

Internal Combustion Engines—Piston Rings—Quality Requirements

This SAE Standard is equivalent to ISO Standard 6621/5.

1. **Scope**—Differences, where they exist, are shown in Appendix A.

This SAE Standard specifies the quality aspects that are capable of definition but not normally found on a drawing specification.

The difficulty of trying to define in absolute terms the quality attainable in normal commercial manufacture of piston rings is well known. In this document the commonly encountered aspects of quality in terms of casting defects and other departures from ideal are quantified. Many minor defects are clearly quite acceptable; other defects because of size or numbers are inadmissible.

This document covers the following:

- a. Single piece piston rings of grey, carbide, malleable, spheroidal graphite cast iron or steel
- b. Multipiece piston rings (oil control rings) consisting of cast iron parts and spring components
- c. Single piece and multipiece rings of steel, i.e., oil control rings in the form of strip steel components or steel segments (rails) with spring expander components

In addition to specifying certain limits of acceptance relating to inspection measuring principles (covered by SAE J1589) this document also covers those features for which no recognized quantitative measurement procedures exist and which are only checked visually with normal eyesight and without magnification. Such features (superficial defects) are additional to the standard tolerances of ring width, radial wall thickness, and closed gap.

The requirements of this document apply to all rings up to and including 200 mm diameter covered by the above classification for both reciprocating internal combustion engines and compressors.

1.1 **Rationale**—SAE J1996 is being discontinued because the content of this standard is also contained in ISO 6621-5. Therefore, to eliminate duplication and confusion in coordinating the standards between ISO and SAE, this document will be discontinued. The SAE Piston and Ring Standards Committee will now continue to support ISO in updating the standards as appropriate.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2008 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:

Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

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

SAE DESIGNATION	ISO ¹ EQUIVALENT	INTERNAL COMBUSTION ENGINES—PISTON RINGS
J1588	6621/1	Vocabulary
J1589	6621/2	Measuring principles
J1590	6621/3	Material specifications
J1591	6621/4	General specifications
J1996	6621/5	Quality requirements
INTERNAL COMBUSTION ENGINES—PISTON RINGS		
J1997	6622/1	Rectangular rings
J1998	6622/2 TR	Rectangular rings with narrow ring width
INTERNAL COMBUSTION ENGINES—PISTON RINGS		
J2000	6624/1	Keystone rings
J2001	6624/2 TR	Half keystone rings
J2002	6625	INTERNAL COMBUSTION ENGINES—PISTON RINGS— OIL CONTROL RINGS
J2003	6626	INTERNAL COMBUSTION ENGINES—PISTON RINGS— COILSPRING LOADED OIL CONTROL RINGS
J2004	6627 TR	INTERNAL COMBUSTION ENGINES—PISTON RINGS— EXPANDER/SEGMENT OIL CONTROL RINGS
J2226		INTERNAL COMBUSTION ENGINES—PISTON RINGS— STEEL RECTANGULAR RINGS
	2859	SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY ATTRIBUTES

3. Definitions—The terminology used in this document is as given in SAE J1588.

4. Visible Defects

4.1 General—Visible defects are divided into two principle classes as described in 4.2 to 4.5.

The first class covers those defects frequently found in castings and includes such defects as porosity, sand inclusions, cavities, etc.

The second class of defects covers mechanical abrasions which may occur during machining or handling of rings, and includes scratches, dents, chipping, burns, and cracks.

1. TR refers to Technical Report

Inspection of piston rings for such defects is generally carried out visually, without magnification, by inspectors having normal eyesight, corrected if necessary.

It is not intended that every ring be rigorously inspected for size and distribution of defects but rather that the values given in the tables and text be used as a general guide. However, in case of doubt, the values given should be used as the means of judging the quality of the rings.

4.2 Pores, Cavities, and Sand Inclusions—Such defects are permissible on uncoated surfaces and edges provided that the values given in Table 1 for size, number, and spacing are not exceeded.

NOTE—The depth of porosity cannot be checked visually and, therefore, no limiting values are given.

TABLE 1—PERMISSIBLE VALUES OF SIZE, NUMBER AND SPACING OF PORES, CAVITIES AND SAND INCLUSIONS

Dimensions are millimeters

Nominal diameter d_1	Defect size max on periphery ⁽¹⁾	Defect size max on other surfaces ⁽¹⁾	Defect size max on peripheral edges	Defect size max on other edges ⁽²⁾	Number per ring max	Spacing ⁽³⁾ min
$30 \leq d_1 < 60$	0.1	0.3	0.1	0.1	2	4
$60 \leq d_1 < 100$	0.15	0.5	0.1	0.2	4	4
$100 \leq d_1 < 150$	0.2	0.5	0.1	0.3	6	8
$150 \leq d_1 \leq 200$	0.2	0.8	0.1	0.4	6	8

1. The defects should not be closer to an edge than one-half of the maximum permissible size of the defect, with a minimum of 0.2 mm.
2. Not on inside gap edges of piston rings with internal notch.
3. Spacing includes defects on adjacent or opposite surfaces.

4.3 Scratches, Indentations, Depressions, and Cracks

4.3.1 SCRATCHES—Isolated scratches are permissible provided that:

- a. No burrs are produced exceeding the permissible values given in 4.4.1.1
- b. On the periphery with turned surface they are not deeper than the tool marks or, for peripheries without a turned surface, not deeper than 0.004 mm
- c. On the side faces they are not deeper than 0.01 mm
- d. On other surfaces they are not deeper than 0.06 mm

4.3.2 INDENTATIONS AND DEPRESSIONS—Indentations and Depressions are permissible provided that:

- a. The values given in Table 11 for number and spacing of defects are met
- b. No burrs are produced exceeding the permissible values given in 4.4.1.1
- c. They do not exceed the values for size and depth given in Table 2

Rings of a coated/inlaid type shall not have indentations or depressions on the periphery.

NOTE—Indentations arising from hardness measurements on the side faces are acceptable provided that they do not exceed the limits given in Tables 2 and 11.

TABLE 2—PERMISSIBLE SIZE OF INDENTATIONS AND DEPRESSIONS

Dimensions are millimeters			
Nominal diameter d_1	Defect size max on periphery	Defect size max on side face	Depth max
$30 \leq d_1 < 100$	0.3	0.6	10% of corresponding
$100 \leq d_1 < 200$	0.5	1	max defect size surface

4.3.3 CRACKS—No cracks are permissible.

See also 4.5.4 for chromium-plated peripheries.

4.4 Edges

4.4.1 EDGE CONFIGURATION—All edges of the piston ring shall be sharp; ideally they should be free from burrs and from ragged edges whether arising from crumbling of material or from deburring. Such conditions are almost impossible to achieve regularly in volume production and, hence, both burrs and removal of edge material is permitted up to the maximum sizes given in 4.4.1.1 and 4.4.1.2.

4.4.1.1 *Burrs*—Burrs are permitted up to the maximum values given in Table 3. The orientation and direction of burrs shall relate to the functional surfaces of the piston ring, that is to say any burr present should point in the direction of sliding motion of the ring and not normal to the direction of sliding.

Any burrs remaining on the edges of rings should be firmly adherent, forming an integral part of the edge.

TABLE 3—MAXIMUM SIZE OF BURRS FOR ALL SIZES OF RING

Dimensions are millimeters	
Location of burr	Size of burr ⁽¹⁾ max
On edges adjacent to	
the peripheral surface and side faces	0.006
the butt ends (gap surfaces)	0.04
the outside groove face (oil rings)	0.2
the inside surface and the ends of the slots (oil rings)	0.5
all other surfaces	0.1

1. Maximum values of burrs on steel rings are to be agreed on between manufacturer and purchaser.

- 4.4.1.2 *Edge Material Removal*—To eliminate protruding burrs in any direction, it is permissible to remove material from the edges to the values given in Table 4.

TABLE 4—EDGE MATERIAL REMOVAL IN DEBURR OPERATIONS

Dimensions are millimeters	
Location of edge	Removal of material max
On peripheral edges	0.08
On peripheral edges of the gap ⁽¹⁾	0.15
On other edges	0.25

1. Does not apply to rings coated on the periphery that have gap edge chamfers.

- 4.4.2 CHIPPING AND SIMILAR DEFECTS ON PERIPHERAL EDGES, PERIPHERAL EDGES AT THE GAP, OUTSIDE GAP CORNERS AND ON PERIPHERAL CHAMFERS

- 4.4.2.1 Chipping and similar defects are permitted on these points provided that:

- They are free of loosely adhering particles
- No burrs are produced exceeding the values permitted in 4.4.1.1
- They do not exceed half the width of any witness land on, for example, taper-faced rings
- They do not exceed the values given in the following tables:
 - Table 5 for uncoated rings
 - Table 6 for plated, coating rings
 - Table 7 for spray-coated rings
 - Table 8 for chamfers on all rings

Typical defects are illustrated in Figures 1 to 6.

(See 4.4.2.2 for explanations of F and K.)