SAE International™ SURFACE VEHICLE STANDARD

SAE J2004

CAN-CELLED JUN2008

Issued 1992-09
Cancelled 2008-06

Superseding J2004 APR1998

Internal Combustion Engines—Piston Rings—Expander/Segment Oil Control Rings

This SAE Standard is equivalent to ISO Standard 6627 TR.

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

This SAE Standard specifies the dimensional features of commonly used oil control rings having two steel segments (rails) separated and expanded by one steel expander/spacer.

The segments vary in width from 0.4 to 0.6 mm. The assembly width ranges from 2.5 to 4.75 mm. The 4.75 mm width is equivalent to existing 3/16 in applications. Expander design will vary considerably with piston ring manufacturer.

The total circumferential deflection and the piston groove depth should be considered when designing these oil rings to optimize the fit of the ring assembly into the piston groove.

This document applies to oil control rings up through 125 mm for reciprocating internal combustion engines. It may also be used for piston rings of compressors working under similar conditions.

1.1 **Rationale**—SAE J2004 is being discontinued because the content of this standard is also contained in ISO 6627. 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.

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2. References

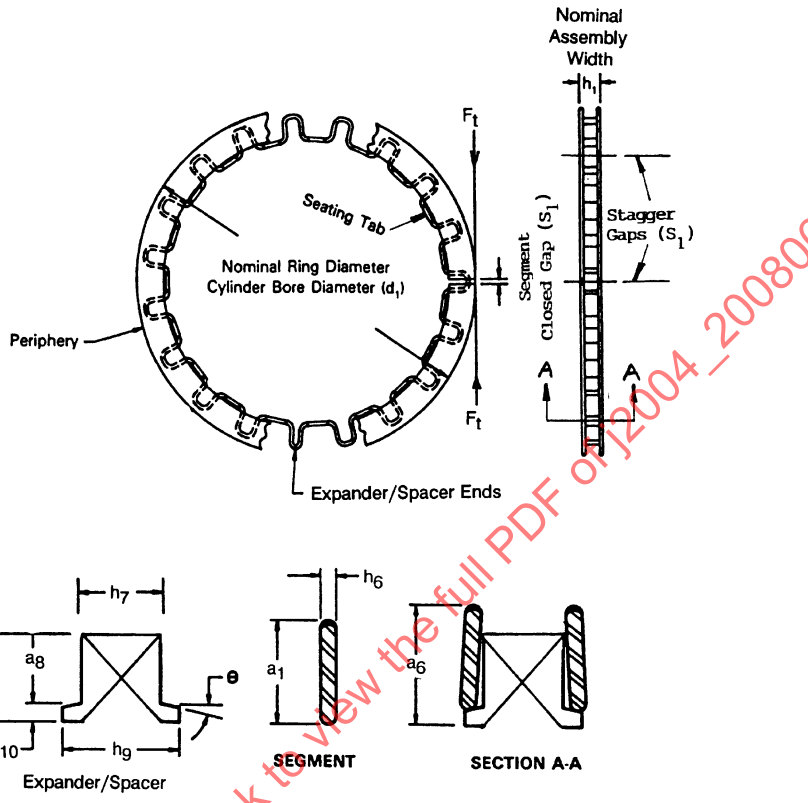
2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

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
J1999	6623	INTERNAL COMBUSTION ENGINES—PISTON RINGS—SCRAPER RINGS
		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—COIL SPRING 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
	1101	TECHNICAL DRAWINGS—Tolerancing of form, orientation, location and run-out—Generalities, definitions, symbols indications on drawings

1. TR refers to Technical Report

3. Expander/Segment Assembly—When assembled in the engine the segments and expander shall be positioned as shown in Figure 1.



a_1 Segment Radial Wall Thickness	h_1 Nominal Assembly Width	d_1 Nominal Assembly Diameter
a_8 Spacer Radial Height	h_7 Spacer Width	θ Seating Tab Angle
a_{10} Seating Tab Height	h_9 Expander Width	F_t Tangential Force
a_6 Assembly Radial Thickness	h_6 Segment Width	
a_9 Expander Radial Height	s_1 Segment Closed Gap	

NOTE—For measuring purposes only, segment gaps shall be in line and expander/spacer ends shall be at the back of the segments (see SAE J1589 3.2.5b).

FIGURE 1—EXPANDER/SEGMENT ASSEMBLY

3.1 Ring Types—There are any number of possible oil ring expander designs. The more common designs in use today are designated in Figures 2 through 6.

3.2 Cross Section Configuration

3.2.1 ES-1 TYPE

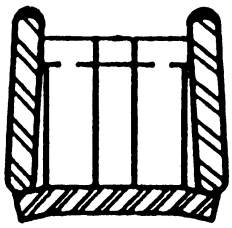


FIGURE 2—ES-1 TYPE

3.2.2 ES-2 TYPE

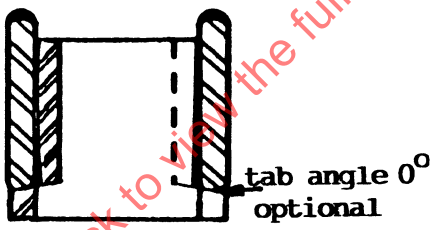


FIGURE 3—ES-2 TYPE

3.2.3 ES-3 TYPE

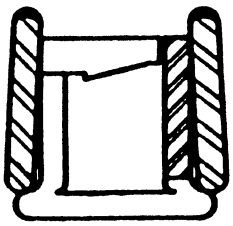


FIGURE 4—ES-3 TYPE

3.2.4 ES-4 TYPE

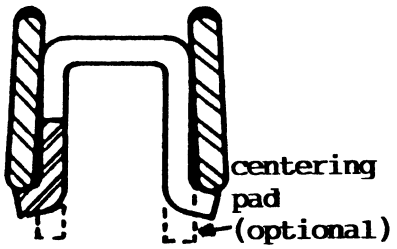


FIGURE 5—ES-4 TYPE

3.2.5 ES-5 TYPE

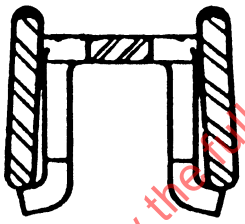


FIGURE 6—ES-5 TYPE

4. Common Features

4.1 Expander Seating Tab Angle—(See Figure 7.)

The expander may be designed with the seating tabs at a slight angle resulting in side sealing between the segment and the side of the piston groove.

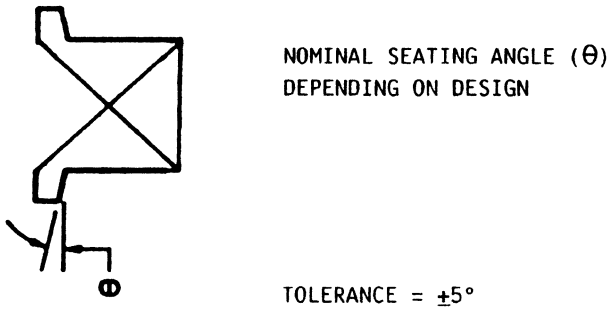


FIGURE 7—EXPANDER SEATING TAB ANGLE

4.2 Segment Chromium Thickness—(See Figure 8.)

(Common feature of segment is chrome plated periphery.)

FIGURE 8—SEGMENT CHROMIUM THICKNESS

TABLE 1—LAYER THICKNESS
Dimensions in millimeters

Chromium	Thickness min
CR1	0.05
CR2	0.10
CR3	0.15

4.3 Segment Width (h_6)—(See Figure 9.)

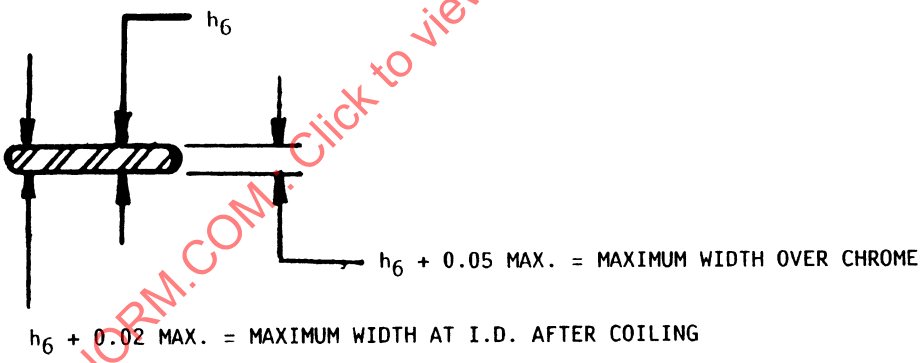


FIGURE 9—SEGMENT WIDTH (h_6)

5. Materials

5.1 Expander

Austenitic Stainless Steel (SAE J1590)
Carbon Steel (as agreed upon between client and manufacturer)

5.2 Segment—Carbon Steel

6. *Force and Nominal Contact Pressure*

6.1 Tangential Force (F_t)—The force of expander/segment oil control rings is determined by the force of the expander and can be calculated with the following equation:

$$F_t = 1/2P_o \cdot d_1 \cdot 2h_6 \quad \text{(Eq. 1)}$$

P_o = Required Nominal Contact Pressure

The force exerted by the segments is negligible.

In Table 3 of Section 7, Dimensions, the F_t has been tabulated at a unit pressure of $P_o = 1$ N/mm^2.

6.2 Nominal Contact Pressure P_o—F_t for selected unit pressures is calculated by use of the multiplying factors in Table 2:

TABLE 2—NOMINAL CONTACT PRESSURE P_o

Multiplying Factor x F_t (From Table 3)	Unit Pressure P_o
1.60(1)	1.60 N/mm^2
1.25	1.25 N/mm^2
1.00	1.00 N/mm^2
0.80	0.80 N/mm^2
0.60(2)	0.60 N/mm^2

1. Recommended for repair sizes only.
2. Not recommended $<d_1 = 65$ mm.

7. *Dimensions*

TABLE 3—DIMENSIONS

Dimensions in millimeters

Nominal diameter d_1	Segment width h_6 Column				Tolerance	Segment Closed gap s_1		F_t (P_0 = 1 N/mm^2) Column				Tolerance	Nominal assembly width h_1 (using available h_8) Column				
	1	2	3	4		Nom	Tolerance	1	2	3	4		1-3	1-3	1-4	1-4	4
40								16	18	20							
41								16.4	18.4	20.5							
42								16.8	18.9	21							
43								17.2	19.3	21.5							
44								17.6	19.8	22							
45								18	20.2	22.5							
46								18.4	20.7	23							
47								18.8	21.1	23.5							
48								19.2	21.6	24							
49						0.15	+0.50	19.6	22	24.5							
50							0	20	22.5	25							
51								20.4	22.9	25.5							
52								20.8	23.4	26							
53								21.2	23.8	26.5							
54								21.6	24.3	27							
55								22	24.7	27.5							
56								22.4	25.2	28							
57								22.8	25.6	28.5							
58								23.2	26.1	29							
59								23.6	26.5	29.5			2.5				
60								24	27	30	36						
61								24.4	27.4	30.5	36.6						
62								24.8	27.9	31	37.2						
63								25.2	28.3	31.5	37.8	± 30 % if					
64								25.6	28.8	32	38.4	F_t < 30 N					
65	0.4	0.45	0.5	0.6	+0.025			26	29.2	32.5	39	± 20% if		3	3.5	4	4.75
66					0			26.4	29.7	33	39.6	F_t > 30 N					
67						0.2		26.8	30.1	33.5	40.2						
68								27.2	30.6	34	40.8						
69								27.6	31	34.5	41.4						
70								28	31.5	36	42						
71								28.4	31.9	36.5	42.6						
72								28.8	32.4	36	43.2						
73								29.2	32.8	36.5	43.8						
74								29.6	33.3	37	44						
75							+0.75	30	33.7	37.5	45						
76							0	30.4	34.2	38	45.6						
77								30.8	34.6	38.5	46.2						
78								31.7	35.1	39	46.8						
79								31.6	35.5	39.5	47.4						
80								32	36	40	48						
81								32.4	36.4	40.5	48.6						
82						0.25		32.8	36.9	41	49.2						
83								33.2	37.3	41.5	49.8						
84								33.6	37.8	42	50.4						
85								34	38.2	42.5	51						
86								34.4	38.7	43	51.6						
87								34.8	39.1	43.5	52.2						
88								35.2	39.6	44	52.3						
89								35.6	40	44.5	53.4						