SAE Aerospace
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AEROSPACE STANDARD

SAE AS7330

Issued 1992-10
Reaffirmed 2012-11

Superseding AMS7330A

Rings, Retaining - Spiral Wound, Uniform Section Corrosion Resistant Steel Procurement Specification For

FSC 5365

RATIONALE

AS7330 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Type:

This procurement specification covers aircraft quality retaining rings of the spiral wound type with uniform rectangular cross-sections and made from a corrosion resistant austenitic iron base alloy of the type identified under the Unified Numbering System as UNS S30200, and of spring temper condition.

1.2 Classification:

Retaining rings shall conform to one of the following types and classes:

a. Type I - External Ring, Class 1, Medium Duty
b. Type I - External Ring, Class 2, Heavy Duty
c. Type II - Internal Ring, Class 1, Medium Duty
d. Type II - Internal Ring, Class 2, Heavy Duty

1.3 Application:

Intended for use on aerospace propulsion systems for retaining parts on shafts and in housing bores where extended temperature use is not greater than 400 °F.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1.1 Aerospace Material Specifications:

AMS 2645	Fluorescent Penetrant Inspection
AMS 5866	Steel Wire, Flat, Corrosion Resistant, 18Cr-9.0Ni (SAE 30302) Spring Temper

2.1.1.2 Aerospace Standards:

AS3215	Ring, Retaining - Spiral, Internal, Heavy Duty, Cres
AS3216	Ring, Retaining - Spiral, External, Heavy Duty, Cres
AS3217	Ring, Retaining - Spiral, Internal, Light Duty, Cres
AS3218	Ring, Retaining - Spiral, External, Light Duty, Cres
AS3219	Ring, Retaining, Spiral, Minimum Distortion, Dimensional and Acceptance Standard For

2.1.2 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2.1 Military Standard:

MIL-STD-2073-1	DoD Materiel, Procedures for Development and Application of Packaging Requirements

2.1.3 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

2.1.4 ANSI Publications: Available from American National Standards Institute, Inc., 11 West 42nd Street, 13th Floor, New York, NY 10036.

ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

2.2 Definitions:

DEFECTIVE: A unit of product which contains one or more defects.

PRODUCTION INSPECTION LOT: Shall be all finished parts of the same part number, made from a single heat of alloy, heat treated at the same time to the same specified condition, produced as one continuous run, and submitted for vendor's inspection at the same time.

2.3 Unit Symbols:

%	- percent (1% = 1/100)
°F	- degree Fahrenheit
in^2	- square inch
lbf	- pounds force
ks	- kips (1000 pounds) per square inch
sp gr	- specific gravity
HR15N	- hardness, Rockwell, 15N scale
HR30N	- hardness, Rockwell, 30N scale
HRA	- hardness, Rockwell, A scale
HRC	- hardness, Rockwell, C scale

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be AMS 5866 spring temper steel, corrosion resistant, flat wire, unless otherwise specified on the part drawing.

3.2 Design:

Finished (completely manufactured) parts shall conform to the following requirements:

3.2.1 Design and Dimensions: Unless otherwise specified on the part drawing, retaining rings furnished under this specification shall conform to the design, shape, dimensions, and other requirements specified on the applicable AS standard drawing as in 2.1.1.2. Dimensions shall conform after all processing.

NOTE: Class 1, Medium Duty is assigned to the AS Light Duty rings as in 2.1.1.2.

3.2.2 Surface Texture: Surface texture of finished parts shall conform to the requirements as specified on the part drawing, determined in accordance with ANSI/ASME B46.1.

3.2.3 Crimp: Retaining rings that are required to be crimped (offset at ring ends) shall meet the requirements in AS3219.

3.2.4 Irregularity of Form: The following ring form irregularities shall be not greater than that specified in AS3219:

a. Dish and parallelism
b. Misalignment
c. Radial deformation
d. Distortion and kink

3.2.5 Removal Provision: All rings shall be notched to facilitate their removal from the groove. Notch dimensions shall be as specified on the part drawing.

3.2.6 Edges: The edges of the ring material shall be rounded except at the ends and at the removal notches. The edge radius shall be as specified on the part drawing. All edges, including those at the retaining ring ends and at the removal notches, shall be free from burrs, slivers, dents, nicks, cracks, and other irregularities.

3.3 Fabrication:

3.3.1 Rings shall be wound as a spiral of two or more turns from strip of uniform cross section and rounded edges, cold worked sufficiently to meet the requirements of 3.4 on the finished rings.

3.3.2 Passivation: Unless otherwise specified on the part drawing, finished rings shall be passivated by immersion in one of the following solutions at the temperature and for the time shown, and then rinsing and drying:

a. 20 to 50% by volume of nitric acid at 70 to 90 °F for 30 to 40 minutes.
b. 20 to 50% by volume of nitric acid plus 2 to 3% by weight of sodium dichromate operated at 70 to 90 °F for 30 to 40 minutes, at 120 to 130 °F for 20 to 30 minutes, or at 145 to 155 °F for 10 to 15 minutes.

3.4 Properties:

3.4.1 Hardness: Shall be used as a reference to approximate tensile strength, and shall be as specified in Table 1, determined in accordance with ASTM E 18.

TABLE 1 - Hardness, Reference

Ring Wire, Cross Section Thickness minimum, inch	Hardness
0.008 to 0.015, inclusive	83.0 to 86.0 HR15N
over 0.015 to 0.022, inclusive	64.0 to 69.5 HR40N
over 0.022 to 0.047, inclusive	72.0 to 74.9 HRA
over 0.047 to 0.062, inclusive	39.8 to 48.5 HRC
over 0.062 to 0.074, inclusive	38.0 to 47.0 HRC

3.4.2 Tensile Strength: Rings rectangular section wire shall have tensile strength specified in Table 2, determined in accordance with ASTM E 8.

TABLE 2 - Tensile Strength

Ring Wire, Cross Section Thickness minimum, inch	Tensile Strength ksi
0.008 to 0.022, inclusive	210 to 250
over 0.022 to 0.047, inclusive	200 to 235
over 0.047 to 0.062, inclusive	185 to 235
over 0.062 to 0.074, inclusive	175 to 225

3.4.3 Rings shall not be rejected on the basis of hardness if the tensile strength properties specified in 3.4.2 are met.

3.4.4 Performance: Retaining rings shall be capable of undergoing the test of 4.5.2.1 without showing indications of cracks, excessive permanent set or distortion or other conditions detrimental to use of the rings. Distortion or permanent set shall not be to the extent where the minimum diametral interference fit between the ring diameter and the groove diameter, under the stack-up of tolerances is less than 0.003 times the groove diameter as specified in Tables 5 and 6, calculated as follows:

$$F = \phi A - \phi C \geq 0.003 \phi C \qquad \text{(Eq. 1)}$$

where:

F = minimum interference fit between ring and groove after performance test

ϕA = maximum ID, external ring as measured after performance test

ϕA = minimum OD, internal ring as measured after performance test

ϕC = minimum groove diameter, external ring

ϕC = maximum groove diameter, internal ring

3.5 Quality:

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials and from imperfections detrimental to usage of the parts.

3.5.1 Fluorescent Penetrant Inspection: Parts shall be fluorescent penetrant inspected in accordance with AMS 2645. There shall be no evidence of cracks, seams, laminations, blanking tears, or laps.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of parts shall supply all samples for vendor's test and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the parts conform to the requirements of this specification.

4.2 Responsibility for Compliance:

The manufacturer's system for parts production shall be based on preventing product defects, rather than detecting the defects at final inspection and then requiring corrective action to be invoked. An effective manufacturing in-process control system shall be established, subject to the approval of the purchaser, and used during the production of parts.

4.3 Production Acceptance Tests:

The purpose of production acceptance tests is to check, as simply as possible, using a method which is inexpensive and representative of the part usage, with the uncertainty inherent in random sampling, that the parts comprising a production inspection lot satisfy the requirements of this specification.

4.3.1 Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each production inspection lot. A summary of acceptance tests is specified in Table 3.

TABLE 3 - Summary of Acceptance Tests

Characteristic	Req. Para.	Sample Size	Test Method
Nondestructive Tests			
Design & Dimensions	3.2	4.4.2	Conventional measuring methods and 4.5.1.1
Fluorescent Penetrant Inspection	3.5.1	4.4.2	Per AMS 2645 and 4.5.1.2
Quality	3.5	4.4.2	Visual
Packaging and Identification	5.1	none	Visual
Destructive Tests			
Material Composition	3.1	4.4.1	Per material specification
Hardness	3.4.1	4.4.3	ASTM E 18 and 4.5.2.2
Tensile Strength	3.4.2	4.4.3	ASTM E 8 and 4.5.2.3
Performance	3.4.4	4.4.3	Per 4.5.2.1

4.4 Acceptance Tests Sampling:

4.4.1 Material: One sample of wire, from which retaining rings were made, from each heat of alloy.

4.4.2 Nondestructive Tests - Visual and Dimensional: A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 7.

4.4.3 Destructive Tests: A random sample of parts shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 8.

4.4.4 Acceptance Quality: Of random samples examined or tested, acceptance quality shall be based on zero defectives.

4.5 Inspection:

4.5.1 Nondestructive Tests: 4.5.1.1Visual and Dimensional Examination: Sample retaining rings selected in accordance with 4.4.2 shall be visually and dimensionally examined to verify compliance with the requirements of the part drawing and this specification. The rings shall be accepted or rejected in accordance with 4.4.4.

4.5.1.2 Nondestructive Inspection: Parts shall be fluorescent penetrant inspected in accordance with AMS 2645 and shall meet the requirements in 3.5.1.

4.5.2 Destructive Tests: Sample retaining rings selected in accordance with 4.4.3 shall be tested as specified in 4.5.2.1, 4.5.2.2, and 4.5.2.3 and shall be accepted or rejected in accordance with 4.4.4.

4.5.2.1 Performance Tests: Prior to the hardness test of 4.5.2.2, the sample retaining rings selected in accordance with 4.4.3 shall be subjected to the tests of 4.5.2.1.1 and 4.5.2.1.2 as applicable.

4.5.2.1.1 Type I, Classes 1 and 2: External retaining rings in accordance with AS3216 and AS3218 shall be expanded over and removed from a groove having a nominal shaft diameter and groove dimensions as specified in Table 5 (see Figure 1 and Table 4) for the applicable retaining ring size. After repeating this test five times, the rings shall be visually and dimensionally inspected for conformance to the requirements of 3.4.4.

4.5.2.1.2 Type II, Classes 1 and 2: Internal retaining rings in accordance with AS3215 and AS3217 shall be compressed into and removed from a groove having a nominal bore diameter and groove dimensions as specified in Table 6 (see Figure 2 and Table 4) for the applicable retaining ring size. After repeating this test five times, the rings shall be visually and dimensionally inspected for conformance to the requirements of 3.4.4.

4.5.2.2 Hardness Test: After the tests of 4.5.2.1, each sample retaining ring selected in accordance with 4.4.2 shall be tested for conformance to the hardness requirements specified in 3.4.1. The surfaces of both sides of each sample shall be prepared for hardness testing by removal of surface conditions which may affect the hardness reading. Hardness readings shall be taken as close as practicable to the center of the surface width of the ring.

4.5.2.3 Tensile Strength Test: Tensile strength test shall be conducted in accordance with ASTM E 8 on three specimens of wire material of the same lot of alloy used to produce the production inspection lot of the finished parts. Such specimens shall withstand the tensile strength stress specified in 3.4.2. The rectangular cross-section area of the wire specimen shall be determined from measurements of thickness and width taken prior to the test. The tensile test load shall be determined as follows:

$$A = T \times W - .12(T)^2 \quad \text{(Eq. 2)}$$

$$F = S_t \times A \times 1000 \quad \text{(Eq. 3)}$$

where:

A = area, for this test, of wire specimen cross-section, in^2

T = thickness of wire specimen, inch

W = width of wire specimen, inch

F = test tensile load, lbf

S_t = tensile stress specified in 3.4.2, ksi

4.6 Reports:

The vendor of parts shall furnish with each shipment a report stating that the chemical composition of the parts conforms to the applicable material specification, showing the results of tests to determine conformance to the acceptance examination and tests requirements of this specification. This report shall include the purchase order number, lot number, AS7330, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.7 Rejected Lots:

If a production inspection lot is rejected, the vendor of parts may perform corrective action to screen out or rework the defective parts, and resubmit for acceptance tests inspection as in Table 3. Resubmitted lots shall be clearly identified as reinspected lots.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Parts having different part numbers shall be packed in separate containers.

5.1.2 Each container of parts shall be marked to show not less than the following information:

RETAINING RINGS, STEEL, CORROSION RESISTANT
AS7330
PART NUMBER
LOT NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

5.1.3 Containers of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, industrial packaging, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Direct U.S. Military Procurement:

Purchase documents should specify not less than the following:

Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired
Level A packaging, if required (see 5.1.4)

8.2 Key Words:

Ring, retaining; procurement specification

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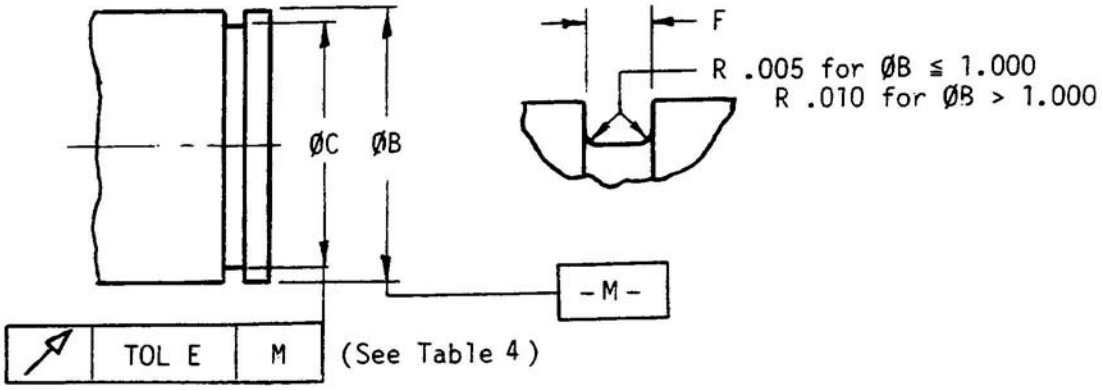

FIGURE 1 - Groove Dimensions, Type I, Classes 1 and 2 Retaining Rings
(See Table 5)

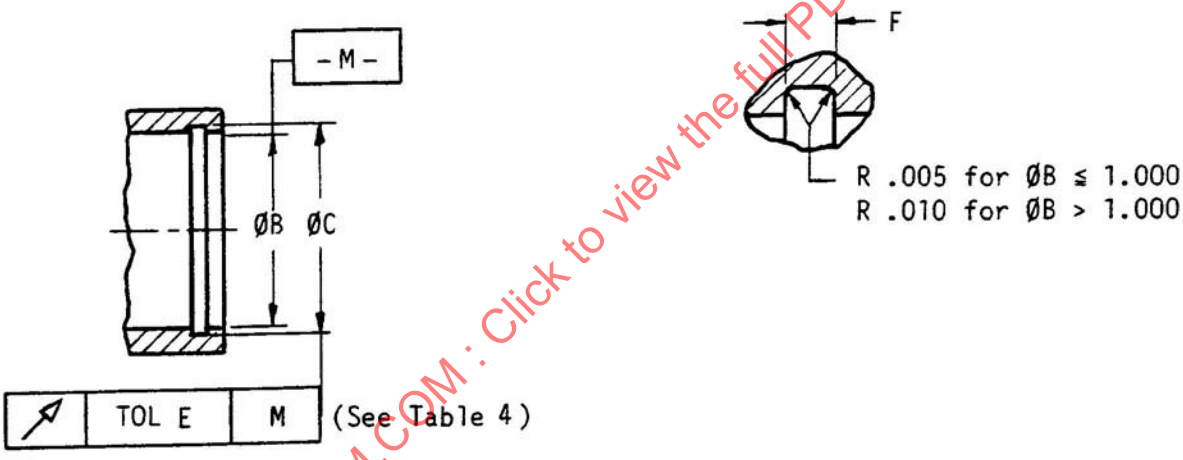

FIGURE 2 - Groove Dimensions, Type II, Classes 1 and 2 Retaining Rings
(See Table 6)

TABLE 4 - Groove Runout Tolerance (inches)

E	ϕB
.004	.469 thru 1.094
.006	over 1.094 thru 2.165
.008	over 2.165 thru 3.149
.010	over 3.149 thru 5.907
.012	over 5.907 thru 15.000

TABLE 5 - Groove Dimensions, Type I Retaining Rings (inches)

Nom Shaft ϕB	Class 1 ϕC	Class 1 F	Class 2 ϕC	Class 2 F
.469	---	---	.441 - .445	.029 - .032
.500	.472 - .476	.030 - .033	.466 - .470	.039 - .042
531	.503 - .507	.030 - .033	---	---
.551	.523 - .527	.030 - .033	.517 - .521	.039 - .042
.562	.534 - .538	.030 - .033	.528 - .532	.039 - .042
.594	.566 - .572	.030 - .033	.556 - .562	.039 - .042
.625	.591 - .597	.030 - .033	.585 - .591	.039 - .042
.656	.622 - .628	.030 - .033	---	---
.669	.635 - .641	.030 - .033	.626 - .632	.039 - .042
.688	.653 - .659	.030 - .033	.643 - .649	.046 - .049
.718	.684 - .690	.030 - .033	---	---
.750	.716 - .722	.036 - .039	.701 - .707	.046 - .049
.781	.747 - .753	.036 - .039	.730 - .736	.046 - .049
.812	.778 - .784	.036 - .039	.759 - .765	.046 - .049
.843	.809 - .815	.036 - .039	---	---
.875	.835 - .841	.036 - .039	.818 - .824	.046 - .049
.906	.866 - .872	.036 - .039	---	---
.938	.897 - .903	.036 - .039	.879 - .885	.046 - .049
.968	.922 - .928	.042 - .045	---	---
.984	.938 - .944	.042 - .045	.923 - .929	.046 - .049
1.000	.954 - .960	.042 - .045	.937 - .943	.046 - .049
1.023	.977 - .983	.042 - .045	.958 - .964	.046 - .049
1.031	.985 - .991	.042 - .045	---	---
1.062	1.016 - 1.024	.042 - .045	.994 - 1.002	.056 - .060
1.094	1.047 - 1.055	.042 - .045	---	---
1.125	1.079 - 1.087	.042 - .045	1.055 - 1.063	.056 - .060
1.156	1.110 - 1.118	.042 - .045	---	---
1.188	1.136 - 1.144	.048 - .052	1.114 - 1.122	.056 - .060
1.219	1.166 - 1.174	.048 - .052	---	---
1.250	1.198 - 1.206	.048 - .052	1.172 - 1.180	.056 - .060
1.281	1.229 - 1.237	.048 - .052	---	---
1.312	1.260 - 1.268	.048 - .052	1.228 - 1.236	.056 - .060
1.344	1.291 - 1.299	.048 - .052	---	---
1.375	1.319 - 1.327	.048 - .052	1.287 - 1.295	.056 - .060
1.406	1.350 - 1.358	.048 - .052	---	---
1.438	1.381 - 1.389	.048 - .052	1.346 - 1.354	.056 - .060
1.469	1.412 - 1.420	.048 - .052	---	---
1.500	1.444 - 1.452	.048 - .052	1.402 - 1.410	.056 - .060
1.562	1.502 - 1.512	.056 - .060	1.463 - 1.473	.068 - .072

TABLE 5 - Groove Dimensions, Type I Retaining Rings (inches) (Continued)

Nom Shaft ϕB	Class 1 ϕC	Class 1 F	Class 2 ϕC	Class 2 F
1.575	1.515 - 1.525	.056 - .060	---	---
1.625	1.561 - 1.571	.056 - .060	1.524 - 1.534	.068 - .072
1.688	1.623 - 1.633	.056 - .060	1.584 - 1.594	.068 - .072
1.750	1.686 - 1.696	.056 - .060	1.645 - 1.655	.068 - .072
1.771	1.703 - 1.713	.056 - .060	1.664 - 1.674	.068 - .072
1.812	1.744 - 1.754	.056 - .060	1.703 - 1.713	.068 - .072
1.875	1.803 - 1.813	.056 - .060	1.764 - 1.774	.068 - .072
1.938	1.866 - 1.876	.056 - .060	---	---
1.969	1.897 - 1.907	.056 - .060	1.852 - 1.862	.068 - .072
2.000	1.924 - 1.934	.056 - .060	1.881 - 1.891	.068 - .072
2.062	1.986 - 1.998	.056 - .060	1.940 - 1.952	.086 - .091
2.125	2.045 - 2.057	.056 - .060	1.997 - 2.009	.086 - .091
2.156	2.076 - 2.088	.056 - .060	2.026 - 2.038	.086 - .091
2.165	2.085 - 2.097	.056 - .060	---	---
2.188	2.107 - 2.119	.056 - .060	---	---
2.250	2.170 - 2.182	.056 - .060	2.114 - 2.126	.086 - .091
2.312	2.228 - 2.240	.056 - .060	2.172 - 2.184	.086 - .091
2.362	2.278 - 2.290	.056 - .060	---	---
2.375	2.291 - 2.303	.056 - .060	2.233 - 2.245	.086 - .091
2.438	2.349 - 2.361	.056 - .060	2.293 - 2.305	.086 - .091
2.500	2.412 - 2.424	.056 - .060	2.354 - 2.366	.086 - .091
2.559	2.467 - 2.479	.056 - .060	2.413 - 2.425	.086 - .091
2.562	2.470 - 2.482	.056 - .060	---	---
2.625	2.533 - 2.545	.056 - .060	2.475 - 2.487	.086 - .091
2.688	2.591 - 2.603	.056 - .060	2.535 - 2.547	.086 - .091
2.750	2.654 - 2.666	.056 - .060	2.596 - 2.608	.103 - .108
2.812	2.716 - 2.728	.056 - .060	---	---
2.875	2.775 - 2.787	.056 - .060	2.715 - 2.727	.103 - .108
2.938	2.837 - 2.849	.056 - .060	2.773 - 2.785	.103 - .108
2.952	2.852 - 2.864	.056 - .060	---	---
3.000	2.898 - 2.910	.068 - .073	2.832 - 2.844	.103 - .108
3.062	2.960 - 2.972	.068 - .073	2.892 - 2.904	.103 - .108
3.125	3.021 - 3.033	.068 - .073	2.951 - 2.963	.103 - .108
3.149	3.045 - 3.057	.068 - .073	---	---
3.156	---	---	2.980 - 2.992	.103 - .108
3.188	3.083 - 3.095	.068 - .073	---	---
3.250	3.144 - 3.156	.068 - .073	3.070 - 3.082	.103 - .108
3.312	3.202 - 3.214	.068 - .073	---	---
3.344	3.233 - 3.245	.068 - .073	3.160 - 3.172	.103 - .108

TABLE 5 - Groove Dimensions, Type I Retaining Rings (inches) (Continued)

Nom Shaft fB	Class 1 fC	Class 1 F	Class 2 fC	Class 2 F
3.375	3.265 - 3.277	.068 - .073	---	---
3.438	3.325 - 3.337	.068 - .073	3.251 - 3.263	.103 - .108
3.500	3.388 - 3.400	.068 - .073	3.310 - 3.322	.120 - .125
3.543	3.427 - 3.439	.068 - .073	3.351 - 3.363	.120 - .125
3.562	3.446 - 3.458	.068 - .073	---	---
3.625	3.509 - 3.521	.068 - .073	3.429 - 3.441	.120 - .125
3.688	3.569 - 3.581	.068 - .073	3.487 - 3.499	.120 - .125
3.740	3.622 - 3.634	.068 - .073	---	---
3.750	3.632 - 3.644	.068 - .073	3.546 - 3.558	.120 - .125
3.812	3.694 - 3.706	.068 - .073	---	---
3.875	3.751 - 3.763	.068 - .073	3.667 - 3.679	.120 - .125
3.938	3.814 - 3.826	.068 - .073	3.728 - 3.740	.120 - .125
4.000	3.870 - 3.882	.068 - .073	3.786 - 3.798	.120 - .125
4.062	3.933 - 3.945	.068 - .073	---	---
4.125	3.994 - 4.006	.068 - .073	---	---
4.134	4.004 - 4.016	.068 - .073	---	---
4.188	4.052 - 4.064	.068 - .073	---	---
4.250	4.114 - 4.126	.068 - .073	4.059 - 4.071	.120 - .125
4.312	4.176 - 4.188	.068 - .073	---	---
4.331	4.194 - 4.206	.068 - .073	---	---
4.375	4.239 - 4.251	.068 - .073	4.184 - 4.196	.120 - .125
4.438	4.301 - 4.313	.068 - .073	---	---
4.500	4.358 - 4.370	.068 - .073	4.304 - 4.316	.120 - .125
4.562	4.416 - 4.428	.079 - .084	---	---
4.625	4.479 - 4.491	.079 - .084	---	---
4.688	4.541 - 4.553	.079 - .084	---	---
4.724	4.578 - 4.590	.079 - .084	---	---
4.750	4.604 - 4.616	.079 - .084	4.544 - 4.556	.120 - .125
4.812	4.666 - 4.678	.079 - .084	---	---
4.875	4.729 - 4.741	.079 - .084	---	---
4.938	4.791 - 4.803	.079 - .084	---	---
5.000	4.850 - 4.862	.079 - .084	4.784 - 4.796	.120 - .125
5.118	4.968 - 4.980	.079 - .084	---	---
5.125	4.975 - 4.987	.079 - .084	---	---
5.250	5.100 - 5.114	.079 - .084	5.023 - 5.037	.139 - .145
5.375	5.221 - 5.235	.079 - .084	---	---
5.500	5.346 - 5.360	.079 - .084	5.258 - 5.272	.139 - .145
5.511	5.357 - 5.371	.079 - .084	---	---
5.625	5.471 - 5.485	.079 - .084	---	---

TABLE 5 - Groove Dimensions, Type I Retaining Rings (inches) (Continued)

Nom Shaft ϕB	Class 1 ϕC	Class 1 F	Class 2 ϕC	Class 2 F
5.750	5.590 - 5.604	.079 - .084	5.498 - 5.512	.139 - .145
5.875	5.715 - 5.729	.079 - .084	---	---
5.905	5.745 - 5.759	.079 - .084	---	---
6.000	5.840 - 5.854	.079 - .084	5.738 - 5.752	.139 - .145
6.125	5.945 - 5.961	.094 - .100	---	---
6.250	6.070 - 6.086	.094 - .100	5.977 - 5.993	.174 - .182
6.299	6.119 - 6.135	.094 - .100	---	---
6.375	6.195 - 6.211	.094 - .100	---	---
6.500	6.320 - 6.336	.094 - .100	6.217 - 6.233	.174 - .182
6.625	6.435 - 6.451	.094 - .100	---	---
6.750	6.560 - 6.576	.094 - .100	6.457 - 6.473	.174 - .182
6.875	6.685 - 6.701	.094 - .100	---	---
7.000	6.810 - 6.826	.094 - .100	6.697 - 6.713	.174 - .182
7.125	6.925 - 6.941	.094 - .100	---	---
7.250	7.050 - 7.066	.094 - .100	6.934 - 6.950	.174 - .182
7.375	7.175 - 7.191	.094 - .100	---	---
7.500	7.300 - 7.316	.094 - .100	7.172 - 7.188	.209 - .217
7.625	7.415 - 7.431	.094 - .100	---	---
7.750	7.540 - 7.556	.094 - .100	7.412 - 7.428	.209 - .217
7.875	7.665 - 7.681	.094 - .100	---	---
8.000	7.790 - 7.806	.094 - .100	7.652 - 7.668	.209 - .217
8.250	8.030 - 8.046	.094 - .100	7.892 - 7.908	.209 - .217
8.500	8.280 - 8.296	.094 - .100	8.132 - 8.148	.209 - .217
8.750	8.520 - 8.536	.094 - .100	8.375 - 8.391	.209 - .217
9.000	8.770 - 8.786	.094 - .100	8.612 - 8.628	.209 - .217
9.250	9.010 - 9.026	.094 - .100	8.852 - 8.868	.209 - .217
9.500	9.260 - 9.276	.094 - .100	9.092 - 9.108	.209 - .217
9.750	9.500 - 9.516	.094 - .100	9.330 - 9.346	.209 - .217
10.000	9.750 - 9.766	.094 - .100	9.567 - 9.583	.209 - .217
10.250	9.990 - 10.006	.094 - .100	9.804 - 9.824	.209 - .217
10.500	10.240 - 10.256	.094 - .100	10.044 - 10.064	.209 - .217
10.750	10.480 - 10.496	.094 - .100	10.283 - 10.303	.209 - .217
11.000	10.730 - 10.746	.094 - .100	10.523 - 10.543	.209 - .217
11.250	---	---	10.762 - 10.782	.209 - .217
11.500	---	---	11.001 - 11.021	.209 - .217
11.750	---	---	11.240 - 11.260	.209 - .217
12.000	---	---	11.480 - 11.500	.209 - .217
12.250	---	---	11.719 - 11.739	.209 - .217
12.500	---	---	11.959 - 11.979	.209 - .217

TABLE 5 - Groove Dimensions, Type I Retaining Rings (inches) (Continued)

Nom Shaft ϕB	Class 2 ϕC	Class 2 F
12.750	12.196 - 12.220	.209 - .217
13.000	12.436 - 12.460	.209 - .217
13.250	12.675 - 12.699	.209 - .217
13.500	12.915 - 12.939	.209 - .217
13.750	13.154 - 13.178	.209 - .217
14.000	13.393 - 13.417	.209 - .217
14.250	13.632 - 13.656	.209 - .217
14.500	13.872 - 13.896	.209 - .217
14.750	14.111 - 14.135	.209 - .217
15.000	14.351 - 14.375	.209 - .217

TABLE 6 - Groove Dimensions, Type II Retaining Rings (inches)

Nom Bore ϕB	Class 1 ϕC	Class 1 F	Class 2 ϕC	Class 2 F
.500	.524 - .528	.030 - .033	.528 - .532	.039 - .042
.512	.536 - .540	.030 - .033	.540 - .544	.039 - .042
.531	.555 - .559	.030 - .033	---	---
.562	.586 - .590	.030 - .033	.594 - .598	.039 - .042
.594	.617 - .621	.030 - .033	---	---
.625	.649 - .653	.030 - .033	.663 - .667	.039 - .042
.656	.680 - .684	.030 - .033	---	---
.688	.711 - .715	.030 - .033	.730 - .734	.039 - .042
.719	.742 - .746	.030 - .033	---	---
.750	.780 - .784	.036 - .039	.794 - .798	.039 - .042
.777	.805 - .811	.036 - .039	.822 - .828	.046 - .049
.781	.809 - .815	.036 - .039	---	---
.812	.840 - .846	.036 - .039	.859 - .865	.046 - .049
.844	.877 - .883	.036 - .039	---	---
.866	.900 - .906	.036 - .039	.917 - .923	.046 - .049
.875	.909 - .915	.036 - .039	.928 - .934	.046 - .049
.901	---	---	.956 - .962	.046 - .049
.906	.940 - .946	.036 - .039	---	---
.938	.972 - .978	.036 - .039	.997 - 1.003	.046 - .049
.969	1.008 - 1.014	.042 - .045	---	---
.987	1.027 - 1.033	.042 - .045	---	---
1.000	1.040 - 1.046	.042 - .045	1.063 - 1.069	.046 - .049
1.023	1.063 - 1.069	.042 - .045	1.088 - 1.094	.046 - .049
1.031	1.071 - 1.077	.042 - .045	---	---
1.062	1.100 - 1.108	.042 - .045	1.126 - 1.134	.056 - .060
1.094	1.131 - 1.139	.042 - .045	---	---
1.125	1.163 - 1.171	.042 - .045	1.193 - 1.201	.056 - .060
1.156	1.194 - 1.202	.042 - .045	---	---
1.188	1.232 - 1.240	.048 - .052	1.258 - 1.266	.056 - .060
1.219	1.262 - 1.270	.048 - .052	---	---
1.250	1.294 - 1.302	.048 - .052	1.326 - 1.334	.056 - .060
1.281	1.325 - 1.333	.048 - .052	---	---
1.312	1.356 - 1.364	.048 - .052	1.392 - 1.400	.056 - .060
1.344	1.391 - 1.399	.048 - .052	---	---
1.375	1.423 - 1.431	.048 - .052	1.457 - 1.465	.056 - .060
1.406	1.454 - 1.462	.048 - .052	---	---
1.438	1.485 - 1.493	.048 - .052	1.524 - 1.532	.056 - .060
1.456	1.504 - 1.512	.048 - .052	1.544 - 1.552	.056 - .060
1.469	1.516 - 1.524	.048 - .052	---	---