

Rubber Rings for Automotive Applications

1. Scope—This SAE Recommended Practice covers the dimensional and material requirements of rubber O-rings for automotive application and rectangular section rubber seal rings for automotive applications.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J200—Classification System for Rubber Materials

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 395—Test Methods for Rubber Property—Compression Set

ASTM D 412—Test Methods for Rubber Properties in Tension

ASTM D 471—Test Method for Rubber Property—Effect of Liquids

ASTM D 573—Test Method for Rubber—Deterioration in an Air Oven

ASTM D 676

ASTM D 746—Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D 865—Test Method for Rubber—Deterioration by Heating in Air (Test Tube Enclosure)

ASTM D 1414—Test Methods for Rubber O-Rings

3. 120R1—Rubber O-Rings for Automotive Application

3.1 Scope

- a. This SAE Recommended Practice covers the dimensional and material requirements of rubber O-rings for use in automotive sealing applications. Included are the recommended gland dimensions for standard size O-rings.

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- b. The material and dimensional requirements established by this specification are based upon the following:
 - 1. Static and dynamic applications.
 - 2. Compounds of nominal 70 durometer hardness.
 - 3. Fluid pressures of 1500 psi max (increased compound hardness, back-up rings, or reduced clearances, or both, promote sealing to much greater pressures).
 - 4. Rotary seal applications are sometimes possible, but special design considerations are necessary and special compound recommendations can be obtained from seal suppliers.

3.2 Material Classifications—Two classes of material are covered by this specification. O-rings shall be classified in accordance with their intended use as follows:

- a. Class I—Oil resistant service
- b. Class II—Gasoline resistant service

Applications requiring resistance to special fluids can usually be satisfied by numerous compounds available. Suppliers should be contacted for their recommendations whenever possible. (See tables for compound designations in SAE J200.)

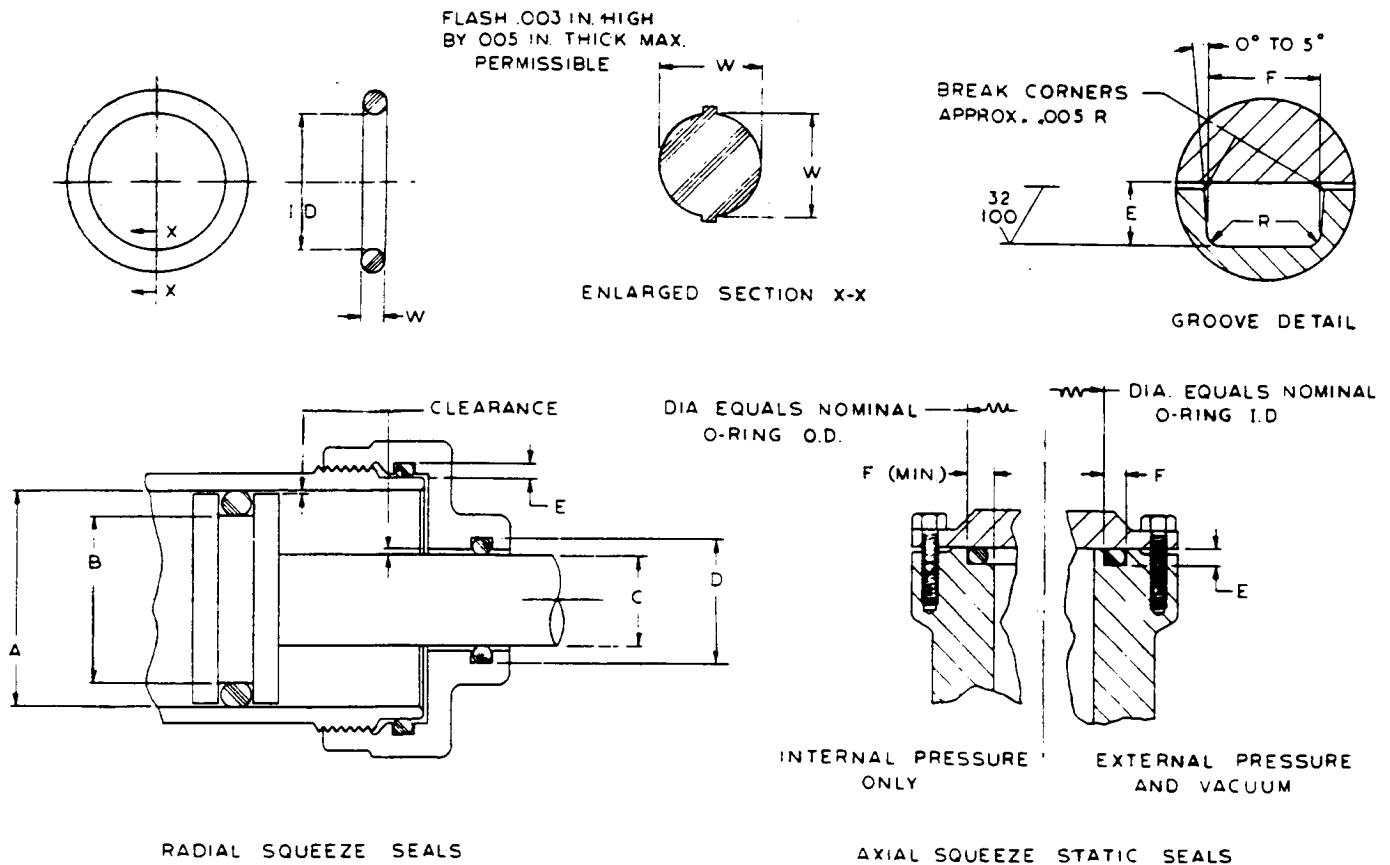
3.3 Basis of Purchase—Material and sizes required are specified by listing the SAE specification number, service classification, size number, and identification, when desired.

EXAMPLE—SAE Specification No..... 120R1
 Class..... II
 Size..... 128

3.4 Physical Requirements

- a. Quality control and source approval tests shall be conducted on the actual seal ring when the section diameter is 0.100 in or larger, and the inside diameter is 1 in or larger. Smaller section parts do not provide reliable data. If, by necessity, smaller sizes are tested, then special specification limits and test procedures shall be based on actual part performance as agreed between the purchaser and the supplier.
- b. Test specimens shall conform to the requirements specified in Table 1.

3.5 Dimensions and Tolerances—O-rings shall conform to the dimensions and tolerances prescribed in Table 2. For dimensional standardization purposes, O-rings shall be numbered as shown in Table 3.



MAXIMUM RECOMMENDED CLEARANCE, IN (INCLUDING PISTON OR ROD TO BORE CONCENTRICITY)

psi	70 Hardness	80 Hardness	90 Hardness	psi	70 Hardness	80 Hardness	90 Hardness
0	0.010	0.010	0.010	1500	0.003	0.005	0.008
250	0.010	0.010	0.010	2000	—	0.004	0.005
500	0.008	0.010	0.010	3000	—	0.003	0.004
1000	0.005	0.008	0.010	5000	—	—	0.003

NOTE—Data in bold face indicates basis for establishment of Table 2.

FIGURE 1—O-RING DESIGN EXAMPLES

TABLE 1—PHYSICAL REQUIREMENTS

	Class I Oil Service ASTM Specimen	Class I Oil Service Actual Part	Class II Fuel Service ASTM Specimen	Class II Fuel Service Actual Part
(a) Original Physical Properties				
Hardness points	70 ± 5	—	70 ± 5	—
Tensile strength, min, psi	1500	1200	1500	1200
Ultimate elongation, min, %	200	150	200	150
Ultimate elongation, max, %	400	400	400	400
Modulus at 100 elongation, min, psi	450	400	450	400
(b) Heat Aging, 70 h at ___ °F				
Hardness, points change	+10	—	+10	—
Tensile strength, max, % change	-15	-15	-15	-15
Elongation, max, % change	-50	-50	-50	-50
(c) Compression Set, 70 h at ___ °F				
ASTM specimen, max, %	35	—	25	—
0.200 to 0.300 in, max, %	—	45	—	35
0.100 to 0.200 in, max, %	—	65	—	55
(d) Fluid Aging, 70 h at ___ °F				
Type of ASTM Fluid	No. 1 Oil	No. 1 Oil	Fuel A	Fuel A
Hardness, points change	-5 to +8	—	0 to -8	—
Tensile strength, max, % change	-15	-15	-15	-15
Elongation, max, % change	-40	-40	-25	-25
Volume change, max, %	±5	±5	±3	±3
Dry-out volume change, max, % (4 h at 158 °F)	—	—	-6	-6
(e) Fluid Aging, 70 h at ___ °F				
Type of ASTM Fluid	No. 3 Oil	No. 3 Oil	Fuel B	Fuel B
Hardness, points change	0 to -15	—	-20	—
Tensile strength, max, % change	-30	-30	-50	-50
Elongation, max, % change	-40	-40	-50	-50
Volume change, max, %	+20	+20	+25	+25
Dry-out volume change, max, % (4 h at 158 °F)	—	—	-10	-10
(f) Fluid Aging, 70 h at ___ °F				
Type of ASTM Fluid			Fuel C	Fuel C
Volume change, max, %			+35	+35
(g) Low Temperature Aging				
Brittleness at -20 °F	No cracks	—	No cracks	—
Figure 8 bend, 5 h at -40 °F	—	No cracks	—	No cracks

NOTE—The limits in this table for actual parts are for parts 0.100 in cross section and larger. If smaller cross section parts are tested, special limits shall be agreed upon between the purchaser and the supplier.

TABLE 2—DIMENSIONS AND TOLERANCES, IN

Size No.	Actual Size ID	Actual Size OD (Ref)	Dynamic Seals A Cylinder Bore Dia	Dynamic Seals B Piston Groove Dia	Dynamic Seals C Rod Dia	Dynamic Seals D Rod Gland Groove Dia	
Tolerance	±0.005	—	+0.002 -0.000	+0.000 -0.002	+0.000 -0.002	+0.002 -0.000	
006	0.114	0.254	0.250	0.140	0.125	0.235	
007	0.145	0.285	0.281	0.171	0.156	0.266	
008	0.176	0.316	0.312	0.202	0.188	0.298	
009	0.208	0.348	0.343	0.233	0.219	0.329	
010	0.239	0.379	0.375	0.265	0.250	0.360	
011	0.301	0.441	0.437	0.327	0.312	0.422	
012	0.364	0.504	0.500	0.390	0.375	0.485	W—Actual seal width
013	0.426	0.566	0.563	0.453	0.437	0.547	0.070 in ± 0.003 in
014	0.489	0.629	0.625	0.515	0.500	0.610	E—Groove width, in:
015	0.551	0.691	0.688	0.578	0.562	0.672	Dynamic—
016	0.614	0.754	0.750	0.640	0.625	0.735	0.055-0.057
017	0.676	0.816	0.812	0.702	0.688	0.798	Static:
018	0.739	0.879	0.875	0.765	0.750	0.860	Radial—
Tolerance	±0.006	—	+0.002 -0.000	+0.000 -0.002	+0.000 -0.002	+0.002 -0.000	0.049-0.055
019	0.801	0.941	0.937	0.827	0.812	0.922	Axial—
020	0.864	1.004	1.000	0.890	0.875	0.985	0.045-0.050
021	0.926	1.066	1.062	0.952	0.937	1.047	F—Groove length, in—
022	0.989	1.129	1.125	1.015	1.000	1.110	0.090-0.100
023	1.051	1.191	1.188	1.078	1.062	1.172	R—Radius, in—
024	1.114	1.254	1.250	1.140	1.125	1.235	0.005-0.015
025	1.176	1.316	1.312	1.202	1.188	1.298	Cross-sectional squeeze, in, min:
026	1.239	1.379	1.375	1.265	1.250	1.360	Dynamic—0.010
027	1.301	1.441	1.437	1.327	1.312	1.422	Static:
028	1.364	1.504	1.500	1.390	1.375	1.485	Radial—0.012
							Axial—0.017
							Piston groove diameter shall be concentric with piston OD within 0.002 total indicator reading and rod gland groove diameter shall be concentric with rod bore diameter within 0.002 total indicator reading.
Tolerance	±0.010	—	+0.002 -0.000	+0.000 -0.002	+0.000 -0.002	+0.002 -0.000	
029	1.489	1.629	1.625	1.515	1.500	1.610	
030	1.614	1.754	1.750	1.640	1.625	1.735	
031	1.739	1.879	1.875	1.765	1.750	1.860	
032	1.864	2.004	2.000	1.890	1.875	1.985	Note—Sizes 013 to 045 are not generally used for dynamic seals and are not ordinarily recommended for such service. In special cases where space or other factors dictate the desirability of small cross-sections, these sizes should be incorporated into a design only after a careful engineering analysis and thorough testing.
033	1.989	2.129	2.125	2.015	2.000	2.110	
034	2.114	2.254	2.250	2.140	2.125	2.235	
035	2.239	2.379	2.375	2.265	2.250	2.360	
036	2.364	2.504	2.500	2.390	2.375	2.485	
037	2.489	2.629	2.625	2.515	2.500	2.610	
038	2.614	2.754	2.750	2.640	2.625	2.735	
Tolerance	±0.015	—	+0.002 -0.000	+0.000 -0.002	+0.000 -0.002	+0.002 -0.002	

TABLE 2—DIMENSIONS AND TOLERANCES, IN (CONTINUED)

Size No.	Actual Size ID	Actual Size OD (Ref)	Dynamic Seals A Cylinder Bore Dia	Dynamic Seals B Piston Groove Dia	Dynamic Seals C Rod Dia	Dynamic Seals D Rod Gland Groove Dia
039	2.739	2.879	2.875	2.765	2.750	2.860
040	2.864	3.004	3.000	2.890	2.875	2.985
041	2.989	3.129	3.125	3.015	3.000	3.110
042	3.239	3.379	3.375	3.265	3.250	3.360
043	3.489	3.629	3.625	3.515	3.500	3.610
044	3.739	3.879	3.875	3.765	3.750	3.860
045	3.989	4.129	4.125	4.015	4.000	4.110
Tolerance	±0.005 -0.000	— -0.003	+0.003 -0.003	+0.000 -0.000	+0.000 -0.003	+0.003 -0.000
110	0.362	0.568	0.562	0.388	0.375	0.549
111	0.424	0.630	0.625	0.451	0.437	0.611
112	0.487	0.693	0.688	0.514	0.500	0.674
113	0.549	0.755	0.750	0.576	0.562	0.736
114	0.612	0.818	0.812	0.638	0.625	0.799
115	0.674	0.880	0.875	0.701	0.688	0.862
116	0.737	0.943	0.937	0.763	0.750	0.924
Tolerance	±0.006	—	+0.003 -0.000	+0.000 -0.003	+0.000 -0.003	+0.003 -0.000
117	0.799	1.005	1.000	0.826	0.812	0.986
118	0.862	1.068	1.062	0.888	0.875	1.049
119	0.924	1.130	1.125	0.951	0.937	1.111
120	0.987	1.193	1.188	1.014	1.000	1.174
121	1.049	1.255	1.250	1.076	1.062	1.236
122	1.112	1.318	1.312	1.138	1.125	1.299
123	1.174	1.380	1.375	1.201	1.188	1.362
124	1.237	1.443	1.437	1.263	1.250	1.424
125	1.299	1.505	1.500	1.326	1.312	1.486
126	1.362	1.568	1.562	1.389	1.375	1.549
127	1.424	1.630	1.625	1.451	1.437	1.611
128	1.487	1.693	1.688	1.514	1.500	1.674

W—Actual seal width

0.103 in ± 0.003 in

E—Groove width, in:

Dynamic—

0.087–0.090

Static:

Radial—

0.080–0.086

Axial—

0.072–0.080

F—Groove length, in—

0.140–0.150

R—Radius, in—

0.005–0.020

Cross-sectional squeeze, in, min:

Dynamic—0.010

Static:

TABLE 2—DIMENSIONS AND TOLERANCES, IN (CONTINUED)

Size No.	Actual Size ID	Actual Size OD (Ref)	Dynamic Seals A Cylinder Bore Dia	Dynamic Seals B Piston Groove Dia	Dynamic Seals C Rod Dia	Dynamic Seals D Rod Gland Groove Dia	
Tolerance	±0.010	—	+0.003 -0.000	+0.000 -0.003	+0.000 -0.003	+0.003 -0.000	Radial—0.014 Axial—0.020
129	1.549	1.755	1.750	1.576	1.562	1.736	Piston groove diameter shall be concentric with piston OD within 0.003 total indicator reading and rod gland groove diameter shall be concentric with rod bore diameter within 0.003 total indicator reading.
130	1.612	1.818	1.812	1.638	1.625	1.799	
131	1.674	1.880	1.875	1.701	1.688	1.862	
132	1.737	1.943	1.937	1.763	1.750	1.924	Sizes 117 to 163 are not generally used for dynamic seals and are not ordinarily recommended for such service. In special cases where space or other factors dictate the desirability of small cross-sections, these sizes should be incorporated into a design only after a careful engineering analysis and thorough testing.
133	1.799	2.005	2.000	1.826	1.812	1.986	
134	1.862	2.068	2.062	1.888	1.875	2.049	
135	1.925	2.131	2.125	1.951	1.937	2.111	
136	1.987	2.193	2.188	2.014	2.000	2.174	
137	2.050	2.256	2.250	2.076	2.062	2.236	
138	2.112	2.318	2.312	2.138	2.125	2.299	
139	2.175	2.381	2.375	2.201	2.188	2.362	
140	2.237	2.443	2.437	2.263	2.250	2.424	
141	2.300	2.506	2.500	2.326	2.312	2.486	
142	2.362	2.568	2.563	2.389	2.375	2.549	
143	2.425	2.631	2.625	2.451	2.437	2.611	
144	2.487	2.693	2.688	2.514	2.500	2.674	
145	2.550	2.756	2.750	2.576	2.562	2.736	
146	2.612	2.818	2.812	2.638	2.625	2.799	
Tolerance	±0.015	—	+0.003 -0.000	+0.000 -0.003	+0.000 -0.003	+0.003 -0.000	
147	2.675	2.881	2.875	2.701	2.688	2.862	
148	2.737	2.943	2.937	2.763	2.750	2.924	
149	2.800	3.006	3.000	2.826	2.812	2.986	
150	2.862	3.068	3.062	2.888	2.875	3.049	
151	2.987	3.193	3.188	3.014	3.000	3.174	
152	3.237	3.442	3.437	3.263	3.250	3.424	
153	3.487	3.693	3.688	3.514	3.500	3.674	
154	3.737	3.943	3.937	3.763	3.750	3.924	
155	3.987	4.193	4.188	4.014	4.000	4.174	
156	4.237	4.443	4.437	4.263	4.250	4.424	
157	4.487	4.693	4.687	4.514	4.500	4.674	
158	4.737	4.943	4.937	4.763	4.750	4.924	
159	4.987	5.193	5.188	5.014	5.000	5.174	
Tolerance	±0.023	—	+0.003 -0.000	+0.000 -0.003	+0.000 -0.003	+0.003 -0.000	
160	5.237	5.442	5.437	5.263	5.250	5.424	
161	5.487	5.693	5.688	5.514	5.500	5.674	
162	5.737	5.943	5.937	5.763	5.750	5.924	
163	5.987	6.193	6.188	6.014	6.000	6.174	