master or regional master, reference master, working gauge

4.1.11
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

4.1.12
make-up shoulder
sealing shoulder on a rotary shouldered connection

4.1.13
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 part of ISO 10424

4.1.14
master gauge
gauges used for calibration of other gauges

NOTE These include reference master, regional master and grand master gauges.

4.1.15
mating stand-off
stand-off between the plug and ring members of a gauge set

NOTE Interchange stand-off is the stand-off between each member and a gauge higher in the ranking scheme.

4.1.16
pin connection
pin end
threaded connection on oil country tubular goods with external (male) threads

4.1.17
pin thread
external (male) threads of a rotary shouldered connection

4.1.18
pitch
axial distance between successive threads, which, in a single start thread, is equivalent to lead

4.1.19
pitch cone
imaginary cone whose diameter at any point is equal to the pitch diameter of the thread at the same point

4.1.20
pitch diameter
diameter at which the distance across the threads is equal to the distance between the threads

4.1.21
product
drill string component with rotary shouldered connection in accordance with this part of ISO 10424

4.1.22
reference dimension
dimension that is a result of two or more other dimensions

4.1.23
rotary shouldered connection
thread connection used on drill stem elements which has coarse, tapered threads and sealing shoulders

4.1.24
stand-off
distance between faces of gauges, or gauge and product when mated

4.1.25
stress-relief groove
⟨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.

4.1.26
taper
increase in the diameter of the pitch cone with length

NOTE The taper is expressed in millimetres per millimetre (inches per foot) of thread length.

4.1.27
thread form
thread profile in an axial plane for a length of one pitch

4.1.28
thread height
distance between the crest and root, normal to the axis of the thread

4.1.29
tolerance
amount of variation permitted

4.1.30
working gauges
gauges used for gauging rotary shouldered connections

4.2 Design types and definitions

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.

4.2.1
full-hole style
FH style
type and size of rotary shouldered connection having thread form of V-040 or V-050

NOTE The number relates to a historical drill-pipe size.

4.2.2
GOST Z style
type and size of the rotary shouldered connection, covered by a Russian standard and having the V-038R, V-040 or V-050 thread form

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

4.2.3
H90 style
type and size of rotary shouldered connection having a 90° thread form

NOTE The number relates to a historical drill-pipe size.

4.2.4
IF style
type and size of the rotary shouldered connection having the V-038R thread form

NOTE 1 The number relates to a historical drill-pipe size.

NOTE 2 The thread form was historically V-065.

4.2.5
number style
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).

4.2.6
open-hole style
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.

4.2.7
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.

4.2.8
regular style
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.

4.2.9
SL H90 style
type and size of rotary shouldered connection having a 90° thread form and heavy truncation

NOTE The number relates to a historical drill-pipe size.

4.3 Abbreviations and symbols

4.3.1 Abbreviations

c/bore	Counterbore
CW	Cold working
dia.	Diameter
FF	Full face
FH	Full-hole (style)
ID	Inside diameter
IF	Internal-flush (style)
LH	Left-hand
LT	Low-torque modification
max.	Maximum
min.	Minimum
NC	Numbered-connection (style)
OD	Outside diameter
OH	Open-hole (style)
ref	Reference (dimension)
REG	Regular (style)
RH	Right-hand
SRG	Stress-relief groove
thds	Threads

4.3.2 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 pitch cone addendum
C_{GP}	Pitch diameter at working gauge point
C	Pitch diameter of thread at gauge point
d_{b}	Diameter of ball for lead and taper gauges
D_{BG}	Diameter of box member at stress-relief groove
d_{bh}	Diameter of ball for thread-height gauge
D_{CB}	Diameter of cylinder of boreback stress-relief contour
D_{FG}	Diameter of face groove and box counterbore in low-torque feature
D_{FP}	Diameter of plug fitting plate
D_{L}	Large diameter of pin

D_{LF}	Diameter of flat on pin
D_{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_S	Small diameter of pin
D_{SRG}	Diameter of pin stress-relief groove
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 (minimum)
L_{ct}	Length of thread lead multiple, compensated for taper
L_{CB}	Boreback length
L_{CYL}	Depth of cylinder of boreback contour
L_{fp}	Thickness of gauge fitting plate
L_{ft}	Distance from shoulder to first full-depth pin thread
L_{GP}	Distance from shoulder to gauge point
L_{pg}	Total length of plug gauge
L_{rg}	Total length of ring gauge
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
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_c Radius at corners of crest flat

r_r Radius at corners of root flat

R Root radius, product thread

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

R_{FG} Radius at corners of low-torque grooves

S Mating stand-off of gauges

S_0 Stand-off of certified reference master gauges

S_1 Stand-off of the working plug gauge on a reference master gauge

S_2 Stand-off of the working ring gauge on a reference master gauge

T Taper, expressed as millimetres of diameter per millimetre of length or inches of diameter per foot of length

T_{FP} Thickness of gauge fitting plate

φ Half of the included angle of the taper cone

θ Angle between the thread flank and the normal to the thread axis

5 Information to be supplied by purchaser

In placing orders for equipment manufactured with rotary shouldered connections in accordance with this part of ISO 10424, the purchaser shall specify the following on the purchase order:

— number of this part of ISO 10424;

— thread style and size;

— if necessary, supplementary requirements as detailed in Clause 6, which are optional with the purchaser.

6 Threading

6.1 Thread profile and dimensions

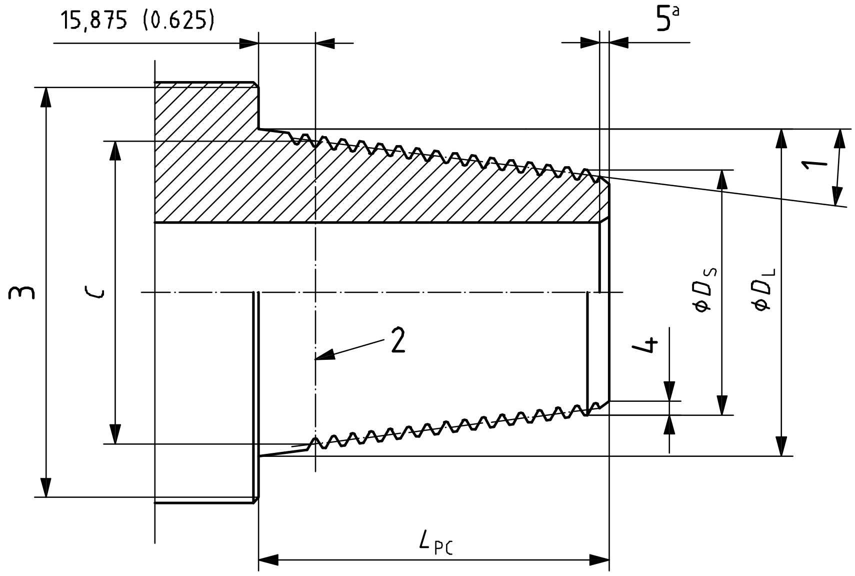
6.1.1 Overall dimensions

Rotary shouldered connections shall be furnished in the sizes and styles shown in Table 1. Dimensions of rotary shouldered connections shall conform to Tables 1 and 2, and Figures 1 and 2. The taper, T, in Tables 1 and 2, is related to the half-angle, φ, in Figures 1 and 2, by $T = 2 \tan\varphi$.

The dimensions shown in Tables 1 and 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 conforming to this part of ISO 10424 shall be acceptable, if certified reference master gauges exist for these threads.

Dimensions in millimetres (inches)



Key

1 taper half-angle, φ

2 plane of gauge point

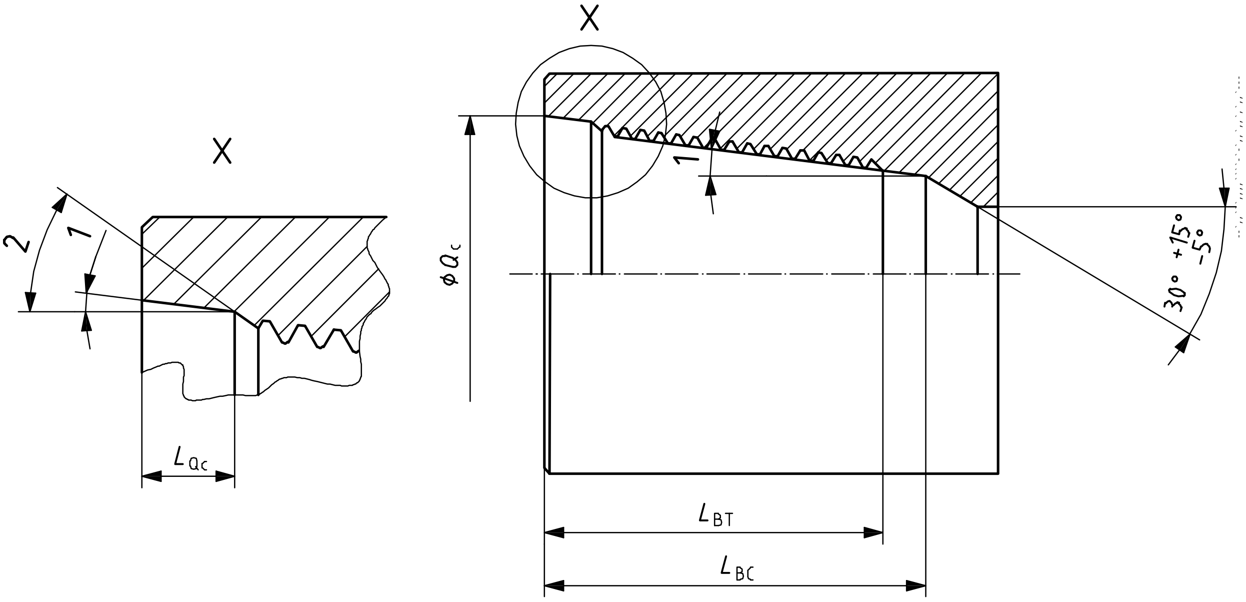
3 connection bevel diameter; see 6.2

4 outside bevel, angle optional to manufacturer

5 optional inside bevel

[a] In accordance with ISO 11961 or product specification.

Figure 1 — Pin connection



Key

1 taper half-angle, φ

2 chamfer angle, typically 25° to 45°

Figure 2 — Box connection

Table 1 — Product thread dimensions for preferred connections
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Connection style and size	**Thread form**	**Taper** [b]	**Threads per 25,4 mm**	**Pitch dia. at gauge point**	**Large dia. of pin**	**Pin cylinder dia.**	**Small dia. of pin**	**Pin length** [c]	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore**	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		mm/mm			ref.	± 0,4	ref.	$^{0}_{-3}$	min.	$^{+9}_{0}$	$^{+0,8}_{-0,4}$	$^{+1,6}_{-0,8}$	max.
NC23	V-038R	1/6	4	59,817 0	65,10	61,90	52,40	76,20	79,38	92,08	66,68	15,88	12,70
NC26	V-038R	1/6	4	67,767 2	73,05	69,85	60,35	76,20	79,38	92,08	74,61	15,88	12,70
NC31	V-038R	1/6	4	80,848 2	86,13	82,96	71,31	88,90	92,08	104,78	87,71	15,88	12,70
NC35	V-038R	1/6	4	89,687 4	94,97	92,08	79,09	95,25	98,42	111,12	96,84	15,88	12,70
NC38	V-038R	1/6	4	96,723 2	102,00	98,83	85,07	101,60	104,78	117,48	103,58	15,88	12,70
NC40	V-038R	1/6	4	103,428 8	108,71	105,56	89,66	114,30	117,48	130,18	110,33	15,88	12,70
NC44	V-038R	1/6	4	112,191 8	117,47	114,27	98,42	114,30	117,48	130,18	119,06	15,88	12,70
NC46	V-038R	1/6	4	117,500 4	122,78	119,61	103,73	114,30	117,48	130,18	124,62	15,88	12,70
NC50	V-038R	1/6	4	128,059 2	133,34	130,43	114,29	114,30	117,48	130,18	134,94	15,88	12,70
NC56	V-038R	1/4	4	142,646 4	149,24	144,86	117,49	127,00	130,18	142,88	150,81	15,88	12,70
NC61	V-038R	1/4	4	156,921 2	163,52	159,16	128,59	139,70	142,88	155,58	165,10	15,88	12,70
NC70	V-038R	1/4	4	179,146 2	185,74	181,38	147,64	152,40	155,58	168,28	187,32	15,88	12,70
1 REG	V-055	1/8	6	29,311 6	32,54	31,32	27,78	38,10	50,80	53,98	33,04	11,13	10,16
1-1/2 REG	V-055	1/8	6	39,141 4	42,37	41,17	36,02	50,80	53,98	66,80	42,88	11,13	10,16
2-3/8 REG	V-040	1/4	5	60,080 4	66,68	63,88	47,62	76,20	79,38	92,08	68,26	15,88	12,70
2-7/8 REG	V-040	1/4	5	69,605 4	76,20	73,41	53,98	88,90	92,08	104,78	77,79	15,88	12,70
3-1/2 REG	V-040	1/4	5	82,292 7	88,89	86,11	65,07	95,25	98,42	111,12	90,49	15,88	12,70
4-1/2 REG	V-040	1/4	5	110,867 7	117,46	114,68	90,47	107,95	111,12	123,82	119,06	15,88	12,70
5-1/2 REG	V-050	1/4	4	132,944 1	140,20	137,41	110,03	120,65	123,82	136,52	141,68	15,88	12,70
6-5/8 REG	V-050	1/6	4	146,248 1	152,19	149,40	131,02	127,00	130,18	142,88	153,99	15,88	12,70
7-5/8 REG	V-050	1/4	4	170,549 1	177,80	175,01	144,46	133,35	136,52	149,22	180,18	15,88	12,70
8-5/8 REG	V-050	1/4	4	194,731 1	201,98	199,14	167,85	136,53	139,70	152,40	204,39	15,88	12,70
5 1/2 FH	V-050	1/6	4	142,011 4	147,95	145,16	126,78	127,00	130,18	142,88	150,02	15,88	12,70
6-5/8 FH	V-050	1/6	4	165,597 8	171,53	168,73	150,37	127,00	130,18	142,88	173,83	15,88	12,70

[a] See Table A.1 for USC units.

[b] Taper, T: 1/6 mm/mm corresponds to a half-angle of φ = 4,764°.
1/4 mm/mm corresponds to a half-angle of φ = 7,125°.
1/8 mm/mm corresponds to a half-angle of φ = 3,576°.

[c] For roller cone drill bits only, the pin length may vary by −5 mm.

6.1.2 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).

6.1.3 Stand-off

Rotary shouldered connections shall be produced with stand-off tolerances as specified in Clause 8.

6.1.4 Thread axis

Thread axes of rotary shouldered connections, except on bits, shall not deviate from the design axes of the product by an angle greater than 0,057° [0,001 mm/mm (0.001 in/in) of projected axis]. The design axis shall be assumed to intersect the thread axis at the plane of the joint shoulder.

6.1.5 Lead tolerance

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

a) ± 0,038 mm per 25,4 mm (0.001 5 in per in) for any 25,4 mm (1.0 in) between first and last full depth threads;

b) ± 0,114 mm (0.004 5 in) between first and last full depth threads, or the sum of 0,025 4 mm (0.001 in) for each 25,4 mm (1 in) between first and last full depth threads, whichever is greater.

Clause 8 describes the method for determining lead.

6.1.6 Taper tolerance

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

a) pin thread: +0,002 5 mm/mm to 0 mm/mm (0.030 in/ft to 0 in/ft) average taper between first and last full depth threads;

b) box thread: 0 mm/mm to −0,002 5 mm/mm (0 in/ft to −0.030 in/ft) average taper between first and last full depth threads.

Methods for determining taper are described in 8.5.

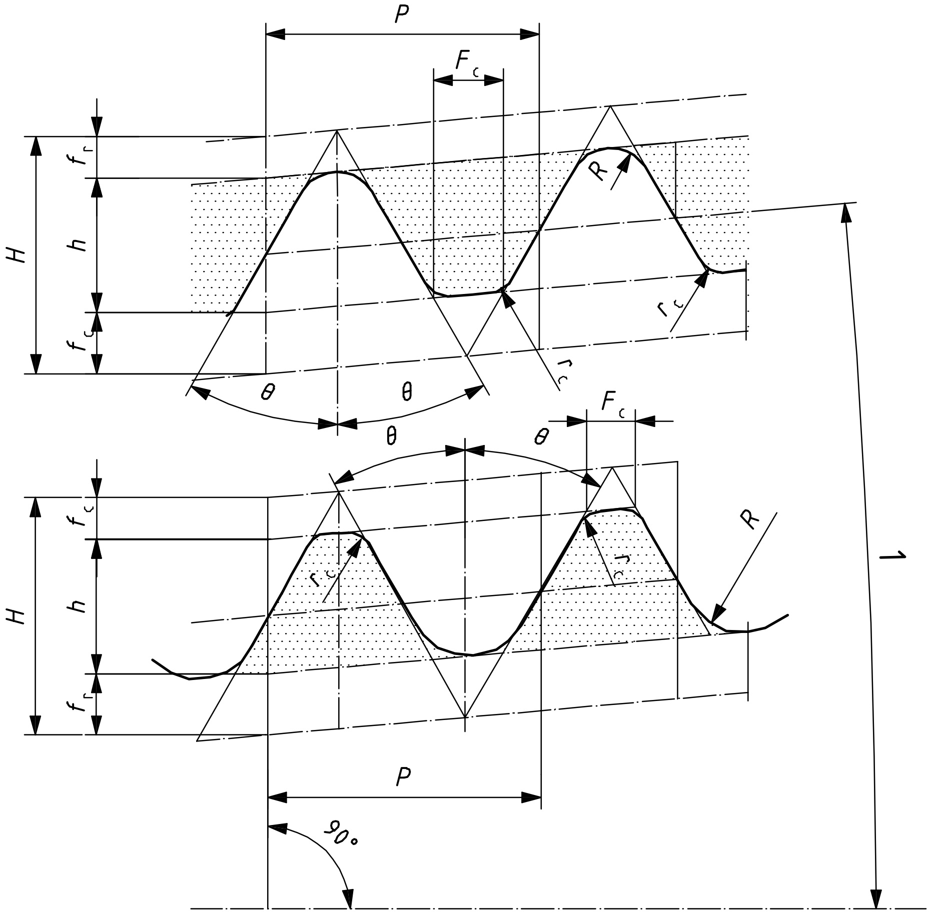
6.1.7 Thread form

The thread form shall be as defined in Table 2, and shown in Figures 3 and 4.

Table 2 — Product thread form dimensions
(SI units [a])

Dimensions in millimetres, unless otherwise specified

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	4,233 33
Half angle	θ, deg ± 0,75	30	30	30	30	30	30
Taper	T, mm/mm	1/6	1/4	1/4	1/6	1/4	1/8
Crest flat width	F_c, ref.	1,65	1,65	1,02	1,27	1,27	1,40
Root radius	R	0,97	0,97	0,51	0,64	0,64	N/A
Root flat width	F_r, ref.	N/A	N/A	N/A	N/A	N/A	1,19
Root flat corner radius	r_r ± 0,2	N/A	N/A	N/A	N/A	N/A	0,38
Thread height, not truncated	H, ref.	5,486 53	5,470 62	4,376 50	5,486 53	5,470 62	3,661 40
Crest truncation	f_c	1,426 50	1,422 36	0,875 31	1,097 31	1,094 12	1,208 26
Root truncation	f_r	0,965 20	0,965 20	0,508 00	0,635 00	0,635 00	1,032 51
Thread height truncated	$h\ ^{+0,025}_{-0,076}$	3,094 83	3,083 06	2,993 19	3,754 22	3,74150	1,420 63
Crest flat corner radius	r_c ± 0,2	0,38	0,38	0,38	0,38	0,38	0,38
NOTE See Figures 4 and 5 for meaning of dimensions.							
[a] See Table A.2 for values in USC units.							

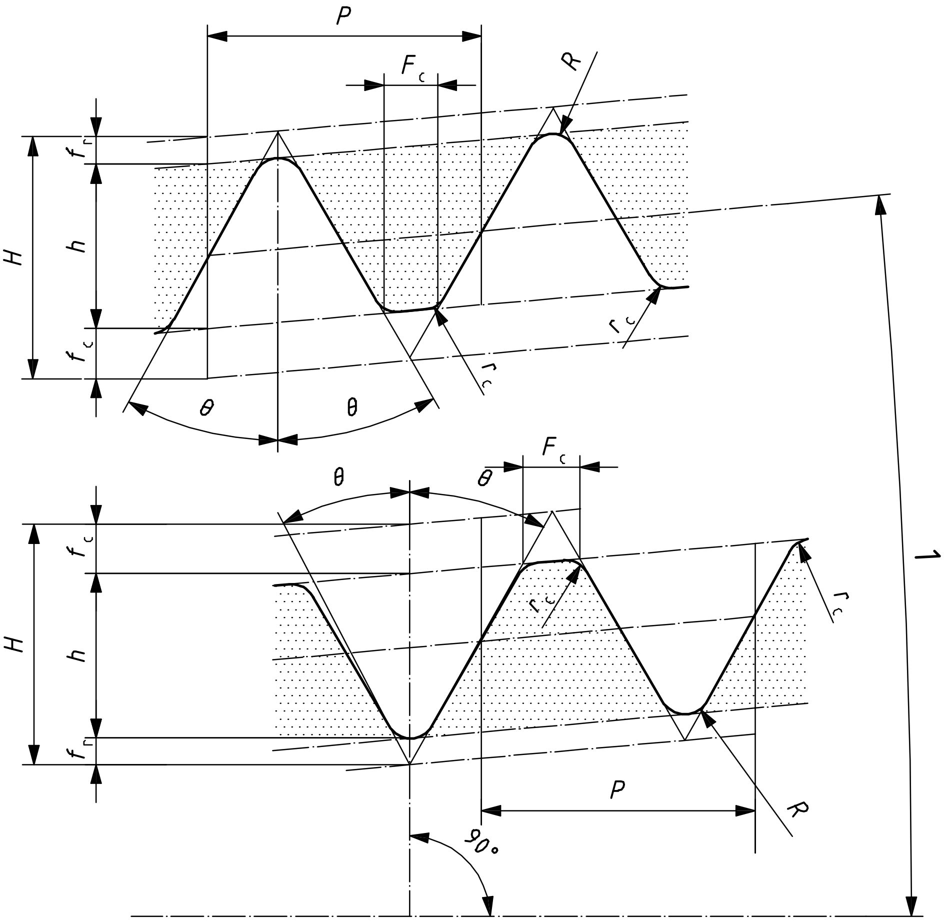


a) V-038R

Key

1 taper half-angle, φ

Figure 3 — Product thread forms

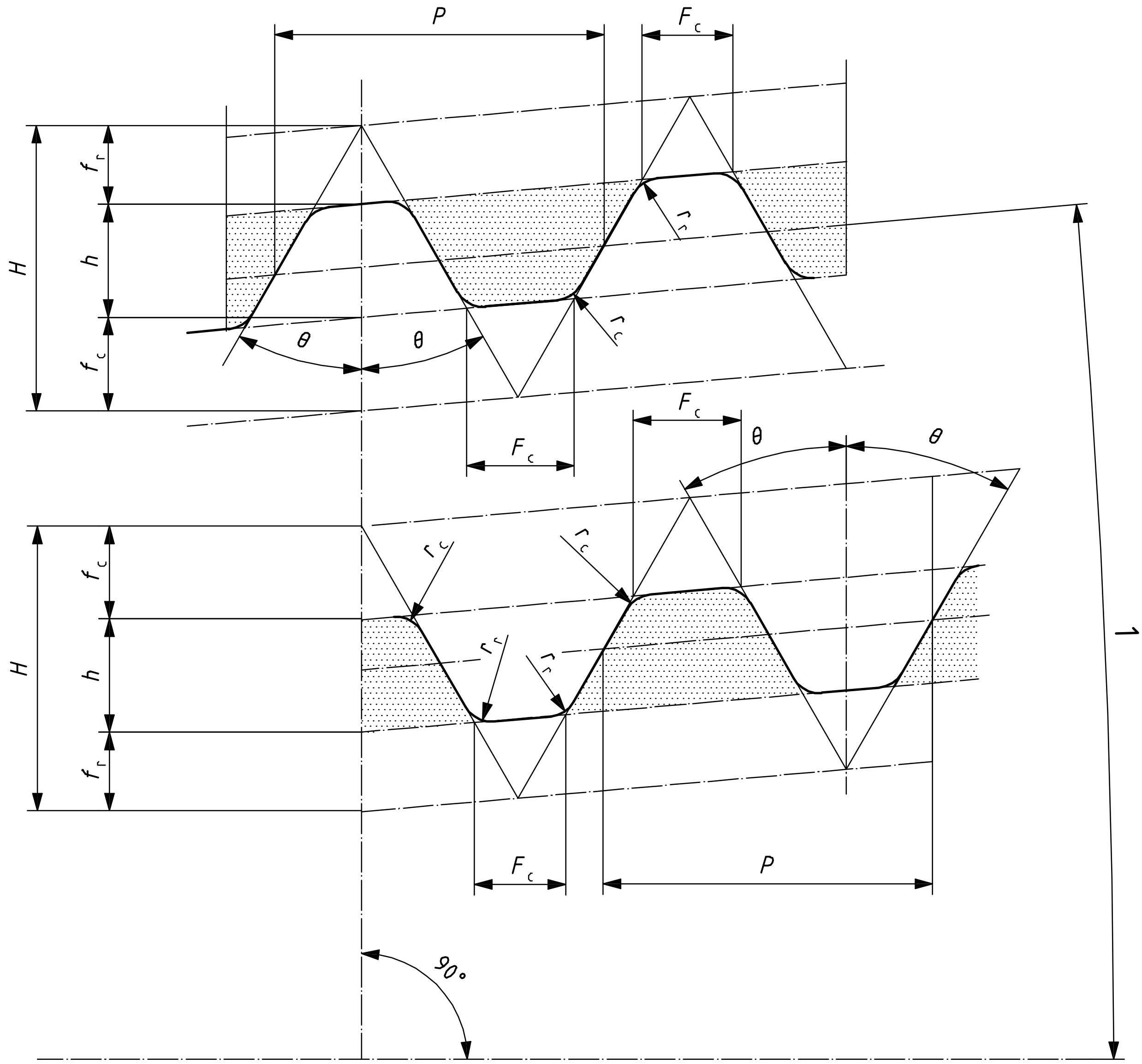


b) V-050, V-040

Key

1 taper half-angle, φ

Figure 3 (*continued*)



Key

1 taper half-angle, φ

Figure 4 — Product thread form V-055

6.1.8 Pin base diameter

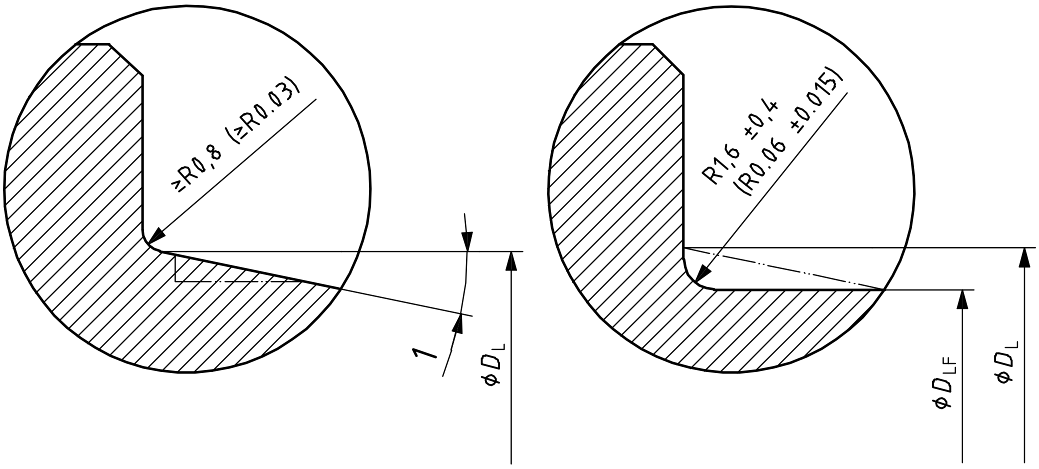
Pin base diameter dimensional requirements shall be as follows.

a) Rotary shouldered connections on drill collars shall have a cylindrical region at the base conforming to the dimension D_{LF} of Table 1, and shall have a 1,6 mm ± 0,4 mm (0.062 in ± 0.015 in) radius at the pin base as shown in Figure 5, except when a stress-relief groove is used.

b) Rotary shouldered connections on products other than drill collars may have a tapered region at the pin base rather than a cylindrical region. When the tapered base is used, the radius at the intersection of the taper and the sealing face shall be equal to or greater than 0,8 mm (0.03 in), as shown in Figure 5.

c) The distance between the pin shoulder and the intersection of the pin base diameter with the thread flank at the first point of full thread depth shall not exceed L_{ft} (see Figure 6 and Table 1).

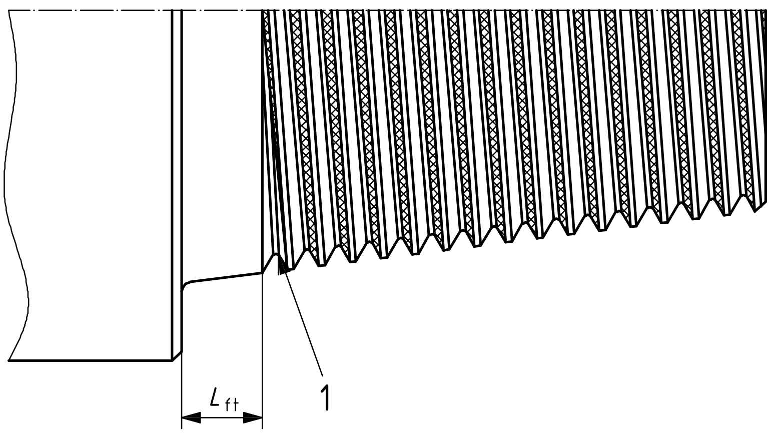
Dimensions in millimetres (inches)



Key

1 taper half-angle, φ

Figure 5 — Pin base cylinder



Key

1 first point of full thread depth

Figure 6 — First point of full thread depth

6.1.9 Box counterbore

The box counterbore shall have the diameter, Q_C, specified in Table 1, and taper, T, as described in 6.1.1 and shown in the detail of Figure 2. The depth of the counterbore shall be L_{Qc}, as specified in Table 1. The angle of the bevel at the intersection of the counterbore and the first threads is optional to the manufacturer and is typically 25° to 45°.

6.2 Bevels for drill collars and tools that mate directly with drill collars

Bevel diameters on drill collars and tools that mate with them are based on a computation described in detail in Annex I, which depends on the outside diameter at the connection. The bevel diameter for the smallest diameter commonly used, the reference diameter, is listed in Table 3. The bevel diameter is re-calculated for every 6,4 mm (0.25 in) increase in outside diameter of the drill collar. For every 6,4 mm (0.25 in) increase (or decrease) in outside diameter, the bevel diameter is also increased (or decreased) by 4,8 mm (0.19 in).

Bevel diameters for low-torque features have been arbitrarily set and shall not increase with diameter changes.

Unless otherwise specified, bevel tolerances shall be ± 0,4 mm (± 0.015 in).

These bevel diameters shall not apply to products that have specific requirements in API Spec 7 and ISO 10424-1, tool joints, bits or boxes that mate with bits.

Table 3 — Reference bevel diameters for 60° included thread angle connections when used on drill collars
(SI units [a])

Dimensions in millimetres

1	2	3	4	5	6	7	8	9
Connection size and style	**Reference OD** [b]	**Reference bevel diameter**	**Connection size and style**	**Reference OD** [b]	**Reference bevel diameter**	**Connection size and style**	**Reference OD** [b]	**Reference bevel diameter**
NC23	79,38	76,20	NC50	161,92	155,18	51/2 REG	165,10	159,54
NC26	85,72	82,95	NC56	190,50	180,58	65/8 REG	190,50	181,37
NC31	104,78	100,41	NC61	209,55	198,44	75/8 REG	219,08	209,55
NC35	120,65	114,70	NC70	241,30	227,81	75/8 REG LT	244,48	234,95
NC38	120,65	116,28	23/8 REG	79,38	76,60	85/8 REG FF	241,30	232,17
NC40	133,35	127,40	27/8 REG	98,42	90,88	85/8 REG LT	269,88	266,70
NC44	146,05	139,70	31/2 REG	107,95	103,58	51/2 FH	171,45	165,89
NC46	152,40	145,26	41/2 REG	139,70	134,54	65/8 FH	203,20	195,66

NOTE These bevel diameters do not apply to tool joints, bits or boxes that mate with bits.

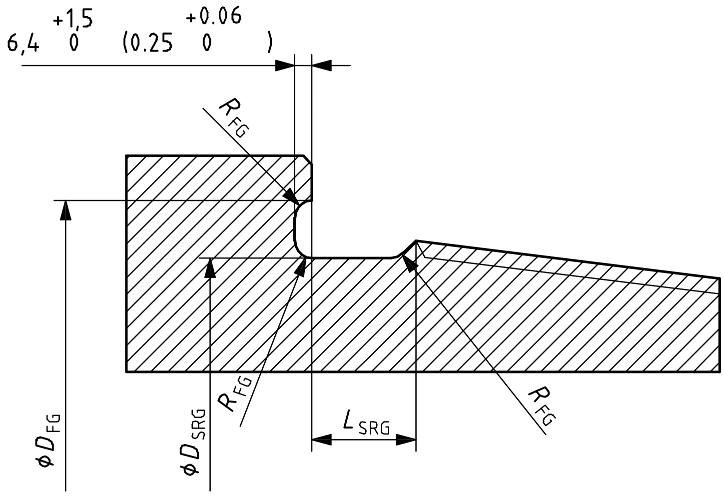
[a] See Table A.3 for USC units.

[b] See 6.2 for OD larger than the reference OD.

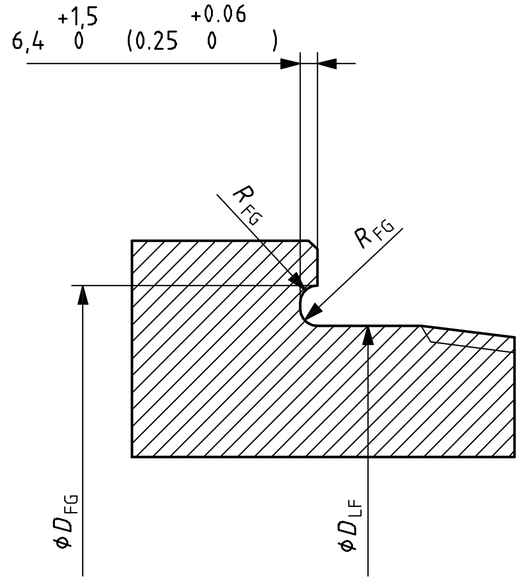
6.3 Low-torque feature

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 make-up torque to achieve adequate compressive stress on the sealing face while maintaining bending stiffness. These features are shown in Figure 7, and dimensions in Table 4. These features shall be mandatory above the product diameter indicated.

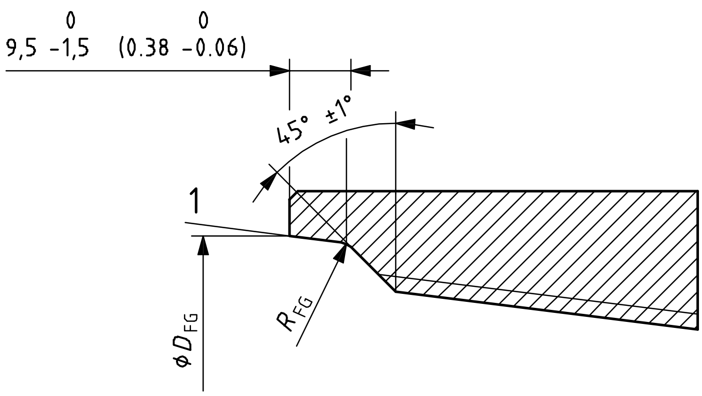
Dimensions in millimetres (inches), unless otherwise specified



a) Pin with SRG



b) Pin without SRG



c) Low-torque box

Key

1 taper

Figure 7 — Low-torque feature for certain connections with ODs larger than 241 mm (9.5 in)

Table 4 — Low-torque feature
(SI units [a])

Dimensions in millimetres

1	2	3	4
Connection size and style	**Required above OD**	**Face groove diameter** $D_{FG}\ ^{+0,8}_{-0,4}$	**Face groove radius** $R_{FG}\ ^{0}_{-0,4}$
7-5/8 REG	241,3	196,9	6,35
8-5/8 REG	266,7	228,6	6,35
NOTE See Figure 7.			
[a] See Table A.4 for USC units.			

7 Product optional features

7.1 General

The requirements given in 7.2 to 7.6 apply only if stated on the purchase order.

7.2 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: a groove on the pin and a boreback contour for boxes or a groove on both the pins and boxes. The boreback stress-relief contour is the recommended design for the box connection. However, the box relief groove also has been shown to provide beneficial effects.

These features are shown in Figures 8 through 10. The dimensions for connections not listed here may be calculated according to the equations in Annex I. 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 5.

Stress-relief grooves are not recommended for use on pin threads with pitch diameter, C, at gauge point smaller than 89 mm (3.5 in).

The boreback contour is not recommended for use on threads with pin length, L_{PC}, smaller than 89 mm (3.5 in).

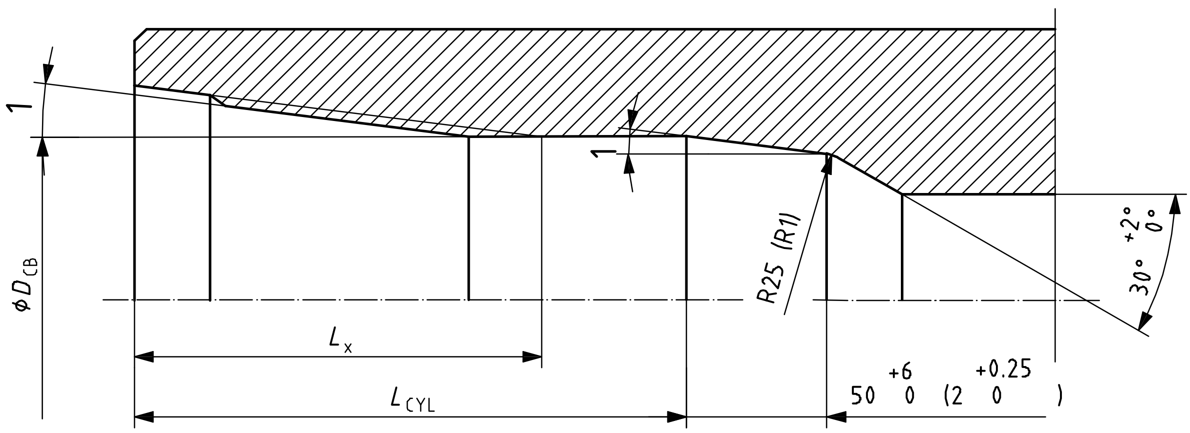
Stress-relief grooves on pins cause a slight reduction in the tensile strength and section modulus of the connection. However, under most conditions this reduction in cross-sectional area is more than offset by the reduction in fatigue failures. If unusually high loads are expected, calculations of the effect should be made.

Table 5 — Stress-relief groove and boreback contour dimensions for preferred connections
(SI units [a])

Dimensions in millimetres

1	2	3	4	5	6	7	8
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	Length of pin groove
	D_{CB}	L_X	L_{CYL}	D_{BG}	L_{BG}	D_{SRG}	L_{SRG}
	$^{+0,38}_{0}$	reference	± 7,9	$^{+0,79}_{0}$	$^{0}_{-3,1}$	$^{0}_{-0,79}$	± 0,79
NC35	82,15	82,55	133,35	84,53	85,72	82,07	25,40
NC38	88,11	88,90	139,70	90,49	92,08	89,10	25,40
NC40	92,87	101,60	152,40	94,85	104,78	95,81	25,40
NC 44	101,60	101,60	152,40	103,58	104,78	104,57	25,40
NC46	106,76	101,60	152,40	109,14	104,78	109,88	25,40
NC50	117,48	101,60	152,40	119,46	104,78	120,45	25,40
NC56	121,84	114,30	165,10	123,03	117,48	134,04	25,40
NC61	132,95	127,00	177,80	134,14	130,18	148,31	25,40
NC70	152,00	139,70	190,50	153,19	142,88	170,54	25,40
4-1/2 REG	94,46	95,25	146,05	96,04	98,42	101,93	25,40
5-1/2 REG	114,30	107,95	158,75	114,30	111,12	123,67	25,40
6-5/8 REG	134,14	114,30	165,10	134,94	117,48	137,59	25,40
7-5/8 REG	148,83	120,65	171,45	148,83	123,82	161,26	25,40
8-5/8 REG	172,24	123,82	174,63	172,24	127,00	185,45	25,40
5 1/2 FH	129,78	114,30	165,10	130,97	117,48	133,35	25,40
6-5/8 FH	153,59	114,30	165,10	154,38	117,48	156,95	25,40
NOTE See Figures 8 to 10.							
[a] See Table A.5 for USC units.							

Dimensions in millimetres (inches) unless otherwise specified



Key

1 taper half-angle, φ

Figure 8 — Box boreback feature

Dimensions in millimetres (inches) unless otherwise specified

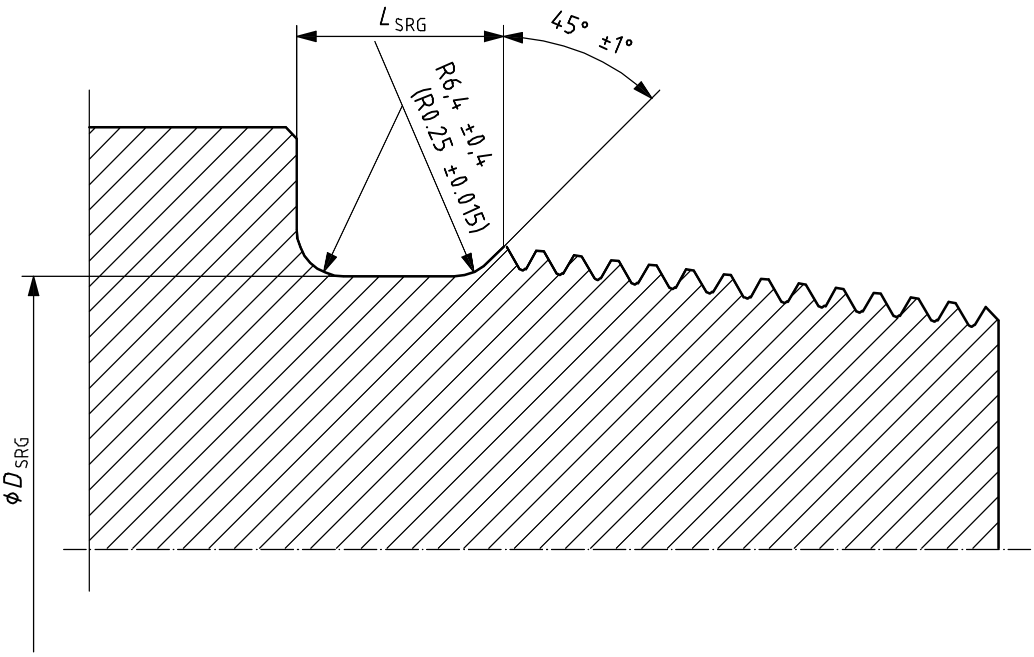
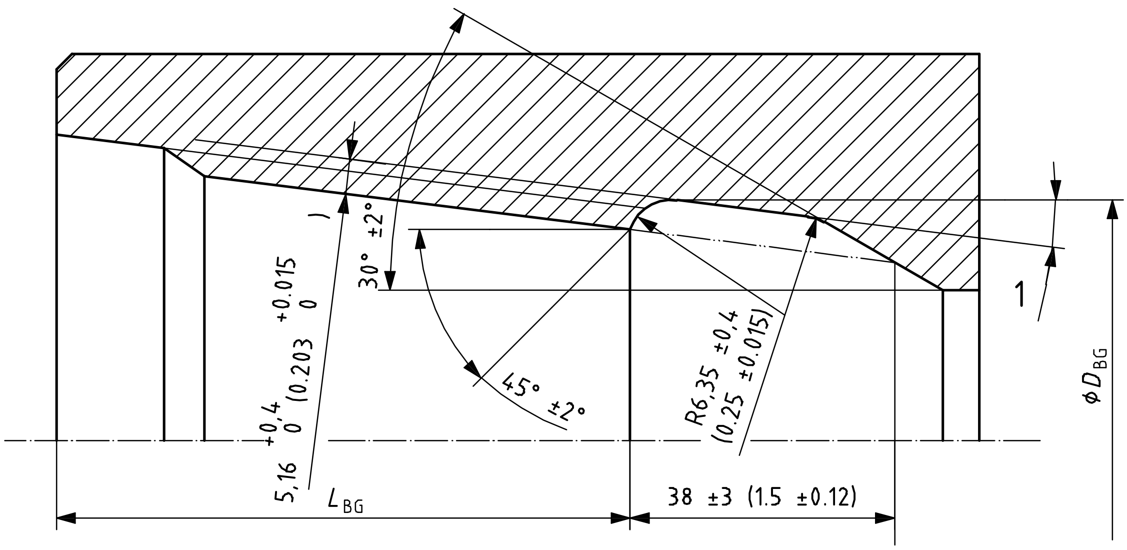


Figure 9 — Pin stress-relief groove

Dimensions in millimetres (inches) unless otherwise specified



Key

1 taper half-angle, φ

Figure 10 — Box stress-relief groove

7.3 Benchmarks

7.3.1 General

If so specified, 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 should be applied 3,18 mm (0.125 in) from the face, on the pin base or on the box counterbore.

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

Two types of benchmarks are used.

7.3.2 Cylinder benchmark

The cylinder benchmark consists of a turned flat in the box counterbore or on the pin base, 3,18 mm (0.125 in) long, as shown in Figures 11 and 12.

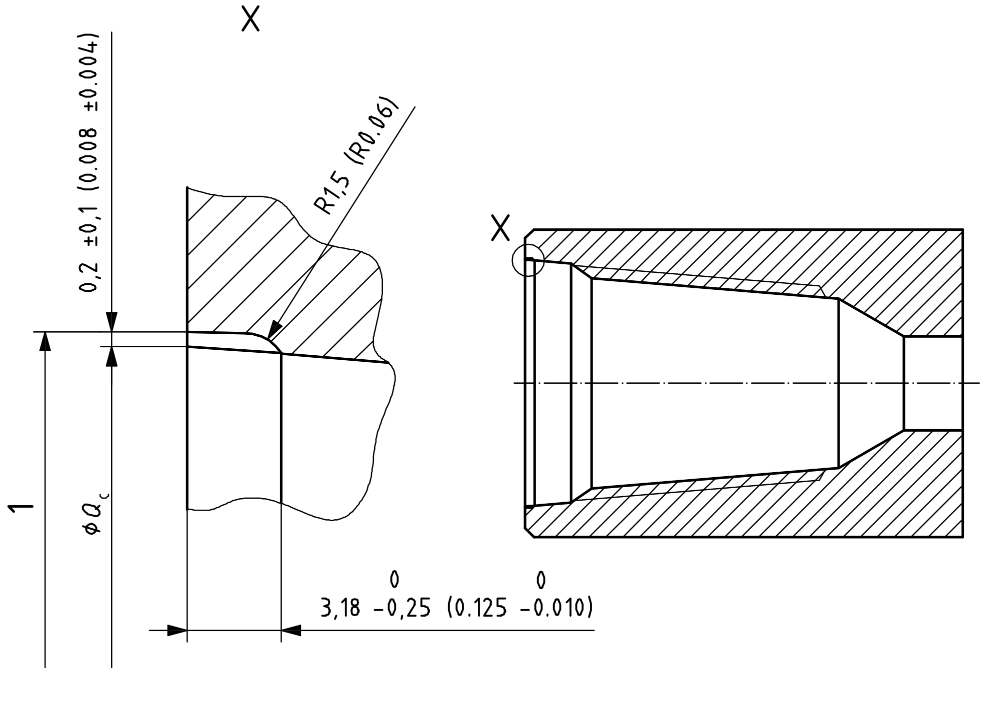
The diameter of the cylinder benchmark feature in the box is the counterbore diameter, Q_c, plus 0,4 mm (0.016 in).

The diameter of the cylinder benchmark feature on the pin is the pin base cylinder diameter, D_{LF}, plus 0,8 mm (0.032 in).

7.3.3 Stamped benchmark

The stamped benchmark consists of a 4,7 mm (0.19 in) diameter circle with a bar tangent to the circle. The bar is located to the side of the circle nearest the make-up shoulder. The benchmark is stamped on the product so that the bar is parallel to the make-up shoulder and positioned 3,18 mm (0.125 in) from the shoulder face, as shown in Figure 13.

Dimensions in millimetres (inches)



Key

1 benchmark diameter; see 7.3.2

Figure 11 — Cylinder benchmark — Box

Dimensions in millimetres (inches)

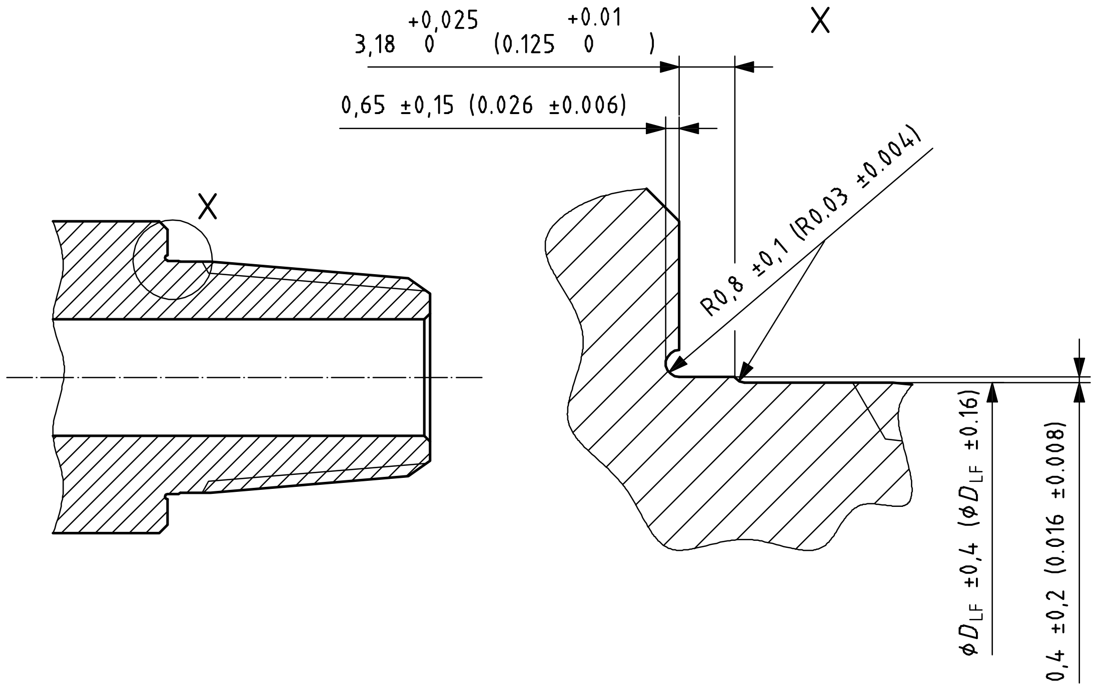


Figure 12 — Cylinder benchmark — Pin

Dimensions in millimetres (inches)

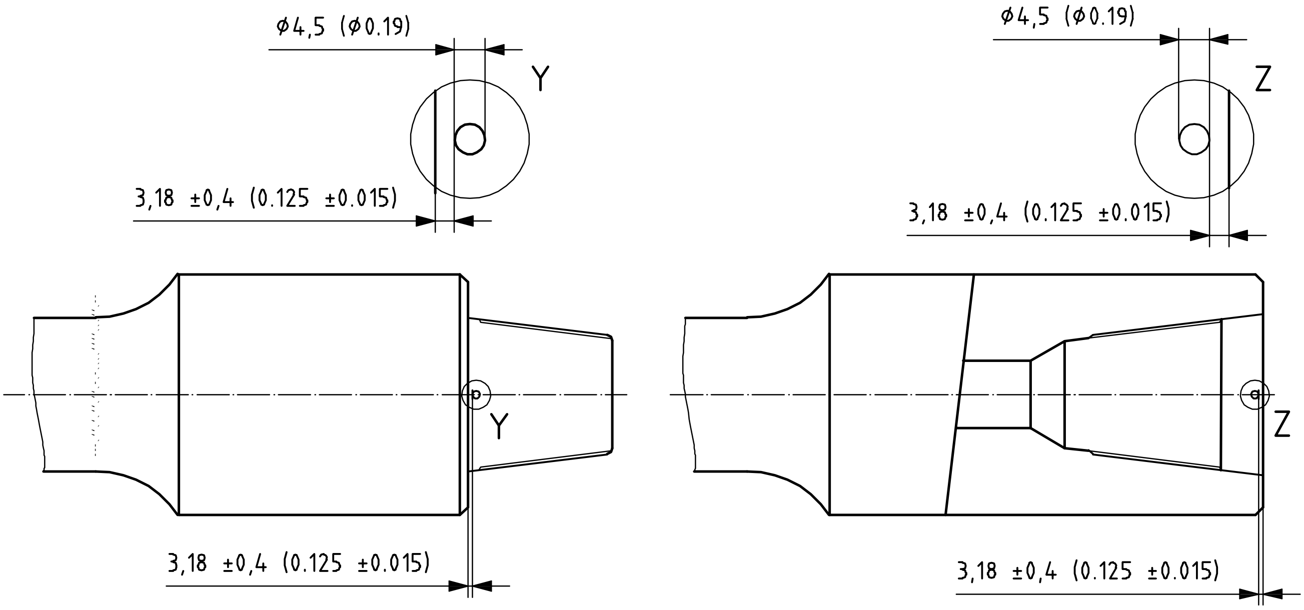


Figure 13 — Stamped benchmark

7.4 Surface treatment

All gauging shall be done before surface treatment.

7.5 Cold working

If so specified, the roots of threads may be cold worked after gauging. A connection shall be considered to conform to this specification if it meets the requirements of this part of ISO 10424 before cold working. In such event, the connection shall also be stamped with the mark "CW" to indicate cold working after gauging. A pin connection shall be so marked on the end of the pin. A box connection shall be marked in the box counterbore.

NOTE 1 Gauge stand-off changes after cold working of threads. Cold working of gauged connections can, therefore, result in connections that do not fall within the gauge stand-off of this part of ISO 10424. This does not affect the interchangeability of connections and improves the performance of connections in fatigue.

NOTE 2 Cold working procedures are outside the scope of this document. Improper cold working can be damaging to the connection.

7.6 Break-in

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

8 Product gauging

8.1 Gauging

8.1.1 General

Any manufacturer who desires to produce drill-stem members utilizing rotary shouldered connections conforming to this part of ISO 10424 shall own or have access to calibrated reference master gauges, consisting of individual reference master plug(s) and reference master ring gauge(s) conforming to the requirements in 9.2.2.

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 stand-off, lead, taper and thread form described in this part of ISO 10424. The intent of this part of ISO 10424 is that any thread element of the product shall be acceptable if any measurement of that element, measured as defined in 8.1.2 to 8.6, is found to be in conformance. That is, the variation of gauges, within tolerances, shall not be a reason for rejection.

8.1.2 Precautions

8.1.2.1 Temperature

All instruments shall be exposed to the same temperature conditions as the product for inspection, 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 stand-off if the temperature is far from 20 °C (68 °F), and should be taken into account.

8.1.2.2 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 B, C and D. If any instrument is damaged, for instance, inadvertently dropped or severely shocked, it should not be used for inspection purposes until its accuracy has been re-established.

8.1.2.3 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.

8.2 Stand-off measurement

8.2.1 Stand-off

The stand-off 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, but this effect is small when they are in conformance with the specification.

8.2.2 Working gauges

The manufacturer shall have available working gauges, as defined in Clause 9, 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 D 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 Clause 10. 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 Clause 10.

8.2.3 Stand-off tolerances

Tolerances on stand-off values shall be as specified in Figure 14. The stand-offs, S_1 and S_2, to the working gauges are defined in 9.1. 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. Gauge stand-off may change after the application of surface treatment and may cause the stand-off 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 part of ISO 10424 if it meets its requirements before the application of the surface treatment.

8.3 Gauge contact points

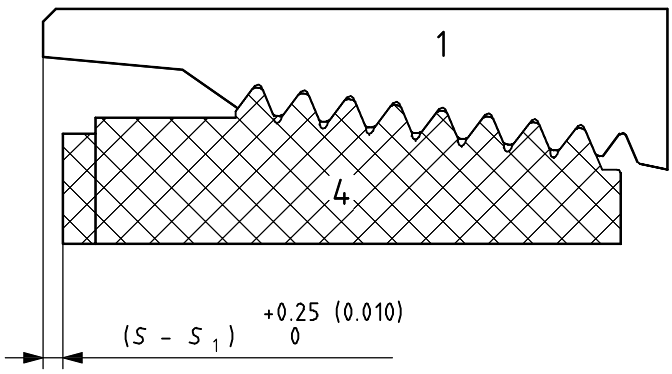
The measurement of lead and taper should preferably be made as close as practical to the pitch cone of the thread. Contact points of lead and taper gauges shall, therefore, be of the ball-point type and should preferably be made of tungsten carbide or tantalum carbide. The dimensions of the ball-point contacts shall be such that they contact the thread flanks rather than the thread root. The ball-points meeting flank contact requirements are specified in Table 6, column 5. The contact points for thread height gauges should be ball type with a diameter as specified in Table 6, column 7 and shall not contact the thread flank.

8.4 Lead measurement

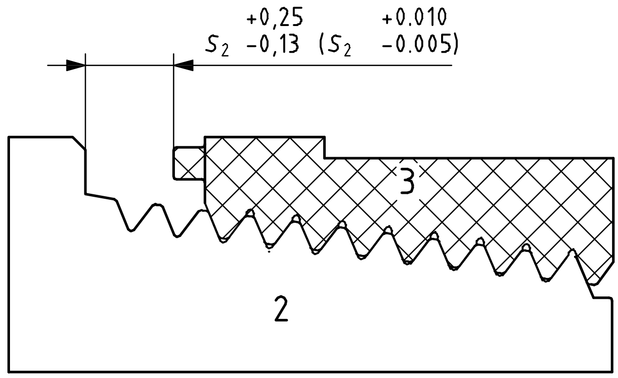
8.4.1 Lead tolerances

Lead tolerances shall be expressed in terms of millimetres per 25,4 mm (inches 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 should be calculated to the basis of millimetres per 25,4 mm (inches per 1 in). For cumulative measurements, observed errors represent the cumulative errors.

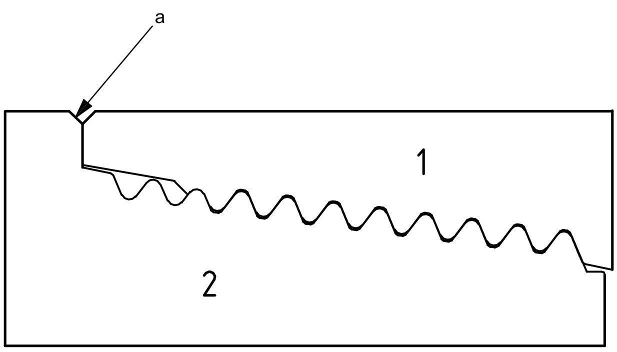
Dimensions in millimetres (inches)



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

a Hand tight.

Figure 14 — Gauging practice

8.4.2 Lead gauges

The lead of threads shall be gauged with a lead gauge. The accuracy of the measuring mechanism shall be 0,005 mm (0.000 2 in) or better.

8.4.3 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 values shown in Table 6. The distance between any two adjacent notches of the template shall be accurate within a tolerance of ± 0,003 mm (± 0.000 1 in), and between any two non-adjacent notches within a tolerance of ± 0,005 mm (± 0.000 2 in).

Table 6 — Compensated thread lengths, thread heights and ball-point diameters
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7
Thread form	**Taper** T mm/mm	**Threads per 25,4 mm** n	**Compensated thread length** [b] L_{ct}	**Ball-point diameter for taper and lead** d_b ± 0,05	**Thread height compensated for taper** [c] h_{cn}	**Ball-point diameter for thread height** d_{bh} ± 0,05
V-038R	1/6	4	25,488 0	3,67	3,087	1,83
V-038R	1/4	4	25,597 7	3,67	3,067	1,83
V-040	1/4	5	25,597 7	2,92	2,974	0,86
V-050	1/4	4	25,597 7	3,66	3,718	1,12
V-050	1/6	4	25,488 0	3,67	3,743	1,12
V-055	1/8	6	25,449 6	2,44	1,418	1,83

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] See Table A.6 for USC units.

[b] Compensated thread length, L_{ct}, is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[c] Compensated thread height, h_{cn}, is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

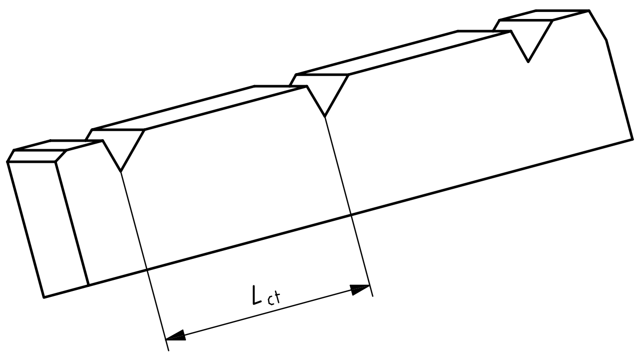


Figure 15 — Standard lead template

8.5 Taper measurement

8.5.1 Taper errors

For all threads of rotary shouldered connections, taper tolerances shall be expressed in terms of millimetres per millimetre (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 millimetres per millimetre (inches per foot) basis.

8.5.2 Taper calipers

The taper of threads shall be measured with an instrument having an accuracy of 0,010 mm (0.000 4 in) or better within the measurement range used.

8.6 Thread height measurement and gauges

Thread height should be measured with an instrument having an accuracy of 0,010 mm (0.000 4 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 parallel to the taper cone instead of parallel to the thread axis. For the U-groove on standard templates, the depth of the groove shall conform to the dimensions shown in Table 6, column 6, within a tolerance of ± 0,005 mm (± 0.000 2 in).

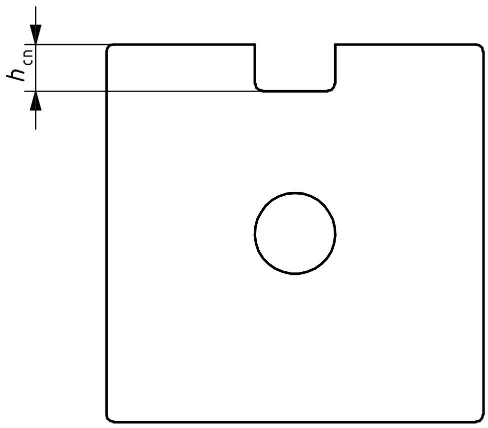


Figure 16 — Thread height setting standard

9 Gauge relationships for rotary shouldered connections

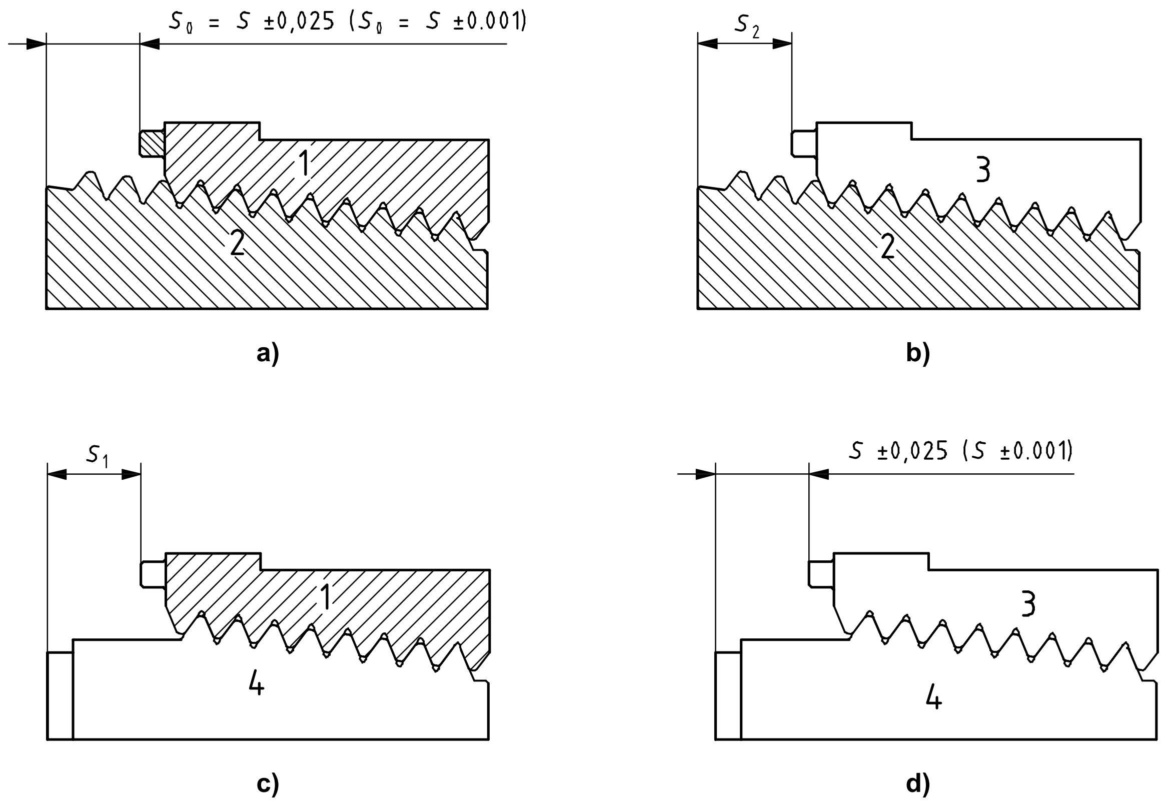
9.1 Gauge relationship

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 stand-off 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 stand-off value, S_1, of the working plug gauge. The certified Reference Master plug gauge is used to establish the stand-off 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 11. These values shall be recorded for each working gauge member, together with the identification number of the reference master set from which they are derived.

The stand-off value, S_0, of certified reference master gauges [Figure 17 a)] shall be measured at 20 °C ± 1 °C (68 °F ± 2 °F). All other measurements [Figure 17 b) to 17 d)] should be at ambient temperature.

The mating stand-off 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.

Dimensions in millimetres (inches)



Key

1 certified reference master ring gauge

2 certified reference master plug gauge

3 working ring gauge (mated to plug gauge, key item 4)

4 working plug gauge

Figure 17 — Gauge relationships

9.2 Gauge specifications

9.2.1 Specifications

The gauge specifications in this part of ISO 10424 derive from API Spec 7. Gauges manufactured earlier than one year after the initial publication of this part of ISO 10424 and conforming to the requirements of API Spec 7 at the time of manufacture shall be considered to conform to this part of ISO 10424.

9.2.2 Master gauges

Grand, regional and reference master gauges shall conform to the dimensions specified in Tables 7 and 8, Figures 18 and 19. Grand and regional master gauges shall conform to the tolerances specified in Table 10. Reference master gauges shall conform to the tolerances specified in Table 11. The same gauging principles and tolerances may be applied to the connections listed in Annex F, and all required thread dimensions may be calculated from the thread elements. Prior to use, all regional and reference master gauges shall be calibrated as required in Clause 10.

9.2.3 Working gauge

Working gauges shall conform to the dimensions specified in Tables 7 to 9, Figures 18 and 20, and to the tolerances specified in Table 12. All working plug gauges shall have the unused threads removed from the large end, except for gauges with mating stand-off of 9,525 mm (0.375 in) such as 1 REG 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 27,4 mm to 28,5 mm (1.080 in to 1.120 in) from the surface used to determine stand-off.

For working gauges, the gauge point for pitch diameter is located 34,925 mm (1.375 in) from the measuring face.

Table 7 — Gauge thread form dimensions
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9
Form of thread	**Threads per 25,4 mm** n	**Lead**	**Half angle** θ degree	**Taper** T mm/mm	**Thread height not truncated** H reference	**Gauge root truncation** f_{rg} max.	**Gauge crest truncation** f_{cg}	**Gauge thread height truncated** h_g reference
V-038R	4	6,350 00	30	1/6	5,486 53	1,355 98	1,651 00	2,479 55
V-038R	4	6,350 00	30	1/4	5,470 62	1,355 98	1,651 00	2,463 64
V-040	5	5,080 00	30	1/4	4,376 50	1,002 28	1,002 28	2,371 93
V-050	4	6,350 00	30	1/4	5,470 62	1,221 23	1,221 23	3,028 16
V-050	4	6,350 00	30	1/6	5,486 53	1,224 28	1,224 28	3,037 97
V-055	6	4,233 33	30	1/8	3,661 40	N/A	1,399 54	2,261 86

NOTE 1 See Figure 18 for meaning of dimensions.

NOTE 2 In computing thread height and truncation, account is 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 3 See Tables 10 to 12 for tolerances on columns 3, 4 and 7.

[a] See Table A.7 for USC units.

Table 8 — Gauge thread dimensions for preferred connections
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9
				Diameter at gauge point				
Style and size	**Thread form**	**Taper**	**Threads per 25,4 mm**	**Pitch** [b]	**Major (plug) reference** [b]	**Minor (ring) reference** [c]	**Pitch diameter at working gauge point** [d]	**Gauge stand-off**
		T mm/mm	n	C	D_{MP}	D_{MR}		S
NC23	V-038R	1/6	4	59,817 000	62,001 7	57,632 3	56,642 000	15,875
NC26	V-038R	1/6	4	67,767 200	69,951 9	65,582 5	64,592 200	15,875
NC31	V-038R	1/6	4	80,848 200	83,032 9	78,663 5	77,673 200	15,875
NC35	V-038R	1/6	4	89,687 400	91,872 1	87,502 7	86,512 400	15,875
NC38	V-038R	1/6	4	96,723 200	98,907 9	94,538 5	93,548 200	15,875
NC40	V-038R	1/6	4	103,428 800	105,613 5	101,244 1	100,253 800	15,875
NC44	V-038R	1/6	4	112,191 800	114,376 5	110,007 1	109,016 800	15,875
NC46	V-038R	1/6	4	117,500 400	119,685 1	115,315 7	114,325 400	15,875
NC50	V-038R	1/6	4	128,059 180	130,243 8	125,874 5	124,884 180	15,875
NC56	V-038R	1/4	4	142,646 400	144,815 1	140,477 7	137,883 900	15,875
NC61	V-038R	1/4	4	156,921 200	159,089 9	154,752 5	152,158 700	15,875
NC70	V-038R	1/4	4	179,146 200	181,314 9	176,977 5	174,383 700	15,875
1 REG	V-055	1/8	6	29,311 600	30,172 7	28,449 3	26,930 350	9,525
1-1/2 REG	V-055	1/8	6	39,141 400	40,002 5	38,279 1	36,760 150	9,525
2-3/8 REG	V-040	1/4	5	60,080 398	62,452 3	57,708 5	55,317 898	15,875
2-7/8 REG	V-040	1/4	5	69,605 398	71,977 3	67,233 5	64,842 898	15,875
3-1/2 REG	V-040	1/4	5	82,292 698	84,664 6	79,920 8	77,530 198	15,875
4-1/2 REG	V-040	1/4	5	110,867 698	113,239 6	108,495 8	106,105 198	15,875
5-1/2 REG	V-050	1/4	4	132,944 108	135,972 3	129,915 7	128,181 608	15,875
6-5/8 REG	V-050	1/6	4	146,248 120	149,286 0	143,210 0	143,073 120	15,875
7-5/8 REG	V-050	1/4	4	170,549 062	173,577 2	167,520 9	165,786 562	15,875
8-5/8 REG	V-050	1/4	4	194,731 132	197,759 3	191,702 7	189,968 632	15,875
5 1/2 FH	V-050	1/6	4	142,011 400	145,049 2	138,973 6	138,836 400	15,875
6-5/8 FH	V-050	1/6	4	165,597 840	168,635 7	162,559 9	162,422 840	15,875

[a] See Table A.8 for USC units.

[b] The values in columns 5 and 6 apply only to grand, regional, and reference master plug gauges.

[c] The values in column 7 apply only to ring gauges.

[d] The values in column 8 apply only to working plug gauges.

Table 9 — Gauge external dimensions for preferred connections
(SI units [a])

Dimensions in millimetres

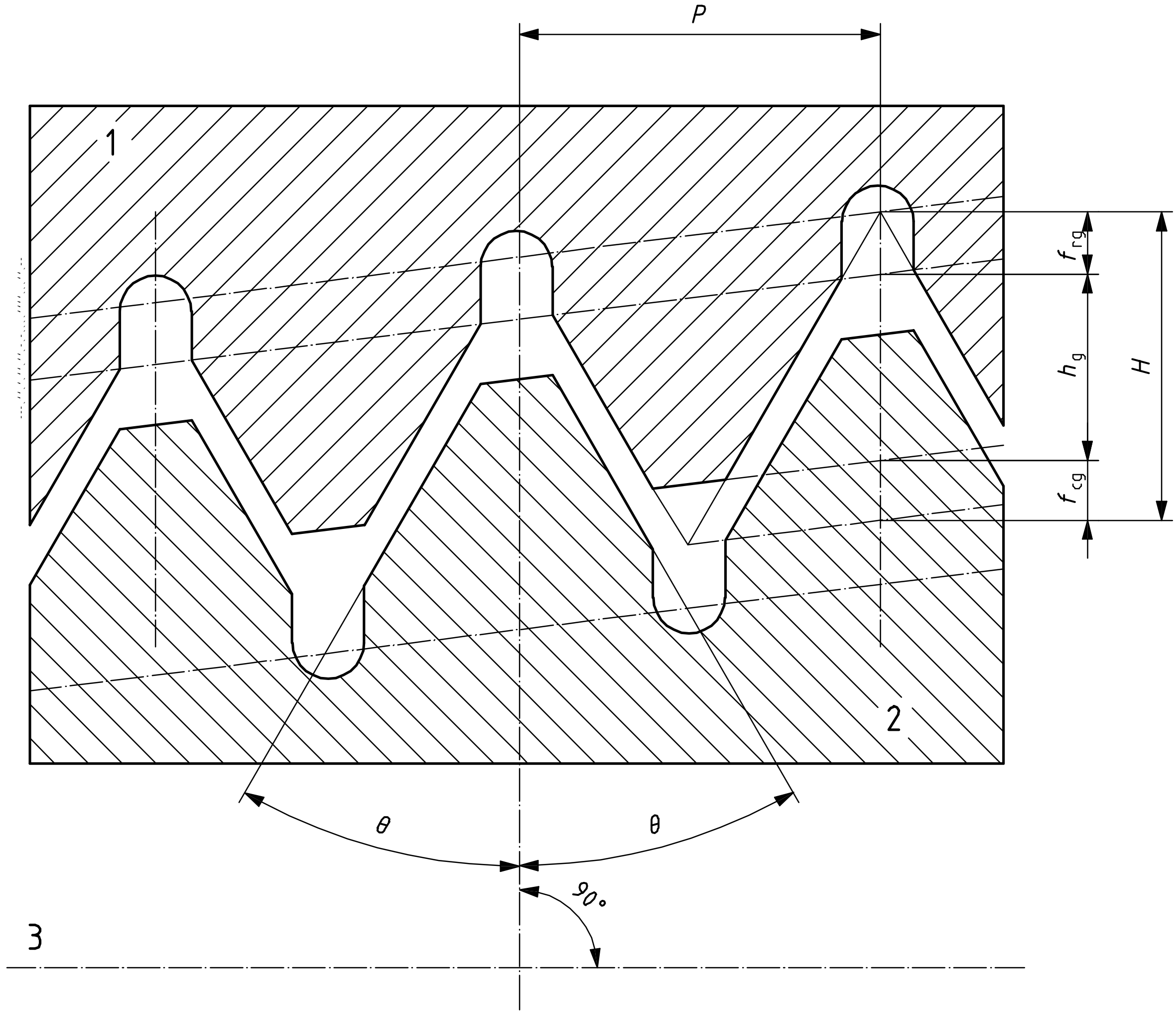
1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [b] D_{FP}	**Ring gauge length** L_{rg}	**Ring gauge outside diameter** D_R	**Diameter of ring gauge counterbore** Q
NC23	76,20	52,22	60,32	98,42	64,03
NC26	76,20	60,17	60,32	106,36	71,98
NC31	88,90	73,25	73,02	130,18	85,06
NC35	95,25	82,09	79,38	133,35	93,90
NC38	101,60	89,13	85,72	142,88	100,94
NC40	114,30	95,83	98,42	149,22	107,67
NC44	114,30	104,60	98,42	161,92	116,41
NC46	114,30	109,91	98,42	165,10	121,72
NC50	114,30	120,47	98,42	180,98	132,28
NC56	127,00	135,08	111,12	200,02	146,86
NC61	139,70	149,35	123,82	215,90	161,14
NC70	152,40	171,58	136,52	238,12	183,36
1 REG	38,10	[c]	28,58	63,50	34,54
1-1/2 REG	50,80	[c]	41,28	73,03	42,88
2-3/8 REG	76,20	54,13	60,32	95,25	64,29
2-7/8 REG	88,90	63,65	73,02	107,95	73,81
3-1/2 REG	95,25	76,33	79,38	127,00	86,51
4-1/2 REG	107,95	104,90	92,08	158,75	115,09
5-1/2 REG	120,65	125,88	104,78	190,50	137,85
6-5/8 REG	127,00	138,38	111,12	209,55	151,10
7-5/8 REG	133,35	163,09	117,48	241,30	175,41
8-5/8 REG	136,53	187,27	120,65	273,05	199,59
5 1/2 FH	127,00	134,42	111,12	196,85	146,91
6-5/8 FH	127,00	157,73	111,12	228,60	170,46

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] See Table A.5 for USC units.

[b] The thickness of fitting plates TFP shall be 9,53 mm maximum for all gauge sizes with pitch diameter less than 143,0 mm and 11,10 mm maximum for all larger gauge sizes.

[c] There is no fitting plate on 1 REG and 1-1/2 REG.



Key

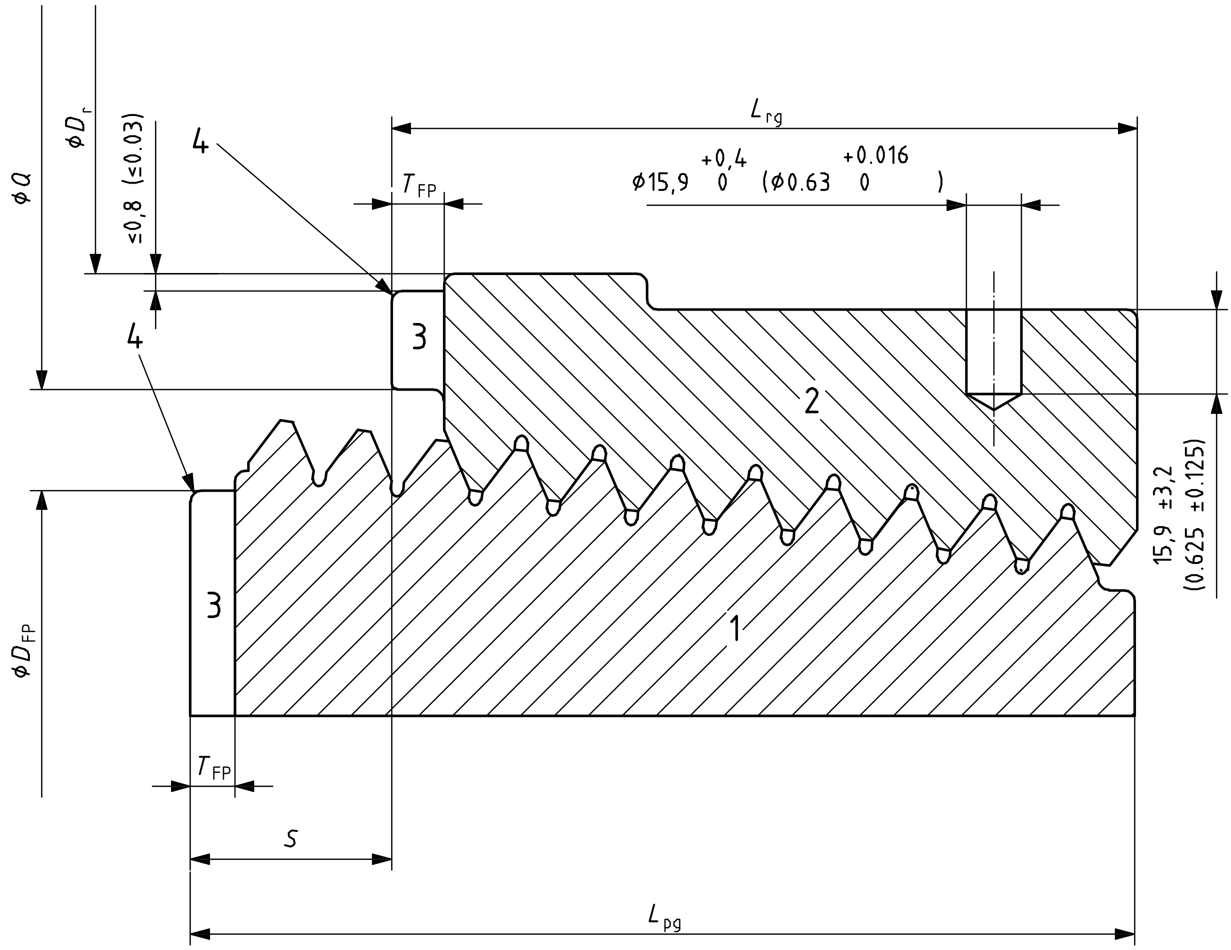
1 ring threads

2 plug threads

3 axis of thread

Figure 18 — Gauge thread form

Dimensions in millimetres (inches)



Key

1 master plug gauge

2 master ring gauge

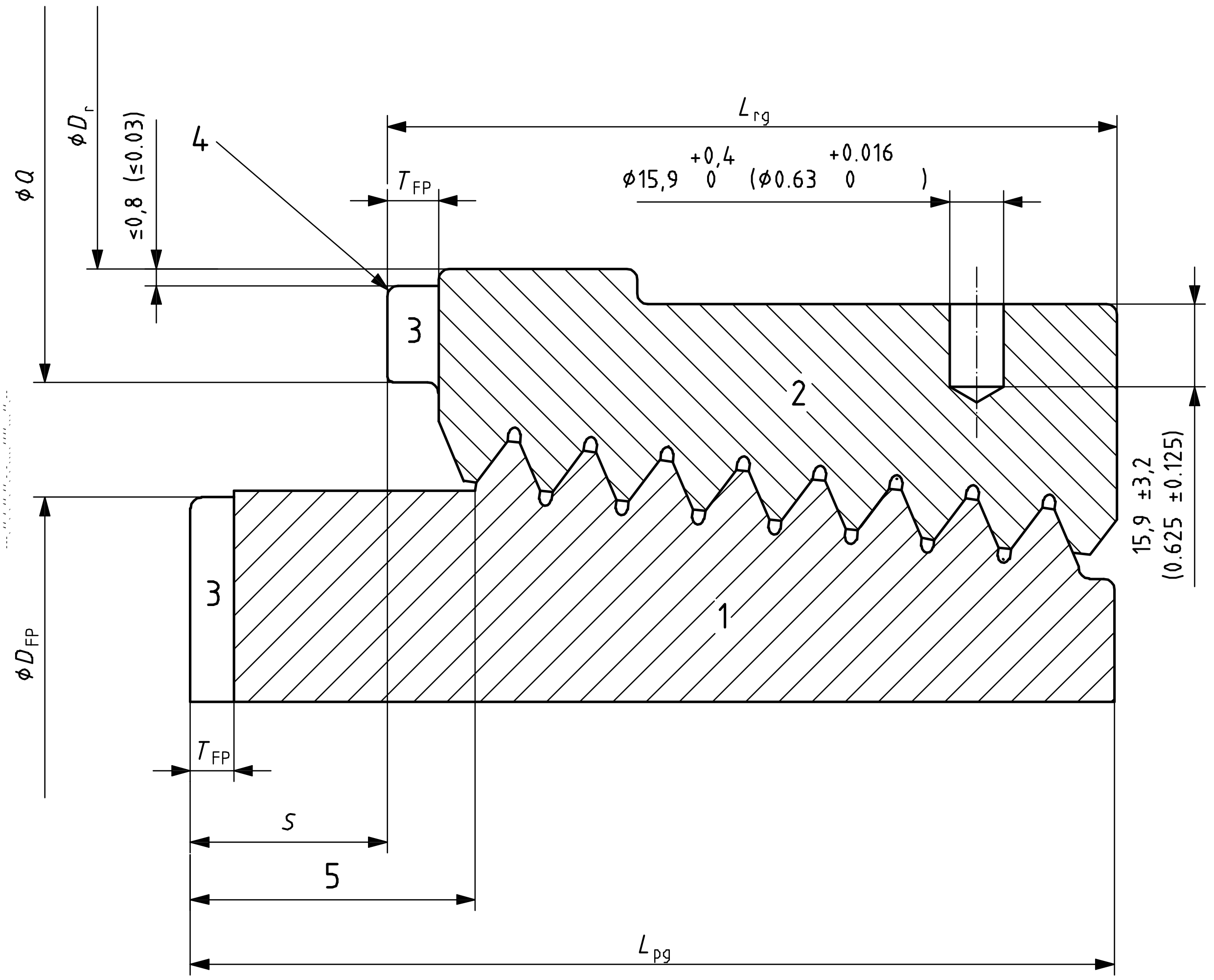
3 fitting plate

4 chamfer fitting plates where shown: 0,8 (0.03) × 45°

NOTE For gauges with pitch diameter < 50 mm (2.0 in), the diameter of the radial holes shall be reduced from 15,9 mm to 9,53 mm $^{+0,25}_{0}$ (from 0.65 in to 0.38 in $^{+0,01}_{0}$).

Figure 19 — Grand, regional and reference master thread gauges

Dimensions in millimetres (inches)



Key

1 working plug gauge

2 working ring gauge

3 fitting plate

4 chamfer fitting plates where shown: 0,8 (0.03) × 45°

5 length of removed thread of plug gauge; see 9.2.3

NOTE For gauges with pitch diameter $<$ 50 mm (2.0 in), the diameter of the radial holes shall be reduced from 15,9 mm to 9,53 mm $^{+0,25}_{0}$ (from 0.65 in to 0.38 in $^{+0,01}_{0}$).

Figure 20 — Working thread gauges

9.2.4 General design

All plug and ring gauges shall be 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 2006, 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 stand-off of 9,53 mm (0.375 in) such as 1 REG 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 (0.000 4 in). The fitting plate thickness, T_{FP}, shall be 9,53 mm (0.375 in) maximum for all gauges with pitch diameter, C, of 142,20 mm (5.598 in) or less, and 11,10 mm (0.437 in) maximum for gauges with pitch diameter, C, larger than 142,20 mm (5.598 in).

9.2.5 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 2. The undercut shall be of such depth as to clear the basic sharp thread; otherwise the shape of the undercut is not important.

9.2.6 Initial stand-off

New and reconditioned plug and ring gauges shall conform to the mating stand-off dimension, specified in Table 8, and the mating stand-off tolerances specified in Tables 10 to 12.

The interchange stand-off for plug and ring gauges against grand, regional and reference master gauges shall conform to the nominal stand-off of Table 8 and the interchange stand-off tolerances specified in Tables 10 to 12.

NOTE The requirements for interchange stand-off place a restriction on the magnitude of the thread-element errors that can be present in gauges that meet both the mating and interchange stand-off requirements. If the errors in certain thread elements are at or near the maximum limits allowed by Tables 10 to 12, then it is often necessary that the errors on other thread elements be well within the limits to compensate. Differences in lead in mated gauges can be partially or completely compensated by difference in taper.

Table 10 — Tolerances on gauge dimensions for regional and grand master gauges
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2		3	
Element	**Tolerances**			
	Plug		**Ring**	
Pitch diameter at gauge point [b]	± 0,005		—	
Lead [c]:				
Pitch diameter ⩽ 99	± 0,005		± 0,008	
Pitch diameter > 99	± 0,008		± 0,010	
Taper limits [d]:	min.	max.	min.	max.
All	0,003	0,010	−0,030	−0,015
Half angle of thread, degrees	± 0,083		± 0,167	
Mating stand-off, S			± 0,025	
Interchange stand-off, regional master against grand master	± 0,102		± 0,102	
Crest truncation, f_{cg}	± 0,028 4		± 0,027 9	
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] See Table A.10 for USC units.

[b] Helix angle correction shall be disregarded in pitch diameter determinations.

[c] 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.

[d] The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange stand-off due to lead errors. See Figure 22 for meaning of taper limits.

Table 11 — Tolerances on gauge dimensions for reference master gauges
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2		3	
Element	**Tolerances**			
	Plug		**Ring**	
Pitch diameter at gauge point [b]:				
Pitch diameter ⩽ 152	± 0,010		—	
Pitch diameter > 152	± 0,013		—	
Lead [c]:				
Pitch diameter ⩽ 152	± 0,010		± 0,015	
Pitch diameter > 152	± 0,013		± 0,018	
Taper limits [d]:	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 stand-off, S	—		± 0,025	
Interchange stand-off, reference master against regional master or grand master	± 0,102		± 0,102	
Crest truncation, f_{cg}	± 0,031 8		± 0,031 8	
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] See Table A.11 for USC units.

[b] Helix angle correction shall be disregarded in pitch diameter determinations.

[c] 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.

[d] 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 stand-off due to lead errors. See Figure 22 for meaning of taper limits.

Table 12 — Tolerances on gauge dimensions for working gauges
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2		3	
Element	**Tolerances**			
	Plug		**Ring**	
Pitch diameter at gauge point [b]:				
Pitch diameter ⩽ 152	± 0,010		—	
Pitch diameter > 152	± 0,013		—	
Lead [c]:				
Pitch diameter ⩽ 152	± 0,010		± 0,015	
Pitch diameter > 152	± 0,013		± 0,018	
Taper [d]:	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 stand-off, S	—		± 0,025	
Interchange stand-off, Working gauge against Reference Master	± 0,102		± 0,102	
Crest truncation, f_{cg}	± 0,031 8		± 0,031 8	
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] See Table A.12 for USC units.

[b] Helix angle correction shall be disregarded in pitch diameter determinations. The gauge point for working gauges is 34,925 mm (1.375 in) from the measurement face.

[c] 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.

[d] 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 stand-off due to lead errors. See Figure 22 for meaning of taper limits.

9.2.7 External elements

Dimensions L_{pg}, L_{rg}, D_R and Q, and fitting plate dimensions, D_{FP} and T_{FP}, shall conform to the dimensions given in Table 9 and the tolerances in Tables 10 to 12. The length of the controlled outside dimension, D_R, of the ring gauge is optional to the manufacturer.

9.2.8 Marking

9.2.8.1 General

Plug and ring gauges shall be permanently marked by the gauge manufacturer with the markings given in 9.2.8.2 through 9.2.8.6. Plug gauges should preferably be marked 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 which are considered necessary by the gauge maker may be added.

9.2.8.2 Size

Size or number of gauge is as given in Table 8, column 1.

9.2.8.3 Style

Style of connection is as given in Table 8, column 1, with left-hand indication, if applicable.

EXAMPLE 1 NC Rotary.

EXAMPLE 2 REG LH Rotary.

9.2.8.4 Class

The classes of gauges are working, reference master or regional master.

9.2.8.5 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 certified gauges, the certifying agency shall assign a unique number and this shall also be marked.

9.2.8.6 Date

The date of certification shall be marked on all regional and reference master gauges. In recertifying reconditioned gauges, the previous certification date shall be replaced with the date of recertification. Dates of retest, as required by 10.3.1.5, shall not be marked on reference master or working gauges.

9.2.8.7 Stand-off

The initial mating stand-off of reference master gauges and working gauges shall be marked on the ring gauge only. Mating stand-off values determined by periodic retest as specified in 10.3.1.6 shall not be marked on reference master or working gauges.

EXAMPLE 1	A certified regional master	NC56 rotary gauge shall be marked as follows:
		NC56 rotary regional master
	A B Co (or mark)	Identification number
		Date of certification
		Mating stand-off

EXAMPLE 2 An NC56 working gauge shall be marked as follows:

	NC56 rotary working
A B Co (or mark)	Identification number
	Date of certification
	Mating stand-off

EXAMPLE 3 A certified reference master 4-1/2REG rotary gauge shall be marked as follows:

	4-1/2REG rotary reference master
A B Co (or mark)	Identification number
	Date of certification
	Mating stand-off

10 Gauge calibration

10.1 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 9.2.2 and 9.2.3, including the originally certified stand-off values. The calibration system shall establish the frequency of retest in conformance with 10.3.1.5 and 10.3.1.6. 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. All instruments shall be exposed to the same temperature conditions as the gauge for inspection, for a time sufficient to eliminate any temperature difference. All dimensions shall be measured at 20 °C ± 1 °C (68 °F ± 2 °F).

10.2 Acceptance criteria

Any element specified in this part of ISO 10424 shall be considered acceptable if two conditions are met.

— The uncertainty of the measurement is less than or equal to the greater of 25 % of the tolerance range and 0,002 5 mm (0.000 1 in).

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

10.3 Gauge measurement methods

10.3.1 Determination of stand-off

10.3.1.1 Mating and interchange stand-off

Mating and interchange stand-off (see Figure 17) shall be determined as specified in 10.3.1.2 through 10.3.1.6.

During the test, all pieces entering into the measurement shall be at a uniform temperature of 20 °C ± 1 °C (68 °F ± 2 °F).

10.3.1.2 Cleanliness

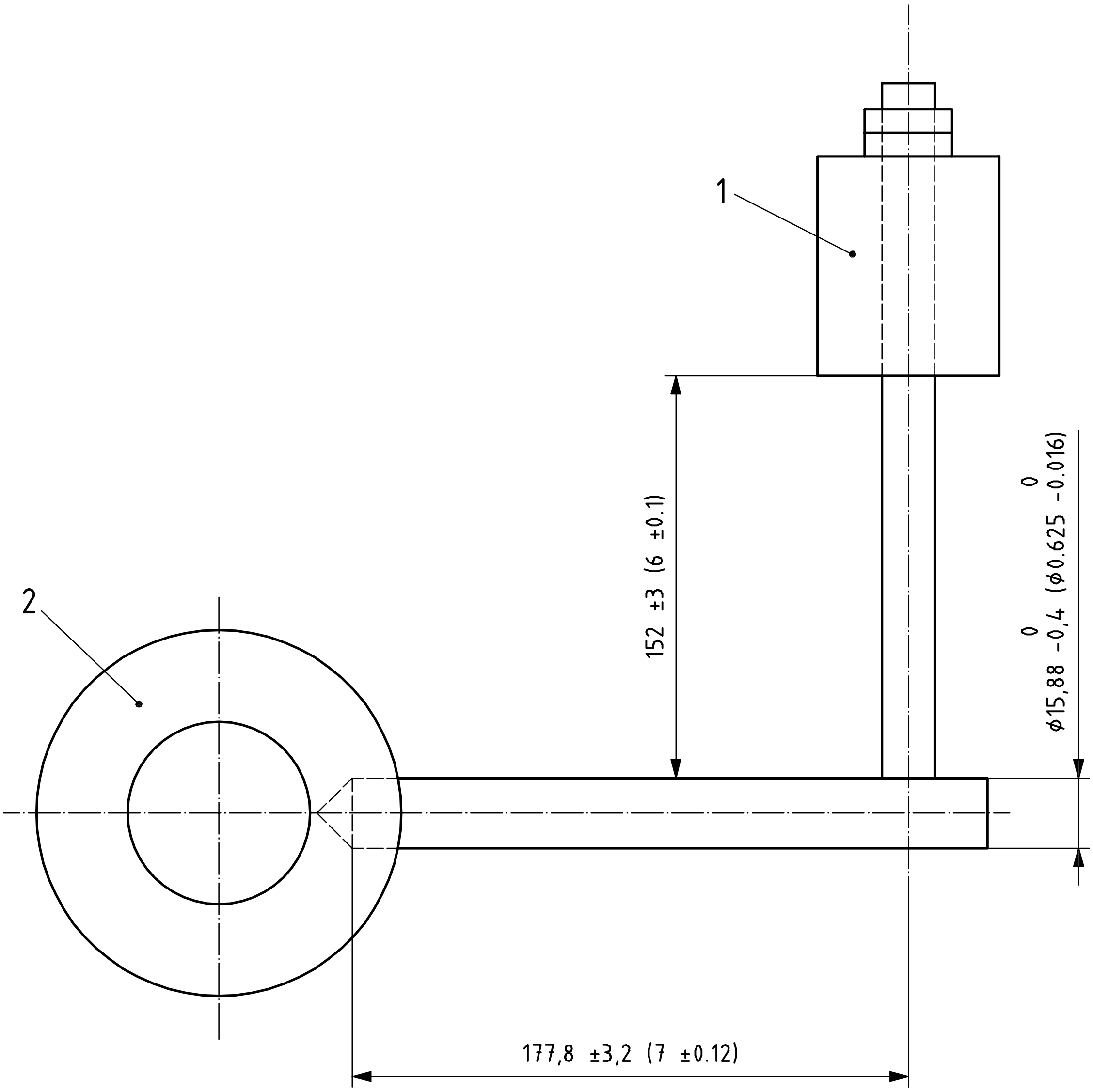
Gauges shall be free of visible evidence of contaminants before mating. A thin film of medicinal mineral oil shall be wiped on the threads with clean chamois skin or bristle brush.

10.3.1.3 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 the following:

- 0,45 kg (1 lb) for gauges with pitch diameter up to 50 mm (1.98 in);
- 0,91 kg (2 lb) for gauges with pitch diameter over 50 mm (1.98 in) to 81 mm (3.15 in);
- 1,36 kg (3 lb) for gauges with pitch diameter over 81 mm (3.15 in) to 130 mm (5.12 in);
- 1,82 kg (4 lb) for gauges with pitch diameter over 130 mm (3.15 in) to 166 mm (6.50 in);
- 2,27 kg (5 lb) for gauges with pitch diameter over 166 mm (6.50 in) to 180 mm (7.09 in);
- 2,72 kg (6 lb) for gauges with pitch diameter greater than 180 mm (7.09 in).

Dimensions in millimetres (inches)



Key

1 weight

2 ring gauge

NOTE For use with gauges with pitch diameter < 50 mm (2.0 in), the diameter of the torque arm shall be reduced from 15,88 mm to 9,50 mm $^{0}_{-0,025}$ (from 0.625 in to 0.374 in $^{0}_{-0.010}$).

Figure 21 — Torque hammer

10.3.1.4 Torquing method

The number of torque-hammer blows is unimportant. A sufficient number 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.

10.3.1.5 Periodic retest

10.3.1.5.1 General

Plug and ring gauges shall be periodically retested according to the schedule specified in 10.3.1.5.2 and 10.3.1.5.3 to insure the gauges remain within the stand-off limits specified in 10.3.1.6.

10.3.1.5.2 Master gauges

Regional and reference master gauges shall be retested for mating and interchange stand-off at least once each seven 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 stand-off 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 at one of the recognized testing agencies.

10.3.1.5.3 Working gauges

Working gauges shall be retested periodically for mating and interchange stand-off against certified reference masters. The frequency at which working gauges should be retested depends entirely upon the amount of use. Frequency of retest shall ensure that mating and interchange stand-off is maintained within the requirements of 10.3.1.1. A calibration system as specified in 10.1 shall be used to establish frequency of retest.

10.3.1.6 Retest stand-off

Mating stand-off of regional and reference master gauges and working gauges (plugs and rings) on periodic retest shall conform to the following wear limit tolerances from the originally established mating values:

a) regional masters: $^{+0,012\,7}_{-0,033\,0}$ mm ($^{+0.000\,5}_{-0.001\,3}$ in);

b) reference masters: $^{+0,012\,7}_{-0,058\,4}$ mm ($^{+0.000\,5}_{-0.002\,3}$ in);

c) working gauges: $^{+0,012\,7}_{-0,058\,4}$ mm ($^{+0.000\,5}_{-0.002\,3}$ 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 ± 0,100 0 mm (0.003 96 in).

Any gauges not conforming to these axial limit tolerances shall be removed from service or reconditioned as described in 10.3.1.7.

10.3.1.7 Reconditioning

Plug and ring gauges reported as in non-conformance with the stand-off requirements of 10.3.1.1 or 10.3.1.6, 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. Reconditioned regional master and reconditioned reference master gauges shall be resubmitted for initial certification in accordance with the requirements of 10.4 before returning to service. Reconditioned working gauges shall be inspected for compliance with the requirements of 9.2.

10.3.2 Measurement of elements

10.3.2.1 Taper

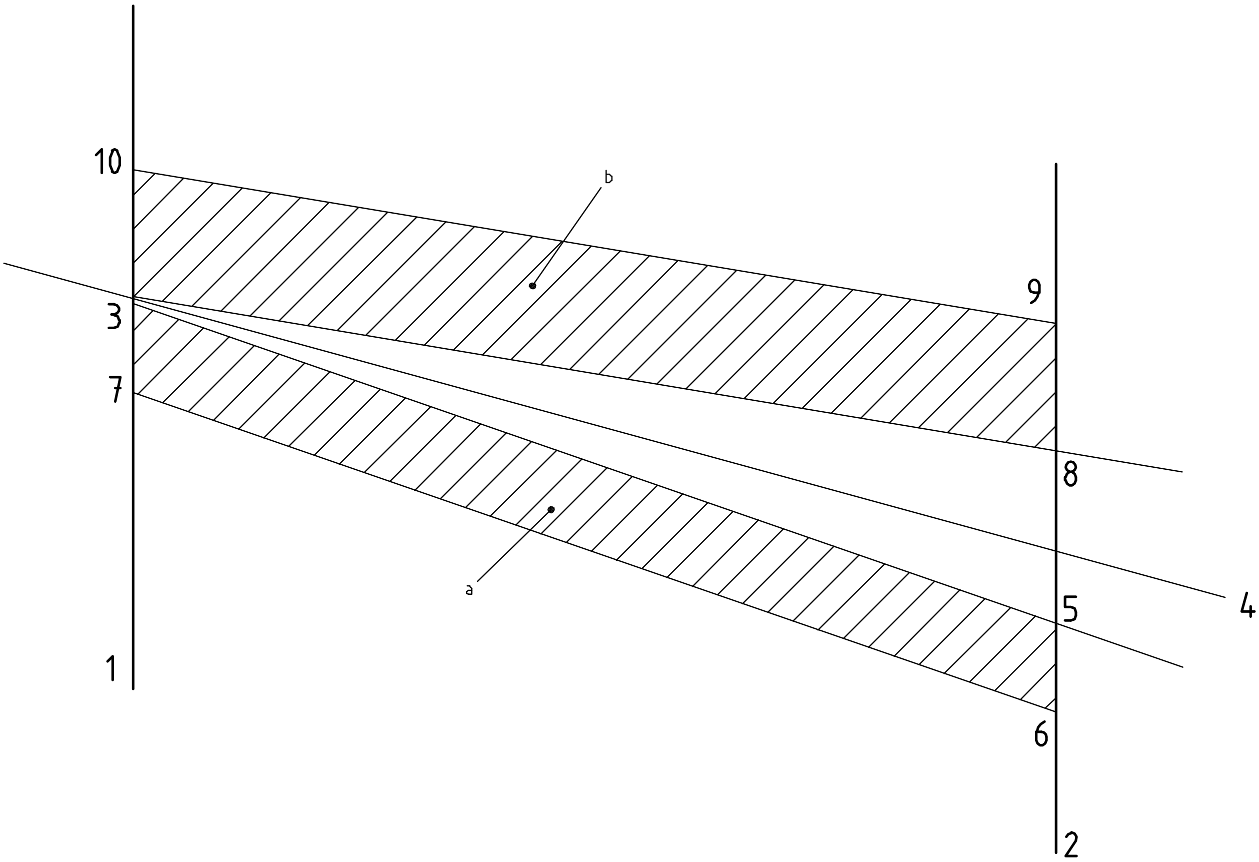
The taper tolerances are defined over the full ring gauge length, L_{rg}.

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 10 to 12. The taper over lengths less than the full threaded length shall be such that the pitch diameter cone at any intermediate thread falls within the limits illustrated in Figure 22.

The limits are defined by

— 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;

— 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
2 small end of gauge
3 base point for taper tolerance
4 basic taper cone
5 tolerance limit for plug, minimum taper
6 tolerance limit for plug, maximum taper
7 point for taper tolerance
8 tolerance limit for ring, maximum taper
9 tolerance limit for ring, minimum taper
10 point for the geometric tolerance for the ring

[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.

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 (5.083 6 in), the tolerance range for the pitch diameter six threads down is calculated as follows.

a) Compute effect of nominal taper:

T × 6 threads × P = 1/6 mm/mm × 6 × 6,35 mm = 6,350 mm (0.250 0 in)

b) Compute effect of minimum taper tolerance:

(0,003 mm/98,4 mm) × 6 threads × 6,35 mm = –0,001 mm

(0.000 1 in/3.875 in) × 6 threads × 0.25 in = –0.000 04 in

c) Compute tolerance band:

0,003 – 0,010 = –0,007 mm (0.000 3 in)

d) Resulting in an allowable range of pitch diameter at this location as follows:

$129{,}124 - 6{,}350 - 0{,}001 \text{ mm} = 122{,}774\,^{0}_{-0{,}007} \text{ mm}$

$5.083\,6 - 0.250\,0 - 0.000\,04 \text{ in} = 4.833\,6\,^{0}_{-0.000\,3} \text{ in}$

10.3.2.2 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 10 to 12. These dimensions shall be measured or checked on laboratory instruments to certify the tolerances shown in Tables 10 to 12.

10.3.2.3 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 due account of the taper half-angle.

10.4 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 part of ISO 10424. Such certification shall be issued only by a metrology laboratory qualified for this kind of certification activity by a competent national accreditation body of a member body of ISO. These metrology laboratories and accreditation bodies shall operate in accordance with ISO/IEC 17025 or equivalent standards.

The American Petroleum Institute (API) maintains a certification program for gauges for the preferred connections listed above as described in Annex E.

Annex A
(informative)

Tables in USC units

Table A.1 — Product thread dimensions for preferred connections

Dimensions in inches, unless otherwise specified

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 dia. at gauge point**	**Large dia. of pin**	**Pin cyl. dia.**	**Small dia. of pin**	**Pin length** [b]	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore** c	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		in/ft			reference	± 0.015	reference	$^{0}_{-0.12}$	min.	$^{+0.38}_{0}$	$^{+0.030}_{-0.015}$	$^{+0.06}_{-0.03}$	max.
NC23	V-038R	2.0	4.0	2.355 00	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	2.668 00	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	3.183 00	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	3.531 00	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	3.808 00	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	4.072 00	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	4.417 00	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	4.626 00	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	5.041 70	5.250	5.135	4.500	4.500	4.625	5.125	5.312	0.625	0.50
NC56	V-038R	3.0	4.0	5.616 00	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	6.178 00	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	7.053 00	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	1.154 00	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	1.541 00	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	2.365 37	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	2.740 37	3.000	2.890	2.125	3.500	3.625	4.125	3.062	0.625	0.50
3-1/2 REG	V-040	3.0	5.0	3.239 87	3.500	3.390	2.562	3.750	3.875	4.375	3.562	0.625	0.50
4-1/2 REG	V-040	3.0	5.0	4.364 87	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	5.234 02	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	5.757 80	5.992	5.882	5.158	5.000	5.125	5.625	6.062	0.625	0.50
7-5/8 REG	V-050	3.0	4.0	6.714 53	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	7.666 58	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	5.591 00	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	6.519 60	6.753	6.643	5.920	5.000	5.125	5.625	6.844	0.625	0.50

[a] 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 $\varphi = 3.576°$.

[b] For roller cone drill bits only, the pin length may vary by −0.19 in.

Table A.2 — Product thread form dimensions

Dimensions in inches, unless otherwise specified

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	0.166 667
Half angle, of thread	θ, deg ± 0.75	30	30	30	30	30	30
Taper	T, in/ft	2	3	3	3	2	1.5
Crest flat width	F_c, ref	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, ref	N/A	N/A	N/A	N/A	N/A	0.047
Root flat corner radius	r_r ± 0.008	N/A	N/A	N/A	N/A	N/A	0.015
Thread height, not truncated	H, ref.	0.216 005	0.215 379	0.172 303	0.215 379	0.216 005	0.144 150
Crest truncation	f_c	0.056 161	0.055 998	0.034 461	0.043 076	0.043 201	0.047 569
Root truncation	f_r	0.038 000	0.038 000	0.020 000	0.025 000	0.025 000	0.040 650
Thread height truncated	$h\ ^{+0.001}_{-0.003}$	0.121 844	0.121 381	0.117 842	0.147 303	0.147 804	0.055 930
Crest flat corner radius	r_c ± 0.008	0.015	0.015	0.015	0.015	0.015	0.015

NOTE See Figures 4 and 5 for meaning of dimensions.

Table A.3 — Reference bevel diameters for 60° included thread angle connections when used on drill collars

Dimensions in inches

1	2	3	4	5	6	7	8	9
Connection size and style	**Reference OD** [a]	**Reference bevel dia.**	**Connection size and style**	**Reference OD** [a]	**Reference bevel dia.**	**Connection size and style**	**Reference OD** [a]	**Reference bevel dia.**
NC 23	3.125	3.000	NC 50	6.375	6.109	5-1/2 REG	6.500	6.281
NC 26	3.375	3.266	NC 56	7.500	7.109	6-5/8 REG	7.500	7.141
NC 31	4.125	3.953	NC 61	8.250	7.813	7-5/8 REG	8.625	8.250
NC 35	4.750	4.516	NC 70	9.500	8.969	7-5/8 REG LT	9.625	9.250
NC 38	4.750	4.578	2-3/8 REG	3.125	3.016	8-5/8 REG FF	9.500	9.141
NC 40	5.250	5.016	2-7/8 REG	3.875	3.578	8-5/8 REG LT	10.625	10.500
NC 44	5.750	5.500	3-1/2 REG	4.250	4.078	5-1/2 FH	6.750	6.531
NC 46	6.000	5.719	4-1/2 REG	5.500	5.297	6-5/8 FH	8.000	7.703

NOTE These bevel diameters do not apply to tool joints, bits or connections that mate with bits.

[a] For OD larger than the reference OD, see 6.2.

Table A.4 — Low-torque feature

Dimensions in inches

1	2	3	4
Connection size and style	Required above OD	Face groove diameter D_{FG} $^{+0.031}_{-0.015}$	Face groove radius R_{FG} $^{0}_{-0.015}$
7-5/8 REG	9.50	7.75	0.25
8-5/8 REG	10.50	9.00	0.25
NOTE See Figure 7.			

Table A.5 — Stress-relief groove and boreback contour dimensions for preferred connections

Dimensions in inches

1	2	3	4	5	6	7	8
	Box boreback contour			Box groove		Pin groove	
Connection size and style	Cylinder diameter D_{CB} $^{+0.015}_{0}$	Depth to last thread scratch L_X reference	Depth to end of cylinder L_{CYL} ± 0.31	Diameter of box groove D_{BG} $^{+0.031}_{0}$	Depth to start of box groove L_{BG} $^{0}_{-0.13}$	Diameter of pin groove D_{SRG} $^{0}_{-0.031}$	Length of pin groove L_{SRG} ± 0.031
NC35	3.234	3.25	5.25	3.328	3.38	3.231	1.00
NC38	3.469	3.50	5.50	3.562	3.62	3.508	1.00
NC40	3.656	4.00	6.00	3.734	4.12	3.772	1.00
NC44	4.000	4.00	6.00	4.078	4.12	4.117	1.00
NC46	4.203	4.00	6.00	4.297	4.12	4.326	1.00
NC50	4.625	4.00	6.00	4.703	4.12	4.742	1.00
NC56	4.797	4.50	6.50	4.844	4.62	5.277	1.00
NC61	5.234	5.00	7.00	5.281	5.12	5.839	1.00
NC70	5.984	5.50	7.50	6.031	5.62	6.714	1.00
4-1/2 REG	3.719	3.75	5.75	3.781	3.88	4.013	1.00
5-1/2 REG	4.500	4.25	6.25	4.500	4.38	4.869	1.00
6-5/8 REG	5.281	4.50	6.50	5.312	4.62	5.417	1.00
7-5/8 REG	5.859	4.75	6.75	5.859	4.88	6.349	1.00
8-5/8 REG	6.781	4.88	6.88	6.781	5.00	7.301	1.00
5-1/2 FH	5.109	4.50	6.50	5.156	4.62	5.250	1.00
6-5/8 FH	6.047	4.50	6.50	6.078	4.62	6.179	1.00
NOTE See Figures 8 through 10.							

Table A.6 — Compensated thread lengths, thread heights and ball-point diameters

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7
Thread form	**Taper** T in/ft	**Threads per in** n	**Compensated thread length** [a] L_{ct}	**Ball-point diameter for taper and lead** d_b ± 0.002	**Thread height compensated for taper** [b] h_{cn}	**Ball-point diameter for thread height** d_{bh} ± 0.002
V-038R	2	4	1.003 47	0.144	0.121 6	0.072
V-038R	3	4	1.007 78	0.144	0.120 7	0.072
V-040	3	5	1.007 78	0.115	0.117 1	0.034
V-050	3	4	1.007 78	0.144	0.146 4	0.044
V-050	2	4	1.003 47	0.144	0.147 4	0.044
V-055	1.5	6	1.001 95	0.096	0.055 8	0.072

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] Compensated thread length, L_{ct}, is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] Compensated thread height, h_{cn}, is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

Table A.7 — Gauge thread form dimensions

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7	8	9
Form of thread	**Threads per inch** n	**Lead**	**Half angle** θ degrees	**Taper** T in/ft	**Thread height not truncated** H reference	**Gauge root truncation** f_{rg} max.	**Gauge crest truncation** f_{cg}	**Thread height truncated** h_g reference
V-038R	4	0.250 000	30	2	0.216 005	0.053 385	0.065 000	0.097 620
V-038R	4	0.250 000	30	3	0.215 379	0.053 385	0.065 000	0.096 994
V-040	5	0.200 000	30	3	0.172 303	0.039 460	0.039 460	0.093 383
V-050	4	0.250 000	30	3	0.215 379	0.048 080	0.048 080	0.119 219
V-050	4	0.250 000	30	2	0.216 005	0.048 200	0.048 200	0.119 605
V-055	6	0.166 667	30	1.5	0.144 150	N/A	0.055 100	0.089 050

NOTE 1 See Figure 18 for meaning of dimensions.

NOTE 2 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 3 See Tables A.10 through A.12 for tolerances on columns 3, 4 and 7.

Table A.8 — Gauge thread dimensions for preferred connections

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7	8	9
Style and size	**Thread form**	**Taper**	**Threads per inch**	**Diameter at gauge point**			**Pitch diameter at working gauge point** [c]	**Gauge stand-off**
				Pitch [a]	**Major (plug) reference** [a]	**Minor (ring) reference** [b]		
		T in/ft	n	C	D_{MP}	D_{MR}		S
NC23	V-038R	2.0	4	2.355 00	2.441 01	2.269 00	2.230 00	0.625 0
NC26	V-038R	2.0	4	2.668 00	2.754 01	2.582 00	2.543 00	0.625 0
NC31	V-038R	2.0	4	3.183 00	3.269 01	3.097 00	3.058 00	0.625 0
NC35	V-038R	2.0	4	3.531 00	3.617 01	3.445 00	3.406 00	0.625 0
NC38	V-038R	2.0	4	3.808 00	3.894 01	3.722 00	3.683 00	0.625 0
NC40	V-038R	2.0	4	4.072 00	4.158 01	3.986 00	3.947 00	0.625 0
NC44	V-038R	2.0	4	4.417 00	4.503 01	4.331 00	4.292 00	0.625 0
NC46	V-038R	2.0	4	4.626 00	4.712 01	4.540 00	4.501 00	0.625 0
NC50	V-038R	2.0	4	5.041 70	5.127 71	4.955 70	4.916 70	0.625 0
NC56	V-038R	3.0	4	5.616 00	5.701 38	5.530 62	5.428 50	0.625 0
NC61	V-038R	3.0	4	6.178 00	6.263 38	6.092 62	5.990 50	0.625 0
NC70	V-038R	3.0	4	7.053 00	7.138 38	6.967 62	6.865 50	0.625 0
1 REG	V-055	1.5	6	1.154 00	1.187 95	1.120 05	1.060 25	0.375 0
1-1/2 REG	V-055	1.5	6	1.541 00	1.574 95	1.507 05	1.447 25	0.375 0
2-3/8 REG	V-040	3.0	5	2.365 37	2.458 75	2.271 99	2.177 87	0.625 0
2-7/8 REG	V-040	3.0	5	2.740 37	2.833 75	2.646 99	2.552 87	0.625 0
3-1/2 REG	V-040	3.0	5	3.239 87	3.333 25	3.146 49	3.052 37	0.625 0
4-1/2 REG	V-040	3.0	5	4.364 87	4.458 25	4.271 49	4.177 37	0.625 0
5-1/2 REG	V-050	3.0	4	5.234 02	5.353 24	5.114 79	5.046 52	0.625 0
6-5/8 REG	V-050	2.0	4	5.757 80	5.877 40	5.638 20	5.632 80	0.625 0
7-5/8 REG	V-050	3.0	4	6.714 53	6.833 75	6.595 31	6.527 03	0.625 0
8-5/8 REG	V-050	3.0	4	7.666 58	7.785 80	7.547 35	7.479 08	0.625 0
5-1/2 FH	V-050	2.0	4	5.591 00	5.710 60	5.471 40	5.466 00	0.625 0
6-5/8 FH	V-050	2.0	4	6.519 60	6.639 20	6.400 00	6.394 60	0.625 0

[a] The values in columns 5 and 6 apply only to grand, regional, and reference master plug gauges.

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

[c] The values in column 8 apply only to working plug gauges.

Table A.9 — Gauge external dimensions for preferred connections

Dimensions in inches

1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [a] 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	[b]	1.125	2.500	1.360
1-1/2 REG	2.000	[b]	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] The thickness of fitting plates TFP shall be 0.375 in maximum for all gauge sizes with pitch diameter less than 5.63 in and 0.437 in maximum for all larger gauge sizes.

[b] There is no fitting plate on 1 REG and 1-1/2 REG.

Table A.10 — Tolerances on gauge dimensions for regional and grand master gauges

Dimensions in inches, unless otherwise specified

<table>
<tr><td>1</td><td colspan="2">2</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Element</td><td colspan="4">Tolerances</td></tr>
<tr><td colspan="2">Plug</td><td colspan="2">Ring</td></tr>
<tr><td>Pitch diameter at gauge point [a]:</td><td colspan="2">± 0.000 2</td><td colspan="2">—</td></tr>
<tr><td>Lead [b]:
Pitch diameter ⩽ 3.90
Pitch diameter > 3.90</td><td colspan="2">
± 0.000 2
± 0.000 3</td><td colspan="2">
± 0.000 3
± 0.000 4</td></tr>
<tr><td>Taper limits [c]:</td><td>min.</td><td>max.</td><td>min.</td><td>max.</td></tr>
<tr><td>All</td><td>0.000 1</td><td>0.000 4</td><td>−0.001 2</td><td>−0.000 6</td></tr>
<tr><td>Half angle of thread, degrees</td><td colspan="2">± 0.083</td><td colspan="2">± 0.167</td></tr>
<tr><td>Mating stand-off, S</td><td colspan="2">—</td><td colspan="2">± 0.001</td></tr>
<tr><td>Interchange stand-off,
Regional Master against Grand Master</td><td colspan="2">± 0.004</td><td colspan="2">± 0.004</td></tr>
<tr><td>Crest truncation, f_{cg}</td><td colspan="2">± 0.001 12</td><td colspan="2">± 0.001 10</td></tr>
<tr><td>Gauge lengths, L_{pg} and L_{rg}</td><td colspan="2">± 0.093</td><td colspan="2">± 0.093</td></tr>
<tr><td>Plug fitting plate diameter, D_{FP}</td><td colspan="2">± 0.015</td><td colspan="2">—</td></tr>
<tr><td>Ring gauge outside diameter, D_R</td><td colspan="2">—</td><td colspan="2">± 0.015</td></tr>
<tr><td>Ring gauge counterbore, Q</td><td colspan="2">—</td><td colspan="2">± 0.015</td></tr>
<tr><td colspan="5">NOTE See Figure 19.</td></tr>
<tr><td colspan="5">[a] Helix angle correction shall be disregarded in pitch diameter determinations.
[b] 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] The pitch cone of the ring gauge is provided with a minus taper in order to minimize variations in interchange stand-off due to lead errors. See Figure 22 for meaning of taper limits.</td></tr>
</table>

Table A.11 — Tolerances on gauge dimensions for reference master gauges

Dimensions in inches, unless otherwise specified

1	2		3	
Element	**Tolerances**			
	Plug		**Ring**	
Pitch diameter at gauge point [a]:	—		—	
Pitch diameter ⩽ 5.598	± 0.000 4		—	
Pitch diameter > 5.598	± 0.000 5		—	
Lead [b]:				
Pitch diameter ⩽ 5.598	± 0.000 4		± 0.000 6	
Pitch diameter > 5.598	± 0.000 5		± 0.000 7	
Taper limits [c]:	min.	max.	min.	max.
L_{rg} 3.5 and shorter	0	0.000 4	−0.001 2	−0.000 4
L_{rg} 3.56 through 4	0	0.000 5	−0.001 4	−0.000 4
L_{rg} 4.06 through 4.5	0	0.000 6	−0.001 6	−0.000 4
L_{rg} 4.56 through 5	0	0.000 7	−0.001 8	−0.000 4
L_{rg} 5.06 through 5.5	0	0.000 8	−0.002 0	−0.000 4
L_{rg} 5.56 and longer	0	0.000 9	−0.002 2	−0.000 4
Half angle of thread, degrees	± 0.117		± 0.25	
Mating stand-off, S	—		± 0.001	
Interchange stand-off, Reference Master against Regional Master or Grand Master	± 0.004		± 0.004	
Crest truncation, f_{cg}	± 0.001 25		± 0.001 25	
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] Helix angle correction shall be disregarded in pitch diameter determinations.

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

Table A.12 — Tolerances on gauge dimensions for working gauges

Dimensions in inches, unless otherwise specified

1	2		3	
Element	**Tolerances**			
	Plug		**Ring**	
Pitch diameter at gauge point [a]:	—		—	
Pitch diameter ⩽ 5.598	± 0.000 4		—	
Pitch diameter > 5.598	± 0.000 5		—	
Lead [b]:	—		—	
Pitch diameter ⩽ 5.598	± 0.000 4		± 0.000 6	
Pitch diameter > 5.598	± 0.000 5		± 0.000 7	
Taper limits [c]:	min.	max.	min.	max.
L_{rg} 3.5 and shorter	0	0.000 6	−0.001 4	−0.000 4
L_{rg} 3.56 through 4	0	0.000 7	−0.001 6	−0.000 4
L_{rg} 4.06 through 4.5	0	0.000 8	−0.001 8	−0.000 4
L_{rg} 4.56 through 5	0	0.000 9	−0.002 0	−0.000 4
L_{rg} 5.06 through 5.5	0	0.001 0	−0.002 2	−0.000 4
L_{rg} 5.56 and longer	0	0.001 1	−0.002 4	−0.000 4
Half angle of thread, degrees	± 0.117		± 0.25	
Mating stand-off, S	—		± 0.001	
Interchange stand-off, Working gauge against Reference Master	± 0.004		± 0.004	
Crest truncation, f_{cg}	± 0.001 25		± 0.001 25	
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] Helix angle correction shall be disregarded in pitch diameter determinations.

[b] 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] L_{rg} values are listed in Table A.9, column 4. The pitch cone of the ring gauge is provided with a minus taper in order to minimise variations in interchange stand-off due to lead errors. See Figure 22 for meaning of taper limits.

Annex B
(informative)

Care and use of regional master gauges

B.1 Protective coating

The gauging surfaces of regional 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 period of six months, the gauges 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 two 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 penetrate the gauge surface and cause small rust spots. Since the custodian might not know when the regional masters will be used again upon completing the check of the stand-off of a set of reference master gauges against the regional masters, the use of petrolatum as protection is advised in all cases.

B.2 Storage

Gauges should be stored unassembled in a well controlled temperature environment. If 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 regional 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.

B.3 Cleaning

In the determination of stand-off values, both regional master and reference 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 reference gauges should be inspected for damaged threads, rust, etc. Gauges with burrs or rough threads that can damage the regional 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 discoloured surfaces. It is apparent that the friction factor enters into the determination of stand-off values. A gummy oil deposit on the gauge seriously adds to the friction. It is inadvisable to determine stand-off on gauges with such a deposit.

B.4 Lubrication

For the stand-off 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 flows out of the ends of the gauge and, if trapped, can effect the stand-off value.

B.5 Torquing 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 stand-off 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). Stand-off 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 stand-off value to be reported.

Annex C
(normative)

Shipment of reference master gauges

C.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 stand-off determinations.

C.2 Cleaning

Oily deposits or discolorations can 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.

C.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.

C.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.

C.5 Packing

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

C.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.

C.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 ship collect. Owners should indicate to the custodian whether gauges are to be returned by freight or express.

C.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 can 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.

C.9 Customs requirements and shipping

Owners of gauges that are to be transported by ship abroad for test shall 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 transportation prepaid 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 arranges 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 D
(normative)

Care and use of working gauges

D.1 Gauge wear

A reduction in mating stand-off of used working gauges is not serious providing the wear on thread elements has been uniform and that correction in gauging stand-off, as shown by comparison with the reference masters, is applied when gauging product threads.

D.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.

D.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.

D.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 to look for slivers on the gauging surfaces. Those observed should be removed with a fine file or stone.

D.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 protects the gauge when in use and increases 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 (5.91 in) long may be used for this purpose. Loose gauging produces loose joints.

Annex E
(informative)

API gauge certification requirements

NOTE The American Petroleum Institute (API) maintains a certification program for gauges for the connections defined as preferred by this part of ISO 10424. The requirements are listed here for information.

E.1 Gauge certification

E.1.1 Certification program requirements

In order to be recognized in this program, new and reconditioned regional master and reference master gauges should be submitted for certification as to the accuracy of all essential elements as defined in 9.2.

New and reconditioned reference master gauges shall be submitted to one of the certification agencies listed below for certification. The holder of the grand master gauges shall be the certifying agency for all Regional Master gauges.

— National Institute of Standards and Technology, Gaithersburg, MD 20899, USA

— National Physical Laboratory, Teddington, England

— National Research Laboratory of Metrology, Ibaraki, Japan

— Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina

— National Institute of Metrology, Beijing, People's Republic of China

E.1.2 General requirements

Regional master, reference master and working gauges shall be certified in complete sets, i.e., a reference master plug and reference master ring. A single gauge may be certified only if accompanied by a previously certified mating gauge. When a previously certified mating gauge is used, the relevant certificate shall be furnished to the certifying agency as proof of the accuracy of the mating gauge.

All gauges submitted for certification shall be permanently marked with their unique identification number at the time of submittal.

E.1.3 Certification

The gauge manufacturer shall select one of the certification agencies to inspect new and reconditioned regional master and reference master gauges for conformance to the requirements of 9.2. For each set of gauges that comply with all requirements, the gauge manufacturer shall obtain a certificate from the certifying agency as evidence of the gauge accuracy. The certificate shall contain the following information:

a) name of certifying agency;

b) signature of inspector;

c) date of certification;

d) manufacturer serial number of each gauge;

e) mating stand-off measurement;

f) interchange stand-off measurement;

g) statement of compliance with 9.2.

The certifying agency shall retain a copy of the certificate of certification for audit purposes, for a minimum of seven years.

E.1.4 Interchange stand-off

All new and reconditioned reference master gauges shall be submitted to one of the certification agencies for determination of interchange stand-off against grand or regional master gauges, as required in 10.1.

E.1.5 Regional master gauges

Regional master gauges, which the certification agencies have on deposit, are used to check the interchange stand-off of reference master gauges. Only reference master gauges shall be checked with the regional master gauges.

Regional master gauges shall not be used to inspect used working gauges.

E.1.6 Stand-off report

If the gauge conforms to the interchange stand-off limits as specified in 10.3.1.5 and 10.3.1.6, the gauge manufacturer or reconditioner shall obtain from the certifying agency a report showing both the mating and interchange stand-off values. The manufacturer or reconditioner shall retain a copy of the report for a minimum of seven years, for audit purposes.

E.1.7 Marking

All sets of regional or reference master gauges found in full conformance with the requirements of 9.2 shall have both plug gauge and ring gauge permanently marked with the name or identification mark of the certifying agency.

E.2 Certification agencies

E.2.1 General

Application to become an API gauge certification agency is open to any metrology laboratory capable of demonstrating compliance to API policy and specified requirements. Interested parties should notify the API Upstream Standards Segment.

E.2.2 Master gauge custodian

The custodian of the API grand master gauges is the US National Institute of Standards and Technology, Gaithersburg, Maryland 20899, USA.

E.2.3 Agency capabilities

All gauge certification agency applicants shall be required to demonstrate measurement capability in the following areas:

a) facility and environment;

b) inspection equipment;

c) standards and calibration;

d) personnel qualification;

e) organizational structure;

f) documentation;

g) storage and handling.

E.2.4 Agency approval

The metrology laboratories that meet these requirements are recognized by the API Upstream Standards Segment and listed in the API composite list as the certifying agencies for master gauges. These laboratories can certify only gauges for which they possess corresponding regional master gauges. A list of regional masters, valid as of 2005, is provided in Annex J.

Annex F
(informative)

Other rotary shouldered connections

F.1 Interchangeable connections

Connections defined in the main body of this part of ISO 10424 are considered preferred. They include NC23 to NC70, 1 REG to 8-5/8 REG, 5-1/2 FH and 6-5/8 FH. Connections in the NC style (column 1 of Table F.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 F.1 — Interchangeable connections

NC	IF	FH	SH	XH	DSL	EF	WO
Numbered Connection	**Internal Flush**	**Full Hole**	**Slim Hole**	**eXtra Hole**	**Double StreamLine**	**External Flush**	**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	—	—	—	4-1/2 EF	—

F.2 GOST connections

The majority of connections specified by GOST are interchangeable with connections in this part of ISO 10424. The equivalence is listed below. The tolerances are slightly different between these the GOST standards and this part of ISO 10424.

Table F.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	—	—

F.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 list items a) through c):

a) Different pin length:

— NC38 and 3-1/2 WO

— 2-7/8 OH SW and 2-7/8 OH LW,

— 4 OH SW and 4 OH LW;

b) Different taper:

— NC44 and 4 OH;

c) Pitch diameter within 1,5 mm (0.06 in):

— NC26 and 2-3/8 WO,

— NC31 and 2-7/8 XH = 2-7/8 WO,

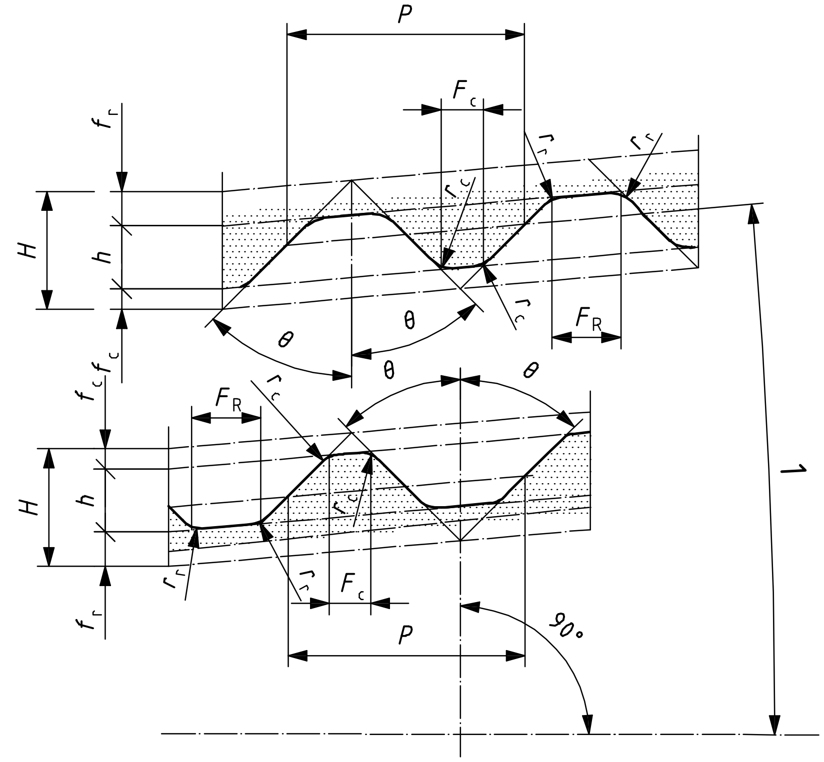
— NC35 and 4 SH.

F.4 Product threads for non-preferred connections

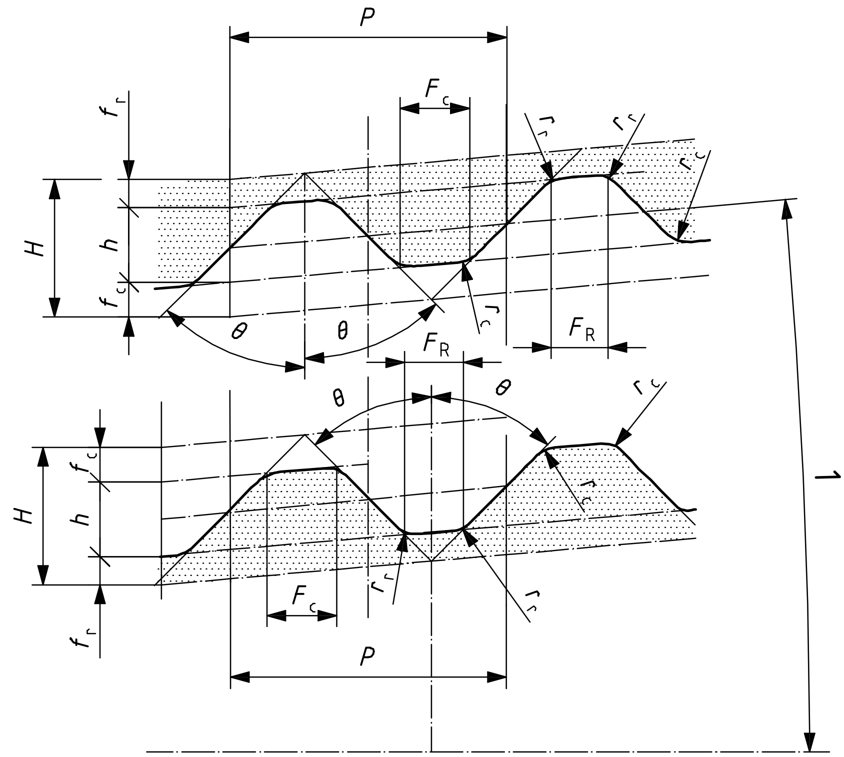
There are many rotary shouldered connections other than those defined as preferred above. Their thread elements are listed in Tables F.3 to F.6.

F.5 Product thread dimensions

There are several thread forms in use other than those specified in Tables 1 and 2 in SI units (Tables A.1 and A.2 in USC units). They are illustrated in Figure F.1, and the dimensions in SI units are given in Tables F.3 and F.5. (Tables F.4 and F.6 give USC units.)

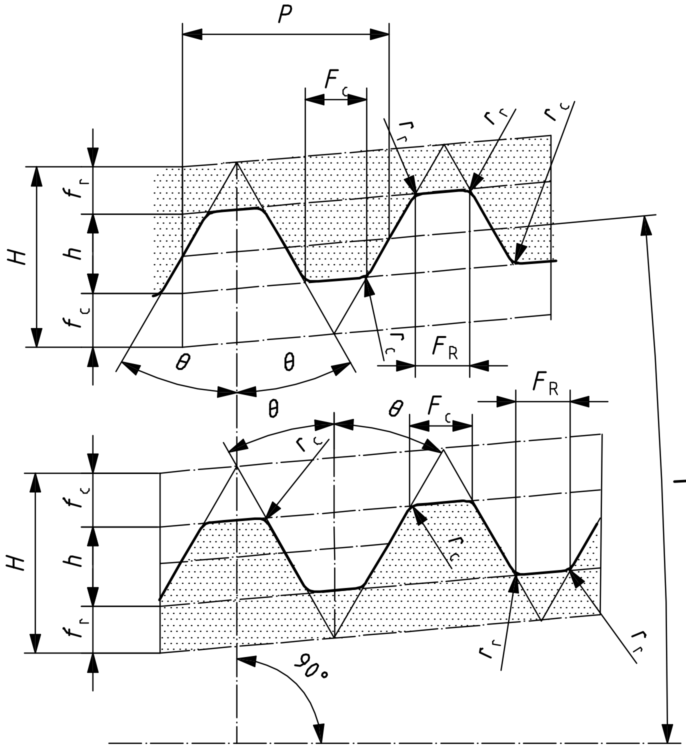


a) 90-V-050



b) 90-V-084

Figure F.1 — Thread forms for 90-V-050, 90-V-084 and V-076



c) V-076

Key

1 taper half angle, φ

Figure F.1 — Thread forms for 90-V-050, 90-V-084 and V-076 (*continued*)

Table F.3 — Thread dimensions
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7
Thread form		**90-V-050**	**90-V-050**	**V-065**	**V-076**	**90-V-084**
Threads per 25,4 mm	n	3,5	3,5	4	4	3
Lead, ref.	—	7,257 14	7,257 14	6,35	6,35	8,466 67
Half angle	θ, 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, ref.	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, ref.	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.	3,603 37	3,571 88	5,486 53	5,492 09	4,221 86
Crest truncation	f_c	0,630 49	0,625 16	1,426 49	1,670 61	1,069 52
Root truncation	f_r	0,432 87	0,425 02	1,228 98	1,471 88	0,866 32
Thread height truncated	$h^{+0,025}_{-0,076}$	2,540 00	2,521 71	2,831 06	2,349 50	2,286 00
Crest flat corner radius	r_c ± 0,2	0,38	0,38	0,38	0,38	0,38
NOTE See Figures 4, 5, and F.1.						
[a] See Table F.4 for USC units.						

Table F.4 — Thread dimensions
(USC units)

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7
Thread form		**90-V-050**	**90-V-050**	**V-065**	**V-076**	**90-V-084**
Threads per inch	n	3.5	3.5	4	4	3
Lead, ref.		0.285 714	0.285 714	0.25	0.25	0.333 333
Half angle	θ, deg ± 0,75	45	45	30	30	45
Taper	T, in/ft	2	3	2	1.5	1.25
Crest flat width	F_c, ref.	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, ref.	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	0.141 865	0.140 625	0.216 005	0.216 224	0.166 215
Crest truncation	f_c	0.024 823	0.024 613	0.056 161	0.065 772	0.042 107
Root truncation	f_r	0.017 043	0.016 733	0.048 385	0.057 948	0.034 107
Thread height truncated	$h\ ^{+0.001}_{-0.003}$	0.100 000	0.099 280	0.111 459	0.092 504	0.090 000
Crest flat corner radius	r_c ± 0.008	0.015	0.015	0.015	0.015	0.015
NOTE See Figures 4, 5 and F.1.						

Table F.5 — Product dimensions for non-preferred connections
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Connection style and size	**Thread form**	**Taper [b]**	**Threads per 25,4 mm**	**Pitch dia. at gauge point**	**Large dia. of pin**	**Pin cylinder dia.**	**Small dia. of pin**	**Pin length [c]**	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore**	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		mm/mm			ref.	± 0,4	ref.	$^{0}_{-3}$	min.	$^{+9}_{0}$	$^{+0,8}_{-0,4}$	$^{+1,6}_{-0,8}$	max.
NC10	V-055	1/8	6	27,000 20	30,23	29,03	25,47	38,10	41,28	53,98	30,58	11,13	10,16
NC12	V-055	1/8	6	32,131 00	35,36	34,16	29,80	44,45	47,62	60,32	35,71	11,13	10,16
NC13	V-055	1/8	6	35,331 40	38,56	37,36	33,00	44,45	47,62	60,32	38,91	11,13	10,16
NC16	V-055	1/8	6	40,868 60	44,10	42,90	38,54	44,45	47,62	60,32	44,48	11,13	10,16
NC77	V-038R	1/4	4	196,621 40	203,22	198,83	161,94	165,10	168,28	180,98	204,79	15,88	12,70
2-7/8 FH	V-040	1/4	5	85,481 16	92,08	87,71	69,85	88,90	92,08	104,78	93,66	15,88	12,70
3-1/2 FH	V-040	1/4	5	94,843 60	101,44	98,65	77,63	95,25	98,42	111,12	102,79	15,88	12,70
4-1/2 FH	V-040	1/4	5	115,112 80	121,71	118,92	96,31	101,60	104,78	111,12	123,82	15,88	12,70
5-1/2 IF	V-038R	1/6	4	157,200 60	162,48	159,54	141,31	127,00	130,18	142,88	163,91	15,88	12,70
6-5/8 IF	V-038R	1/6	4	184,175 40	189,45	186,53	168,29	127,00	130,18	142,88	190,90	15,88	12,70
2-3/8 OH LW	V-076	1/8	4	65,735 20	69,87	67,47	62,33	60,32	63,50	76,20	71,04	15,88	12,70
2-3/8 OH SW	V-076	1/8	4	65,735 20	69,87	67,47	62,33	60,32	63,50	76,20	71,04	15,88	12,70
2-7/8 OH LW	V-076	1/8	4	75,793 60	79,93	77,39	71,99	63,50	66,68	79,38	81,36	15,88	12,70

Table F.5 (*continued*)

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Connection style and size	**Thread form**	**Taper** [b]	**Threads per 25,4 mm**	**Pitch dia. at gauge point**	**Large dia. of pin**	**Pin cylinder dia.**	**Small dia. of pin**	**Pin length** [c]	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore**	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		mm/mm			ref.	± 0,4	ref.	$^{0}_{-3}$	min.	$^{+9}_{0}$	$^{+0,8}_{-0,4}$	$^{+1,6}_{-0,8}$	max.
2-7/8 OH SW	V-076	1/8	4	75,793 60	79,93	77,39	70,80	73,02	76,20	98,42	81,36	15,88	12,70
3-1/2 OH LW	V-076	1/8	4	94,691 20	98,83	96,44	88,51	82,55	85,72	98,42	100,41	15,88	12,70
3-1/2 OH SW	V-076	1/8	4	94,691 20	98,83	96,44	88,51	82,55	85,72	98,42	100,41	15,88	12,70
4 OH LW	V-076	1/8	4	112,166 40	116,30	113,90	105,19	88,90	92,08	104,78	117,87	15,88	12,70
4 OH SW	V-076	1/8	4	112,166 40	116,30	113,90	103,60	101,60	104,78	117,48	117,87	15,88	12,70
4-1/2 OH LW	V-076	1/8	4	120,700 80	124,84	122,63	112,93	95,25	98,42	111,13	125,81	15,88	12,70
4-1/2 OH SW	V-076	1/8	4	120,700 80	124,84	122,63	112,93	95,25	98,42	111,13	125,81	15,88	12,70
2-3/8 PAC	V-076	1/8	4	55,956 20	60,09	58,88	52,55	60,32	63,50	76,20	61,12	9,52	6,35
2-7/8 PAC	V-076	1/8	4	60,172 60	64,31	61,90	56,77	60,32	63,50	76,20	65,48	9,52	6,35
3-1/2 PAC	V-076	1/8	4	73,253 60	77,39	76,20	67,07	82,55	85,72	98,43	78,98	9,52	6,35
2-3/8 SH	V-038R	1/6	4	56,642 00	61,92	59,13	49,75	73,02	76,20	88,90	63,50	15,88	12,70
4 SH	V-038R	1/6	4	91,541 60	96,82	94,06	82,00	88,90	92,08	104,78	98,43	15,88	12,70
2-3/8 WO	V-038R	1/6	4	66,167 00	71,45	68,66	61,39	60,32	63,50	76,20	72,63	15,88	12,70
2-7/8 WO	V-038R	1/6	4	79,273 40	84,55	81,71	71,85	76,20	79,38	92,08	85,72	15,88	12,70
3-1/2 WO	V-038R	1/6	4	96,723 20	102,00	99,21	87,19	88,90	92,08	104,78	103,58	15,88	12,70
2-7/8 XH	V-038R	1/6	4	79,222 60	84,50	81,71	67,57	101,60	104,78	117,48	85,33	15,88	9,53
3-1/2 XH	V-038R	1/6	4	91,541 60	96,82	94,03	82,00	88,90	92,08	104,78	98,42	15,88	12,70
3-1/2 H90	90-V-050	1/6	3.5	99,786 44	104,77	102,92	87,84	101,60	104,78	117,48	106,36	15,88	12,70
4 H90	90-V-050	1/6	3.5	109,311 44	114,30	109,54	96,31	107,95	111,13	123,83	115,89	15,88	12,70
4-1/2 H90	90-V-050	1/6	3.5	117,795 04	122,78	119,61	103,73	114,30	117,48	130,18	124,22	15,88	12,70
5 H90	90-V-050	1/6	3.5	124,665 74	129,65	125,02	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	131,536 44	136,52	131,78	116,42	120,65	123,83	136,53	138,11	15,88	12,70
6-5/8 H90	90-V-050	1/6	3.5	147,411 44	152,40	147,65	131,23	127,00	130,18	142,88	153,99	15,88	12,70
7 H90	90-V-050	1/4	3.5	158,808 42	165,10	160,35	130,17	139,70	142,88	155,58	166,69	15,88	12,70
7-5/8 H90	90-V-050	1/4	3.5	181,383 94	187,67	182,93	148,78	155,58	158,75	171,45	189,31	15,88	12,70
8-5/8 H90	90-V-050	1/4	3.5	203,608 94	209,90	205,16	167,83	168,28	171,45	184,15	211,53	15,88	12,70
2-3/8 SL H90	90-V-084	5/48	3	65,481 20	69,22	67,87	61,78	71,44	74,61	87,31	70,25	15,88	12,70
2-7/8 SL H90	90-V-084	5/48	3	77,444 60	81,18	80,19	73,41	74,61	77,79	90,49	82,15	15,88	12,70
3-1/2 SL H90	90-V-084	5/48	3	93,675 20	97,41	96,01	88,98	80,96	84,14	96,84	98,42	15,88	12,70
GOST Z-161	V-050	1/6	4	155,962 25	161,90	160,05	140,73	127,00	130,18	142,88	163,93	15,88	12,70
GOST Z-189	V-050	1/6	4	183,462 25	189,40	187,55	168,23	127,00	130,18	142,88	191,76	15,88	12,70

[a] See Table F.6 for USC units.

[b] Taper, T: 1/6 mm/mm corresponds to a half-angle of φ = 4,764°.
1/4 mm/mm corresponds to a half-angle of φ = 7,125°.
1/8 mm/mm corresponds to a half-angle of φ = 3,576°.
5/48 mm/mm corresponds to a half-angle of φ = 2,981°.

[c] For roller cone drill bits only, the pin length may vary by 5– mm.

Table F.6 — Product dimensions for non-preferred connections
(USC units)

Dimensions in inches, unless otherwise specified

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 dia. at gauge point**	**Large dia. of pin**	**Pin cylinder dia.**	**Small diameter of pin**	**Pin length** [b]	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore**	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		in/ft			ref.	± 0.015	ref.	$^{0}_{-0.12}$	min.	$^{+0.38}_{0}$	$^{+0.030}_{-0.015}$	$^{+0.06}_{-0.03}$	max.
NC10	V-055	1.5	6	1.063 00	1.190	1.143	1.003	1.500	1.625	2.125	1.204	0.438	0.40
NC12	V-055	1.5	6	1.265 00	1.392	1.345	1.173	1.750	1.875	2.375	1.406	0.438	0.40
NC13	V-055	1.5	6	1.391 00	1.518	1.471	1.299	1.750	1.875	2.375	1.532	0.438	0.40
NC16	V-055	1.5	6	1.609 00	1.736	1.689	1.517	1.750	1.875	2.375	1.751	0.438	0.40
NC77	V-038R	3	4	7.741 00	8.001	7.828	6.376	6.500	6.625	7.125	8.062	0.625	0.50
2-7/8 FH	V-040	3	5	3.365 40	3.625	3.453	2.750	3.500	3.625	4.125	3.688	0.625	0.50
3-1/2 FH	V-040	3	5	3.734 00	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	4.532 00	4.792	4.682	3.792	4.000	4.125	4.625	4.875	0.625	0.50
5-1/2 IF	V-038R	2	4	6.189 00	6.397	6.281	5.564	5.000	5.125	5.625	6.453	0.625	0.50
6-5/8 IF	V-038R	2	4	7.251 00	7.459	7.344	6.626	5.000	5.125	5.625	7.516	0.625	0.50
2-3/8 OH LW	V-076	1.5	4	2.588 00	2.751	2.656	2.454	2.375	2.500	3.000	2.797	0.625	0.50
2-3/8 OH SW	V-076	1.5	4	2.588 00	2.751	2.656	2.454	2.375	2.500	3.000	2.797	0.625	0.50
2-7/8 OH LW	V-076	1.5	4	2.984 00	3.147	3.047	2.834	2.500	2.625	3.125	3.203	0.625	0.50
2-7/8 OH SW	V-076	1.5	4	2.984 00	3.147	3.047	2.787	2.875	3.000	3.500	3.203	0.625	0.50
3-1/2 OH LW	V-076	1.5	4	3.728 00	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	3.728 00	3.891	3.797	3.485	3.250	3.375	3.875	3.953	0.625	0.50
4 OH LW	V-076	1.5	4	4.416 00	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	4.416 00	4.579	4.484	4.079	4.000	4.125	4.625	4.641	0.625	0.50
4-1/2 OH LW	V-076	1.5	4	4.752 00	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	4.752 00	4.915	4.828	4.446	3.750	3.875	4.375	4.953	0.625	0.50
2-3/8 PAC	V-076	1.5	4	2.203 00	2.366	2.318	2.069	2.375	2.500	3.000	2.406	0.375	0.25
2-7/8 PAC	V-076	1.5	4	2.369 00	2.532	2.437	2.235	2.375	2.500	3.000	2.578	0.375	0.25
3-1/2 PAC	V-076	1.5	4	2.884 00	3.047	3.000	2.641	3.250	3.375	3.875	3.109	0.375	0.25
2-3/8 SH	V-038R	2	4	2.230 00	2.438	2.328	1.959	2.875	3.000	3.500	2.500	0.625	0.50
4 SH	V-038R	2	4	3.604 00	3.812	3.703	3.229	3.500	3.625	4.125	3.875	0.625	0.50
2-3/8 WO	V-038R	2	4	2.605 00	2.813	2.703	2.417	2.375	2.500	3.000	2.859	0.625	0.50
2-7/8 WO	V-038R	2	4	3.121 00	3.329	3.217	2.829	3.000	3.125	3.625	3.375	0.625	0.50
3-1/2 WO	V-038R	2	4	3.808 00	4.016	3.906	3.433	3.500	3.625	4.125	4.078	0.625	0.50
2-7/8 XH	V-038R	2	4	3.119 00	3.327	3.217	2.660	4.000	4.125	4.625	3.359	0.625	0.38
3-1/2 XH	V-038R	2	4	3.604 00	3.812	3.702	3.229	3.500	3.625	4.125	3.875	0.625	0.50
3-1/2 H90	90-V-050	2	3.5	3.928 60	4.125	4.052	3.458	4.000	4.125	4.625	4.188	0.625	0.50
4 H90	90-V-050	2	3.5	4.303 60	4.500	4.313	3.792	4.250	4.375	4.875	4.562	0.625	0.50
4-1/2 H90	90-V-050	2	3.5	4.637 60	4.834	4.709	4.084	4.500	4.625	5.125	4.891	0.625	0.50
5 H90	90-V-050	2	3.5	4.908 10	5.104	4.922	4.313	4.750	4.875	5.375	5.172	0.625	0.50
5-1/2 H90	90-V-050	2	3.5	5.178 60	5.375	5.188	4.583	4.750	4.875	5.375	5.438	0.625	0.50
6-5/8 H90	90-V-050	2	3.5	5.803 60	6.000	5.813	5.167	5.000	5.125	5.625	6.062	0.625	0.50
7 H90	90-V-050	3	3.5	6.252 30	6.500	6.313	5.125	5.500	5.625	6.125	6.562	0.625	0.50

Table F.6 (*continued*)

Dimensions in inches, unless otherwise specified

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 dia. at gauge point**	**Large dia. of pin**	**Pin cylinder dia.**	**Small diameter of pin**	**Pin length** [b]	**Depth of box threads**	**Total box depth**	**Box c/bore dia.**	**Depth of box c/bore**	
		T	n	C	D_L	D_{LF}	D_S	L_{PC}	L_{BT}	L_{BC}	Q_c	L_{Qc}	L_{ft}
		in/ft			ref.	± 0.015	ref.	$^{0}_{-0.12}$	min.	$^{+0.38}_{0}$	$^{+0.030}_{-0.015}$	$^{+0.06}_{-0.03}$	max.
7-5/8 H90	90-V-050	3	3.5	7.141 10	7.389	7.202	5.858	6.125	6.250	6.750	7.453	0.625	0.50
8-5/8 H90	90-V-050	3	3.5	8.016 10	8.264	8.077	6.608	6.625	6.750	7.250	8.328	0.625	0.50
2-3/8 SL H90	90-V-084	1.25	3	2.578 00	2.725	2.672	2.432	2.812	2.938	3.438	2.766	0.625	0.50
2-7/8 SL H90	90-V-084	1.25	3	3.049 00	3.196	3.157	2.890	2.938	3.062	3.562	3.234	0.625	0.50
3-1/2 SL H90	90-V-084	1.25	3	3.688 00	3.835	3.780	3.503	3.188	3.312	3.812	3.875	0.625	0.50
GOST Z-161	V-050	2	4	6.140 25	6.374	6.301	5.541	5.000	5.125	5.625	6.454	0.625	0.50
GOST Z-189	V-050	2	4	7.222 92	7.457	7.384	6.623	5.000	5.125	5.625	7.550	0.625	0.50

[a] Taper, T: 2 in/ft corresponds to a half-angle of φ = 4.764°.
3 in/ft corresponds to a half-angle of φ = 7.125°.
1.5 in/ft corresponds to a half-angle of φ = 3.576°.
1.25 in/ft corresponds to a half-angle of φ = 2.981°.

[b] For roller cone drill bits only, the pin length may vary by 0.19 in.

F.6 Connection features for non-preferred connections

F.6.1 General

A number of connections have historically been used in drill collar sizes that 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 Tables F.7 and F.8. The bevel diameter shall be as indicated, regardless of increase in collar diameter beyond these limits.

F.6.2 Low-torque features for H90 connections

Table F.7 — Low-torque feature
(SI units [a])

Dimensions in millimetres

Connection size and style	Required above OD	Face groove diameter D_{FG}	Bevel diameter
7 H90	218,9	181,0	209,6
7 H90	225,2	181,0	219,0
7-5/8 H90	247,6	203,2	235,0
7-5/8 H90	250,8	203,2	244,3
8-5/8 H90	273,0	238,2	266,7
8-5/8 H90	285,8	238,2	273,0

NOTE 1 See Figure 7.

NOTE 2 Corner radius, R_{FG}, is $6{,}35\ ^{0}_{-0{,}4}$.

[a] See Table F.8 for USC units.

Table F.8 — Low-torque feature
(USC units)

Dimensions in inches

Connection size and style	Required above OD	Face groove diameter D_{FG}	Bevel diameter
7 H90	8.62	7.12	8.25
7 H90	8.87	7.12	8.62
7-5/8 H90	9.75	8.0	9.25
7-5/8 H90	9.87	8.0	9.62
8-5/8 H90	10.75	9.38	10.5
8-5/8 H90	11.25	9.38	10.75

NOTE 1 See Figure 7.

NOTE 2 Corner radius, R_{FG}, is $0.25\ {}^{0}_{-0.015}$.

F.6.3 Bevel diameters

Starting bevel diameters for threads with 60° included angles are listed in Tables F.9 and F.10. The bevel diameters for all threads with 60° included angles follow the same rules: for every 6,35 mm (0.25 in) increase (or decrease) in outside diameter beyond the value indicated, the bevel diameter is also increased (or decreased) by 4,762 mm (0.187 in).

H90 and Slimline H90 connections have 90° included thread flank angles and do not follow the normal rules for bevel diameters. Bevel diameters for these connections were arbitrarily set by the original designer and follow an arbitrary pattern of increases. To determine the bevel diameter of these threads, refer to the appropriate OD ranges listed in Table F.11 (or Table F.12 for USC units).

F.6.4 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 Tables F.13 and F.14. They shall not be used on connections smaller than those indicated in these tables.

Table F.9 — Reference bevel diameters for 60° included thread angle connections when used on drill collars
(SI units [a])

Dimensions in millimetres

1	2	3	4	5	6	7	8	9
Connection size and style	Reference OD	Reference bevel diameter	Connection size and style	Reference OD	Reference bevel diameter	Connection size and style	Reference OD	Reference bevel diameter
NC10	34,92	34,14	2-3/8 OH LW	79,38	76,20	2-3/8 PAC	76,20	69,85
NC12	41,28	39,70	2-3/8 OH SW	79,38	76,20	2-7/8 PAC	79,38	76,20
NC13	46,02	44,45	2-7/8 OH LW	95,25	91,68	3-1/2 PAC	95,25	91,28
NC16	53,98	52,40	2-7/8 OH SW	95,25	91,68	2-3/8 SH	79,38	75,41
NC77	279,40	260,75	3-1/2 OH LW	123,82	117,87	4 SH	120,65	115,09
2-7/8 FH	107,95	104,38	3-1/2 OH SW	123,82	117,87	2-3/8 WO	85,72	82,55
3-1/2 FH	123,82	118,67	4 OH LW	149,22	141,29	2-7/8 WO	101,60	97,63
4-1/2 FH	146,05	140,49	4 OH SW	149,22	141,29	3-1/2 WO	127,00	121,13
5-1/2 IF	187,32	181,37	4-1/2 OH LW	161,92	153,19	2-7/8 XH	104,78	97,63
6-5/8 IF	228,60	219,08	4-1/2 OH SW	161,92	153,19	3-1/2 XH	120,65	115,09

[a] See Table F.10 for USC units.

Table F.10 — Reference bevel diameters for 60° included thread angle connections when used on drill collars
(USC units)

Dimensions in inches

1	2	3	4	5	6	7	8	9
Connection size and style	**Reference OD**	**Reference bevel diameter**	**Connection size and style**	**Reference OD**	**Reference bevel diameter**	**Connection size and style**	**Reference OD**	**Reference bevel diameter**
NC10	1.375	1.344	2-3/8 OH LW	3.125	3.000	2-3/8 PAC	3.000	2.750
NC12	1.625	1.563	2-3/8 OH SW	3.125	3.000	2-7/8 PAC	3.125	3.000
NC13	1.812	1.750	2-7/8 OH LW	3.750	3.609	3-1/2 PAC	3.750	3.594
NC16	2.125	2.063	2-7/8 OH SW	3.750	3.609	2-3/8 SH	3.125	2.969
NC77	11.000	10.266	3-1/2 OH LW	4.875	4.641	4 SH	4.750	4.531
2-7/8 FH	4.250	4.109	3-1/2 OH SW	4.875	4.641	2-3/8 WO	3.375	3.250
3-1/2 FH	4.875	4.672	4 OH LW	5.875	5.563	2-7/8 WO	4.000	3.844
4-1/2 FH	5.750	5.531	4 OH SW	5.875	5.563	3-1/2 WO	5.000	4.769
5-1/2 IF	7.375	7.141	4-1/2 OH LW	6.375	6.031	2-7/8 XH	4.125	3.844
6-5/8 IF	9.000	8.625	4-1/2 OH SW	6.375	6.031	3-1/2 XH	4.750	4.531

Table F.11 — Bevel diameters for connections with 90° included angle threads when used on drill collars
(SI units [a])

Dimensions in millimetres

Connection size and style	**OD**		**Bevel diameter**	**Connection size and style**	**OD**		**Bevel diameter**
	from	**to**			**from**	**to**	
3-1/2 H90	127,00	130,18	122,24	7 H90 FF	209,55	212,72	203,20
	133,35	139,70	127,00		215,90	215,90	209,55
4 H90	139,70	142,88	134,94	7 H90 LT	219,08	222,25	209,55
	146,05	152,40	139,70		225,42	228,60	219,08
	155,58	158,75	146,05	7-5/8 H90 FF	241,30	244,48	234,95
4-1/2 H90	152,40	155,58	146,05	7-5/8 H90 LT	247,65	247,65	234,95
	158,75	165,10	152,40		250,82	260,35	244,48
	168,28	171,45	158,75	8-5/8 H90 FF	266,70	269,88	254,00
5 H90	165,10	168,28	155,58	8-5/8 H90 LT	273,05	279,40	266,70
	171,45	177,80	161,92		282,58	292,10	273,05
5-1/2 H90	171,45	171,45	161,92	2-3/8 SL H90	82,55	82,55	79,38
	174,62	190,50	168,28	2-7/8 SL H90	104,78	104,78	98,42
6-5/8 H90	193,68	193,68	184,15		107,95	107,95	104,78
	196,85	209,55	190,50	3-1/2 SL H90	123,82	123,82	117,48
					127,00	127,00	123,82

[a] See Table F.12 for USC units.

Table F.12 — Bevel diameters for connections with 90° included angle threads when used on drill collars
(USC units)

Dimensions in inches

Connection size and style	OD		Bevel diameter	Connection size and style	OD		Bevel diameter
	from	to			from	to	
3-1/2 H90	5.000	5.125	4.812	7 H90 FF	8.250	8.375	8.000
	5.250	5.500	5.000		8.500	8.500	8.250
4 H90	5.500	5.625	5.312	7 H90 LT	8.625	8.750	8.250
	5.750	6.000	5.500		8.875	9.000	8.625
	6.125	6.250	5.750	7-5/8 H90 FF	9.500	9.625	9.250
4-1/2 H90	6.000	6.125	5.750	7-5/8 H90 LT	9.750	9.750	9.250
	6.250	6.500	6.000		9.875	10.250	9.625
	6.625	6.750	6.250	8-5/8 H90 FF	10.500	10.625	10.000
5 H90	6.500	6.625	6.125	8-5/8 H90 LT	10.750	11.000	10.500
	6.750	7.000	6.375		11.125	11.500	10.750
5-1/2 H90	6.750	6.750	6.375	2-3/8 SL H90	3.250	3.250	3.125
	6.875	7.500	6.625	2-7/8 SL H90	4.125	4.125	3.875
6-5/8 H90	7.625	7.625	7.250		4.250	4.250	4.125
	7.750	8.250	7.500	3-1/2 SL H90	4.875	4.875	4.625
					5.000	5.000	4.875

Table F.13 — Stress-relief grooves and features dimensions for non-preferred connections
(SI units [a])

Dimensions in millimetres

1	2	3	4	5	6	7	8
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**	**Length of pin groove**
	D_{CB}	L_X	L_{CYL}	D_{BG}	L_{BG}	D_{SRG}	L_{SRG}
	$^{+0,38}_{0}$	ref.	± 7,9	$^{+0,79}_{0}$	$^{0}_{-3,1}$	$^{0}_{-0,79}$	± 0,79
NC77	166,29	152,40	203,20	167,48	155,58	188,01	25,40
3-1/2 FH	81,76	82,55	133,35	83,34	85,72	85,90	25,40
4-1/2 FH	100,41	88,90	139,70	102,00	92,08	106,17	25,40
5-1/2 IF	144,46	114,30	165,10	146,45	117,48	149,58	25,40
6-5/8 IF	171,45	114,30	165,10	173,43	117,48	176,56	25,40
3-1/2 OH LW	—	—	—	94,85	73,02	87,71	25,40
3-1/2 OH SW	—	—	—	94,85	73,02	87,71	25,40
4 OH LW	—	—	—	111,52	79,38	105,82	25,40
4 OH SW	105,57	88,90	139,70	109,88	92,08	105,82	25,40
4-1/2 OH LW	115,09	82,55	133,35	119,22	85,72	114,34	25,40
4-1/2 OH SW	115,09	82,55	133,35	119,22	85,72	114,34	25,40
4 SH	—	—	—	87,31	79,38	83,92	25,40
3-1/2 XH	—	—	—	87,31	79,38	83,92	25,40
3-1/2 H90	90,49	88,90	139,70	93,66	92,08	92,48	25,40
4 H90	98,42	95,25	146,05	102,39	98,42	102,00	25,40
4-1/2 H90	106,36	101,60	152,40	109,54	104,78	110,49	25,40
5 H90	111,92	107,95	158,75	115,49	111,12	117,36	25,40
5-1/2 H90	119,06	107,95	158,75	122,24	111,12	124,23	25,40
6-5/8 H90	133,75	114,30	165,10	137,32	117,48	140,10	25,40
7 H90	133,75	127,00	177,80	136,52	130,18	151,01	25,40
7-5/8 H90	152,40	142,88	193,68	154,78	146,05	173,58	25,40
8-5/8 H90	171,45	155,58	206,38	173,83	158,75	195,81	25,40
3-1/2 SL H90	—	—	—	95,35	71,44	86,36	25,40
GOST Z-161	143,77	114,30	165,10	144,85	117,48	147,30	25,40
GOST Z-189	171,27	114,30	165,10	172,35	117,48	174,80	25,40

NOTE See Figures 8 through 10.

[a] See Table F.14 for USC units.

Table F.14 — Stress-relief grooves and features dimensions for non-preferred connections
(USC units)

Dimensions in inches

1	2	3	4	5	6	7	8
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	Length of pin groove
	D_{CB} $^{+0,015}_{0}$	L_X ref.	L_{CYL} $\pm$ 0.31	D_{BG} $^{+0,031}_{0}$	L_{BG} $^{0}_{-0.12}$	D_{SRG} $^{0}_{-0,031}$	L_{SRG} $\pm$ 0.031
NC77	6.547	6.000	8.000	6.594	6.125	7.402	1.000
3-1/2 FH	3.219	3.250	5.250	3.281	3.375	3.382	1.000
4-1/2 FH	3.953	3.500	5.500	4.016	3.625	4.180	1.000
5-1/2 IF	5.688	4.500	6.500	5.766	4.625	5.889	1.000
6-5/8 IF	6.750	4.500	6.500	6.828	4.625	6.951	1.000
3-1/2 OH LW	—	—	—	3.732	2.875	3.453	1.000
3-1/2 OH SW	—	—	—	3.732	2.875	3.453	1.000
4 OH LW	—	—	—	4.389	3.125	4.166	1.000
4 OH SW	4.156	3.500	5.500	4.326	3.625	4.166	1.000
4-1/2 OH LW	4.531	3.250	5.250	4.694	3.375	4.502	1.000
4-1/2 OH SW	4.531	3.250	5.250	4.694	3.375	4.502	1.000
4 SH	—	—	—	3.438	3.125	3.304	1.000
3-1/2 XH	—	—	—	3.438	3.125	3.304	1.000
3-1/2 H90	3.562	3.500	5.500	3.688	3.625	3.641	1.000
4 H90	3.875	3.750	5.750	4.031	3.875	4.016	1.000
4-1/2 H90	4.188	4.000	6.000	4.312	4.125	4.350	1.000
5 H90	4.406	4.250	6.250	4.547	4.375	4.620	1.000
5-1/2 H90	4.688	4.250	6.250	4.812	4.375	4.891	1.000
6-5/8 H90	5.266	4.500	6.500	5.406	4.625	5.516	1.000
7 H90	5.266	5.000	7.000	5.375	5.125	5.945	1.000
7-5/8 H90	6.000	5.625	7.625	6.094	5.750	6.834	1.000
8-5/8 H90	6.750	6.125	8.125	6.844	6.250	7.709	1.000
3-1/2 SL H90	—	—	—	3.754	2.812	3.400	1.000
GOST Z-161	5.660	4.500	6.500	5.703	4.625	5.799	1.000
GOST Z-189	6.743	4.500	6.500	6.785	4.625	6.882	1.000

NOTE See Figures 8 through 10.

F.7 Measurement of thread elements of non-preferred thread forms

Tables F.15 and F.16 provide reference dimensions and ball diameters for the measurement of thread elements of non-preferred thread forms.

Table F.15 — Compensated thread lengths, thread heights and ball-point diameters
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7
Thread form	**Taper** T mm/mm	**Threads per 25,4 mm** n	**Compensated thread length** [b] L_{ct}	**Ball-point diameter for taper and lead** d_b ± 0,05	**Thread height compensated for taper** [c] h_{cn}	**Ball-point diameter for thread height** d_{bh} ± 0,05
90-V-050	1/6	3,5	50,976 1	5,13	2,531	1,83
90-V-050	1/4	3,5	51,195 3	5,13	2,502	1,83
V-065	1/6	4,0	25,488 0	3,67	2,821	1,83
V-076	1/8	4,0	25,449 6	3,67	2,345	1,83
90-V-084	5/48	3,0	25,434 4	5,99	2,283	1,83

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] See Table F.16 for USC units.

[b] Compensated thread length, L_{ct}, is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[c] Compensated thread height, h_{cn}, is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

Table F.16 — Compensated thread lengths, thread heights and ball-point diameters
(USC units)

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7
Thread form	**Taper** T in/ft	**Threads per inch** n	**Compensated thread length** [a] L_{ct}	**Ball-point diameter for taper and lead** d_b ± 0.002	**Thread height compensated for taper** [b] h_{cn}	**Ball-point diameter for thread height** d_{bh} ± 0.002
90-V-050	2	3.5	2.006 93	0.202	0.099 7	0.072
90-V-050	3	3.5	2.015 56	0.202	0.098 5	0.072
V-065	2	4.0	1.003 47	0.144	0.111 1	0.072
V-076	1.5	4.0	1.001 95	0.144	0.092 3	0.072
90-V-084	1.25	3.0	1.001 36	0.236	0.089 9	0.072

NOTE See Figures 15 and 16 for meaning of dimensions.

[a] Compensated thread length, L_{ct}, is for measurements parallel to the taper cone. Non-compensated thread length is parallel to thread axis.

[b] Compensated thread height, h_{cn}, is for measurements normal to the taper cone. Non-compensated thread height is normal to thread axis.

F.8 Gauge dimensions for non-preferred connections

F.8.1 General

Gauges for the connections listed above shall be made to the dimensions listed in Tables F.17 through F.22.

F.8.2 Gauge thread dimensions

Table F.17 — Gauge thread form dimensions for non-preferred thread forms
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9
Form of thread	**Threads per 25,4 mm** n	**Lead**	**Half angle** θ degrees	**Taper** T mm/mm	**Thread height not truncated** H reference	**Gauge root truncation** f_{rg} max.	**Gauge crest truncation** f_{cg}	**Thread height truncated** h_g reference
90-V-050	3,5	7,257 14	45	1/6	3,603 37	0,757 50	0,757 43	2,088 36
90-V-050	3,5	7,257 14	45	1/4	3,571 88	0,752 07	0,752 09	2,067 74
V-065	4,0	6,350 00	30	1/6	5,486 53	1,528 09	1,528 06	2,430 35
V-076	4,0	6,350 00	30	1/8	5,492 09	1,797 71	1,797 81	1,896 67
90-V-084	3,0	8,466 67	45	5/48	4,221 86	1,196 49	1,196 59	1,828 88

NOTE 1 See Figure 18 for meaning of dimensions.

NOTE 2 In computing thread height and truncation, it is necessary to take account of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 3 See Tables 10 through 12 for tolerances on columns 3, 4 and 7.

[a] See Table F.18 for USC units.

Table F.18 — Gauge thread form dimensions for non-preferred thread forms
(USC units)

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6	7	8	9
Form of thread	**Threads per inch** n	**Lead**	**Half angle** θ degrees	**Taper** T in/ft	**Thread height not truncated** H reference	**Gauge root truncation** f_{rg} max.	**Gauge crest truncation** f_{cg}	**Thread height truncated** h_g reference
90-V-050	3.5	0.285 714	45	2	0.141 865	0.029 823	0.029 820	0.082 219
90-V-050	3.5	0.285 714	45	3	0.140 625	0.029 609	0.029 610	0.081 407
V-065	4	0.250 000	30	2	0.216 005	0.060 161	0.060 160	0.095 683
V-076	4	0.250 000	30	1.5	0.216 224	0.070 776	0.070 780	0.074672
90-V-084	3	0.333 333	45	1.25	0.166 215	0.047 106	0.047 110	0.072 003

NOTE 1 See Figure 18 for meaning of dimensions.

NOTE 2 In computing thread height and truncation, it is necessary to take account of taper in reducing thread height for a given pitch, as compared with values for the same pitch on a cylinder.

NOTE 3 See Tables A.10 through A.12 for tolerances on columns 3, 4 and 7.

Table F.19 — Gauge thread dimensions
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6	7	8	9
Style and size	Thread form	Taper *T* mm/mm	Threads per 25,4 mm *n*	Diameter at gauge point Pitch [b] *C*	Major (plug) [b] reference D_{MP}	Minor (ring) [c] reference D_{MR}	Pitch diameter at working gauge point [d]	Gauge stand-off *S*
NC10	V-055	1/8	6	27,000 20	27,991	26,009	24,618 95	15,875
NC12	V-055	1/8	6	32,131 00	33,122	31,140	29,749 75	15,875
NC13	V-055	1/8	6	35,331 40	36,322	34,340	32,950 15	15,875
NC16	V-055	1/8	6	40,868 60	41,860	39,878	38,487 35	15,875
NC77	V-038R	1/4	4	196,621 40	198,993	194,249	191,858 90	15,875
2-7/8 FH	V-040	1/4	5	85,481 16	87,853	83,109	80,718 66	15,875
3-1/2 FH	V-040	1/4	5	94,843 60	97,215	92,472	90,081 10	15,875
4-1/2 FH	V-040	1/4	5	115,112 80	117,485	112,741	110,350 30	15,875
5-1/2 IF	V-038R	1/6	4	157,200 60	159,580	154,821	154,025 60	15,875
6-5/8 IF	V-038R	1/6	4	184,175 40	186,555	181,796	181,000 40	15,875
2-3/8 OH LW	V-076	1/8	4	65,735 20	67,683	63,788	63,353 95	15,875
2-7/8 OH LW	V-076	1/8	4	75,793 60	77,741	73,846	73,412 35	15,875
2-7/8 OH SW	V-076	1/8	4	75,793 60	77,741	73,846	73,412 35	15,875
3-1/2 OH SW	V-076	1/8	4	94,691 20	96,639	92,744	92,309 95	15,875
4 OH LW	V-076	1/8	4	112,166 40	114,114	110,219	109,785 15	15,875
4-1/2 OH SW	V-076	1/8	4	120,700 80	122,648	118,753	118,319 55	15,875
2-3/8 PAC	V-076	1/8	4	55,956 20	57,853	54,060	53,574 95	15,875
2-7/8 PAC	V-076	1/8	4	60,172 60	62,069	58,276	57,791 35	15,875
3-1/2 PAC	V-076	1/8	4	73,253 60	75,150	71,357	70,872 35	15,875
2-3/8 SH	V-038R	1/6	4	56,642 00	59,022	54,262	53,467 00	15,875
4 SH	V-038R	1/6	4	91,541 60	93,921	89,162	88,366 60	15,875
2-3/8 WO	V-038R	1/6	4	66,167 00	68,597	63,737	62,992 00	15,875
2-7/8 WO	V-038R	1/6	4	79,273 40	81,704	76,843	76,098 40	15,875
3-1/2 WO	V-038R	1/6	4	96,723 20	99,154	94,293	93,548 20	15,875
2-7/8 XH	V-038R	1/6	4	79,222 60	81,653	76,792	76,047 60	15,875
3-1/2 XH	V-038R	1/6	4	91,541 60	93,972	89,111	88,366 60	15,875
3-1/2 H90	90-V-050	1/6	3,5	99,786 44	101,926	97,647	96,611 44	15,875
4 H90	90-V-050	1/6	3,5	109,311 44	111,451	107,172	106,136 44	15,875
4-1/2 H90	90-V-050	1/6	3,5	117,795 04	119,934	115,656	114,620 04	15,875
5 H90	90-V-050	1/6	3,5	124,665 74	126,805	122,527	121,490 74	15,875
5-1/2 H90	90-V-050	1/6	3,5	131,536 44	133,676	129,397	128,361 44	15,875

Table F.19 *(continued)*

Dimensions in millimetres, unless otherwise specified

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** [b] C	**Major (plug)** [b] **reference** D_{MP}	**Minor (ring)** [c] **reference** D_{MR}	**Pitch diameter at working gauge point** [d]	**Gauge stand-off** S
6-5/8 H90	90-V-050	1/6	3,5	147,411 44	149,551	145,272	144,236 44	15,875
7 H90	90-V-050	1/4	3,5	158,808 42	160,927	156,690	154,045 92	15,875
7-5/8 H90	90-V-050	1/4	3,5	181,383 94	183,502	179,265	176,621 44	15,875
8-5/8 H90	90-V-050	1/4	3,5	203,608 94	205,727	201,490	198,846 44	15,875
2-3/8 SL H90	90-V-084	5/48	3	65,481 20	67,361	63,602	63,496 83	15,875
2-7/8 SL H90	90-V-084	5/48	3	77,444 60	79,324	75,565	75,460 23	15,875
3-1/2 SL H90	90-V-084	5/48	3	93,675 20	95,555	91,796	91,690 83	15,875
GOST Z-161	V-050	1/6	4	155,962 25	159,000	152,924	152,787 25	15,875
GOST Z-189	V-050	1/6	4	183,462 25	186,500	180,424	180,287 25	15,875

[a] See Table F.20 for USC units.

[b] The values in columns 5 and 6 apply only to grand, regional, and reference master plug gauges.

[c] The values in column 7 apply only to ring gauges.

[d] The values in column 8 apply only to working plug gauges.

Table F.20 — Gauge thread dimensions
(USC units)

Dimensions in inches, unless otherwise specified

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** [a] C	**Major (plug)** [a] **reference** D_{MP}	**Minor (ring)** [b] **reference** D_{MR}	**Pitch diameter at working gauge point** [c]	**Gauge stand-off** S
NC10	V-055	1.5	6	1.063 00	1.102 0	1.024 0	0.969 25	0.625
NC12	V-055	1.5	6	1.265 00	1.304 0	1.226 0	1.171 25	0.625
NC13	V-055	1.5	6	1.391 00	1.430 0	1.352 0	1.297 25	0.625
NC16	V-055	1.5	6	1.609 00	1.648 0	1.570 0	1.515 25	0.625
NC77	V-038R	3	4	7.741 00	7.834 4	7.647 6	7.553 50	0.625
2-7/8 FH	V-040	3	5	3.365 40	3.458 8	3.272 0	3.177 90	0.625
3-1/2 FH	V-040	3	5	3.734 00	3.827 4	3.640 6	3.546 50	0.625

Table F.20 (*continued*)

1	2	3	4	5	6	7	8	9
				Diameter at gauge point				
Style and size	**Thread form**	**Taper**	**Threads per inch**	**Pitch** [a]	**Major (plug)** [a] **reference**	**Minor (ring)** [b] **reference**	**Pitch diameter at working gauge point** [c]	**Gauge stand-off**
		T in/ft	n	C	D_{MP}	D_{MR}		S
4-1/2 FH	V-040	3	5	4.532 00	4.625 4	4.438 6	4.344 50	0.625
5-1/2 IF	V-038R	2	4	6.189 00	6.282 7	6.095 3	6.064 00	0.625
6-5/8 IF	V-038R	2	4	7.251 00	7.344 7	7.157 3	7.126 00	0.625
2-3/8 OH LW	V-076	1.5	4	2.588 00	2.664 7	2.511 3	2.494 25	0.625
2-7/8 OH LW	V-076	1.5	4	2.984 00	3.060 7	2.907 3	2.890 25	0.625
2-7/8 OH SW	V-076	1.5	4	2.984 00	3.060 7	2.907 3	2.890 25	0.625
3-1/2 OH SW	V-076	1.5	4	3.728 00	3.804 7	3.651 3	3.634 25	0.625
4 OH LW	V-076	1.5	4	4.416 00	4.492 7	4.339 3	4.322 25	0.625
4 OH SW	V-076	1.5	4	4.416 00	4.492 7	4.339 3	4.322 25	0.625
4-1/2 OH SW	V-076	1.5	4	4.752 00	4.828 7	4.675 3	4.658 25	0.625
2-3/8 PAC	V-076	1.5	4	2.203 00	2.277 7	2.128 3	2.109 25	0.625
2-7/8 PAC	V-076	1.5	4	2.369 00	2.443 7	2.294 3	2.275 25	0.625
3-1/2 PAC	V-076	1.5	4	2.884 00	2.958 7	2.809 3	2.790 25	0.625
2-3/8 SH	V-038R	2	4	2.230 00	2.323 7	2.136 3	2.105 00	0.625
4 SH	V-038R	2	4	3.604 00	3.697 7	3.510 3	3.479 00	0.625
2-3/8 WO	V-038R	2	4	2.605 00	2.700 7	2.509 3	2.480 00	0.625
2-7/8 WO	V-038R	2	4	3.121 00	3.216 7	3.025 3	2.996 00	0.625
3-1/2 WO	V-038R	2	4	3.808 00	3.903 7	3.712 3	3.683 00	0.625
2-7/8 XH	V-038R	2	4	3.119 00	3.214 7	3.023 3	2.994 00	0.625
3-1/2 XH	V-038R	2	4	3.604 00	3.699 7	3.508 3	3.479 00	0.625
3-1/2 H90	90-V-050	2	3.5	3.928 60	4.012 8	3.844 4	3.803 60	0.625
4 H90	90-V-050	2	3.5	4.303 60	4.387 8	4.219 4	4.178 60	0.625
4-1/2 H90	90-V-050	2	3.5	4.637 60	4.721 8	4.553 4	4.512 60	0.625
5 H90	90-V-050	2	3.5	4.908 10	4.992 3	4.823 9	4.783 10	0.625
5-1/2 H90	90-V-050	2	3.5	5.178 60	5.262 8	5.094 4	5.053 60	0.625
6-5/8 H90	90-V-050	2	3.5	5.803 60	5.887 8	5.719 4	5.678 60	0.625
7 H90	90-V-050	3	3.5	6.252 30	6.335 7	6.168 9	6.064 80	0.625
7-5/8 H90	90-V-050	3	3.5	7.141 10	7.224 5	7.057 7	6.953 60	0.625
8-5/8 H90	90-V-050	3	3.5	8.016 10	8.099 5	7.932 7	7.828 60	0.625
2-3/8 SL H90	90-V-084	1.25	3	2.578 00	2.652 0	2.504 0	2.499 88	0.625
2-7/8 SL H90	90-V-084	1.25	3	3.049 00	3.123 0	2.975 0	2.970 88	0.625
3-1/2 SL H90	90-V-084	1.25	3	3.688 00	3.762 0	3.614 0	3.609 88	0.625
GOST Z-161	V-050	2	4	6.140 25	6.259 8	6.020 6	6.015 25	0.625
GOST Z-189	V-050	2	4	7.222 92	7.342 5	7.103 3	7.097 92	0.625

[a] The values in columns 5 and 6 apply only to grand, regional, and reference master plug gauges.

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

[c] The values in column 8 apply only to working plug gauges.

Table F.21 — Gauge external dimensions
(SI units [a])

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [b] D_{FP} max.	**Ring gauge length** L_{rg}	**Ring gauge outside diameter** D_R reference	**Diameter of ring gauge counterbore** Q min.
NC10	38,1	22,45	22,23	52,64	29,85
NC12	44,45	27,58	28,58	58,80	34,98
NC13	44,45	30,78	28,58	62,64	38,18
NC16	44,45	36,32	28,58	69,28	43,71
NC77	165,1	190,69	149,23	257,84	200,85
2-7/8 FH	88,9	79,55	73,03	124,47	89,71
3-1/2 FH	95,25	88,92	79,38	135,71	99,07
4-1/2 FH	101,6	109,18	85,73	160,03	119,34
5-1/2 IF	127	151,27	111,13	210,55	161,43
6-5/8 IF	127	178,24	111,13	242,92	188,41
2-3/8 OH LW	60,325	60,23	44,45	100,27	69,54
2-7/8 OH LW	63,5	70,29	47,63	112,34	79,60
2-7/8 OH SW	73,025	70,29	57,15	112,34	79,60
3-1/2 OH SW	82,55	89,19	66,68	135,02	98,49
4 OH LW	88,9	106,66	73,03	155,99	115,97
4 OH SW	101,6	106,66	85,73	155,99	115,97
4-1/2 OH SW	95,25	115,20	79,38	166,23	124,50
2-3/8 PAC	60,325	50,50	44,45	88,47	59,71
2-7/8 PAC	60,325	54,72	44,45	93,53	63,92
3-1/2 PAC	82,55	67,80	66,68	109,23	77,00
2-3/8 SH	73,025	50,71	0,00	89,88	60,88
4 SH	88,9	85,61	0,00	131,76	95,78
2-3/8 WO	60,325	60,18	44,45	101,37	70,45
2-7/8 WO	88,9	73,29	73,03	117,09	83,56
3-1/2 WO	88,9	90,74	73,03	138,03	101,01
2-7/8 XH	101,6	73,24	85,73	117,03	83,51
3-1/2 XH	88,9	85,56	73,03	131,82	95,83
3-1/2 H90	101,6	94,09	85,73	141,36	103,78
4 H90	107,95	103,62	92,08	152,79	113,30
4-1/2 H90	114,3	112,10	98,43	162,97	121,79
5 H90	120,65	118,97	104,78	171,22	128,66
5-1/2 H90	120,65	125,84	104,78	179,46	135,53

Table F.21 (*continued*)

Dimensions in millimetres, unless otherwise specified

1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [b] D_{FP} max.	**Ring gauge length** L_{rg}	**Ring gauge outside diameter** D_R reference	**Diameter of ring gauge counterbore** Q min.
6-5/8 H90	127	141,72	111,13	198,51	151,40
7 H90	139,7	153,13	123,83	212,16	162,78
7-5/8 H90	155,575	175,71	139,70	239,25	185,36
8-5/8 H90	168,275	197,93	152,40	265,92	207,58
2-3/8 SL H90	71,4248	60,05	55,55	99,88	69,22
2-7/8 SL H90	74,5998	72,01	58,72	114,24	81,18
3-1/2 SL H90	80,9625	88,24	65,09	133,72	97,41
GOST Z-161	127	149,37	111,13	209,85	160,85
GOST Z-189	127	176,87	111,13	242,85	188,35

NOTE See Figures 19 and 20 for meaning of dimensions.

[a] See Table F.22 for USC units.

[b] The thickness of fitting plates, T_{FP}, shall be 9,53 mm maximum for all gauge sizes with pitch diameter less than 143,0 mm and 11,10 mm maximum for all larger gauge sizes.

Table F.22 — Gauge external dimensions
(USC units)

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [a] D_{FP} max.	**Ring gauge length** L_{rg}	**Ring gauge outside diameter** D_R reference	**Diameter of ring gauge counterbore** Q min.
NC10	1.500	0.884	0.875	2.072	1.175
NC12	1.750	1.086	1.125	2.315	1.377
NC13	1.750	1.212	1.125	2.466	1.503
NC16	1.750	1.430	1.125	2.728	1.721
NC77	6.500	7.508	5.875	10.151	7.907
2-7/8 FH	3.500	3.132	2.875	4.901	3.532
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

Table F.22 (*continued*)

Dimensions in inches, unless otherwise specified

1	2	3	4	5	6
Style and size	**Plug gauge length** L_{pg}	**Fitting plate diameter** [a] D_{FP} max.	**Ring gauge length** L_{rg}	**Ring gauge outside diameter** D_R reference	**Diameter of ring gauge counterbore** Q min.
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	0.000	3.538	2.397
4 SH	3.500	3.370	0.000	5.187	3.771
NC10	1.500	0.884	0.875	2.072	1.175
NC12	1.750	1.086	1.125	2.315	1.377
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] The thickness of fitting plates, T_{FP}, shall be 0.375 in maximum for all gauge sizes with pitch diameter less than 5.63 in and 0.437 in maximum for all larger gauge sizes.

Annex G
(informative)

USC units conversion table

G.1 Conversion table

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

Table G.1 — Conversions factors for metric to USC units

1 mm (millimetre)	= 1/25,4 in = 1/304,8 ft
1 mm/mm (millimetres per millimetre)	= 12 in/ft (inches per foot) = 1 in/in (inch per inch)
1 thread per 25,4 mm	= 1 thread per 1 in
1 kg (kilogram)	= 2,204 6 lb (pounds)

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

$$t_F = (1{,}8 \times t_C) + 32 \qquad \text{(G.1)}$$

G.2 Rounding

The majority of dimensions in this part of ISO 10424 are defined in USC units in API Spec 7. The values used here in SI units are converted using the following rules:

— 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.

— These values include C, f_c, f_r and R.

— Lead and taper are expressed using exact conversions.

— All other dimensions are converted to one fewer decimal place than the original USC units. The conversion to SI units is made so that when reconverted to USC units, with ISO rounding rules, the result is equal to the historical USC value.

— The last retained digit in a number is unchanged when the next digit is less than “5” or raised when it is greater than “5”. When the digit following the last retained digit is exactly “5” followed by all zeros, the last retained digit is unchanged if it is even, or is raised if it is odd.

Annex H
(informative)

Recommended practice for gauging new rotary shouldered connections

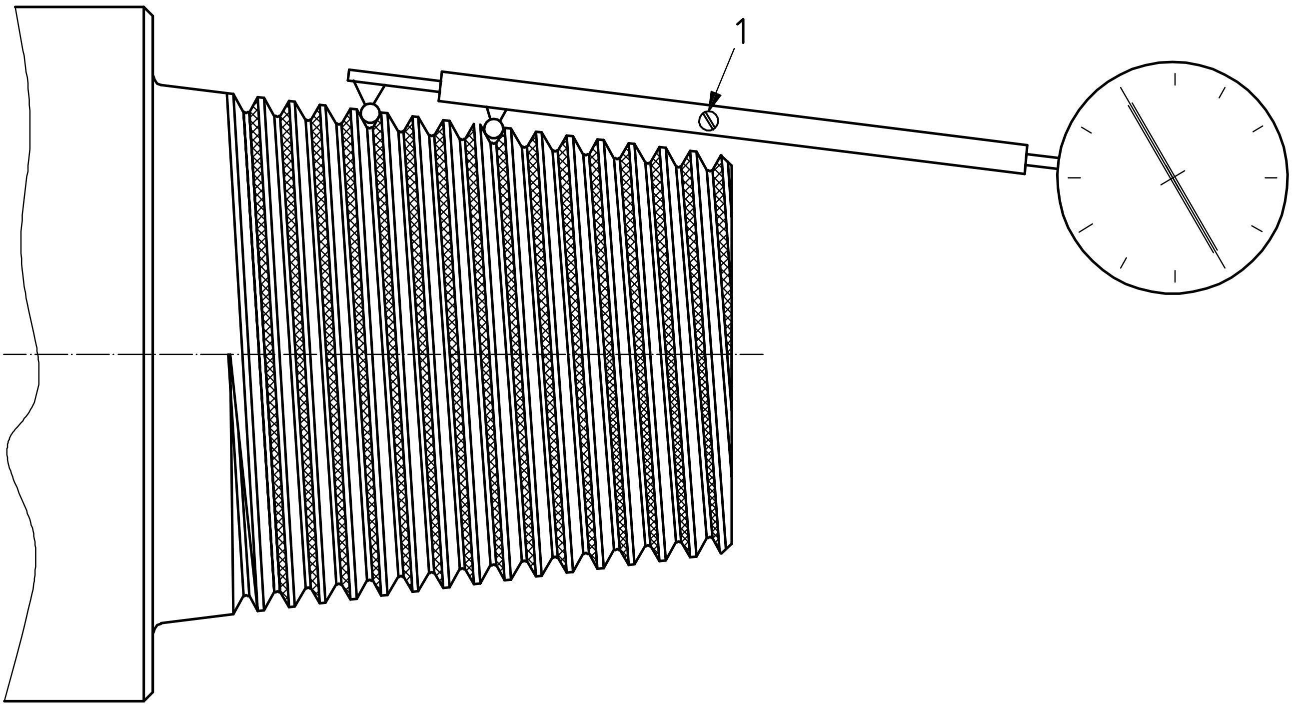
H.1 General

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.

H.2 Lead gauges

H.2.1 General

The lead of threads should be gauged with a lead gauge, one type of which is illustrated in Figure H.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 accuracy of the measuring mechanism shall be 0,005 mm (0.000 2 in) or better.



Key

1 adjusting screw

Figure H.1 — External lead measurement

H.2.2 Adjustment of gauges

Before use, the movable ball-point should be set to provide a distance between points equal to the interval of threads to be gauged (see Table 6) 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, the lock screw on the arm should be loosened, the gauge adjusted to zero by means of the adjusting screw, and the lock screw tightened. This adjustment should be repeated until the gauge registers zero when applied to the template.

H.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.

H.3 Taper measurement

H.3.1 Taper callipers

The taper of threads should be measured with an instrument having a dial-gauge caliper similar to that illustrated in Figures H.2 and H.3. The calliper shall have an accuracy of 0,010 mm (0.000 4 in) or better within the measurement range used.

H.3.2 Procedure for taper measurements

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.

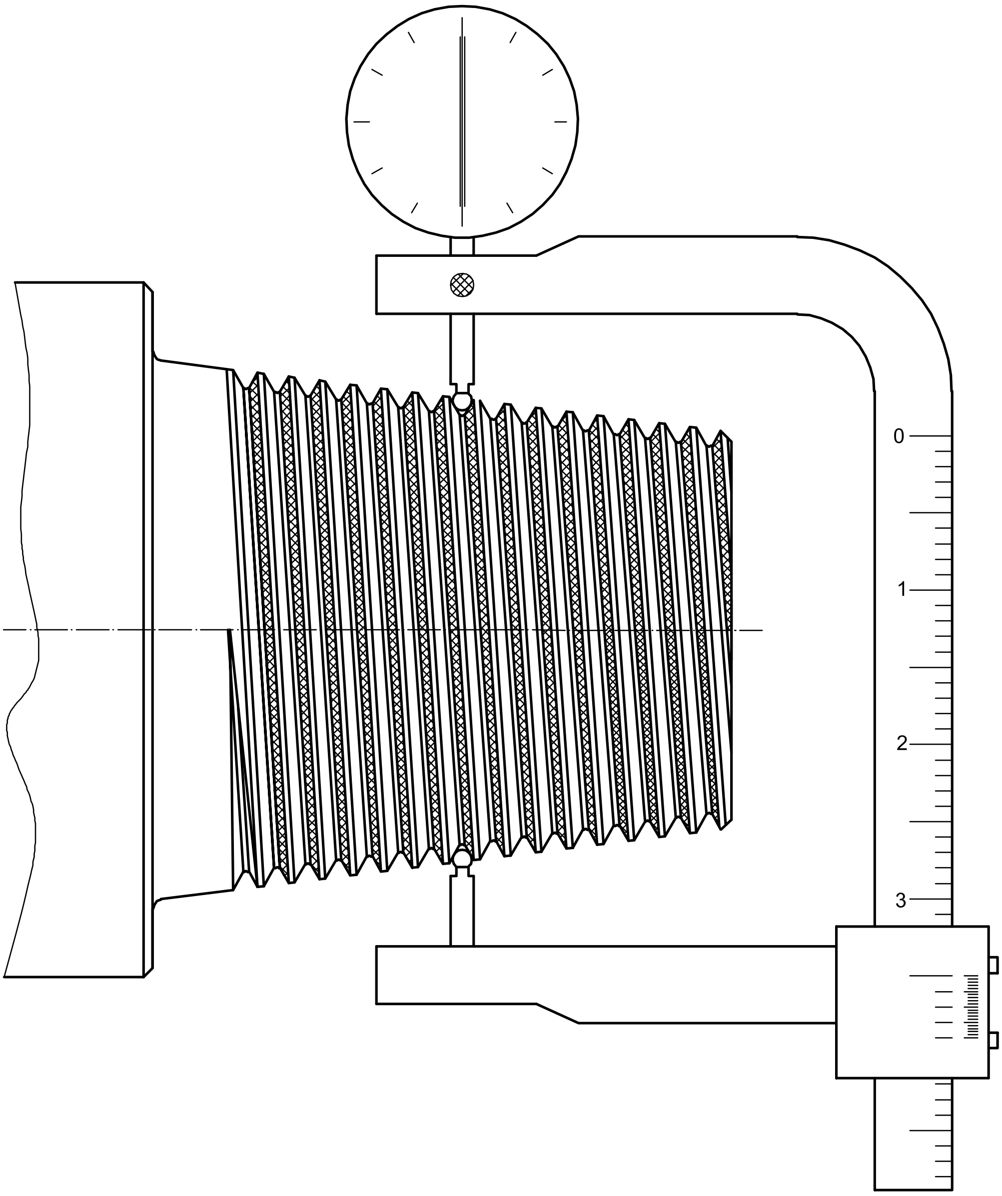


Figure H.2 — Taper measurement — External (pin)

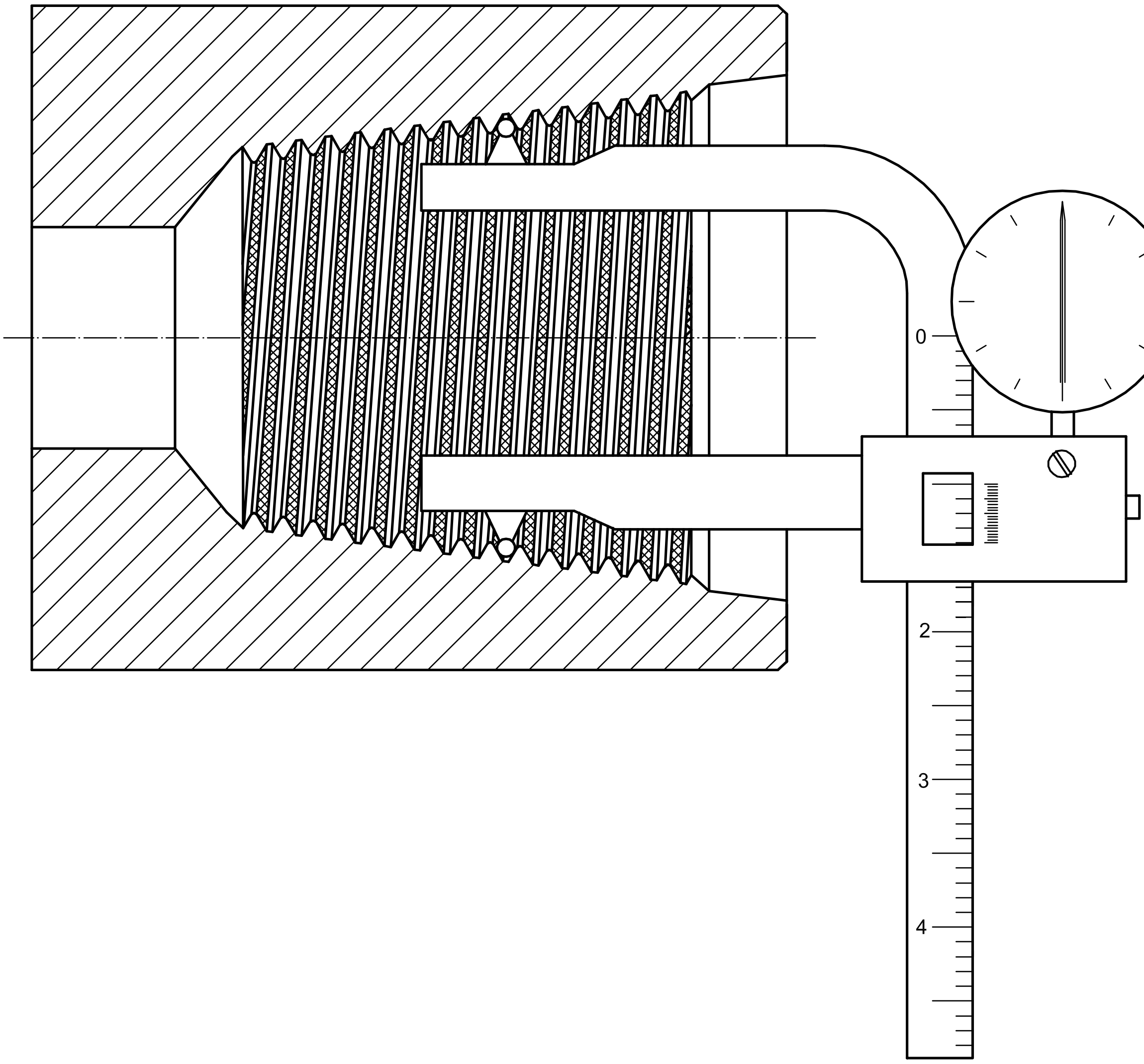


Figure H.3 — Taper measurement internal (box)

H.4 Thread height measurement

H.4.1 Thread height gauges

Thread height should be measured with gauges similar to the type illustrated in Figure H.4 for external threads and internal threads as size permits, or the type illustrated in Figure H.5 for small internal threads. Such gauges shall have indicators graduated to register the deviation in thread height, as illustrated in Figure H.6.

H.4.2 Adjustment

Gauges shall be adjusted when applied to the U-groove for the type of thread to be measured. Gauges having indicators for determining deviation in thread height shall be adjusted to register zero when applied to the applicable groove. Gauges having 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 H.5, if the standard template cannot be positioned flat on the anvil with the pressure arm applied, the arm shall be shifted out of the way to prevent contact with the standard template during adjustment of checks.

H.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 H.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 H.6, the gauge cannot be oscillated. Confirm that the gauge is well seated and properly centred in the groove before taking reading.

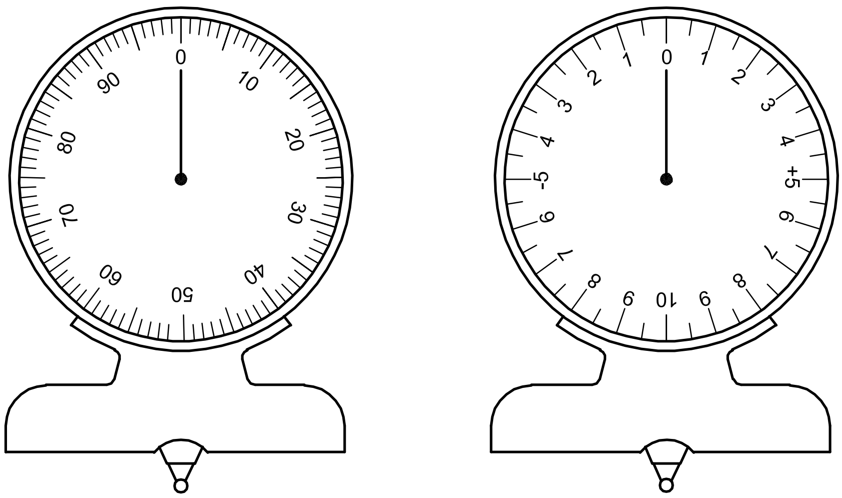


Figure H.4 — Thread-height gauge

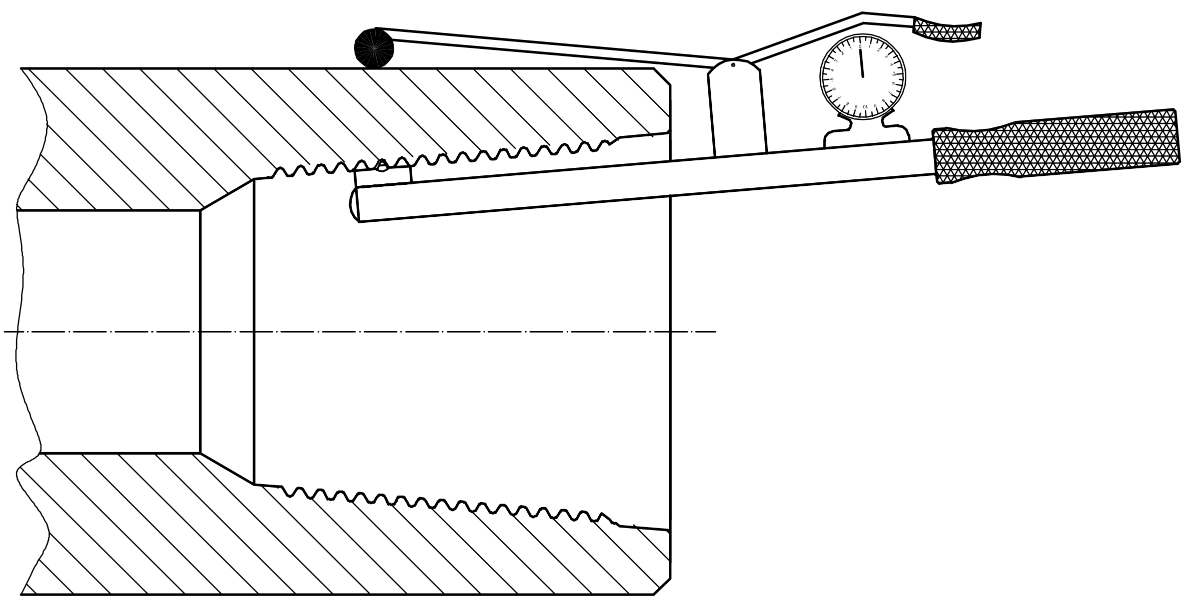


Figure H.5 — Thread-height measurement — Box

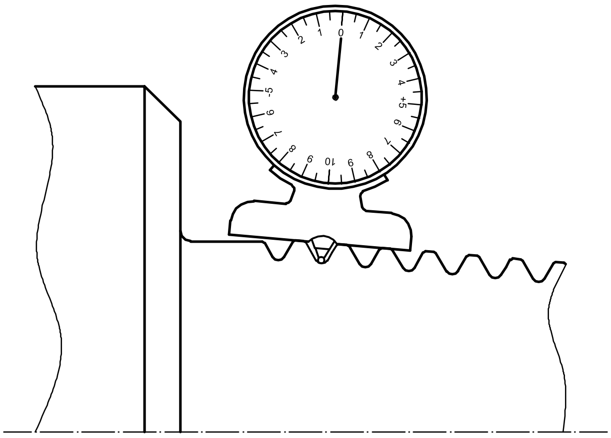


Figure H.6 — Thread-height measure — Pin

Annex I
(informative)

Calculations

I.1 Thread dimensions

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

I.2 Primary dimensions

Table I.1 — Primary dimensions

Pitch diameter at gauge point dimension, L_{GP}	C
Threads per 25,4 mm (1 in)	n
Taper	T
Half angle between thread flanks	θ
Crest flat width	F_c
Root flat width	F_r
Root radius	R
Pin length	L_{PC}
Gauge point from shoulder	L_{GP}

I.3 Derived dimensions

I.3.1 These relations follow from the thread definitions and are used throughout this part of ISO 10424.

I.3.2 Lead, P; see Figure 3:

$$P = 25{,}4 \text{ mm}/n \text{ (1 in}/n)$$

I.3.3 Thread height, H, before truncation; see Figure 3:

$$H = P[1 - (T\tan\theta/2)^2]/(2\tan\theta)$$

I.3.4 Cone half-angle, φ; see Figure 1:

$$\varphi = \arctan(T/2)$$

I.3.5 Crest truncation, f_c; see Figure 3:

$$f_c = F_c[1 - (T\tan\theta/2)^2]/(2\tan\theta)$$

I.3.6 Root truncation, f_r, when there is a root flat; see Figure 4:

$$f_r = F_r[1 - (T\tan\theta/2)^2]/(2\tan\theta)$$

I.3.7 Root truncation when there is no root flat; see Figure 3:

$$f_r = R(1 - \sin\theta)/\sin\theta$$

I.3.8 Major cone diameter, D_L, at pin base; see Figure 1:

$$D_L = C + L_{GP}T + H - 2f_c$$

I.3.9 Major diameter, D_S, at small end of pin; see Figure 1:

$$D_S = D_L - TL_{PC}$$

I.4 Design rules

I.4.1 These relations are the result of design choices and do not necessarily agree with the values defined as standards in this part of ISO 10424. In particular, some of the computed dimensions have historically been rounded in inch units.

I.4.2 Box depth, L_{BC}; see Figure 2:

$L_{BC} = L_{PC} + 15{,}87$ mm (0.62 in).

I.4.3 Box thread depth, L_{BT}; see Figure 2:

$L_{BT} = L_{PC} + 3{,}18$ mm (0.12 in).

I.4.4 Bevel diameters; see Figure 1.

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 down-hole bending. In general, bevels are intended to produce a sealing face that is 65 % to 75 % as wide as the un-bevelled shoulder.

Bevel diameters should be of equal size, within manufacturing tolerances, on mating pins and boxes to minimize the formation of grooves on the sealing faces.

A connection of a given size and style when used on drill collars may find usage on a wide variety of outside diameters. To compensate for the increased width of the un-bevelled face, the bevel diameter should also increase.

Generally, on connections with threads designed with 60° included thread flank angles, the bevel diameter is re-calculated for every 6,4 mm (0.25 in) increase (or decrease) in outside diameter of the drill collar. For every 6,4 mm (0.25 in) increase (or decrease) in outside diameter, the bevel diameter is also increased (or decreased) by 4,8 mm (0.19 in).

Bevel diameters for most connections designed with 60° included thread flank angles can be determined if the design OD is known. Table 3 lists reference ODs and corresponding reference bevel diameters for most 60° included flank angle connections. These reference points were derived by extending the original design ODs and bevels by the amounts discussed above. The OD used in Table 3 is the nominal, without regard to any tolerance.

EXAMPLE Find the required bevel diameter of a drill collar of nominal OD of 175 mm (6.88 in) and NC50 connections. The starting OD (reference OD) is 161,9 mm (6.38 in) or a difference of 13,1 mm (0.52 in). This is 2 times 6,4 mm (0.25 in), so the bevel diameter is 155,2 mm + (2 × 4,8) = 164,80 mm [6.11 in + (2 × 0.19) = 6.49 in].

Exceptions to the rule: The bevel diameter for the NC50 (and connections that interchange with it) on 155,58 mm and 158,75 mm (6 1/8 in and 6 1/4 in) OD drill collars has been arbitrarily set at 153,988 mm (6.062 in), which is outside the rule.

I.4.5 Boreback diameter, D_{CB}, and boreback length, L_{CYL}; see Figure 8:

$$L_{CYL} = L_{PC} - 12{,}7 \text{ mm } (0.5 \text{ in})$$

$$D_{CB} = C + L_{GP}\,T + H - 2f_r - L_{CYL}T$$

I.4.6 Box groove diameter, D_{BG}, and box groove length, L_{BG}; see Figure 10:

$$L_{BG} = L_P - 9{,}52 \text{ mm } (0.375 \text{ in})$$

$$h_{bg} = 5{,}16 \text{ mm } (0.203 \text{ in})$$

$$R_{bg} = 6{,}35 \text{ mm } (0.250 \text{ in})$$

$$D_{BG} = C - T(L_{BG} - L_{GP}) + 2B$$

$$B = \left\{h_{bg} - R_{bg}\left[1 - \cos\left(45° + \varphi\right)\right]\right\}\left[\frac{\sin\left(45°\right)}{\sin\left(45° + \varphi\right)}\right] + R_{bg}\left(1 - \cos 45°\right) - f_c$$

Values of B are listed in Table I.2

I.4.7 Pin stress-relief groove, D_{SRG}; see Figure 9:

$$D_{SRG} = C - H + 2f_r - A$$

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 I.2:

Table I.2 — Auxiliary design dimensions

1	2	3	4	5	6	7
Thread form	**Taper** T	θ	**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	N/A	N/A	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)

I.5 Gauge dimensions

Major diameter, D_{MP}, at gauge point, L_{GP}:

$$D_{MP} = C + (H - 2f_{cg})$$

Minor diameter, D_S, at gauge point, L_{GP}:

$$D_{MR} = C - (H - 2f_{cg})$$

Pitch diameter, C_{GP}, at working gauge point:

$$C_{GP} = C - 19{,}05\ \text{mm}\cdot T$$

$$[C_{GP} = C - 1.375\ \text{in}\cdot(T/12)]$$

$$L_{ct} = 25{,}4\ \text{mm}/\cos\varphi$$

$$(L_{ct} = 1.0\ \text{in}/\cos\varphi)$$

$$D_b = P/(2\cos\theta)$$

Gauge thread height, h_g:

$$h_g = H - f_{cg} - f_{rg}$$

Gauge thread with crest truncation, f_{cg}, for thread forms (V-038R, V-040, V-050) with full root radius, R:

$f_{cg} = R\cos\theta(\tan\varphi + \cot\theta)$ plus an allowance of 0,01 mm to 0,012 mm (0.004 in to 0.005 in)

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

$f_{cg} = f_r + r\cdot(1/\cos\varphi - \sin\theta - \cos\theta\tan\varphi)$ plus an allowance of 0,01 mm to 0,012 mm (0.004 in to 0.005 in)

$f_{rg} = f_{cg}$.

Annex J
(informative)

API grand and regional master rotary connection gauges

J.1 Tables J.1 through J.4 list the regional master gauges known to be in interchange correspondence with the API grand master gauges at the US National Institute of Standards and Technology as of 2005. They are listed for the convenience of those wishing to have gauges certified.

Table J.1 — Registration numbers for gauges for numbered connections

Organization	Numbered connections										
	NC26	NC31	NC35	NC38	NC40	NC44	NC46	NC50	NC56	NC61	NC70
Grand master gauge registration number											
National Institute of Standards and Technology, Gaithersburg, MD 20899, USA	4401	4402	7000	4403	3005	7001	4404	4405	7002	7003	7004
Regional master gauge registration number											
Chengdu Measuring & Cutting Tool Works, Chengdu, People's Republic of China	—	—	—	7831	—	—	—	7832	—	—	—
Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina	7012	7013	—	7014	8082	—	7015	7016	1148	—	—
National Institute of Metrology, Standardization and Industrial Quality, Rio de Janeiro, Brazil	7847	7848	—	7849	7850	—	7851	7852	—	—	—
PMC Lone Star, Willoughby, Ohio, USA	10742	10724	8058	10400	10744	8061	10725	10395	—	8065	—
National Institute of Metrology, Beijing, People's Republic of China	7834	7835	7836	7837	7838	7839	7840	7841	7842	7843	7844
National Physical Laboratory, Teddington, England	8939	8947	7008	8954	3007	7009	8952	8938	7010	7011	8937
National Research Laboratory, Ibaraki, Japan	—	4420	—	4421	—	—	—	4422	—	—	—
TGRC China National Petroleum, Baoji, People's Republic of China	1706	1705	1707	1708	1709	1710	10602	1702	1711	1712	1713

Table J.2 — Registration numbers for gauges for regular right-hand connections

Organization	Right-hand connections							
	2-3/8 REG	2-7/8 REG	3-1/2 REG	4-1/2 REG	5-1/2 REG	6-5/8 REG	7-5/8 REG	8-5/8 REG
Grand master gauge registration number								
National Institute of Standards and Technology, Gaithersburg, MD 20899, USA	1101	1102	1103	1104	1105	1700	1142	1701
Regional master gauge registration number								
Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina	1148	1149	1150	6501	6502	6503	6504	—
National Institute of Metrology, Standardization and Industrial Quality, Rio de Janeiro, Brazil	7856	7875	7876	7877	7878	7879	7880	—
China National Instrument	—	—	10615	—	10608	—	—	—
PMC Lone Star, Willoughby, Ohio, USA	1122	1123	1124	1125	1126	P-46403 and R-46161	10712	1128
National Institute of Metrology, Beijing, People's Republic of China	—	10605	10601	10607	10617	—	10609	10619
National Physical Laboratory, Teddington, England	8945	8946	8948	8953	8951	8950	1146	1147
National Research Laboratory, Ibaraki, Japan	—	—	—	1143	1144	1145	—	—
National Measurement Laboratory, Lindfield, NSW, Australia	—	6022	6023	6024	—	6025	—	—
TGRC China National Petroleum, Baoji, People's Republic of China	1714	1731	1715	1704	1716	1717	1718	1719

Table J.3 — Registration numbers for gauges for regular left-hand connections

Organization	Left-hand connections							
	2-3/8 REG LH	2-7/8 REG LH	3-1/2 REG LH	4-1/2 REG LH	5-1/2 REG LH	6-5/8 REG LH	7-5/8 REG LH	8-5/8 REG LH
Grand master gauge registration number								
National Institute of Standards and Technology, Gaithersburg, MD 20899, USA	1751	1752	1753	1754	1755	1756	1779	1757
Regional master gauge registration number								
National Institute of Metrology, Standardization and Industrial Quality, Rio de Janeiro, Brazil	7881	7882	7883	7884	7885	7886	—	—
PMC Lone Star, Willoughby, Ohio, USA	1758	1759	1760	1761	1762	1763	—	1764
National Institute of Metrology, Beijing, People's Republic of China	—		—	—	—	7890	—	—
National Physical Laboratory, Teddington, England	1771	1772	1773	8940	—	8966	—	—
National Measurement Laboratory, Lindfield, NSW, Australia	—	—	—	1916	—	—	—	—
TGRC China National Petroleum, Baoji, People's Republic of China	1724	1725	1726	—	1727	1728	1729	1730

Table J.4 — Registration numbers for gauges for FH and IF connections

Organization	FH and IF connections				
	3-1/2 FH [a]	4-1/2 FH [a]	5-1/2 FH	6-5/8 FH	5-1/2 IF [a]
Grand master gauge registration number					
National Institute of Standards and Technology, Gaithersburg, MD 20899, USA	3001	3002	3003	3004	4406
Regional master gauge registration number					
Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina	—	—	3031	3032	—
National Institute of Metrology, Standardization and Industrial Quality, Rio de Janeiro, Brazil	7853	7854	7855	—	—
PMC Lone Star, Willoughby, Ohio, USA	—	—	3027	—	—
National Institute of Metrology, Beijing, People's Republic of China	10620	10612	7845	10613	7846
National Physical Laboratory, Teddington, England	8949	8957	8955	3010	8967
National Research Laboratory, Ibaraki, Japan	3027	3028	3030	—	—
National Measurement Laboratory, Lindfield, NSW, Australia	—	3228	—	—	—
TGRC China National Petroleum, Baoji, People's Republic of China	1720	1721	1703	1722	1723

[a] These connections are non-preferred, but are supported by the API gauge system for historical reasons.

ICS 75.180.10

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