Oilfield Hammer Unions

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Oilfield Hammer Unions

1 Scope

1.1 Purpose

This standard specifies minimum requirements for the dimensional and functional interchangeability, design, materials, inspection, marking, storing, and shipment of hammer union parts and assemblies for use in the petroleum and natural gas industries.

This standard does not address the manner (i.e. integral, weld or thread) in which hammer unions are attached to other parts. Requirements for repair and remanufacture of hammer union parts are not included in this standard.

WARNING Hammer unions manufactured under the requirements of this standard are only to be considered interchangeable with hammer unions also manufactured to the requirements of this standard. Hammer unions manufactured under the requirements of this standard are assumed to not be interchangeable with hammer unions not conforming to this standard.

1.2 Applicability

This standard is applicable only to the following figures, nominal sizes, temperatures, and service conditions of hammer unions:

— Figure Numbers: 602, 1002, and 1502

  — Nominal Size: 1 in., 1.5 in., 2 in., 3 in., and 4 in.

— Figure Numbers: 2002 and 2202

  — Nominal Size: 2 in. and 3 in.

— Temperature Range: −75 °F to 250 °F (−60 °C to 121 °C)

— Service: Standard and Sour Service

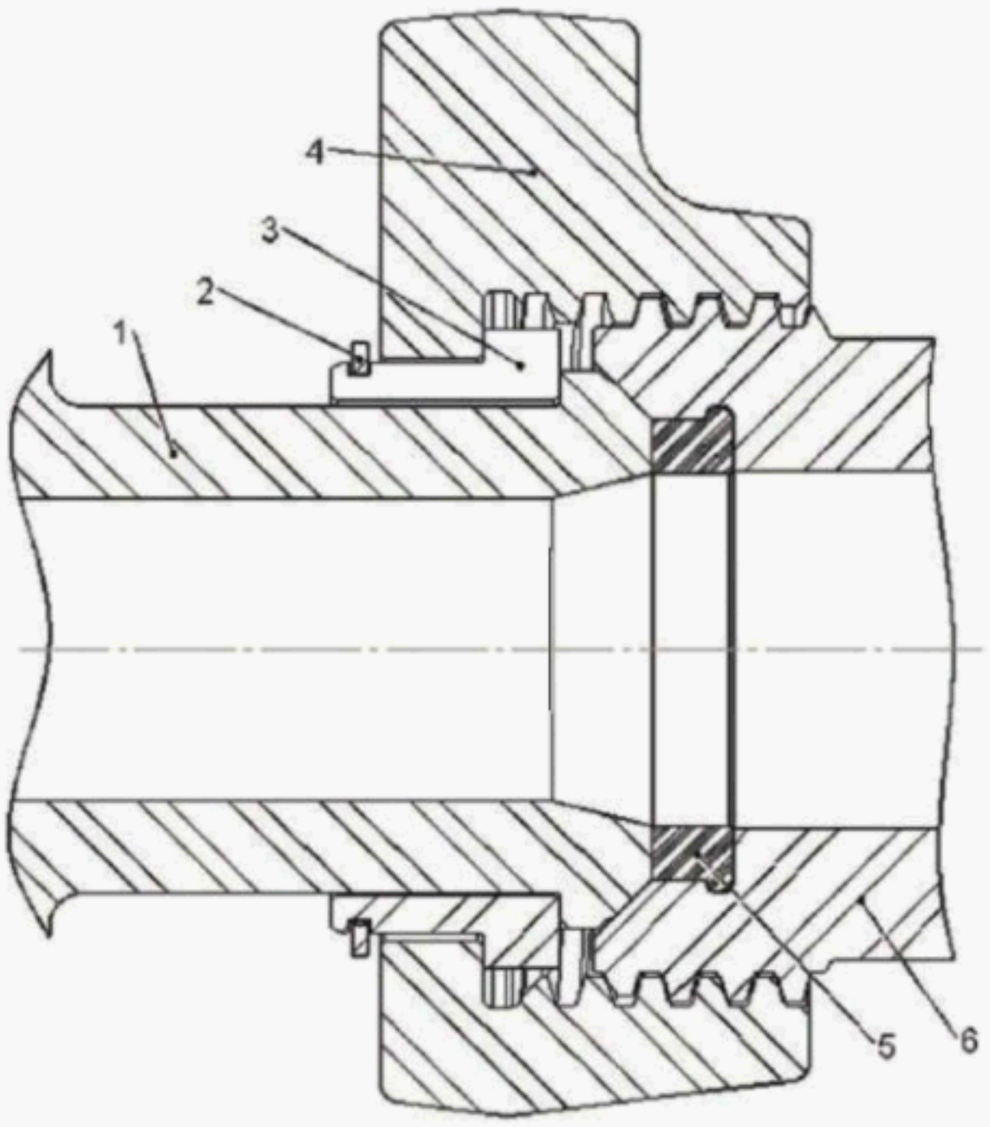
This standard is only applicable to surface installations that are not intended to be insulated, buried, or otherwise denied direct exposure to atmosphere.

1.3 Service Conditions

This standard defines service and operating conditions in terms of pressure, temperature, and sour classification for the retained fluids.

1.4 Hammer Union Assembly Nomenclature

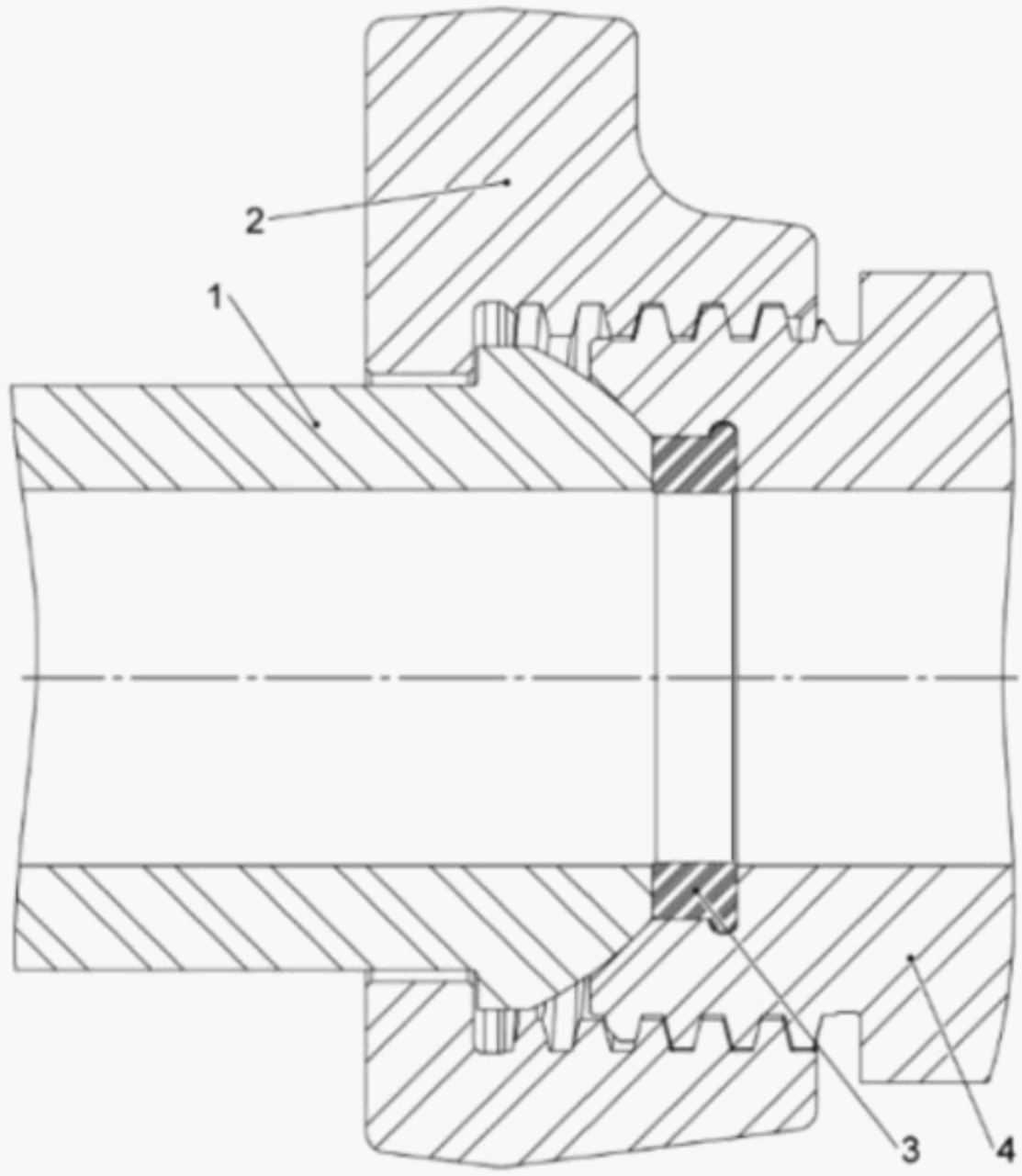
Figure 1 and Figure 2 are examples of hammer unions types within the scope of this standard. Typical figure callouts in this standard are nominal size and figure (e.g. 3” Figure 1502).



Key

Pressure-containing		Pressure-retaining		Miscellaneous	
1	male-end connector	3	nut retainer segments	2	segment retainer ring
5	resilient seal	4	union nut		
6	female-end connector				

Figure 1—Typical Removable Nut Hammer Union Assembly



Key

Pressure-containing		Pressure-retaining	
1	male end connector	2	union nut
3	resilient seal		
4	female end connector		

Figure 2—Typical Non–removable Nut Hammer Union Assembly

2 Normative References

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

API Recommended Practice 7HU1, *Safe Use of 2-inch Hammer Union for Oilfield Applications*

API Specification 6A, *Specification for Wellhead and Tree Equipment*

NACE MR0175/*ISO 15156* [1], *Petroleum and natural gas industries—Materials for use in H2S-containing environments in oil and gas production—Parts 1, 2, and 3*

ASME B1.5, *ACME Screw Threads*

ASME B1.8, *Stub ACME Screw Threads*

[1] NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77084-4906, www.nace.org

ASNT SNT-TC-1A [2] , *Personnel Qualification and Certification in Nondestructive Testing*

ASTM A370 [3] , *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

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

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

ASTM E110, *Standard Test Method for Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers*

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

ASTM E165, *Standard Test Method for Liquid Penetrant Testing for General Industry*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

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

ISO 6506 [4] , *Metallic materials — Brinell hardness test, (all parts)*

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

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

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

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

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

3.1.1
acceptance criteria
Defined limits placed on characteristics of materials, products, processes or services.

3.1.2
accessible surface
Surface readily available for purposes of nondestructive examination that can be viewed by direct line of sight.

3.1.3
chemical analysis
Determination of the chemical composition of material.

3.1.4
date of manufacture
Date of manufacturer's final acceptance of finished part or equipment.

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[2] American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228, www.asnt.org
[3] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org
[4] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org

3.1.5
figure number
Number that designates the dimensional compatibility for a given size.

NOTE The figure number alone is not indicative of pressure rating. It is the user's responsibility to assure that unions are only assembled such that service and pressure ratings are compatible.

3.1.6
forge (verb)
Deform metal plastically into desired shapes with compressive force.

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

3.1.7
function
Operation of a product during service.

3.1.8
heat
Material originating from a final melt, or for re-melted alloys, the raw material originating from a single re-melted ingot.

3.1.9
heat-treatment
heat-treating
Specified, timed sequence of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties.

3.1.10
hot-work
Deform metal plastically at a temperature above the recrystallization temperature.

3.1.11
part
Individual piece used in a hammer union assembly

EXAMPLE Union nut, segment retainer set, male and female end, etc. are parts of a hammer union.

NOTE A part may also be a piece not in finished form.

3.1.12
pressure-containing part
Part exposed to retained fluids whose failure to function as intended results in a release of retained fluid to the atmosphere.

3.1.13
pressure-retaining part
Part not exposed to retained fluids whose failure to function as intended results in a release of retained fluid to the atmosphere.

3.1.14
rated working pressure
Maximum internal pressure that the pressure-containing part is designed to contain when in operation.

3.1.15
record (noun)
Retrievable information.

3.1.16
relevant indication
Surface-rupture NDE indication with major dimensions greater than 1.6 mm ($^{1}/_{16}$ in.).

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

3.1.17
retained fluid
Actual fluid contained by pressure-containing parts.

3.1.18
sour service
Exposure to oilfield environments that contain sufficient H2S to cause cracking of materials by the mechanisms addressed by NACE MR0175/ISO 15156.

3.1.19
standard service
Exposure to oilfield environments that do not contain sufficient H2S to cause cracking of materials by the mechanisms addressed by NACE MR0175/ISO 15156.

3.1.20
wetted surface
Any surface intended to have contact with retained fluid.

3.1.21
wrought
Product, structure, or material that contains no cast dendritic elements.

3.1.22
yield strength
Stress level at which material plastically deforms and does not return to its original dimensions when the load is released.

NOTE All yield strengths specified in this standard are considered as being the 0.2 % yield offset strength in accordance with ISO 6892 or ASTM A370.

3.2 Abbreviations

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

AQL	acceptable quality level
ER	equivalent round
FIG	figure
HBW	Brinell hardness number
MT	magnetic particle test
NDE	nondestructive examination
NPST	non-pressure seal thread
PT	liquid penetrant examination
QTC	qualification test coupon

4 Design and Performance—General Requirements

4.1 Service Conditions

4.1.1 Material Service Ratings

For sour service, the material shall meet the requirements of NACE MR0175/ISO 15156 for chemistry, processing, and properties (e.g. hardness) for the male-end connector, female-end connector, and union nut.

NOTE 1 Choosing specific materials for specific conditions is ultimately the responsibility of the purchaser.

NOTE 2 Resistance to cracking caused by H2S is influenced by several other factors, some of the limits for which are given in NACE MR0175/ISO 15156. These include, but are not limited to:

— pH;

— temperature;

— chloride concentration;

— elemental sulfur.

NOTE Nut retainer segments are not required to meet the requirements of NACE MR0175/ISO 15156, regardless of standard or sour service.

4.1.2 Pressure Ratings

The rated working pressure for union connectors shall not exceed the pressure ratings in Table 1.

NOTE The hammer unions covered in this standard are capable of withstanding hydrostatic Factory Acceptance Testing at 1.5 times rated working pressure for new assemblies, when the requirements of this standard are followed.

Table 1—Pressure Rating for Union Figure Number and Service

Figure Number	Pressure Rating	
	Standard Psi (MPa)	Sour Psi (MPa)
602	6000 (41.4)	6000 (41.4)
1002	10,000 (69.0)	7500 (51.7)
1502	15,000 (103.5)	10,000 (69.0)
2002	20,000 (138.0)	N/A
2202	N/A	15,000 (103.5)

4.1.3 Temperature Ratings

Metallic parts shall use one or more of the specified temperature ratings with minimum and maximum temperatures as shown in Table 2 or custom temperature ranges within the range specified in 1.2.

NOTE Minimum temperature is the lowest temperature to which the part may be subjected during operation. Maximum temperature is the highest temperature to which the part may be subjected during operation. Temperatures during assembly and installation are out of scope of these temperature ranges.

Table 2—Temperature Ratings for Metallic Parts

Temperature Classification	Temperature Range [a]			
	°F		(°C)	
	Min. [b]	Max. [c]	Min. [b]	Max. [c]
K	–75	180	–60	82
L	–50	180	–46	82
N	–50	140	–46	60
P	–20	180	–29	82
S	0	140	–18	60
T	0	180	–18	82
U	0	250	–18	121

[a] Temperatures during assembly and installation are out of scope of these temperature ranges.
[b] Minimum temperature is the lowest temperature to which the part may be subjected during operation.
[c] Maximum temperature is the highest temperature to which the part may be subjected during operation.

4.2 Miscellaneous Design Information

4.2.1 Tolerances

Unless otherwise specified in the appropriate table or figure, the tolerances in Table 3 shall apply:

Table 3—Tolerances, Unless Otherwise Stated

Dimension	Tolerance in.
X.XX	± 0.015
X.XXX	± 0.005
X° or X.X°	± 0.5°

4.2.2 Removable Male Connector

The clearance behind the feature as defined by dimensions F and T in Figure 4/Table 8, and dimensions F, T, and P in Figure 5/Table 9, shall allow space for the assembly and disassembly of the union nut and the nut retainer segments.

4.2.3 Nut Retainer Segments

NOTE Maintaining the nut retainer segments in matched sets of three pieces after slitting is not required by this standard due to currently specified tolerances for segment shoulder thickness.

4.2.4 Segment Retainer Ring

A segment retainer ring shall engage the groove of the nut retainer segments in the assembled condition shown in Figure 1 to keep the union nut and all three retainer segments together under normal make-up and break-down activities.

NOTE Reference A.2 for example groove and retainer ring dimensions that satisfy the requirements of this section.

5 Materials

5.1 General

The materials for segment retainer rings, resilient seals, pressure-containing parts, and pressure-retaining parts shall satisfy the requirements below. All metallic materials shall have a wrought microstructure throughout.

5.2 Segment Retainer Ring

Segment retainer rings shall be made of material meeting the functional requirements of 4.2.4.

5.3 Resilient Seal

The resilient seal shall be made of non-metallic material, though a metallic anti-extrusion ring may be included in the resilient seal. The resilient seal shall require a written material specification. The manufacturer's written specification for resilient seal non-metallic materials shall define the following:

— generic base polymer(s);

NOTE ASTM D1418 provides standardized nomenclature for rubber polymers.

— physical property requirements;

— documentation requirements as specified in 7.5.2.2;

— storage and age-control requirements.

The resilient seal shall be manufactured from materials which meet the requirements in the written material specification. Seals with integral anti-extrusion devices should be used at working pressures of greater than or equal to 15,000 psi (103.5 MPa).

5.4 Metallic Pressure-containing and Pressure-retaining Parts

5.4.1 General

Weld repair of material or product shall not be performed at any point in the manufacturing process.

5.4.2 Written Material Specification Requirements

All metallic pressure-containing and pressure-retaining parts shall require a written material specification. The requirements in 5.3 shall be defined in the written material specification.

All pressure-containing and pressure-retaining parts shall be manufactured from materials which meet the requirements in the written material specification.

5.4.3 Union Nuts

Union nuts shall be produced from a single-piece forging.

5.4.4 Hot-working Practices

Materials formed using hot-working practice(s) shall result in a reduction ratio of at least 3:1. In addition, the reduction ratio shall be documented.

5.4.5 Melting Practices

The manufacturer shall specify the melting practices.

5.4.6 Heat-treating

The manufacturer shall specify the heat-treatment method for the material (such as quench and temper; normalize, quench, and temper).

NOTE The manufacturer is not required to specify the times and temperatures for heat-treatment.

All heat-treating of material, parts, and qualification test coupons (QTC) shall be performed with "production type" heat-treating equipment qualified in accordance with a recognized industry standard, such as API 6A, SAE AMS 2750, SAE AMSH6875, or ASTM A991.

"Production type" heat-treating equipment shall be considered equipment that is routinely used to process production parts having an equivalent round (ER) equal to or greater than the ER of the subject QTC.

5.4.7 Chemical Composition

The manufacturer shall specify the chemical composition and composition tolerances of the material.

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

5.4.8 Material Qualification Testing

5.4.8.1 General

The required tensile and impact tests shall be performed on specimens from a QTC.

NOTE The QTC may be a separately forged test coupon, a sacrificial part, or a prolongation.

The QTC shall meet all API 6A PSL 1 QTC requirements for bodies, bonnets, and end and outlet connections.

All sour service nut material and pressure-containing part materials shall meet the requirements for 75K material, as shown in Table 4, and shall meet the material processing and material property requirements of NACE MR0175/ISO 15156.

All standard service nut material and pressure-containing part materials shall meet the requirements for 95K material, as shown in Table 4, except for standard service Figure 602, which shall meet the requirements for either 75K or 95K materials.

All nut retainer segment materials shall meet the requirements for 95K material, as shown in Table 4.

Table 4—Material Property Requirements for Metallic Pressure-containing and Pressure-retaining Parts

Material Designation	0.2 % Yield Strength Min. psi (MPa)	Tensile Strength min. psi (MPa)	Elongation in 2 in. (50 mm) Min.	Reduction in area Min. %	Minimum Brinell Hardness	Maximum Brinell Hardness
75K	75,000 (517)	95,000 (655)	17	35	HBW 197	HBW 237
95K	95,000 (655)	120,000 (827)	15	35	HBW 248	HBW 341

5.4.8.2 Tensile Testing

Tensile testing shall be conducted as follows:

a) Test Method

Tensile testing shall be performed in accordance with the procedures specified in ASTM A370.

A minimum of one tensile test shall be performed. The results of the tensile test(s) shall satisfy the requirements of Table 4 for the applicable material designation.

b) Retesting

If the results of the tensile test(s) do not conform with the properties of Table 4 for the applicable material designation, then two additional tests on two additional test specimens removed from the same QTC with no additional heat-treatment may be performed in an effort to qualify the material. The results of each of these tests shall conform to the properties in Table 4 for the applicable material designation.

5.4.8.3 Impact Testing

Impact testing shall be conducted as follows:

a) Test Method

Impact tests shall be performed in accordance with the Charpy V-notch technique procedures specified in ASTM A370.

To qualify material for a temperature rating, the impact tests shall be performed at or below the lowest rated temperature.

Three impact specimens from the QTC shall be tested. Impact properties as determined from these tests shall satisfy the applicable requirements of Table 5. No individual impact value from the impact tests shall fall below two-thirds of the minimum average impact value in Table 5. No more than one of the three test results shall be below the required minimum average impact value in Table 5.

If subsize specimens are used, the Charpy V-notch impact requirements shall be equal to that of the 0.394 in. (10 mm) × 0.394 in. (10 mm) specimens multiplied by the adjustment factor listed in Table 6.

Table 5—Charpy V-notch Impact Requirements 0.394 in. (10 mm) × 0.394 in. (10 mm)

Temperature		Minimum Average Impact Value	
Classification	Test °F (°C)	Transverse Direction	Longitudinal Direction
		ft-lbf (J)	ft-lbf (J)
K	–75 (–60)	15 (20)	20 (27)
L, N	–50 (–46)	15 (20)	20 (27)
P	–20 (–29)	15 (20)	20 (27)
S, T, U	0 (–18)	15 (20)	20 (27)

Table 6—Adjustment Factors for Sub-size Impact Specimens

Specimen Dimension	Adjustment Factor
0.394 in. (10 mm) × 0.295 in. (7.5 mm)	0.833
0.394 in. (10 mm) × 0.264 in. (6.7 mm)	0.780
0.394 in. (10 mm) × 0.197 in. (5.0 mm)	0.667
0.394 in. (10 mm) × 0.130 in. (3.3 mm)	0.440
0.394 in. (10 mm) × 0.098 in. (2.5 mm)	0.333

b) Retesting

If a test fails, then a retest of three additional specimens removed from the same QTC with no additional heat-treatment may be performed. Each retest impact value shall be equal to or exceed the required minimum average impact value in Table 5.

c) Specimen Orientation

The values listed in Table 5 are the minimum acceptable values for wrought or forged products tested in the transverse or longitudinal direction, or both. The test may be conducted in either direction or both.

5.4.8.4 Hardness Testing

A minimum of one Rockwell or Brinell HBW hardness test shall be performed on the QTC.

Hardness testing shall be performed in accordance with the procedures specified in ISO 6506, ASTM E10, ISO 6508, ASTM E18, or ASTM E110.

ASTM E140 should be referenced for hardness conversions.

The results of the hardness test(s) shall satisfy the requirements of Table 4 for the applicable material designation.

6 Dimensional Requirements

Dimensions for Female End Connectors shall conform to Table 7 and Figure 3. For any configuration other than 3" Figure 1502, the verification requirements of Annex B shall be met if full root radii are incorporated on the threads of the female end connector.

Dimensions for Removeable Male End Connector Style 1 shall conform to Table 8 and Figure 4.

Dimensions for Removeable Male End Connector Style 2 shall conform to Table 9 and Figure 5.

Dimensions for Non-removeable Male End Connector Style 1 shall conform to Table 10 and Figure 6.

Dimensions for Non-removeable Male End Connector Style 2 shall conform to Table 11 and Figure 7.

Dimensions for Union Nuts shall conform to Table 12 and Figure 8. The verification requirements of Annex B shall be met if full root radii are incorporated on the threads of the nut.

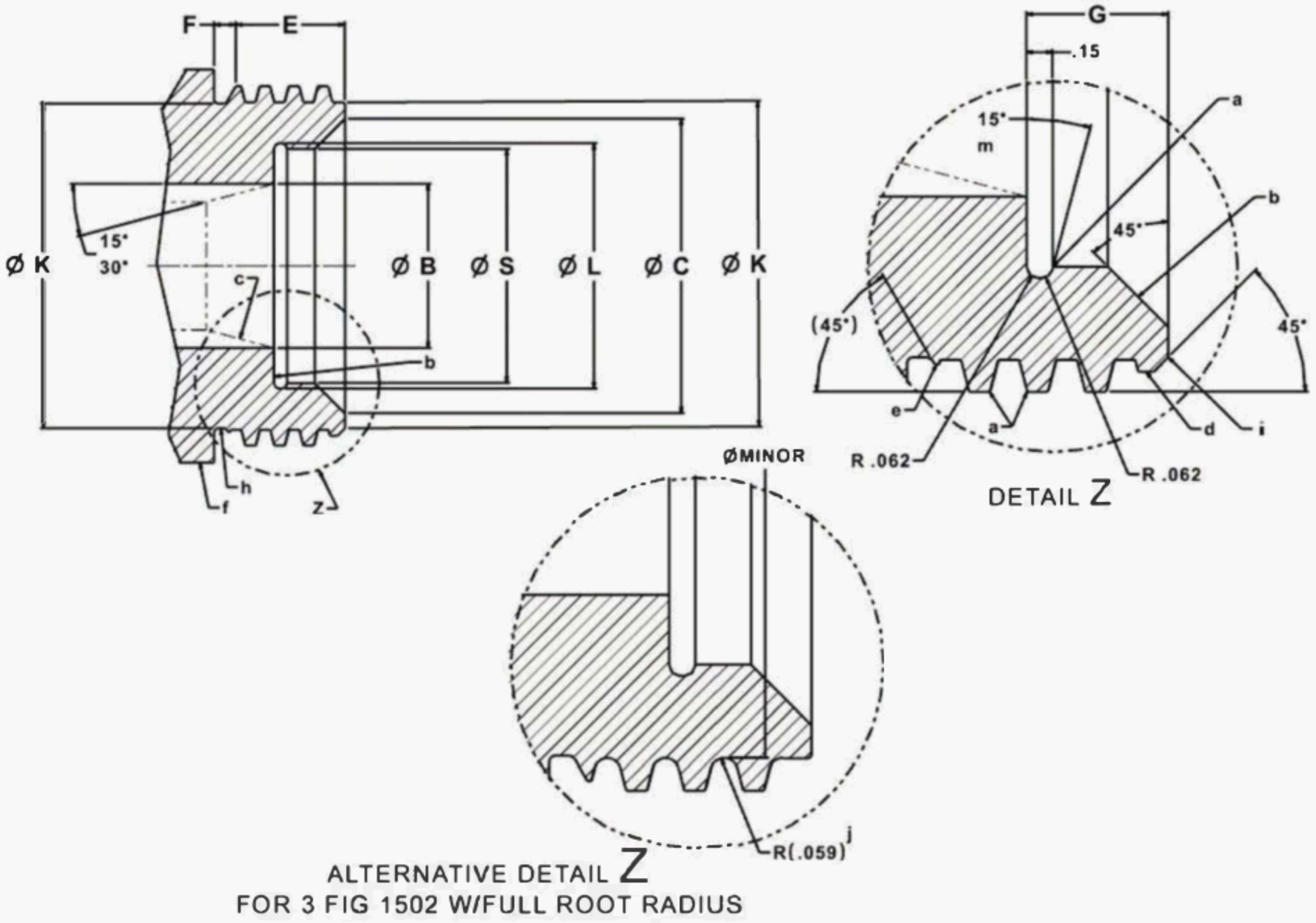
Dimensions for Nut Retainer Segments shall conform to Table 13 and Figure 9.

All dimensions are reported in U.S. Customary (USC) units. All dimensions are in inches unless otherwise noted.

Where a fraction is listed for thread size, the dimension shall be interpreted to the exact significant digits for the fraction with no rounding applied. For example, "6 $^{11}/_{16}$" is exactly 6.6875 in.

All machined surfaces shall have a maximum average roughness of 125 micro-inch with the exception that flow bores shall have a maximum roughness of 250 micro-inch average roughness unless otherwise noted in Figures 3 through 9.

NOTE For illustrations and the associated dimensions for union seals, retainer segments, and retainer segment snap rings, see Annex A.



Key

a	Break sharp corners 0.015 max
b	63 micro-inch max average roughness
c	Bore transition, not to exceed B dimension in Table 7, is applicable for bore diameters smaller than B
d	Trim partial leading thread to 0.03 min crest width
e	Optional trim partial trailing thread to 0.03 min crest width
f	Mark anywhere on exterior except threads and nose.
g	All machined features concentric within 0.010 total indicator runout to dimension "S" (excludes bore beyond leading edge)
h	Trailing thread relief optional
i	Leading thread relief, ØK, to be between 0.010 less than and 0.030 less than the thread minimum minor diameter
j	A full root radius is permitted on the 3 FIG 1502 female end connector
k	Full root radii are permitted on other sizes provided the requirements of Annex B are met
m	Optional angle to make tangent intersection with the radius of the seal groove

Figure 3—Female End Connector

Table 7—Dimensional Requirements for Female End Connector

Figure	Size	Max. Bore	Cone Start of Taper	Seal Gland Bore	Seal Gland Depth	Seal Groove	Eff. Thread Length [d]	Min. Gap	Thread	
		B	C	S [a]	G [a]	L	E [a]	F [e]	Size-Pitch Type-Class	ASME
602 & 1002	1"	1.075	2.000	1.620	0.482	1.759 ± 0.010	0.71	0.25	2 7/16"-6 ACME-2G	B1.5
	1.5"	1.705	2.750	2.214	0.556	2.353 ± 0.010	0.83	0.30	3 3/8"-4 ACME-2G	B1.5
	2"	1.895	3.312	2.683	0.781	2.822 ± 0.010	0.98	0.50	3 13/16"-3 STUB ACME-2G [b]	B1.8
602	3"	3.015	4.750	3.995	0.812	4.134 ± 0.010	1.07	0.45	5 3/8"-3 STUB ACME-2G	B1.8
	4"	4.015	5.656	4.995	0.750	5.134 ± 0.010	1.18	0.45	6 1/4"-3 STUB ACME-2G	B1.8
1002	3"	3.015	4.750	3.995	0.812	4.134 ± 0.010	1.06	0.30	5 3/8"-4 ACME-2G	B1.5
	4"	4.015	5.656	4.995	0.750	5.134 ± 0.010	1.17	0.45	6 1/4"-4 ACME-2G	B1.5
1502	1"	0.895	2.250	1.620	0.607	1.759 ± 0.010	0.99	0.30	2 15/16"-3.5 ACME-2G	B1.5
	1.5"	1.315	3.000	2.214	0.681	2.353 ± 0.010	1.18	0.25	3 11/16"-3.5 ACME-2G	B1.5
	2"	1.895	3.375	2.683	0.812	2.822 ± 0.010	1.17	0.35	4 1/8"-3 ACME-2G	B1.5
	3"	2.770	4.750	3.995	0.812	4.134 ± 0.010	1.22	0.45	5 3/8"-3.5 ACME-2G [c]	B1.5
	4"	3.770	6.030	4.995	0.938	5.134 ± 0.010	1.38	0.30	6 11/16"-3 STUB ACME M1-2G	B1.8
2002	2"	1.315	2.511	1.822	0.659	1.961 ± 0.010	1.19	0.30	3 5/8"-4 ACME-2G	B1.5
	3"	3.015	5.000	3.995	0.938	4.134 ± 0.010	1.38	0.30	6 11/16"-4 ACME-2G	B1.5
2202	2"	1.315	2.511	1.822	0.659	1.961 ± 0.010	1.29	0.20	3 5/8"-5 ACME-2G	B1.5
	3"	3.015	5.000	3.995	0.938	4.134 ± 0.010	1.38	0.30	6 11/16"-5 ACME-2G	B1.5

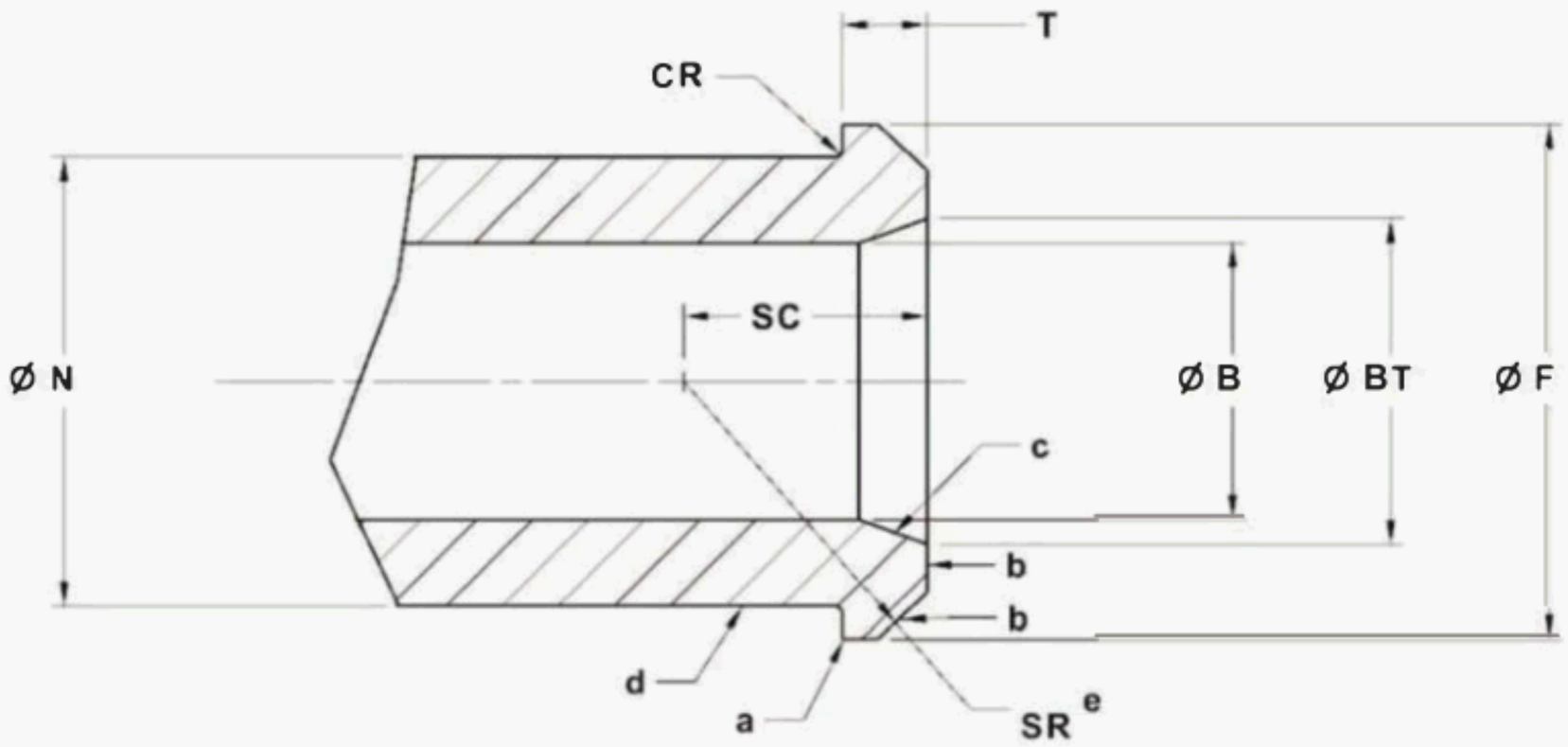
[a] Indicates inspection dimension.

[b] Truncated major diameter 3.775–3.780.

[c] Full root radius minor diameter 4.959–5.004, non-radiused roots per ASME B1.5.

[d] Thread length is defined from the trailing thread to the end of the connection.

[e] The raised shoulder defining this dimension is mandatory for the 2" Figure 602 and 2" Figure 1002 female sub ends per API Recommended Practice 7HU1.



Key

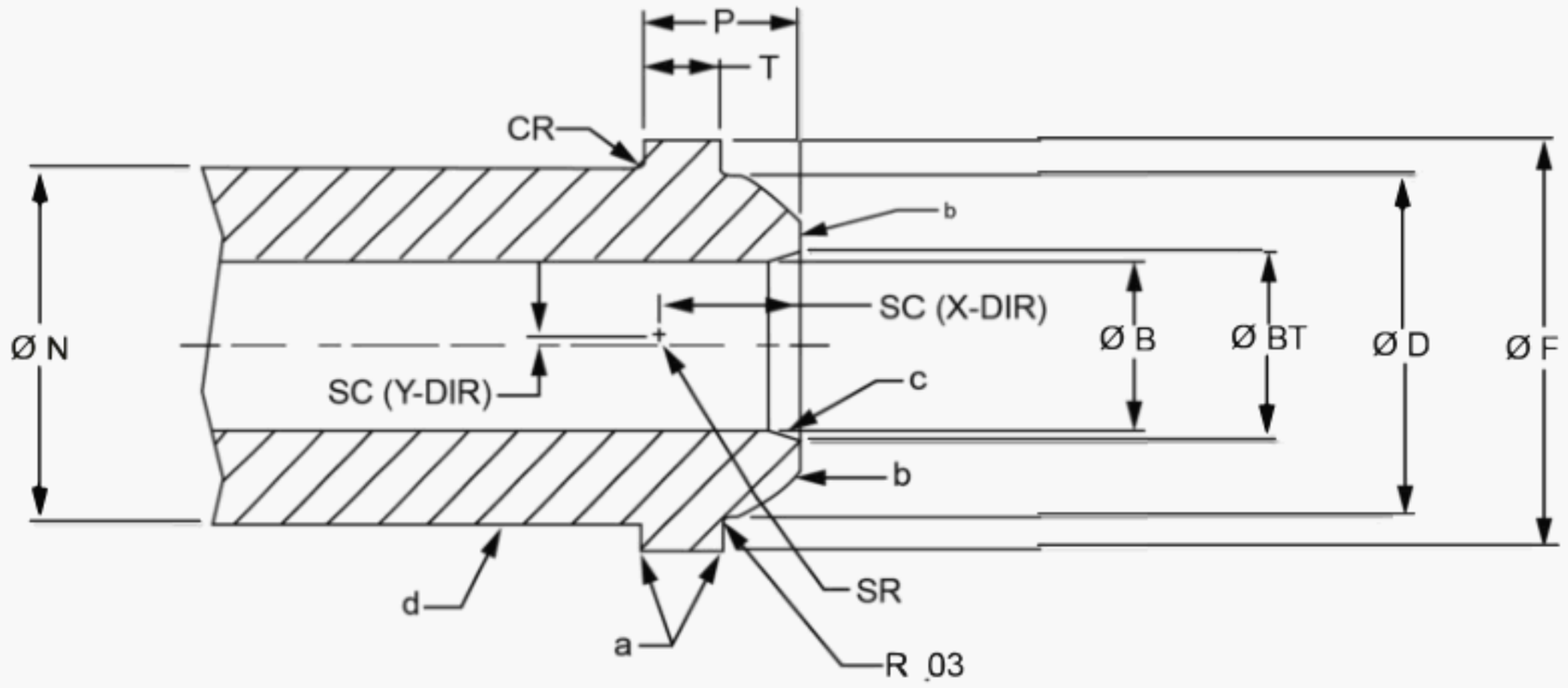
a Break sharp corners 0.015 max
b 63 micro-inch max average roughness
c Optional bore transition
d Permissible marking location
e Spherical radius to be located at true position within 0.010 total indicator runout
f Diameter N maintained for a minimum distance of T + the Nut Retainer Segment length (see Figure 9, dimension L) from the face of the end connector
g Coaxial diameter N, BT, and F to 0.010 total indicator runout to single axis

Figure 4—Removable Male End Connector Style 1

Table 8—Dimensional Requirements for Removable Male End Connector Style 1

Figure	Size	Max. Bore	Max. Bore Transition	Diameter of Flange	Thickness of Flange	Corner Radius	Diameter of Neck	Sphere Center	Sphere Radius
		B	BT	F [a]	T [a]	CR	N [a]	SC	SR
602 & 1002	2"	1.895	1.895	3.089 ± 0.010	0.69	0.035	2.73	1.531	2.031
	3"	3.015	3.075	4.578 ± 0.010	0.72		4.09	2.156	2.937
	4"	4.000	4.015	5.469 ± 0.010	0.81		5.00	2.673	3.656
1502	1"	0.895	0.895	2.188 ± 0.010	0.56		1.88	0.938	1.250
	1.5"	1.315	1.315	2.984 ± 0.010	0.69		2.59	1.344	1.750
	2"	1.895	1.895	3.250 ± 0.010	0.53		2.84	1.531	2.031
	3"	2.770	3.075	4.578 ± 0.010	0.72		4.09	2.156	2.937
	4"	3.770	4.015	5.875 ± 0.010	1.38		5.38	2.656	3.656

[a] Indicates inspection dimension.



Key

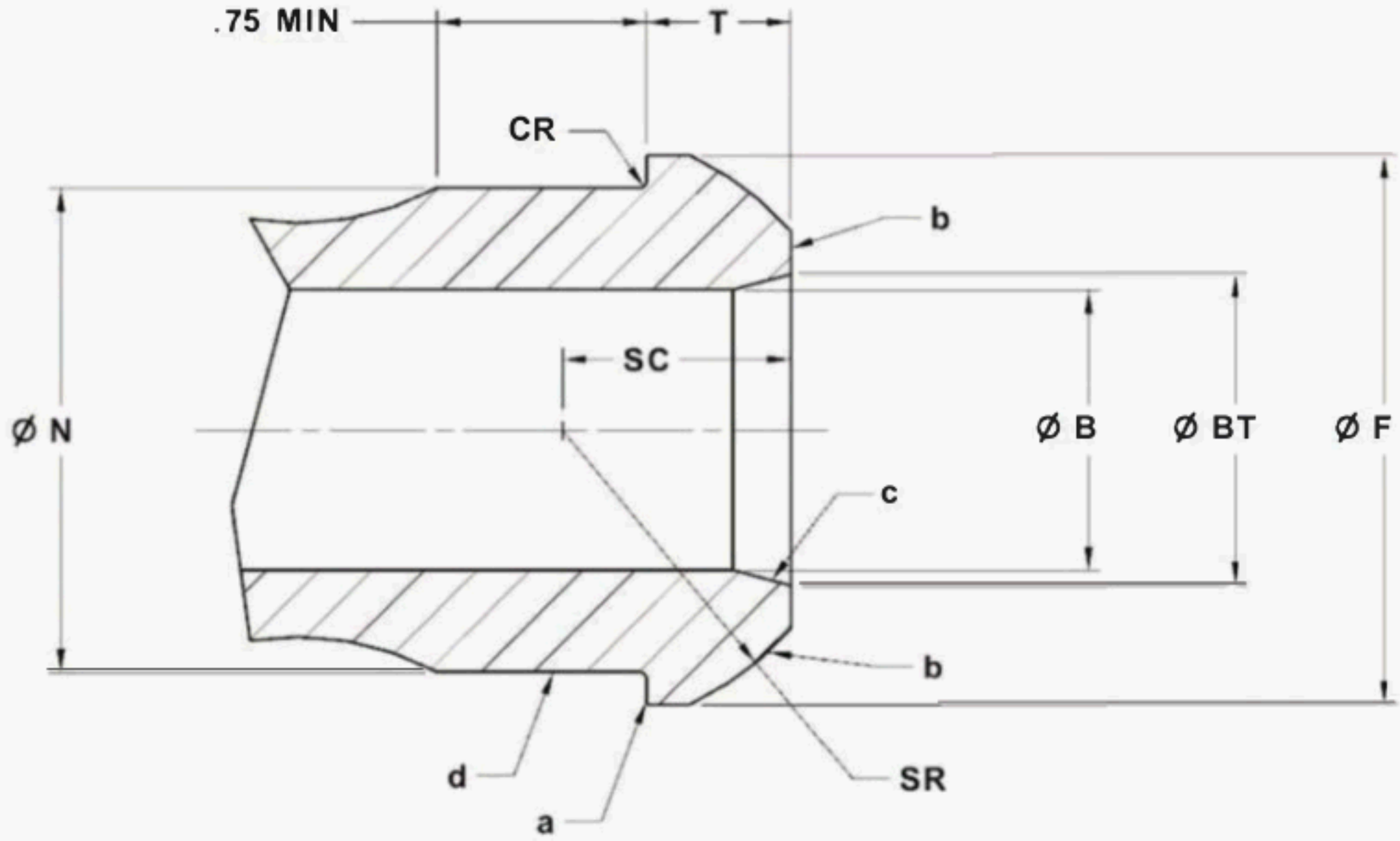
a Break sharp corners 0.015 max
b 63 micro-inch max average roughness
c Optional bore transition
d Permissible marking location
e Spherical radius to be located at true position within 0.010 total indicator runout
f Diameter N maintained for a minimum distance of P + the Nut Retainer Segment length (see Figure 9, dimension L) from the face of the end connector
g Coaxial diameter D, N, BT, and F to 0.010 total indicator runout to single axis

Figure 5—Removable Male End Connector Style 2

Table 9—Dimensional Requirements for Removable Male End Connector Style 2

Figure	Size	Max. Bore	Max. Bore Transition	Diameter of Flange	Thickness of Flange	Corner Radius	Diameter of Neck	Sphere Center	Sphere Radius	Nose Diameter	Nose Protrusion
		B	BT	F [a]	T [a]	CR	N [a]	SC	SR	D	P
2002 & 2202	2"	1.300	1.315	3.000 ± 0.010	0.56	0.035	2.59	0.996	1.345	2.50	1.12
	3"	3.000	3.015	5.880 ± 0.010	0.76		5.38	2.156	2.938	4.88	1.38

[a] Indicates inspection dimension.



Key

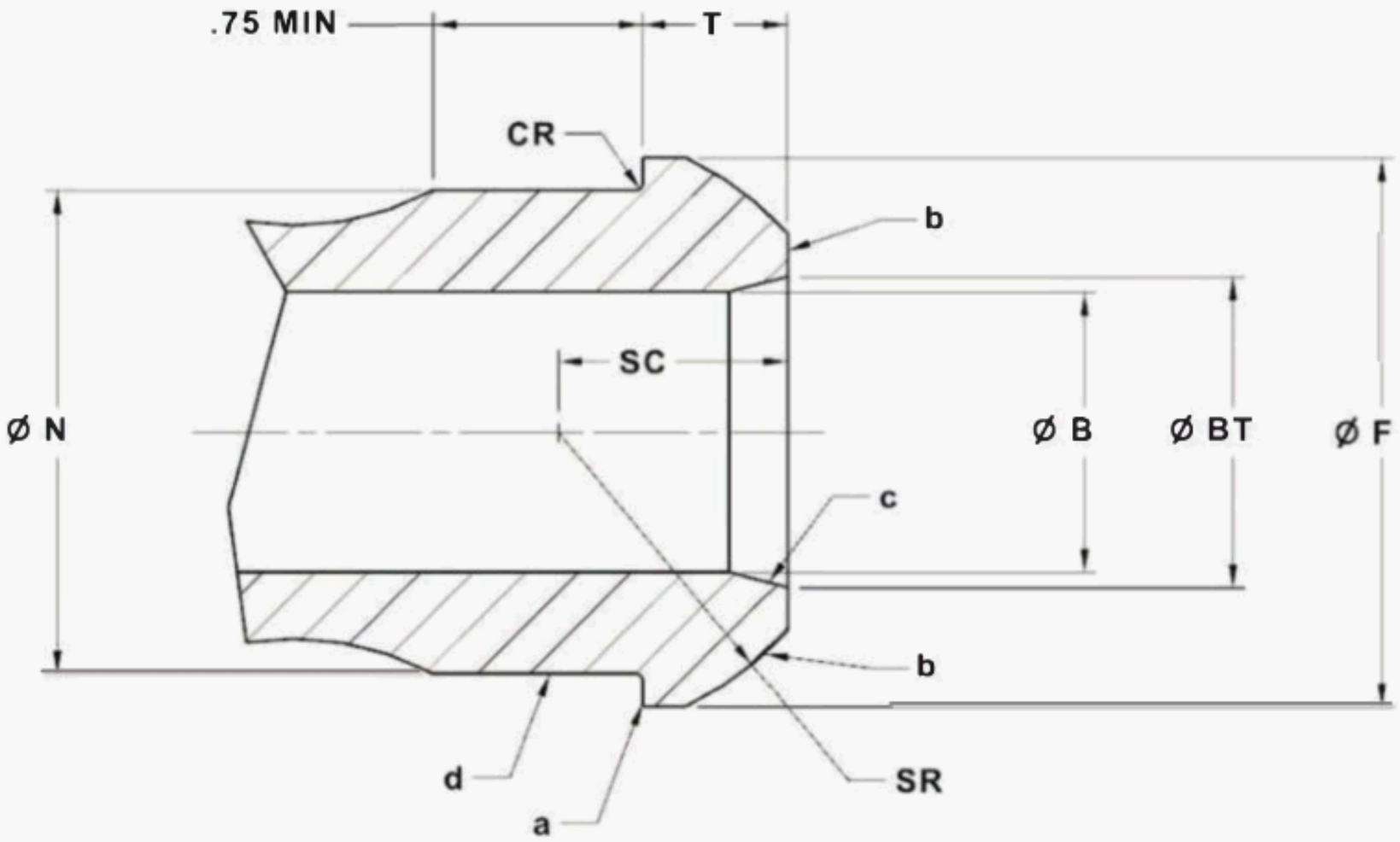
a Break sharp corners 0.015 max
b 63 micro-inch max average roughness
c Optional bore transition
d Permissible marking location
e Spherical radius to be located at true position within 0.010 total indicator runout
f Coaxial diameter N, BT, and F to 0.010 total indicator runout to single axis

Figure 6—Non-removable Male End Connector Style 1

Table 10—Dimensional Requirements for Non-removable Male End Connector Style 1

Figure	Size	Max. Bore	Max. Bore Transition	Diameter of Flange	Thickness of Flange	Corner Radius	Diameter of Neck	Sphere Center	Sphere Radius
		B	BT	F [a]	T [a]	CR	N [a]	SC	SR
602 & 1002	1”	1.125	1.125	2.154 ± 0.010	0.44	0.035	1.75	0.938	1.250
	1.5”	1.705	1.705	2.937 ± 0.010	0.56		2.56	1.344	1.750
	2”	2.060	2.075	3.438 ± 0.010	1.05		3.05	1.531	2.031
	3”	3.000	3.075	5.040 ± 0.010	1.05		4.55	2.156	2.937
	4”	4.000	4.015	5.925 ± 0.010	1.28		5.44	2.673	3.656
1502	2”	2.06	2.075	3.688 ± 0.010	0.97		3.25	1.531	2.031
	3”	3.000	3.015	4.995 ± 0.010	0.94		4.50	2.156	2.937

[a] Indicates inspection dimension.



Key

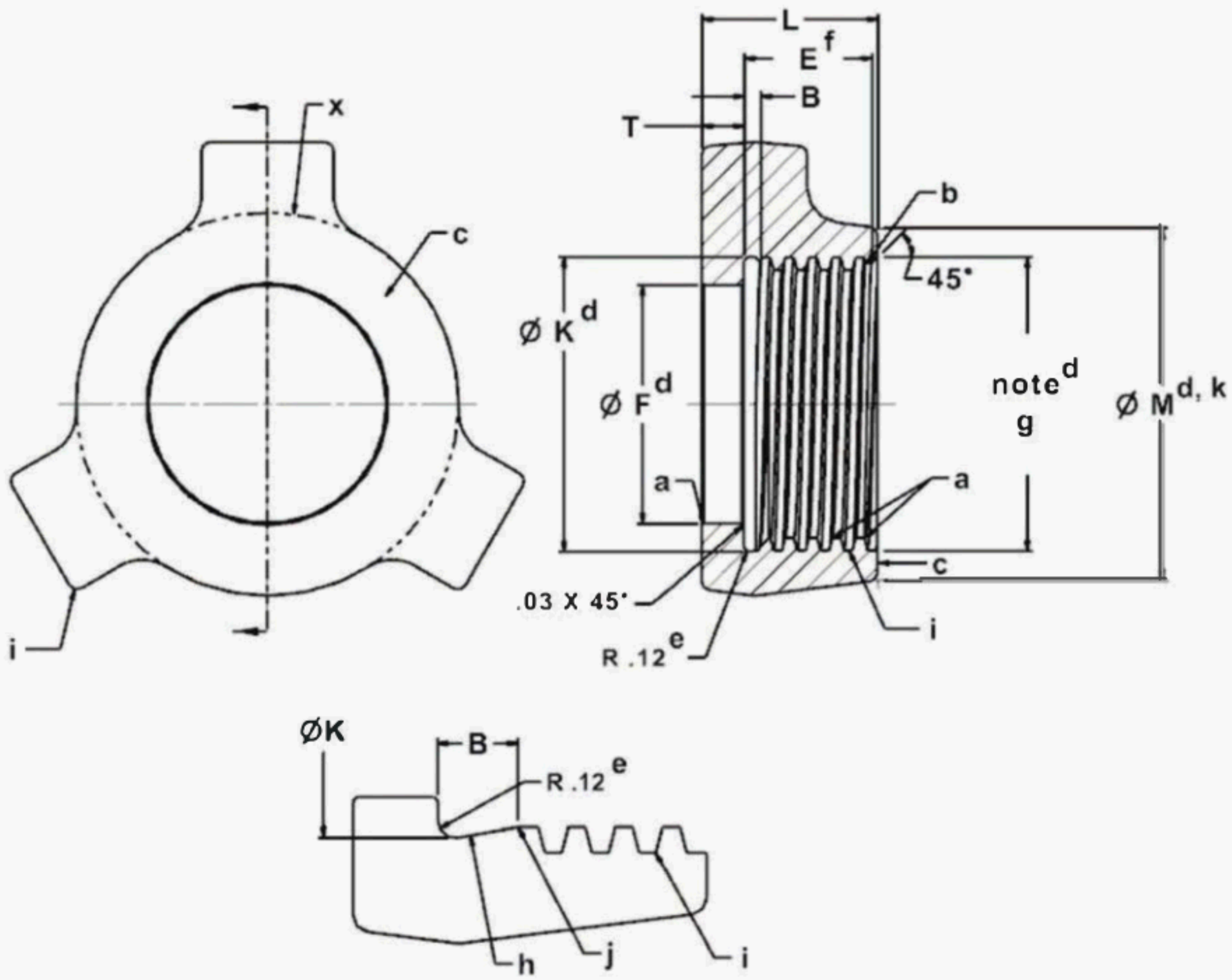
a	Break sharp corners 0.015 max
b	63 micro-inch max average roughness
c	Optional bore transition
d	Permissible marking location
e	Spherical radius to be located at true position within 0.010 total indicator runout
f	Coaxial diameter D, N, BT, and F to 0.010 total indicator runout to single axis

Figure 7—Non-removable Male End Connector Style 2

Table 11—Dimensional Requirements for Non-removable Male End Connector Style 2

Figure	Size	Max Bore	Max Bore Transition	Diameter of Flange	Thickness of Flange	Corner Radius	Diameter of Neck	Sphere Center	Sphere Radius	Nose Diameter	Nose Protrusion
		B	BT	F [a]	T [a]	CR	N [a]	SC	SR	D	P
1502	1	0.880	0.895	2.569 ± 0.010	0.50	0.035	2.18	0.938	1.250	2.188	0.94
	1.5	1.315	1.315	3.375 ± 0.010	0.50		2.96	1.344	1.750	2.984	1.12
	4	3.770	4.015	6.380 ± 0.010	1.38		5.84	2.656	3.656	5.875	2.00
2002 and 2202	2	1.315	1.315	3.345± 0.010	1.07	0.035	3.00	0.996	1.345	2.50	1.62
	3	3.000	3.000	6.350± 0.010	1.38		5.84	2.156	2.938	4.88	2.00

[a] Indicates inspection dimension.



ALTERNATE
UNDERCUT GEOMETRY

Key

a	Break sharp corners 0.015 max
b	Trim partial leading thread to 0.03 min crest width
c	Permissible marking locations (between X and F, and/or M and "note g")
d	Threads and cylindrical surfaces concentric within 0.010 total indicator runout
e	R.09 for 1 FIG 602 and 1 FIG 1002
f	Thread span, E, is from the flange face to the end of the trimmed leading thread
g	Leading thread relief to be a minimum of 0.010 greater than thread maximum major diameter
h	Optional draft relief
i	Full root radii are permitted on other sizes provided the requirements of Annex B are met
j	An optional blind depth thread pullout may be used; however, the minimum thread engagement shall still be maintained.
k	The outside diameter of the nut, along its entire length must be greater than or equal to the minimum nut diameter, M, in Table 12.
l	The union nut shall include a minimum of 3 equally spaced lugs.

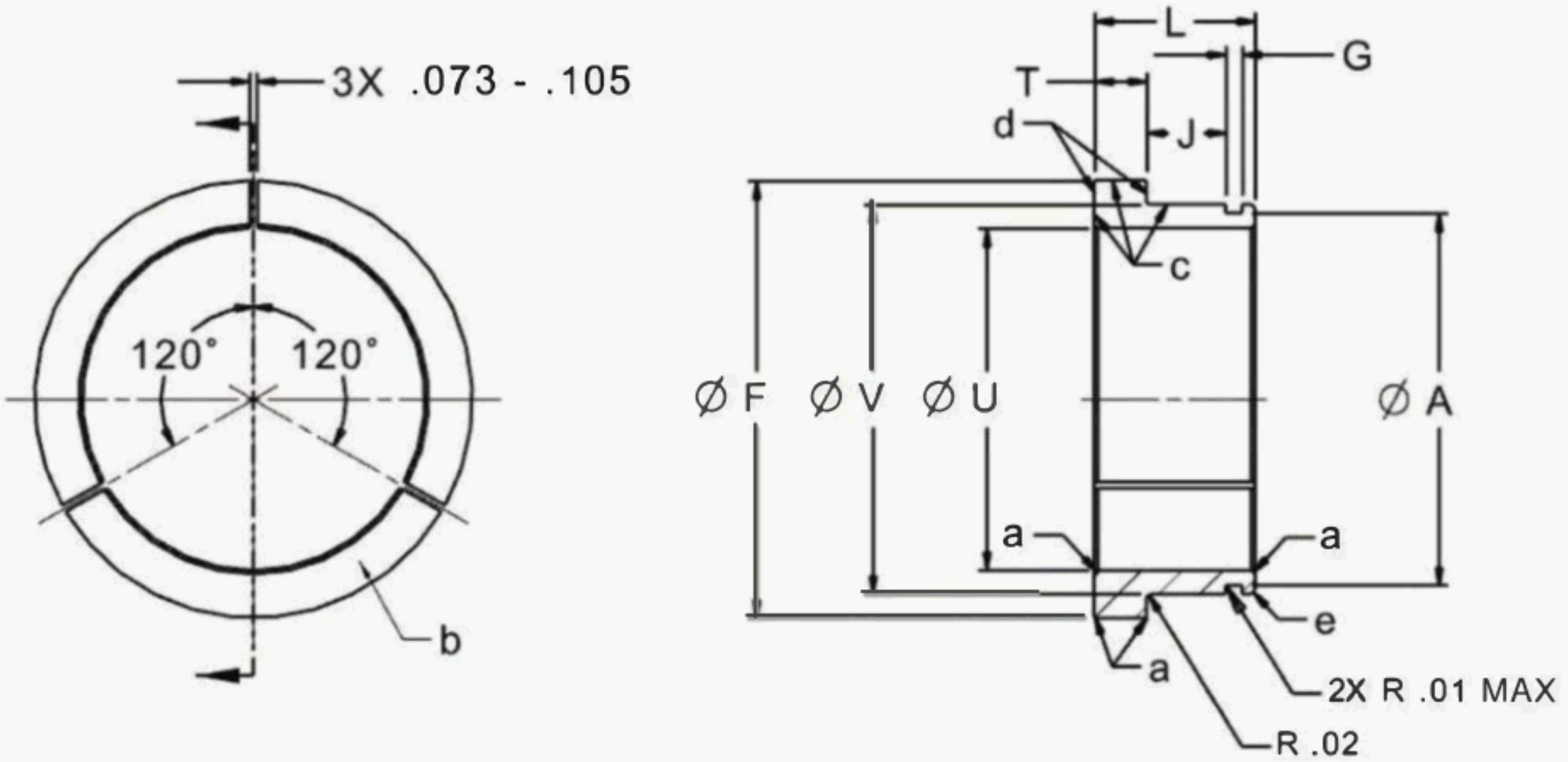
Figure 8—Union Nut

Table 12—Dimensional Requirements for Union Nut

Figure	Size	Flange Diameter		Thickness of Flange		Nut Length		Min. Nut Diameter	Max. Undercut Length	Min. Thread Span	Undercut Diameter	Thread	
		F [a]		T [a]		N [a]		M	B	E	K	Size-Pitch Type-Class	ASME
		Max.	Min.	Max.	Min.	Max.	Min.						
602 & 1002	2"	3.135	3.125	0.530	0.485	2.620	2.560	4.62	0.25	1.885	3.71	3 13/16"-3 STUB ACME-2G	B1.8
602	1"	1.845	1.815	0.340	0.295	1.395	1.365	2.73	0.16	0.915	2.39	2 7/16"-6 ACME-2G	B1.5
	1.5"	2.675	2.645	0.470	0.425	1.780	1.690	4.08	0.19	1.085	3.23	3 3/8"-4 ACME-2G	B1.5
	3"	4.648	4.638	0.530	0.485	2.560	2.470	5.99	0.19	1.825	5.24	5 3/8"-3 STUB ACME-2G	B1.8
	4"	5.520	5.510	0.650	0.605	3.090	2.970	6.94	0.22	2.085	6.19	6 1/4"-3 STUB ACME-2G	B1.8
1002	1"	1.845	1.815	0.340	0.295	1.440	1.360	2.82	0.16	0.915	2.39	2 7/16"-6 ACME-2G	B1.5
	1.5"	2.675	2.645	0.470	0.425	1.780	1.690	4.08	0.19	1.085	3.23	3 3/8"-4 ACME-2G	B1.5
	3"	4.648	4.638	0.650	0.605	2.520	2.490	6.09	0.19	1.685	5.29	5 3/8"-4 ACME-2G	B1.5
	4"	5.520	5.510	0.650	0.605	3.090	2.970	6.94	0.22	2.175	6.19	6 1/4"-4 ACME-2G	B1.5
1502	1"	2.265	2.235	0.470	0.425	2.250	2.130	3.53	0.50	1.535	2.87	2 15/16"-3.5 ACME-2G	B1.5
	1.5"	3.057	3.047	0.590	0.545	2.620	2.560	4.62	0.38	1.785	3.67	3 11/16"-3.5 ACME-2G	B1.5
	2"	3.354	3.344	0.575	0.545	2.580	2.470	5.01	0.28	1.715	3.98	4 1/8"-3 ACME-2G [b]	B1.5
	3"	4.648	4.638	0.650	0.605	2.750	2.690	6.09	0.19	1.855	5.29	5 3/8"-3.5 ACME-2G	B1.5
	4"	5.910	5.900	0.690	0.645	3.710	3.590	7.87	1.31	2.795	6.64	6 11/16"-3 STUB ACME M1–2G	B1.8
2002	2"	3.030	3.020	0.590	0.545	3.190	3.100	4.59	0.16	2.365	3.62	3 5/8"-4 ACME-2G	B1.5
	3"	5.910	5.900	0.690	0.645	3.710	3.590	8.41	1.35	2.795	6.64	6 11/16"-4 ACME-2G	B1.5
2202	2"	3.030	3.020	0.590	0.545	3.190	3.100	4.53	0.99	2.385	3.62	3 5/8"-5 ACME-2G	B1.5
	3"	5.910	5.900	0.690	0.645	3.710	3.590	8.41	1.35	2.795	6.64	6 11/16"-5 ACME-2G	B1.5

[a] Indicates inspection information.

[b] Major diameter 4.145–4.175.



Key

a Break sharp corners 0.015 max
b Separate into 3 equal pieces after machining
c Permissible marking locations
d These surfaces should be parallel with each other and square with segment centerline
e An edge break to aide in assembly of the retainer segment snap ring is recommended. See Annex A for optional geometry at this location.

NOTE 1 Diameters U and V to be concentric within 0.005.
NOTE 2 All other coaxial diameters concentric within 0.010 total indicator runout.
NOTE 3 Diametral dimensions are prior to splitting the part.

Figure 9—Nut Retainer Segments

Table 13—Dimensional Requirements for Nut Retainer Segments

Figure	Size	Diameter of Flange	Thickness of Flange	Groove Width	Nut Clearance	Length	Inside Diameter	Outside Diameter	Groove Diameter
		F [a]	T [a]	G	J	L	U [a]	V [a]	A
602 and 1002	2"	3.593	0.433–0.438	0.125 ± 0.010	0.621	1.38	2.837	3.151–3.161	3.016 ± 0.010
	3"	5.040	0.433–0.438	0.145 ± 0.010	0.692	1.44	4.205	4.661–4.671	4.470 ± 0.010
	4"	5.960	0.495–0.500	0.145 ± 0.010	0.692	1.53	5.125	5.533–5.543	5.370 ± 0.010
1502	1"	2.605	0.370–0.375	0.125 ± 0.010	0.505	1.12	2.000	2.276–2.286	2.175 ± 0.010
	1.5"	3.390	0.433–0.438	0.125 ± 0.010	0.630	1.31	2.705	3.073–3.083	2.930 ± 0.010
	2"	3.750	0.433–0.438	0.125 ± 0.010	0.621	1.34	2.952	3.367–3.377	3.210 ± 0.010
	3"	5.040	0.433–0.438	0.145 ± 0.010	0.692	1.44	4.205	4.661–4.671	4.470 ± 0.010
	4"	6.441	0.625–0.630	0.145 ± 0.010	0.735	1.75	5.471	5.923–5.933	5.781 ± 0.010
2002 & 2202	2"	3.385	0.500–0.505	0.125 ± 0.010	0.598	1.34	2.715	3.043–3.053	2.865 ± 0.010
	3"	6.441	0.625–0.630	0.145 ± 0.010	0.735	1.75	5.471	5.923–5.933	5.781 ± 0.010

[a] Indicates inspection dimension.

7 Quality Control

7.1 General

This section specifies the quality control requirements and quality control record requirements for parts manufactured to meet this standard.

7.2 Measuring and Testing Equipment

Equipment used to inspect, test, or examine material or other parts shall be identified, controlled, and calibrated at specified intervals in accordance with documented instructions, and consistent with nationally or internationally recognized standards specified by the manufacturer.

7.3 Quality Control Personnel Qualifications

7.3.1 Nondestructive Examination (NDE) Personnel

Personnel performing NDE shall be qualified in accordance with the manufacturer's documented training program that is in conformance with ISO 9712, ASNT SNT-TC-1A, or a national or international standard that is equivalent to ISO 9712 or ASNT SNT-TC-1A.

7.3.2 Other Personnel

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

7.4 Quality Control Requirements

7.4.1 General

7.4.1.1 Quality Control Instructions

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

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

7.4.1.2 Acceptance Status

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

7.4.2 Metallic Parts

7.4.2.1 Hardness Testing

The following shall apply:

a) Scope

For sour service nuts and sour service pressure-containing metallic parts, each part shall be hardness tested individually in conformance with NACE MR0175/ISO 15156.

For pressure-containing standard service metallic parts, parts shall be hardness tested with sampling in accordance with ISO 2859-1:1999, Level II, 1.5 acceptable quality level (AQL).

b) Test Method

Hardness testing shall be performed with Brinell or Rockwell methods in accordance with procedures specified in ASTM E110, ISO 6506, Parts 1 through 4, ASTM E10 (Brinell), ISO 6508, Parts 1 through 3, or ASTM E18 (Rockwell).

ISO 18265 or ASTM E140 shall be used for the conversion of hardness readings for materials within the scope of their application.

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

c) Acceptance Criteria

Parts shall meet the hardness requirements given in Table 4.

For parts manufactured from a material that does not conform to the specified minimum hardness value of Table 4, the measured hardness of the material shall exceed the minimum acceptable Brinell hardness value calculated using Equation (1). The tensile strength determined in the tensile test of 5.4.8.2 shall be used for the hardness value in Equation (1).

$$H_{\mathrm{BWc,min.}} = \frac{R_{\mathrm{m,min.}}}{\overline{R}_{\mathrm{m,QTC}}}\left(\overline{H}_{\mathrm{BW,QTC}}\right) \tag{1}$$

where

$H_{\mathrm{BWc,min.}}$ is the minimum acceptable Brinell hardness according to the HBW method for the part after the final heat-treatment cycle (including stress-relieving cycles);

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

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

$\overline{H}_{\mathrm{BW,QTC}}$ is the average of the Brinell hardness values according to the HBW method observed among all tests performed on the QTC.

7.4.2.2 Dimensional Inspection

Dimensional inspection shall be performed on parts. The following apply:

a) Sampling

Sampling shall be in accordance with ISO 2859-1:1999, Level II, 1.5 AQL. Threads on all parts in the sample shall be verified to standard dimensions and tolerances by any suitable method. Inspection dimensions on all parts in the sample shall be verified. Inspection dimensions are denoted in Tables in Section 6.

b) Acceptance Criteria

Threads shall be in accordance with ASME B1.5 or ASME B1.8 as applicable. All features shall meet the dimensions as specified in Section 6.

7.4.2.3 Traceability

Pressure-containing parts and pressure-retaining parts shall have traceability to the heat and heat-treatment performed on the parts.

Identification shall be maintained on materials and parts to facilitate traceability, as required by documented manufacturer requirements. See Section 8.

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

7.4.2.4 Surface NDE

When purchaser specifies NDE on parts covered under this standard, all accessible surfaces of each finished pressure-containing part within the scope of this standard shall be examined by liquid-penetrant (PT) or magnetic-particle (MT) methods after final heat-treatment and final machining operations. The following apply:

a) Test Method

All materials shall be examined in accordance with procedures specified in ASTM E709 (MT) or ASTM E165 (PT). Prods shall not be used on wetted surfaces or sealing surfaces.

NOTE Prods are hand-held electrodes used for local magnetization for surface NDE.

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

b) Acceptance Criteria

Relevant indications shall be evaluated per the acceptance criteria set forth in API 6A.

7.5 Quality Control Records Requirements

7.5.1 General

7.5.1.1 Purpose

The quality control records required by this standard are necessary to substantiate that all materials and products made to meet this standard, conform to the specified requirements.

7.5.1.2 Sour Service Part Records Requirements

The manufacturer shall maintain records that substantiate conformance of sour service nuts and pressure-containing metallic part material to NACE MR0175/ISO 15156.

7.5.1.3 Records Control

The following apply:

a) Quality control records required by this standard shall be legible, identifiable, retrievable, and protected from damage, deterioration, or loss.

b) Quality control records required by this standard shall be retained by the manufacturer for a minimum of ten years following the date of manufacture as marked on the parts associated with the records.

c) All quality control records required by this standard shall identify the inspector and the date of inspection.

7.5.2 Quality Control Records

7.5.2.1 Metallic Part Records

The following records shall be retained by the manufacturer and shall reference the applicable heat and heat-treatment performed on the parts.

a) material test records:

— tensile test,

— impact test,

— hardness test,

— chemical analysis;

b) NDE personnel qualification records (if applicable);

c) heat-treatment temperature, time at temperature, and quench practice;

d) surface NDE records referencing unique part identification numbers (if applicable);

e) part hardness test record (if applicable):

— actual hardness,

— hardness scale;

f) records that dimensional inspection was performed (those activities required by 7.4.2.2).

7.5.2.2 Non-metallic Sealing Material Records

The seal supplier shall certify that materials and end products are in conformance with 5.3.

Certification shall include:

— manufacturer's part number,

— specification number,

— compound number,

— batch number,

— cure/mold date,

— shelf-life expiration date.

NOTE Shelf-life expiration date specifies the date at which the part is not used for new installations.

8 Part Marking

8.1 Marking Requirements

8.1.1 General

Parts shall be marked as specified in Table 14. Additional markings are acceptable as long as the minimum requirements of Table 14 are met.

8.1.2 Marking Method

Permanent marking methods shall be used to properly identify parts. Permissible methods include forging markings into bodies and using low-stress marking methods (i.e. dot, vibration, or rounded V stamping). Sharp V stamping is not permitted.

Suitability for sour service (if applicable) of nuts and figure number of nuts should be identified with raised lettering.

8.1.3 Assembly Name Plate

When the male or female union end is integral to an assembly, markings may be placed on a name plate. Markings on name plate shall meet the requirements of Table 14.

Table 14—Minimum Marking Requirements and Locations

Marking	Location			
	Male and Female End Connector Integral Part [a]	Male and Female End Connector Loose Part [b]	Union Nut	Each Nut Retainer Segment
Nominal Size and Figure Number	Nameplate or Body or OD of Connector	OD of Connector	See Figure 8	See Figure 9 or Tag or Packaging
Rated Working Pressure	Nameplate or Body or OD of Connector	OD of Connector or Packaging	—	—
Temperature class or Min./ Max. for Custom	Nameplate or Body or OD of Connector	OD of Connector or Packaging	—	—
Sour Service (as marked as H2S or SOUR) (if applicable)	Nameplate or Body or OD of Connector	OD of Connector or Packaging	See Figure 8	—
Date of Manufacture	Nameplate or Body or OD of Connector	OD of Connector or Packaging	—	—
API 7HU2	Nameplate or Body or OD of Connector	OD of Connector	See Figure 8	See Figure 9 or Tag or Packaging
Manufacturer's Name or Mark	Nameplate or Body or OD of Connector	OD of Connector	See Figure 8	See Figure 9 or Tag or Packaging
Heat Number or Batch Number	Nameplate or Body or OD of Connector	OD of Connector	See Figure 8	See Figure 9 or Tag or Packaging

[a] Integral parts in the table are those which are part of an assembly and can be pressure tested.
[b] Loose parts in the table are those that are not part of a larger assembly.

8.1.4 Marking Location Limitations

Female union parts shall be marked outside the dimensional boundaries defined in Figure 3. Male union parts shall be marked at the permissible marking locations shown in Figures 4 through 7 or outside the dimensional

boundaries defined in Figures 4 through 7. The union nut and nut retainer segments shall be marked at the location(s) indicated in Figure 8 and Figure 9.

Markings on nuts shall not be applied to faces or portions of faces that form the lug.

9 Storing and Shipping

9.1 Corrosion Prevention

Prior to shipment, parts shall have exposed metallic surfaces protected with a corrosion preventative.

9.2 Sealing-surface Protection

Exposed sealing surfaces shall be protected from mechanical damage during storage and shipping.

9.3 Threads

Threads shall be protected from mechanical damage during storage and shipping.

9.4 Loose Non-metallic Materials

The manufacturer's written, specified requirements for non-metallic seals not assembled into equipment shall include the following minimum provisions:

— indoor storage;

— maximum temperature not to exceed 120 °F (49 °C);

— protected from direct natural light;

— stored unstressed;

— stored away from contact with liquids;

— protected from ozone and radiographic damage.

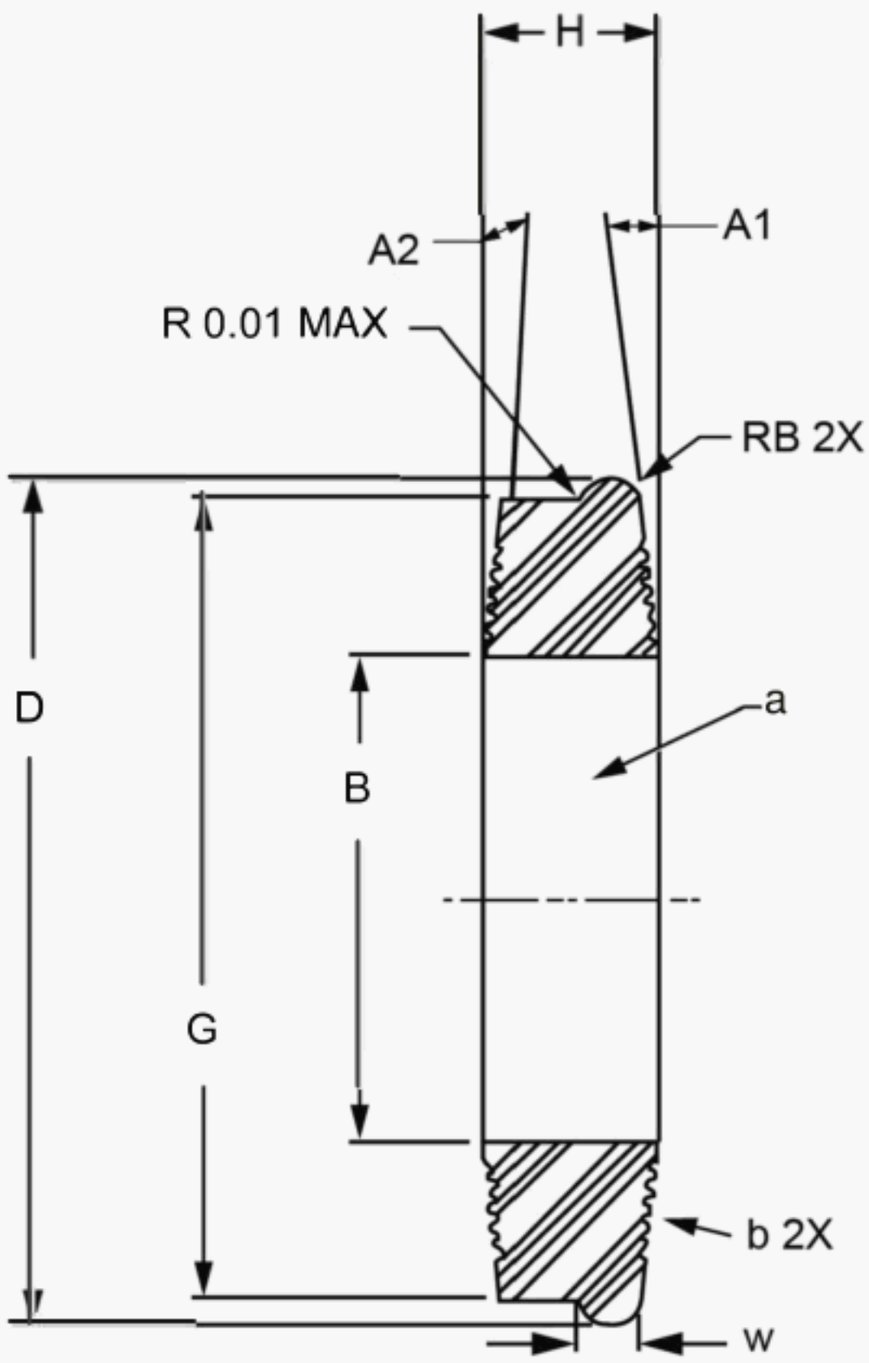
Annex A
(informative)

Reference Geometry

A.1 Union Seal Geometry

A.1.1 Union Seals without Anti-extrusion Rings

An illustration of a union seal without integral anti-extrusion rings is shown in Figure A.1 with the associated dimensions in Table A.1.



Key

a mark in this location
b optional serrations

Figure A.1—Union Seals without Integral Anti-extrusion Ring

Table A.1—Dimensions for Figure A.1, Union Seals without Anti-extrusion Ring

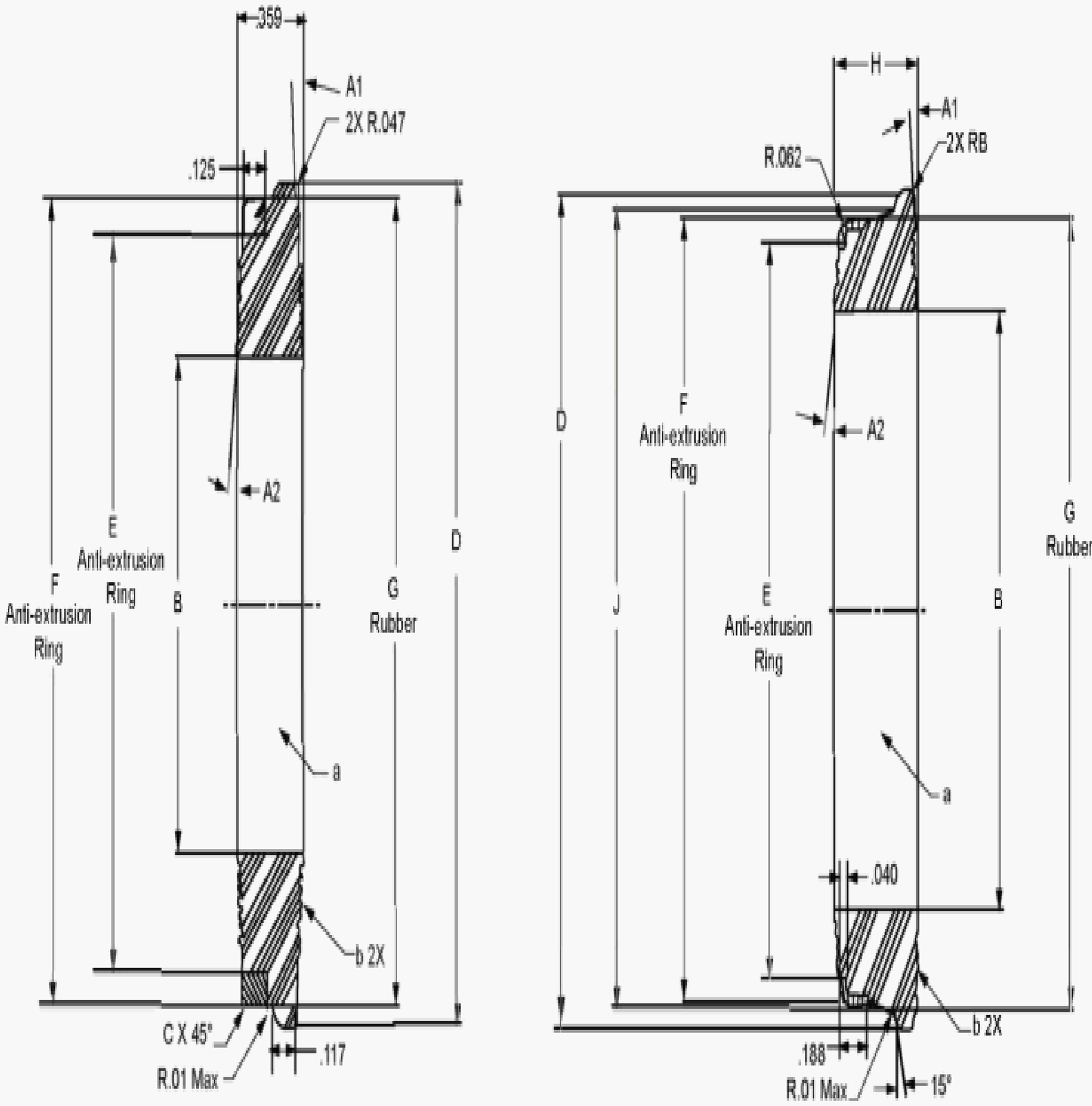
Figure	Size	Seal Height	Inner Diameter		Outside Diameter, Body		Outside Diameter, Bump		Flank Angle, Bottom	Flank Angle, Top	Bump Width	Bump Radius, Bottom
		H	B		G		D		A1	A2	W	RB
			Max.	Min.	Max.	Min.	Max.	Min.				
602 & 1002	1"	0.359	1.246	1.234	1.649	1.637	1.743	1.731	10°		0.117	0.047
	1.5"	0.359	1.844	1.828	2.251	2.235	2.345	2.329	10°		0.117	0.047
1502	1"	0.359	1.010	0.990	1.649	1.637	1.743	1.731	6.7°		0.117	0.047
	1.5"	0.359	1.391	1.375	2.251	2.235	2.345	2.329	5°		0.118	0.047
602, 1002, & 1502	2"	0.570	2.051	2.031	2.745	2.708	2.864	2.833	10°		0.124	0.062
	3"	0.525	3.122	3.094	4.056	4.028	4.164	4.136	5°	8°	0.108	0.054
	4"	0.523	4.135	4.104	5.081	5.050	5.172	5.141	5°	10°	0.100	0.050

A.1.2 Union Seals with Anti-extrusion Rings

Illustrations of two styles of union seals with anti-extrusion rings are shown in Figure A.2 with the associated dimensions in Table A.2 and Table A.3.

Style 1 Anti-extrusion Ring

Style 2 Anti-extrusion Ring



Key

a mark in this location

b optional serrations

Figure A.2—Union Seals with Integral Anti-extrusion Ring, Style 1 and Style 2

Table A.2—Dimensions for Figure A.2, Style 1 Union Seals With Anti-extrusion Ring

Figure	Size	Inner Diameter		Outside Diameter, Body		Outside Diameter, Bump		Flank Angle, Bottom	Flank Angle, Top	Chamfer, Anti-Exterior Ring	Inside Diameter Anti-Exterior Ring	Outside Diameter Anti-Ext Ring	
		B		G		D		A1	A2	C	E	F	
		Max.	Min.	Max.	Min.	Max.	Min.					Max.	Min.
1502	1"	1.010	0.990	1.639	1.629	1.743	1.731	6.7°		0.03	1.451	1.639	1.635
	1.5"	1.391	1.375	2.237	2.227	2.345	2.329	5°		0.03	2.049	2.237	2.233
2002 & 2202	2"	1.441	1.425	1.817	1.815	1.942	1.926	9°		0.05	1.631	1.817	1.813

Table A.3—Dimensions for Figure A.2, Style 2 Union Seals With Anti-extrusion Ring

Figure	Size	Seal Height		Inner Diameter		Outside Diameter Body		Outside Diameter Bump		Outside Diameter Bump to Body Intersect		Bump Radius	Flank Angle Bottom	Flank Angle Top	Inside Diameter Anti-exterior Ring	Outside Diameter Anti-exterior Ring	
		H		B		G		D		J		RB	A1	A2	E	F	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.					Max.	Min.
602, 1002 &1502	2"	0.572	0.562	2.051	2.031	2.677	2.667	2.853	2.833	2.728	2.708	0.058	4°	10°	2.489	2.677	2.673
	4"	0.533	0.520	4.125	4.094	4.988	4.978	5.164	5.131	5.062	5.040	0.050	5°	10°	4.738	4.988	4.980
602, 1002, 1502, 2002 & 2202	3"	0.530	0.520	3.122	3.094	3.988	3.978	4.164	4.108	4.056	4.000	0.054	5°	10°	3.738	3.988	3.982

A.1.3 Optional Sealing Flank for Seal Used in Non-pressure Seal Thread (NPST) Joints

To protect the integrity of the elastomer seals during installation in NPST joints, it is permissible to add flats at the apex of the sealing flanks as illustrated in Figure A.3.

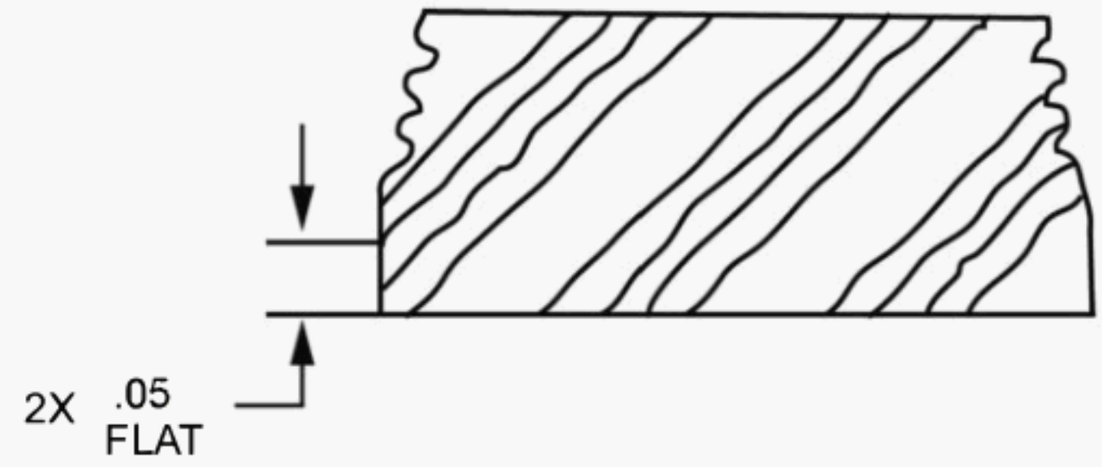


Figure A.3—Modified Sealing Flanks for NPST Union Seals

A.2 Retainer Segment Snap Ring Geometry

An illustration of a retainer segment snap ring is shown in Figure A.4 with the associated dimensions in Table A.4.

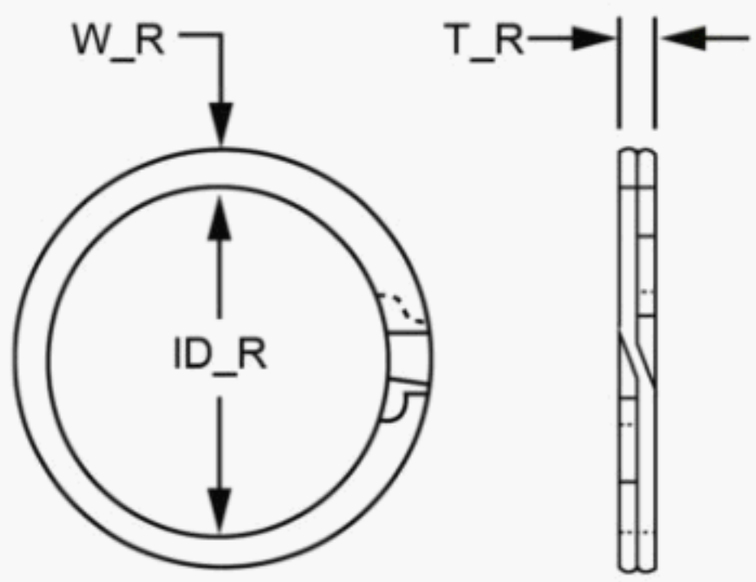


Figure A.4—Retainer Segment Snap Ring Geometry

Table A.4—Dimensions for Figure A.4 Retainer Segment Snap Rings

Figure	Size	Snap Ring Dimensions		
		ID_R	W_R	T_R
602 & 1002	2"	2.957	0.188	0.093
	3"	4.280	0.250	0.111
	4"	5.229	0.375	0.127
1502	1"	2.129	0.141	0.078
	1.5"	2.838	0.188	0.093
	2"	2.957	0.188	0.093
	3"	4.280	0.250	0.111
	4"	5.705	0.375	0.127
2002 & 2202	2"	2.838	0.188	0.093
	3"	5.705	0.375	0.127

A.3 Retainer Segment Rear Edge Break Geometry

An illustration of a retainer segment rear edge break with detail, is shown in Figure A.5 with the associated dimensions in Table A.5.

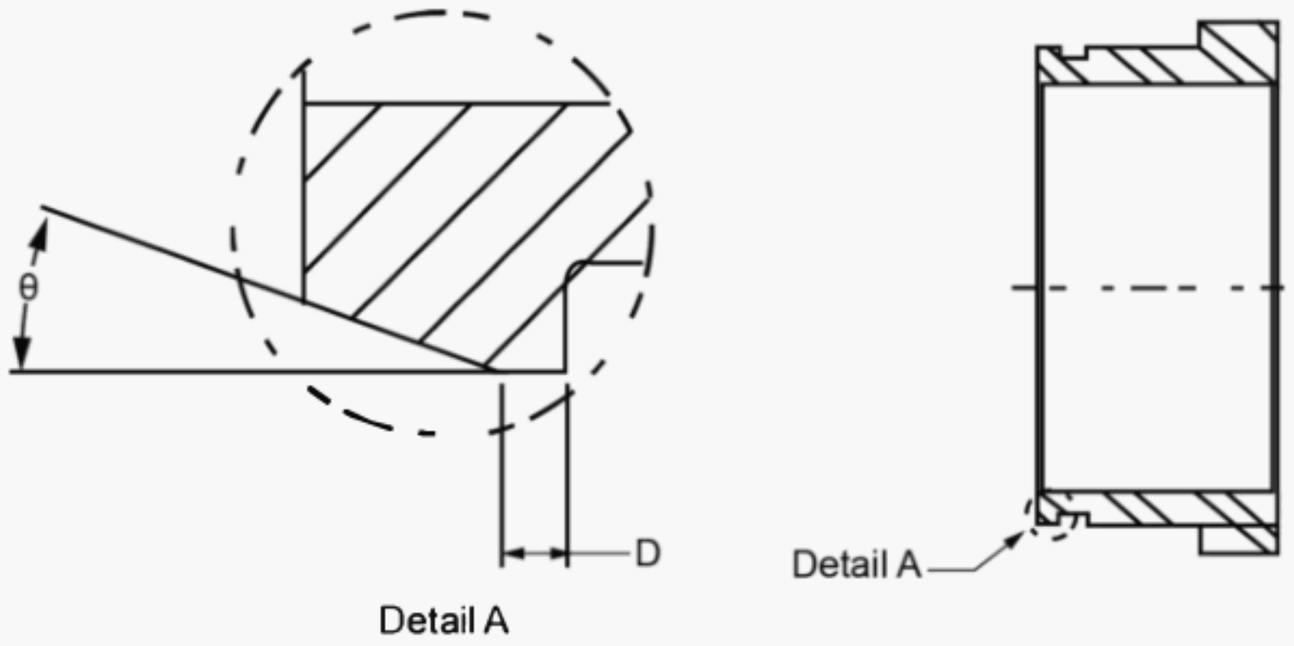


Figure A.5—Dimensions for Figure A.5 Retainer Segment Rear Edge Break

Table A.5—Dimensions for Figure A.5 Retainer Segment Rear Edge Break

Figure	Size	Edge Break Dims	
		D	θ
602 and 1002	2”	0.06	20°
	3”	0.05	20°
	4”	0.05	20°
1502	1”	0.04	20°
	1.5”	0.04	20°
	2”	0.05	20°
	3”	0.05	20°
	4”	0.06	15°
2002 and 2202	2”	0.05	20°
	3”	0.06	15°

Annex B
(normative)

Analysis Methodology for ACME Thread Root Modification

B.1 General

The dimensions, including thread geometry, in Tables 7 through 13 of this document shall be met for a hammer union connection to be in conformance with this standard except where explicitly permitted within this annex.

The dominant, or typical, failure mode for the equipment covered in this standard is through cyclic loading. Experience has shown that the fatigue resistance of these connections may be increased by careful selection of root radii (versus the standard square roots) in the union nut or female sub end ACME threads, or both. Field-proven, modified root geometry has been included in the standard for the 3" FIG 1502 union nut and is the preferred geometry when high amplitude cyclic loading is expected in service.

A hammer union connection that includes modified thread root geometry in the union nut or female sub end, shall be in conformance with the methodology in Annex B.

The analysis methodology defined here may not be used to modify any other explicitly defined geometry in this standard.

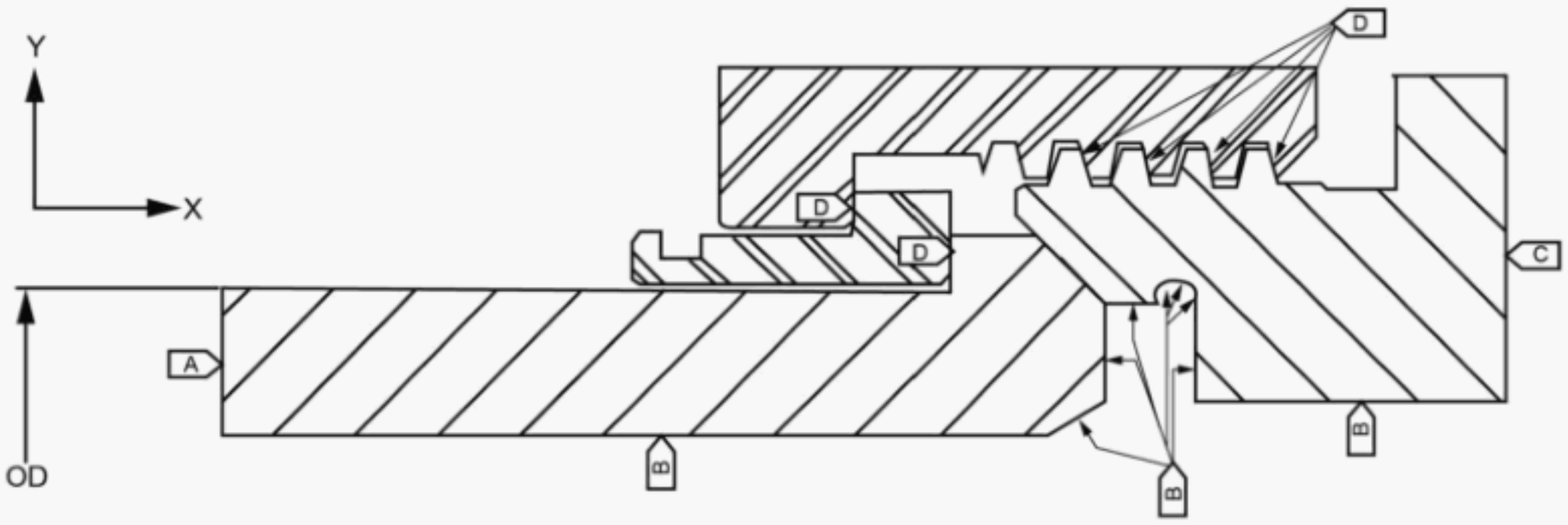
B.2 Analysis Methodology

A proper analysis should incorporate a representative geometric model, minimum material properties, accurate boundary conditions and loads, and a mesh density which is demonstrably capable of accurately predicting the stresses in the thread root.

B.2.1 Geometry and Boundary Conditions

The geometry shall be at the nominal or least material condition and may be a 2D-axisymmetic or 3D model. The union nut lug may not be included in a 2D-axisymmetric model but may be included in the 3D model provided that any symmetry used (partial models with symmetry applied on circumferential faces) to reduce model size (versus a full model) does not imply more than three lugs are included in the full model.

The axial length (along the x-axis in Figure B.1) of the straight-bore section of the male sub and female sub shall be at least 1.5 times greater than the OD of the male sub to reduce the effects of the boundary conditions on the strain response of the joint.



Key

A	End cap load applied to surface in x-direction = (pressure)*(internal area of male sub)
B	Internal pressure applied to surface
C	Frictionless support on the surface, movement in the x-direction restricted
D	Friction contact between surfaces, coefficient of friction = 0.13

Figure B.1—Cross-section of Model Geometry with Boundary Conditions and Loads

B.2.2 Material Properties and Material Model Behavior

The minimum material strength, yield and tensile, shall be used in the analysis, refer to 5.4.8.1. If available, the elastic modulus and Poisson's ratio extracted from material test reports may be used. Otherwise, the values in the Table B.1 shall be used.

The material model used by the software shall be either an elastic-perfectly plastic (bi-linear) or elastic- plastic to avoid over-stiffening the model in high-stress areas.

Table B.1—Default Material Properties for Analysis

Elastic Modulus [psi]	Poisson Ratio [–]
$29.7 \cdot 10^6$	0.29

B.2.3 Loads

The loading is intended to capture the anticipated stresses in the connection under working conditions. These loads include the end cap load, see 'A' in Figure B.1, and the internal pressure, see 'B' in Figure B.1.

The internal pressure, P, used in the analysis shall be the rated working pressure of the connection as specified in Table 1. This internal pressure shall be applied to the bores of the male and female sub ends as well as the surfaces which comprise the seal gland.

The appropriate end cap load, F, shall be applied to the surface at the end of the male sub furthest from the female sub end. The end cap load shall be in the x-direction such that it results in a tensile axial stress in the male sub end pipe wall and shall have a magnitude as calculated in Equation (B.1):

$$F = P\frac{\pi}{4}d_i^2 \tag{B.1}$$

where

d_i is the internal diameter of the male sub.

As this analysis is comparative (with the standard, not radiused root thread geometry as the benchmark), preloading of the joint to simulate make-up is not required provided line-to-line contact is made between all components.

B.2.4 Boundary Conditions

The model shall be fixed at the base of the female sub end, see 'C' in Figure B.1, such that movement is restricted in the x-direction and permitted in the y-direction.

Contacting geometry, see 'D' in Figure B.1, within the model shall be line to line and assigned a friction value of 0.13. The metal-to-metal seal interface between the male and female sub ends shall start in contact. However, any boundary condition that forces contact to be maintained between these subs shall not be applied.

B.2.5 Mesh Convergence Verification

After the initial analysis, the suitability of the mesh in accurately predicting the stress in the areas of interest (the thread roots of the component(s) which were modified) shall be verified.

The mesh is verified if a doubling of the mesh density in the areas of interest (or the entire model) results in a peak equivalent or principal stress that is within 10 % of the preceding analysis on that same geometry and in the same location. The probed location shall be within an area of interest.

B.2.6 Acceptance Criteria

The peak equivalent or principal tensile stress in the modified thread root area shall be less than or equal to the peak equivalent or principal tensile stress of the same connection at nominal dimensions.

A global plastic collapse analysis (see ASME VIII, Division 2, Part 5) may be performed to check that the redistribution of loads in the modified joint do not adversely affect the load capacity of the connection.

Bibliography

[1] ASME *BPVC Section VIII-Rules for Construction of Pressure Vessels Division 2-Alternative Rules*, BPVC-VIII-2-2013

[2] ASTM D1418, *Standard Practice for Rubber and Rubber Latices-Nomenclature*

[3] ASTM A991, *Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat-Treat Steel Products*

[4] SAE AMS 2750, *Pyrometry*

[5] SAE AMSH 6875, *Heat-Treatment of Steel Raw Materials*

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