METRIC AEROSPACE STANDARD

MA4036™	REV. A

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Superseding MA4036

(R) Rings, Retaining - Tapered Width, Uniform Thickness Corrosion Resistant, Procurement Specification For, Metric

FSC 5365

RATIONALE

Delete MIL-STD-105, revise sampling requirements and acceptance testing based on zero defectives, revise packaging requirements to MIL-STD-2073-1, extensive revision to Section 4, update references, extensive editorial updates.

1. SCOPE

1.1 Scope

This specification covers the procurement requirements for corrosion resistant steel retaining rings of the tapered width type with rectangular and beveled cross-sections.

1.2 Classification

Retaining rings shall be of the types and classes shown in Table 1.

Table 1 - Classification

Type	Class	Description
I – Flat, rectangular section	1	Internal, Type 3BM1 per ASME B27.7
	2	External, Type 3AM1 per ASME B27.7
	3	External, Type 3EM1 per ASME B27.8M
II – Flat, beveled section	1	Internal, Series 10-102 per Waldes Truarc (Rotor Clip Co, Inc.)

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 315 °C.

1.4 Dimensions and Tolerances

Dimensions and tolerances in this specification are in millmeters unless otherwise specified.

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS5520	Steel, Corrosion and Heat-Resistant, Sheet, Strip, Foil, and Plate 15Cr - 7.1Ni - 2.5Mo - 1.1Al Solution Heat Treated, Precipitation Hardenable
MA4020	Ring, Retaining - External, Tapered, Type I, Class 2, AMS5520, Metric
MA4021	Ring, Retaining - Internal, Tapered, Type I, Class 1, AMS5520, Metric
MA4029	Ring, Retaining - Internal, Beveled, Tapered, Type II, Class 1, AMS5520, Metric
MA4030	Ring, Retaining - External, Reinforced E-Ring, Type I, Class 3 AMS5520, Metric

2.1.2 ASTM Publications

Available from ASTM International, 100 Bar Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E1417/1417M	Standard Practice for Liquid Penetrant Testing

2.1.3 ASME Publications

Available from ASME, P. O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel. 800-843-2763 (US/Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B27.7	General Purpose Tapered and Reduced Cross Section Retaining Rings
ASME B27.8M	General Purpose Metric Tapered and Reduced Cross Section Retaining Rings
ASME B46.1	Surface Texture (Surface Roughness, Waviness and Lay)

2.1.4 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-STD-2073-1	Standard Practice for Military Packaging

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)
°C	degree Celsius
mm	millimeter
MPa	megapascals
HRC	hardness, Rockwell, C scale

3. TECHNICAL REQUIREMENTS

3.1 Material

AMS5520 corrosion resistant steel, sheet, or strip.

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 MA standard drawings as in 2.1.1. Dimensions shall conform after all processing.

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 ASME B46.1.

3.2.3 Gap Width, Minimum

Type I, Class 1 rings, when seated in a groove as specified in Table 3, shall have a gap between lugs (dimension K as shown in Figure 1) not less than the minimum values for dimension K as specified in Table 3.

3.2.4 Gap Width, Minimum

Type II, Class 1 rings, when seated in a groove as specified in Table 4, shall have a gap between lugs (dimension K as shown in Figure 2) not less than the minimum values for dimension K as specified in Table 4.

3.2.5 Gaging Diameter, Maximum

Type I, Class 2 rings, when seated in a groove as specified in Table 5, shall have an outside diameter (dimension ØK as shown in Figure 3) not greater than the maximum values for ØK as specified in Table 5.

3.2.6 Gaging Diameter, Maximum

Type I, Class 3 rings, when seated in a groove as specified in Table 6, shall have an outside diameter (dimension ØK as shown in Figure 4) not greater than the maximum values for ØK as specified in Table 6.

3.2.7 Dish

The dish (see Figure 5) of Type I and Type II rings shall not exceed the dimensions specified in Table 2 for the applicable ring thickness.

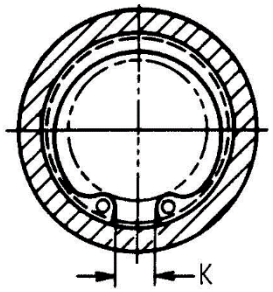

Figure 1 - Gap width minimum
Type I, Class 1 ring
Seated in groove

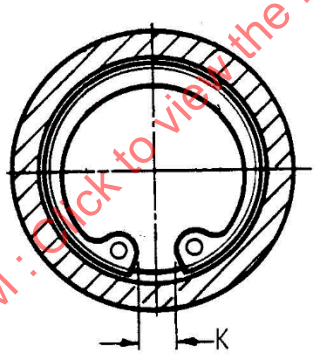

Figure 2 - Gap width minimum
Type II, Class 1 ring
Seated in groove

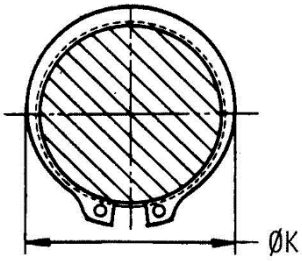

Figure 3 - Gaging dia maximum
Type I, Class 2 ring
Seated in groove

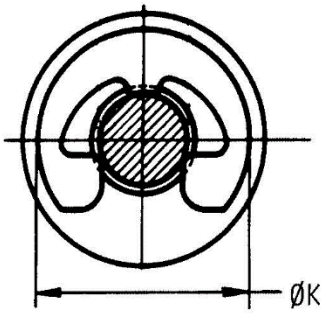

Figure 4 - Gaging dia maximum
Type I, Class 3 ring
Seated in groove

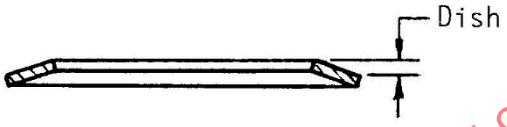

Figure 5 - Dish, Type I and II rings

Table 2 - Ring dish limitations

Types I & II	
Ring Thickness Range mm	Permissible Dish Max mm
0.20-0.53	0.05
0.54-1.03	0.08
1.04-2.71	0.13
2.72-3.87	0.25
3.88-4.92	0.40

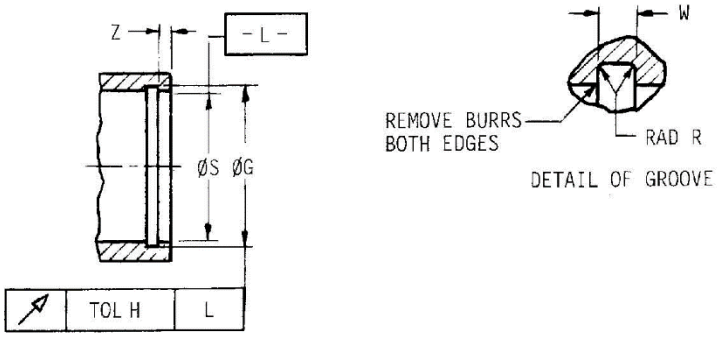

Table 3 - Type I, Class 1, ring groove dimensions and min gap width of ring seated in groove

Bore Diameter ØS Nom	Groove Diameter ØG	Groove Width W	Edge Margin Z Min	Bottom Radius R Max	Runout H	Gap Width K Min
8	8.40- 8.46	0.50-0.60	0.6	0.1	0.03	1.40
9	9.45- 9.51	0.70-0.85	0.7	0.1	0.03	1.50
10	10.50-10.60	0.70-0.85	0.8	0.1	0.03	1.85
11	11.60-11.70	0.70-0.85	0.9	0.1	0.05	1.95
12	12.65-12.75	0.70-0.85	1.0	0.1	0.05	2.25
13	13.70-13.80	1.00-1.15	1.1	0.1	0.05	2.35
14	14.80-14.90	1.00-1.15	1.2	0.1	0.05	2.65
15	15.85-15.95	1.00-1.15	1.3	0.1	0.05	2.80
16	16.90-17.00	1.00-1.15	1.4	0.1	0.10	2.80
17	18.00-18.10	1.00-1.15	1.5	0.1	0.10	3.35
18	19.05-19.15	1.00-1.15	1.6	0.2	0.10	3.40
19	20.10-20.25	1.00-1.15	1.7	0.2	0.10	3.40
20	21.15-21.30	1.00-1.15	1.7	0.2	0.10	3.80
21	22.20-22.35	1.00-1.15	1.8	0.2	0.10	4.20
22	23.30-23.45	1.20-1.35	1.9	0.2	0.10	4.30
23	24.35-24.50	1.20-1.35	2.0	0.2	0.10	4.90
24	25.40-25.55	1.20-1.35	2.1	0.2	0.10	5.20
25	26.60-26.75	1.20-1.35	2.4	0.2	0.10	6.00
26	27.70-27.85	1.20-1.35	2.6	0.2	0.15	5.70
27	28.80-28.95	1.40-1.55	2.7	0.2	0.15	5.90
28	29.80-29.95	1.40-1.55	2.7	0.2	0.15	6.00
30	31.90-32.10	1.40-1.55	2.9	0.2	0.15	6.00
32	33.90-34.10	1.40-1.55	2.9	0.3	0.15	7.30
34	36.10-36.30	1.40-1.55	3.2	0.3	0.15	7.60
35	37.20-37.40	1.40-1.55	3.3	0.3	0.15	8.00
36	38.30-38.50	1.40-1.55	3.5	0.3	0.15	8.30
37	39.30-39.50	1.40-1.55	3.5	0.3	0.15	8.40
38	40.40-40.60	1.40-1.55	3.6	0.3	0.15	8.60
40	42.40-42.60	1.75-1.95	3.6	0.3	0.15	9.70
42	44.50-44.70	1.75-1.95	3.7	0.3	0.15	9.00
45	47.60-47.80	1.75-1.95	3.9	0.3	0.15	9.60
46	48.70-48.90	1.75-1.95	4.0	0.3	0.20	9.70
47	49.80-50.00	1.75-1.95	4.2	0.3	0.20	10.00
48	50.90-51.10	1.75-1.95	4.3	0.3	0.20	10.50
50	53.10-53.30	1.75-1.95	4.6	0.3	0.20	12.10

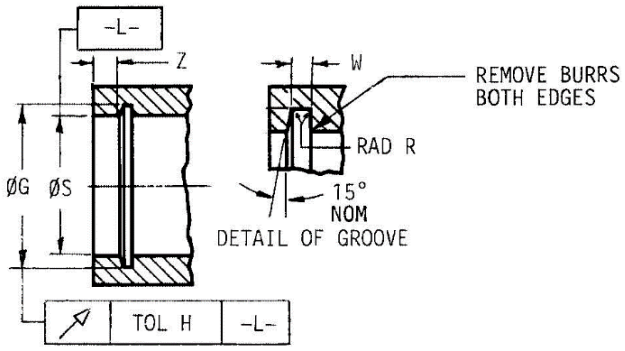

Table 4 - Type II, Class 1, ring groove dimensions and min gap width of ring seated in groove

Bore Diameter ØS Nom	Groove Diameter ØG	Groove Width W	Edge Margin Z Min	Bottom Radius R Max	Runout H	Gap Width K Min
25	26.90-26.98	0.90-1.00	1.4	0.12	0.10	4.6
26	28.00-28.08	0.90-1.00	1.5	0.12	0.15	4.1
27	29.00-29.10	1.10-1.20	1.5	0.12	0.15	4.1
28	30.10-30.20	1.10-1.20	1.6	0.12	0.15	4.2
30	32.10-32.20	1.10-1.20	1.6	0.12	0.15	4.4
32	34.30-34.40	1.10-1.20	1.7	0.12	0.15	5.4
34	36.40-36.50	1.10-1.20	1.8	0.12	0.15	5.4
35	37.50-37.60	1.10-1.20	1.9	0.12	0.15	5.8
36	38.60-38.70	1.10-1.20	2.0	0.12	0.15	5.7
37	39.60-39.70	1.10-1.20	2.0	0.12	0.15	6.0
38	40.70-40.80	1.10-1.20	2.0	0.12	0.15	6.2
40	42.80-42.93	1.30-1.45	2.1	0.12	0.15	6.7
42	45.00-45.13	1.30-1.45	2.3	0.12	0.15	6.7
45	48.20-48.33	1.30-1.45	2.4	0.12	0.15	7.2
46	49.30-49.43	1.30-1.45	2.5	0.12	0.20	7.4
47	50.40-50.53	1.30-1.45	2.6	0.12	0.20	7.7
48	51.40-51.53	1.30-1.45	2.6	0.12	0.20	7.7
50	53.60-53.73	1.30-1.45	2.7	0.12	0.20	8.5
52	55.70-55.85	1.60-1.75	2.8	0.25	0.20	7.9
55	59.10-59.25	1.60-1.75	3.1	0.25	0.20	9.8
57	61.30-61.45	1.60-1.75	3.2	0.25	0.20	9.9
58	62.40-62.55	1.60-1.75	3.3	0.25	0.20	10.1
60	64.50-64.65	1.60-1.75	3.4	0.25	0.20	10.1
62	66.50-66.65	1.60-1.75	3.4	0.25	0.20	11.1
63	67.60-67.75	1.60-1.75	3.5	0.25	0.20	10.9
65	69.70-69.85	2.00-2.15	3.5	0.25	0.20	11.1
68	73.00-73.15	2.00-2.15	3.8	0.25	0.20	11.4
70	75.20-75.35	2.00-2.15	3.9	0.25	0.20	12.7
72	77.20-77.35	2.00-2.15	3.9	0.25	0.20	13.3
75	80.60-80.75	2.00-2.15	4.2	0.25	0.20	12.8
78	83.80-83.95	2.30-2.45	4.4	0.25	0.20	12.9
80	85.90-86.05	2.30-2.45	4.4	0.25	0.20	13.1
82	88.00-88.15	2.30-2.45	4.5	0.25	0.25	15.1

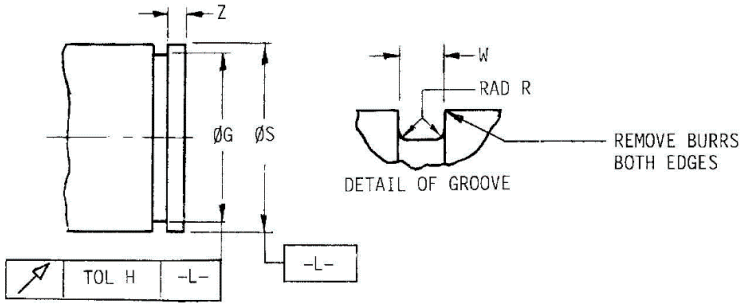

Table 5 - Type I, Class 2, ring groove dimensions and max gaging diameter of ring seated in groove

Bore Diameter ØS Nom	Groove Diameter ØG	Groove Width W	Edge Margin Z Min	Bottom Radius R Max	Runout H	Gap Width K Min
7	6.50- 6.60	0.70-0.85	0.6	0.1	0.05	8.05
8	7.40- 7.50	0.70-0.85	0.8	0.1	0.05	9.15
9	8.35- 8.45	0.70-0.85	0.8	0.1	0.05	10.35
10	9.30- 9.40	0.70-0.85	0.9	0.1	0.05	11.50
11	10.23-10.35	0.70-0.85	1.0	0.1	0.05	12.60
12	11.23-11.35	0.70-0.85	1.0	0.1	0.05	13.80
13	12.18-12.30	1.00-1.15	1.0	0.1	0.10	15.05
14	13.13-13.25	1.00-1.15	1.2	0.1	0.10	15.60
15	14.03-14.15	1.00-1.15	1.3	0.1	0.10	17.20
16	14.95-15.10	1.00-1.15	1.4	0.1	0.10	18.35
17	15.95-16.10	1.00-1.15	1.4	0.1	0.10	19.35
18	16.85-17.00	1.20-1.35	1.5	0.1	0.10	20.60
19	17.80-17.95	1.20-1.35	1.6	0.2	0.10	21.70
20	18.70-18.85	1.20-1.35	1.7	0.2	0.10	22.65
21	19.65-19.80	1.20-1.35	1.8	0.2	0.10	23.80
22	20.55-20.70	1.20-1.35	1.9	0.2	0.10	24.90
23	21.50-21.65	1.20-1.35	2.0	0.2	0.10	26.00
24	22.45-22.60	1.20-1.35	2.1	0.2	0.10	27.15
25	23.35-23.50	1.20-1.35	2.3	0.2	0.10	28.10
26	24.35-24.50	1.20-1.35	2.3	0.2	0.10	29.25
27	25.25-25.45	1.40-1.55	2.3	0.2	0.10	30.35
28	26.20-26.40	1.40-1.55	2.4	0.2	0.10	31.45
30	28.15-28.35	1.40-1.55	2.5	0.2	0.15	33.60
32	30.00-30.20	1.40-1.55	2.7	0.3	0.15	35.90
34	31.80-32.00	1.40-1.55	3.0	0.3	0.15	37.90
35	32.70-32.90	1.40-1.55	3.1	0.3	0.15	39.00
36	33.65-33.85	1.40-1.55	3.2	0.3	0.15	40.20
38	35.50-35.80	1.40-1.55	3.3	0.3	0.15	42.50
40	37.40-37.70	1.75-1.95	3.4	0.3	0.15	44.50
42	39.30-39.60	1.75-1.95	3.6	0.3	0.15	46.90
43	40.20-40.50	1.75-1.95	3.8	0.3	0.15	47.90
45	42.10-42.40	1.75-1.95	3.9	0.3	0.15	50.00
46	43.00-43.30	1.75-1.95	4.0	0.3	0.15	50.90
48	44.90-45.20	1.75-1.95	4.2	0.3	0.15	53.00
50	46.90-47.20	1.75-1.95	4.2	0.3	0.15	55.20

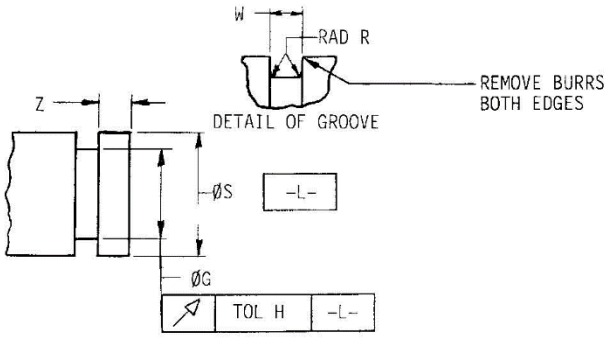

Table 6 - Type I, Class 3, ring groove dimensions and max gaging diameter of ring seated in groove

Bore Diameter ØS Nom	Groove Diameter ØG	Groove Width W	Edge Margin Z Min	Bottom Radius R Max	Runout H	Gap Width K Min
4	2.95- 3.00	0.70-0.85	1.0	0.10	0.05	8.9
5	3.80- 3.85	0.70-0.85	1.1	0.15	0.05	9.9
6	4.75- 4.85	0.70-0.85	1.1	0.15	0.05	11.8
7	5.30- 5.40	0.70-0.85	1.6	0.15	0.08	13.7
8	6.25- 6.40	0.70-0.85	1.6	0.15	0.08	15.6
9	6.95- 7.10	1.00-1.15	1.9	0.15	0.10	16.4
10	7.65- 7.80	1.00-1.15	2.2	0.25	0.10	17.5
11	8.65- 8.80	1.00-1.15	2.2	0.25	0.10	19.7
12	9.35- 9.50	1.20-1.35	2.5	0.25	0.10	20.4
13	10.05-10.20	1.20-1.35	2.8	0.25	0.10	21.3
14	11.05-11.20	1.20-1.35	2.8	0.25	0.10	22.8
15	11.65-11.80	1.20-1.35	3.2	0.25	0.10	23.9

3.2.8 Pitch

The pitch of retaining rings (see Figure 6) shall not exceed the limitations specified in 3.2.8.1 and 3.2.8.2 for the applicable type and class of ring.

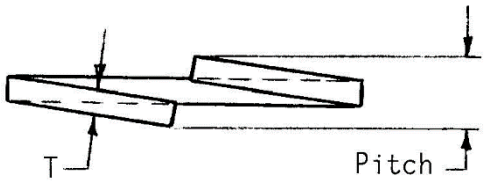

Figure 6 - Pitch

3.2.8.1 Type I, Classes 1 and 2; Type II, Class 1

The pitch of the ring shall not exceed 3T, where T equals nominal thickness of ring.

3.2.8.2 Type I, Class 3

The pitch of the ring shall not exceed 1.5T for ring shaft sizes 13 mm and smaller, and 2T for ring shaft sizes over 13 mm, where T equals nominal thickness of ring.

3.3 Fabrication

3.3.1 Rings shall be blanked from cold rolled, solution heat treated, sheet or strip.

3.3.2 Heat Treatment

Blanked rings shall be austenite conditioned and precipitation heat treated in accordance with the heat treating procedure specified in the material specification.

3.3.3 Passivation

When specified on the part drawing, finished rings, after heat treatment as in 3.3.2, shall be passivated by immersion in one of the following solutions at the temperature and for the time shown, rinsing, and drying:

a. 20 to 50% by volume of nitric acid at 21 to 32 °C for 30 to 40 minutes.

b. 20 to 25% by volume of nitric acid plus 2 to 3% by weight of sodium dichromate operated at 21 to 32 °C for 30 to 40 minutes, at 49 to 54 °C for 20 to 30 minutes, or at 63 to 68 °C for 10 to 15 minutes.

3.4 Properties

3.4.1 Hardness

Shall be uniform and within the range 44 to 51 HRC or equivalent, determined in accordance with ASTM E18.

3.4.2 Permanent Set

All retaining rings shall be capable of undergoing the tests of 4.5.2 without showing any evidence of cracking and without taking a permanent set in excess of the limitations specified as follows:

3.4.2.1 Type I, Class 1 and Type II, Class 1

The rings shall not crack and the permanent set shall not exceed the limitations in Table 7.

3.4.2.2 Type I, Class 2

The rings shall not crack and the permanent set shall not exceed the limitations specified in Table 8.

3.4.2.3 Type I, Class 3

The rings shall grip the minimum groove diameter ØG as specified in Table 6, and shall have no less than 3 point contact.

Table 7 - Permanent set limits for rings, Type I, Class 1 and Type II, Class 1

Ring Bore Dia mm	Permanent Set, Max % of Ring Free Dia
8 thru 12	3.8
13 thru 89	3.0
90 and over	2.5

Table 8 - Permanent set limits for Type I, Class 2 rings

Ring Shaft Dia mm	Permanent Set, Max % of Ring Free Dia
4 thru 12	2.5
13 and over	1.5

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 their performance.

3.5.1 Fluorescent Penetrant Inspection

Parts shall be fluorescent penetrant inspected in accordance with ASTM E1417/E1417M. 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 approval of the purchaser, and used during the production process.

4.3 Product Acceptance Tests

The purpose of product 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 parts comprising a production inspection lot satisfy the requirement of this specification.

4.3.1 Summary of Acceptance Tests

Test 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 9.

Table 9 - Summary of acceptance tests

Characteristic	Rqmt 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 ASTM E1417/E1417M 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 E18 and 4.5.2.2
Permanent Set and Crack	3.4.2	4.4.3	4.5.2.1

4.4 Acceptance Tests Sampling

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

4.4.2 Nondestructive Tests - Visual and Dimensional: A random sample of parts shall be selected from each production inspection lot. The size of the sample shall be as specified in Table 10.

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 11.

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

4.5 Inspection

4.5.1 Nondestructive Tests

4.5.1.1 Visual 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 ASTM E1417/E1417M and shall meet the requirements of 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 and 4.5.2.2 and shall be accepted or rejected in accordance with 4.4.4.

4.5.2.1 Permanent Set and Crack 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, 4.5.2.1.2, and 4.5.2.1.3 as applicable.

4.5.2.1.1 Type I, Class 1 and Type II, Class 1

Class 1 rings (Types I and II) shall be compressed so that the open ends (lugs) of the ring touch but do not overlap. After compressing and releasing the ring 5 times, the ring shall be visually and dimensionally inspected for compliance with the requirements of 3.4.2.1.