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SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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(R) CAST IRON SEALING RINGS (METRIC)

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board Format.

1. ***Scope***—The purpose of this SAE Recommended Practice is to establish specifications for use as a guide to the automatic transmission and hydraulic systems designer, helping him to select cast iron sealing ring width, thickness, coatings, and other accepted design details.

2. ***References***

2.1 Applicable Publication—The following publication forms 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 J1590—Internal Combustion Engines—Piston Rings—Material Specifications

3. ***Materials***—Cast iron sealing rings are generally made from gray cast iron piston ring material. Gray cast iron piston ring material is used for general automotive application. Gray cast iron piston rings are made with a high carbon equivalent iron and with casting techniques that promote, in the small section castings, the most desirable graphite and matrix microstructural conditions for wear resistance and adequate mechanical and physical properties. The chemical element ranges shown in Table 1 represent typical chemical compositions for gray cast iron piston rings. Reference also SAE J1590 Class 10 Subclass 12.

TABLE 1—CHEMICAL ELEMENT RANGES

Elements	%
Total carbon	3.50–3.95
Silicon	2.20–3.10
Manganese	0.40–0.80
Phosphorus	0.30–0.80
Sulfur	0.13 max

3.1 Composition—Alloying elements such as chromium, copper, molybdenum, vanadium, tin, etc., may be added to enhance the material properties or improve the material for special applications.

3.2 Hardness—Rockwell B 95–107 or equivalent.

3.3 Microstructure—Gray cast iron piston rings are made to present an abrasion resistant matrix combined with the best graphite attainable in gray iron for mechanical and physical properties.

The matrix is essentially completely pearlitic or sorbitic with a minimum of free ferrite and massive cementite. The phosphorus constituent, steadite, is uniformly distributed in nonmassive particles.

The graphite will consist principally of randomly oriented flakes that are described as AFS-ASTM Type A or A-B combination. The graphite particles will normally be of AFS-ASTM sizes 4 to 8.

4. Application Design Data

4.1 Surface Finish and Coatings—Sealing rings are usually phosphate or oxide coated. Occasionally, they are used uncoated or covered with a flash of tin or other metallic plating. Ring side finish to be 0.90 µm (35.0 µin) Ra before coating. OD is to be smooth-turned (see Figure 1).

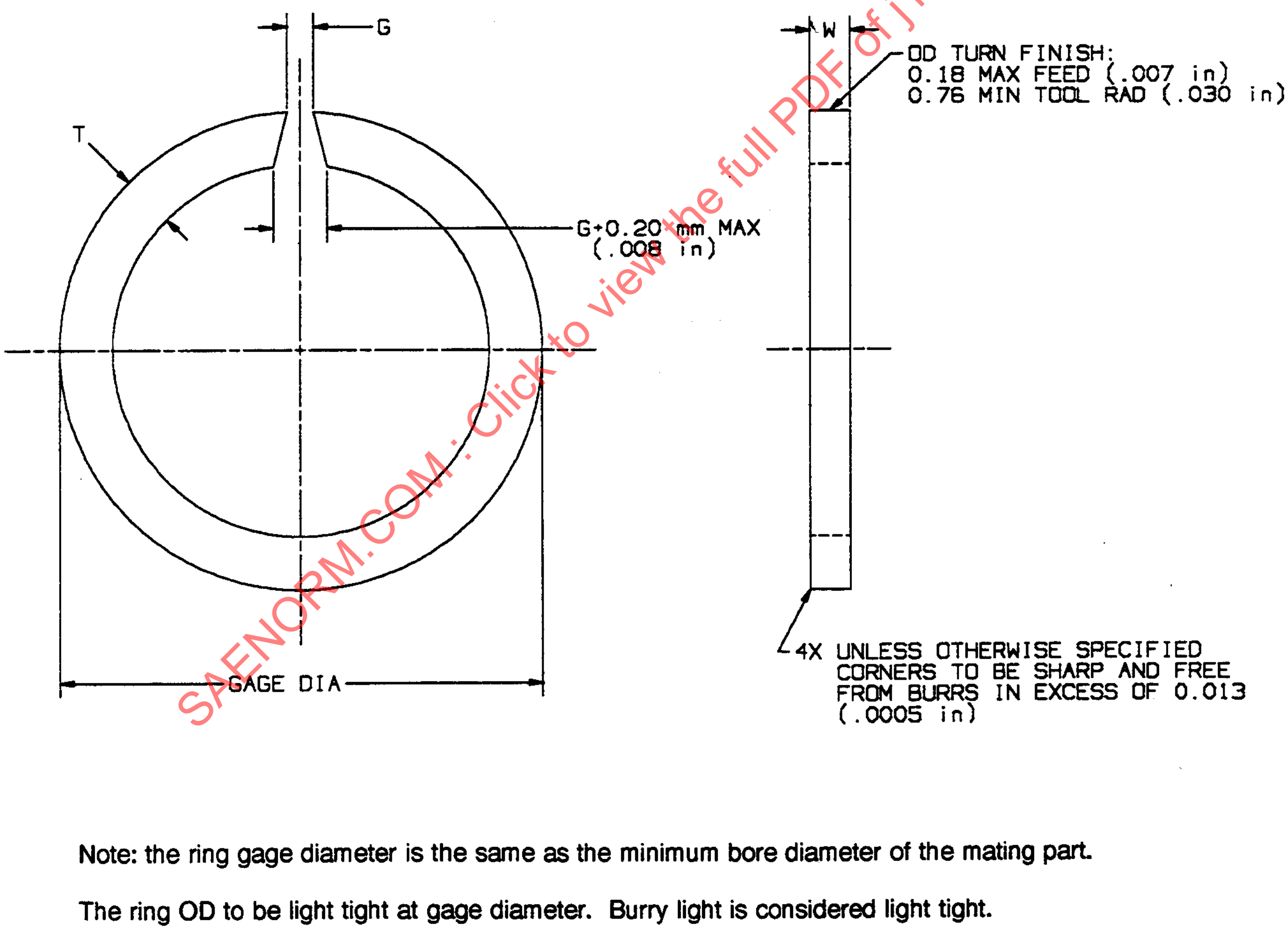


FIGURE 1—SEAL RING DESIGN

4.2 Axial Width (W)—The widths shown in Table 2 are considered "common" sizes. Other widths may be necessary for special applications. The minimum sealing ring width tolerance has historically been 0.025 mm (0.0010 in) for uncoated and phosphated rings less than 127 mm (5.0000 in) in diameter and 0.038 mm

(0.0015 in) for rings more than 127 mm (5.0000 in) in diameter. Consult a ring manufacturer for tolerancing of plated rings. The general failure mode of a hook joint sealing ring is that it spins in the bore and wears on the OD. When the hooks engage, due to the OD wear, they limit the travel and the ring fails to seal on the OD. This typically results in not enough pressure at the clutch. Based on side versus OD torque on the sealing ring, the nominal width should be approximately 1.4 times the radial thickness. Consult a ring manufacturer if the width is less than 1.2 times the radial thickness. (See Figure 1 and Figure 2).

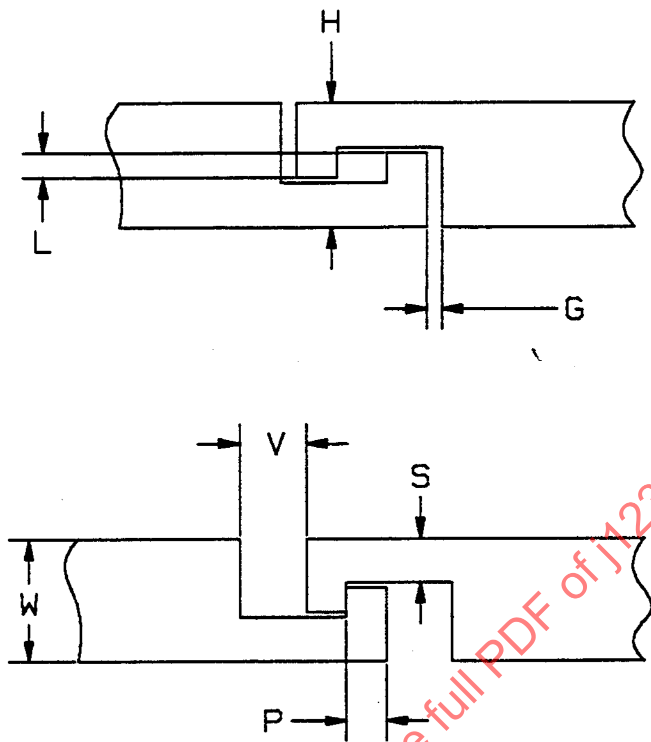
TABLE 2—SEALING RING WIDTH

Nominal Width	Maximum Sealing Ring Width
2.000 mm	1.990 mm (0.0783 in)
2.385 mm (3/32 in)	2.375 mm (0.0935 in)
3.000 mm	2.990 mm (0.1177 in)
3.160 mm (1/8 in)	3.150 mm (0.1240 in)
3.972 mm (5/32 in)	3.962 mm (0.1560 in)
4.000 mm	3.990 mm (0.1571 in)
4.747 mm (3/16 in)	4.737 mm (0.1865 in)
5.000 mm	4.990 mm (0.1965 in)
6.000 mm	5.990 mm (0.2358 in)
6.335 mm (1/4 in)	6.325 mm (0.2490 in)

4.3 **Radial Wall Thickness (T)—**It is recommended that sealing ring radial wall thicknesses be 0.030 to 0.040 times gage diameter. If a somewhat thinner section is desired to minimize groove depths and shaft diameters, a ring manufacturer should be consulted so that a radial wall thickness can be recommended that will still give good sealing characteristics along with the reduced thickness. (See Figure 1.)

4.4 **End Clearance or Compressed Gap (G)—**This document applies to butt joint and hook joint rings. The tolerance required for manufacture increases as the ring diameters get larger. The smallest recommended clearance is 0.05 mm (0.002 in), which should be measured at the OD of the ring in a gage of minimum bore diameter as illustrated in Figure 1 and Figure 2. Consult a ring manufacturer for the upper limit since this dimension considerably affects cost and performance. It would be in the interest of both parties to make sure the tolerance is specified to the best "value added" for a tight tolerance.

4.5 **Hook Joint Details—**Hook joint rings are used when assistance is needed in blind assembly operations. The direction of the hooks is optional as shown in Figure 2. Also shown are the other necessary hook dimensions.

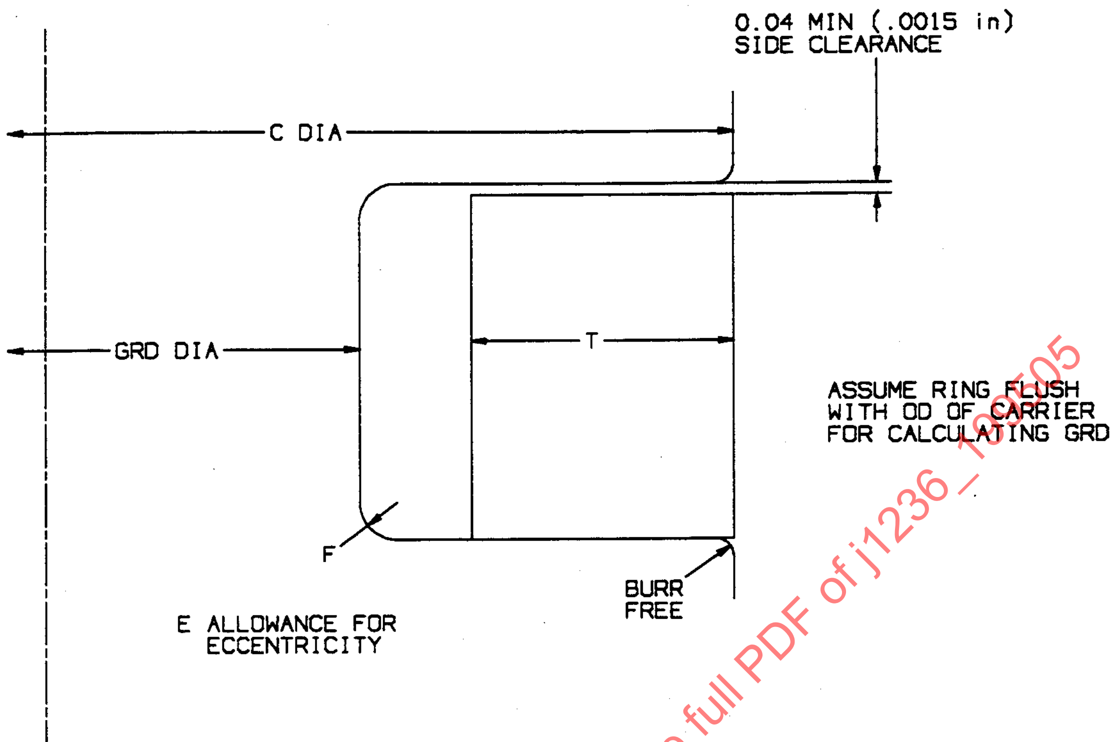


H = Width over hooks in hooked position. (Must be less than ring width at any other point.)
L = 0.25 mm MIN (0.010 in)
P = 0.40 mm MIN (0.015 in)
S = 0.5 (W – 1.0 mm) MIN (0.5* (W — 0.040 in))
V = 0.75 mm MIN* (0.030 in)

*Longer hooks with a wear length, V, of 1.25 mm (0.050 in) minimum are available on larger diameter rings. It is recommended that the 1.25 mm (0.050 in) dimension not be used on rings under 75.0 mm (2.9530 in) in diameter.

FIGURE 2—HOOK JOINT DETAILS

4.6 Grooving Recommendations—The ring groove must be deep enough so that the ring will not bottom in the groove at extreme conditions. The groove root diameter (GRD) may be calculated by using the formula shown in Figure 3. Note that adding ID chamfers to the ring would allow the ring to nest into the groove radius and make GRD max larger and help reduce hang-down (H in 5.1). Also note that reducing ring radial thickness tolerance and GRD tolerance would also help reduce hang-down. The groove sides should be cut perpendicular to the axis of the shaft within 0.02/20 maximum. The groove sides should be flat within 0.025 mm (0.001 in) maximum in 360 degrees and 0.0065 mm (0.00025 in) maximum in 90 degrees. The surface finish on the groove walls should be 1.3 µm (50.0 µin) Ra.



$$GRD_{MAX} = C_{MIN} - 2(T_{MAX} + E_{MAX} + F_{MAX})$$
$$GRD_{MIN} = GRD_{MAX} - 0.25 \text{ mm}$$

Recommended values for E and F:

E_{MAX} = 0.065 mm (0.0025 in)

F_{MAX} = 0.25 mm RADIUS (0.010 in)

Recommended C diameter: This dimension should be as large as possible for best ring function. The limiting factor is usually the runout or wobble of the shaft to the bore with the shaft being sized so the lands do not contact the bore.

FIGURE 3—GROOVE DIAMETER AND SIDE CLEARANCE

5. *Sample Calculation*

5.1 Loading Chamfer Diameter Calculation—In order to properly install the carrier and ring assembly in the bore, without a ring compressor, a chamfer of sufficient diameter is required to allow for the ring bottoming in the groove on one side and the ring hanging out on the other side as illustrated in Figure 4. The minimum radial dimension of the chamfer is equal to the maximum hang-down and can be calculated using Equation 1:

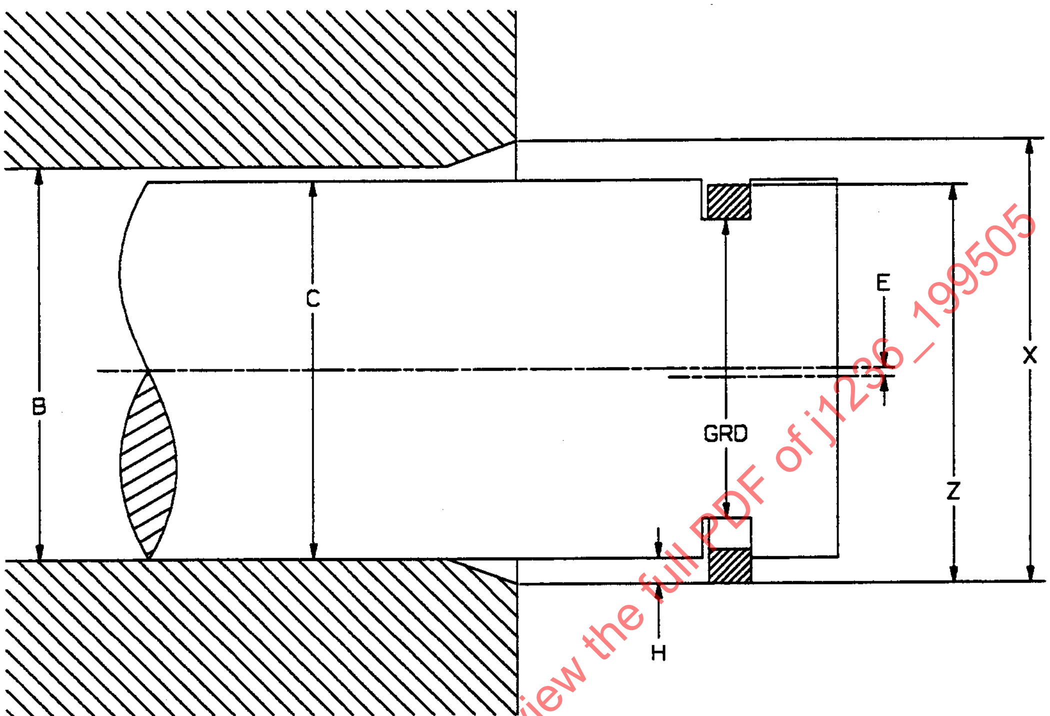
(Eq. 1)

$$H_{MAX} = Z_{MAX} - \left(\frac{GRD_{MIN} + C_{MIN}}{2} + T_{MIN} - E_{MAX}\right)$$

The minimum diameter of the chamfer can be calculated using Equation 2:

(Eq. 2)

$$X_{MIN} = B_{MAX} + 2H_{MAX}$$



B = Bore Diameter (To be round within 0.025 mm (0.001 in). Total out-of-round not to occur in arc less than 90 degrees. Surface finish 1.3 µm (50.0 µin) Ra.)

C = Carrier Diameter
E = Eccentricity GRD to C
F = Groove Fillet
GRD = Groove Root Diameter
H = Hang-Down (Carrier OD to Ring OD)
T = Ring Radial Thickness
X = Bore Chamfer Diameter
Z = Ring Free OD (Hook joint rings—hooks engaged)

FIGURE 4—LOADING CHAMFER DETAILS

5.2 Example Calculation for Sealing Ring Application—See Figure 1 through Figure 4.

Given:

B = 50.52–50.54
C = 50.29–50.42
E = 0.065 max
F = 0.25 max
T = 2.03–2.29
Z = 53.98 max