

SURFACE VEHICLE STANDARD

SAE J1999

REV.
OCT92

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Superseding J1999 OCT89

Submitted for recognition as an American National Standard

INTERNAL COMBUSTION ENGINES—PISTON RINGS—SCRAPER RINGS

This SAE Standard is equivalent to ISO Standard 6623.

(R) **1. Scope and Field of Application** —Differences, where they exist, are shown in Appendix A.

This SAE Standard specifies the essential dimensional features of N, NM, E, and EM scraper piston ring types.

Dimensional Tables 7 and 8 offer the choice of two radial wall thicknesses:

- a. Radial wall thickness "regular" (Table 7)
- b. Radial wall thickness "D/22" (Table 8)

The requirements of this document apply to scraper rings for reciprocating internal combustion piston engines up to and including 200 mm diameter. They may also be used for piston rings of compressors working under similar conditions.

(R) **2. References**

SAE
DESIGNATION

ISO¹
EQUIVALENT

INTERNAL COMBUSTION ENGINES—PISTON RINGS

J1588
J1589
J1590
J1591
J1996

6621/1
6621/2
6621/3
6621/4
6621/5

Vocabulary
Measuring principles
Material specifications
General specifications
Quality requirements

INTERNAL COMBUSTION ENGINES—PISTON RINGS

J1997

6622/1

Rectangular rings

¹ TR refers to Technical Report

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SAE DESIGNATION	ISO ¹ EQUIVALENT	
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

3. Ring Types and Designation Examples

3.1 Types N, NM, E, and EM—Scraper Rings—Common General Features

NOTE—See Table 7 or 8 for dimensions and forces.

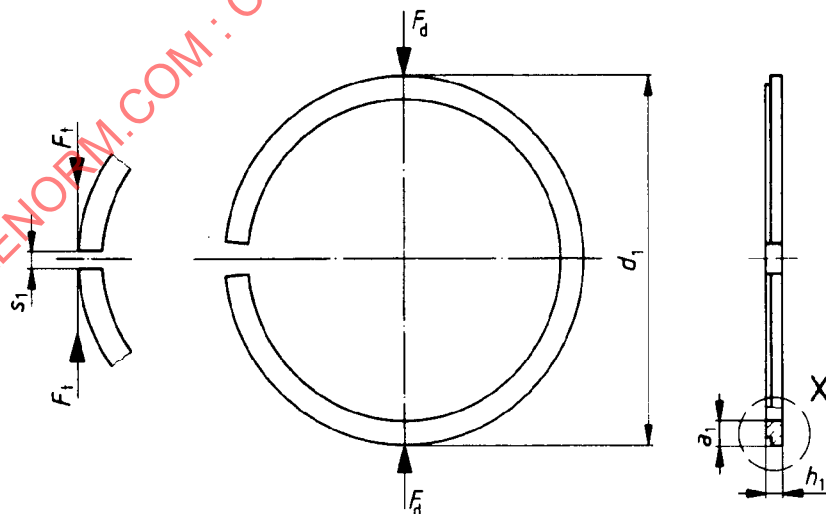


FIGURE 1—TYPES N, NM, E, AND EM

3.2 Type N—Scraper Ring (Napier)

3.2.1 GENERAL FEATURES

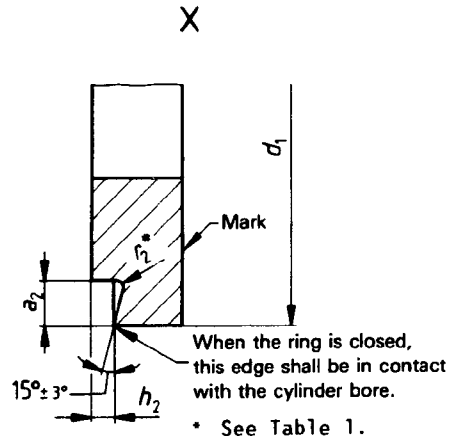


FIGURE 2—TYPE N—DETAIL OF FIGURE 1

(R) TABLE 1— r_2 DIMENSIONS

Dimensions in millimeters

d_1	r_2 max
$30 \leq d_1 < 175$	0.3
$175 \leq d_1 \leq 200$	0.7

3.2.2 DESIGNATION EXAMPLE—Designation of a Napier ring of $d_1 = 90$ mm nominal diameter, radial wall thickness "regular", $h_1 = 2.5$ mm ring width, made of grey cast iron, nonheat-treated (material subclass 12), general features as shown in Figures 1 and 2, and inside chamfered edges.

3.3 Type NM—Scraper Ring (Napier), Taper Faced

3.3.1 GENERAL FEATURES

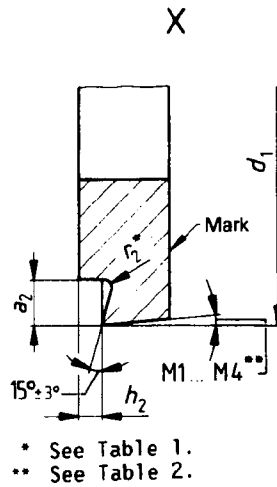


FIGURE 3—TYPE NM—DETAIL OF FIGURE 1

TABLE 2—TAPER

Taper	Uncoated and coated rings (molybdenum)	Uncoated and coated rings (molybdenum)
		Tolerance
M1	10°	+60° 0
M2	30°	+60° 0
M3	60°	+60° 0
M4	90°	+60° 0

3.3.2 DESIGNATION EXAMPLE—Designation of a Napier ring, taper faced M4 = 90°, of d_1 = 90 mm nominal diameter, radial wall thickness "regular", h_1 = 2.5 mm ring width, made of grey cast iron, heat-treated (material subclass 21), general features as shown in Figures 1 and 3, and phosphate all over:

Piston ring SAE J1999 or ISO 6623 - NM4 - 90 x 2.5 - MC21 PO

3.4 Type E—Scraper Ring (Stepped)

3.4.1 GENERAL FEATURES

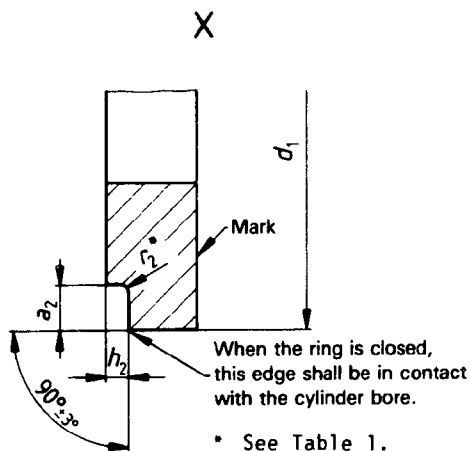


FIGURE 4—TYPE E—DETAIL OF FIGURE 1

3.4.2 DESIGNATION EXAMPLE—Designation of a scraper ring of $d_1 = 90$ mm nominal diameter, radial wall thickness "regular", $h_1 = 2.5$ mm ring width, made of grey cast iron, nonheat-treated (material subclass 12), general features as shown in Figures 1 and 4, and periphery molybdenum coated inlaid design, 0.10 mm minimum thickness.

3.5 Type EM—Scraper Ring (Stepped) Taper Faced

3.5.1 GENERAL FEATURES

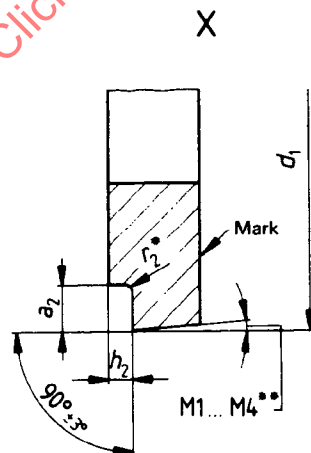


FIGURE 5—TYPE EM—DETAIL OF FIGURE 1

3.5.2 DESIGNATION EXAMPLE—Designation of a scraper ring taper faced M2 = 30°, of d_1 = 90 mm nominal diameter, radial wall thickness "regular", h_1 = 2.5 mm ring width, made of grey cast iron, heat-treated (material subclass 22), general features as shown in Figures 1 and 5, and inside chamfered edges.

4. Common Features

4.1 N, NM, E, and EM Rings—Inside Chamfered Edges (KI)

NOTE—See Table 3 for dimensions.

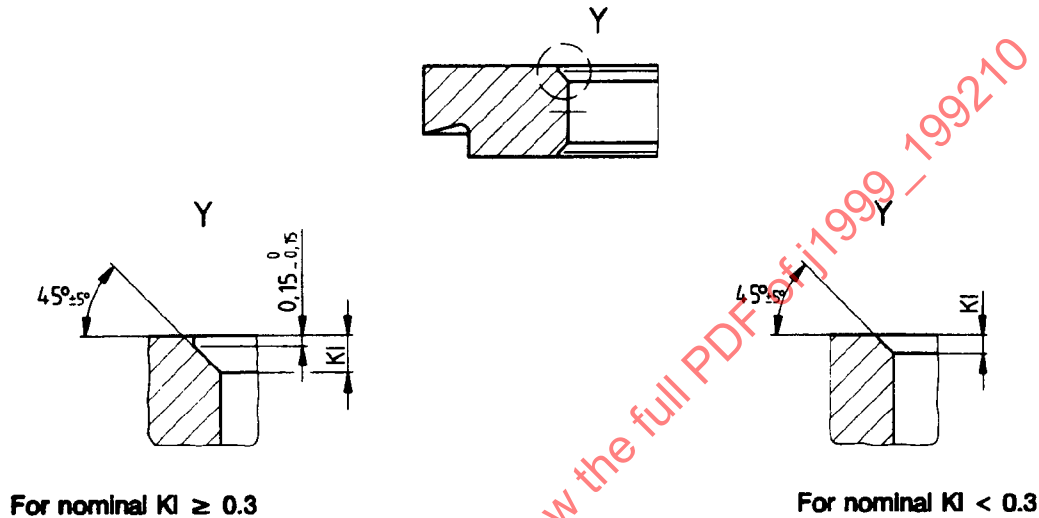


FIGURE 6—INSIDE CHAMFERED EDGES (KI)

(R) TABLE 3—KI DIMENSIONS

Dimensions in millimeters

d_1	KI
$30 \leq d_1 < 50$	0.2 max
$50 \leq d_1 < 125$	0.3 ± 0.15
$125 \leq d_1 < 175$	0.4 ± 0.15
$175 \leq d_1 \leq 200$	0.6 ± 0.2

4.2 N, NM, E, and EM Rings, Coated (Molybdenum Inlaid)—Layer Thickness

NOTE—See Table 4 for dimensions.

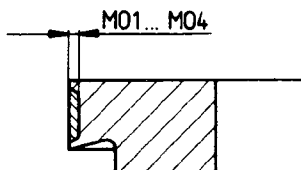


FIGURE 7—LAYER THICKNESS

TABLE 4—LAYER THICKNESS

Dimensions in millimeters

Molybdenum	Thickness min
MO1	0.05
MO2	0.10
MO3	0.15
MO4	0.20

5. **Force Factors**—The tangential and diametral forces given in Tables 7 and 8 shall be corrected when additional features and/or materials other than grey cast iron with a modulus of elasticity of 100 000 MPa are being used.

For common features, the multiplier correction factors given in Tables 5 and 6 and the force correction factors given in SAE J1591 shall be used.

The factors of Table 6 have been calculated with mean coating thickness.

TABLE 5—FORCE CORRECTION FACTORS FOR N, NM, E, AND EM RINGS, WITH FEATURE KI

d_1 mm	Factor
$30 \leq d_1 < 50$	1
$50 \leq d_1 \leq 200$	0.97

**TABLE 6—FORCE CORRECTION FACTORS FOR N, NM, E, AND
EM RINGS, MOLYBDENUM COATED (INLAID TYPE)**

d_1 mm	Factor MO1	Factor MO2	Factor MO3	Factor MO4
$30 \leq d_1 < 50$	0.81	0.75	—	—
$50 \leq d_1 < 100$	0.90	0.86	0.83	0.80
$100 \leq d_1 < 150$	0.94	0.91	0.89	0.87
$150 \leq d_1 \leq 200$	0.95	0.94	0.92	0.90

6. Dimensions—See Tables 7 and 8.

(R) 7. Notes

7.1 Marginal Indicia—The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

PREPARED BY THE SAE PISTON RING STANDARDS COMMITTEE 7

TABLE 7—DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS [REGULAR])

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "regular" a_1		Ring width h_1				Closed gap s_1		Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N				Toler-ance
	Toler-ance		1	2	3	4	Toler-ance		1	2	3	4		1	2	3	4	1	2	3	4	
30	1.25												0.3 ± 0.15					6.2	7.5	8.6	10.8	
31	1.3																	6.7	8	9	11.4	
32	1.35																	7.1	8.4	9.7	12	
33	1.4																	7.1	8.6	9.9	12.5	
34	1.4																	6.7	8	9.2	11.6	
35	1.45																	7.1	8.4	9.7	12.3	
36	1.5																	7.5	8.8	10.3	12.9	
37	1.55																	8	9.2	10.8	13.5	
38	1.6																	8.2	9.7	11.2	14.2	
39	1.65																	8.6	10.1	11.8	14.8	
40	1.65																	8.2	9.7	11.2	14.2	
41	1.7																	8.6	10.1	11.6	14.8	
42	1.75																	9	10.5	12.3	15.5	
43	1.8																	9	10.8	12.5	15.7	
44	1.85																	9.5	11.2	12.9	16.3	
45	1.9																	9.7	11.6	13.3	16.8	
46	1.9																	9.2	11	12.7	16.1	
47	1.95																	9.7	11.4	13.1	16.8	
48	2																	10.1	11.8	13.8	17.4	
49	2.05																	10.5	12.3	14.2	18.1	
50	2.1		1.5	1.75	2	2.5			0.45 ± 0.15	0.5 ± 0.15	0.5 ± 0.15	0.6 ± 0.15						10.8	12.7	14.8	18.7	
51	2.15																	11.2	13.3	15.3	19.4	
52	2.15																	10.8	12.7	14.6	18.5	
53	2.2																	10.8	12.9	14.8	18.7	
54	2.25																	11.2	13.3	15.3	19.4	
55	2.3																	11.6	13.8	15.9	20	
56	2.35																	12	14.2	16.3	20.6	
57	2.4																	21.3	14.6	16.8	21.3	
58	2.4																	11.8	14.2	16.3	20.6	
59	2.45																	12.3	14.6	16.8	21.3	
60	2.5																	12.7	14.8	17.2	21.7	
61	2.55																	12.9	15.3	17.6	22.4	
62	2.6																	13.1	15.5	17.8	22.6	
63	2.65																	13.3	15.9	18.3	23.2	
64	2.65																	12.9	15.3	17.8	22.6	
65	2.7																	13.3	15.7	18.3	23.2	
66	2.75																	13.8	16.3	18.7	23.9	
67	2.8																	14.2	16.8	19.4	24.5	
68	2.85																	14.4	17.2	19.8	25.2	
69	2.9																	14.8	17.6	20.2	25.8	

This table is shown in ISO format. Commas represent decimal points.

TABLE 7 - DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS [REGULAR]) (CONTINUED)

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "regular" a_1	Ring width h_1				Closed gap s_1	Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N			
		Column					For h_1 shown in column					For h_1 shown in column				For h_1 shown in column			
		1	2	3	4		1	2	3	4		1	2	3	4	1	2	3	4
70	2,9									0,7	6,7	7,9	9,2	11,6	14,4	17	19,8	24,9	
71	2,95									$\pm 0,15$	6,9	8,1	9,4	11,9	14,8	17,4	20,2	25,6	
72	3										6,9	8,2	9,5	12	14,8	17,6	20,4	25,8	
73	3,05										7,1	8,4	9,7	12,3	15,3	18,1	20,9	26,4	
74	3,1										7,2	8,6	9,9	12,6	15,5	18,5	21,3	27,1	
75	3,15									0,8	7,4	8,8	10,1	12,8	15,9	18,9	21,7	27,5	
76	3,15									$\pm 0,15$	7,2	8,5	9,8	12,5	15,5	18,3	21,1	26,9	
77	3,2										7,4	8,7	10,1	12,8	15,9	18,7	21,7	27,5	
78	3,25										7,5	8,9	10,3	13,1	16,1	19,1	22,1	28,2	
79	3,3										7,7	9,1	10,5	13,4	16,6	19,6	22,6	28,8	
80	3,35										7,9	9,3	10,8	13,7	17	20	23,2	29,5	
81	3,4										7,9	9,4	10,8	13,8	17	20,2	23,2	29,7	
82	3,4										7,7	9,1	10,6	13,4	16,6	19,6	22,8	28,8	
83	3,45										7,9	9,3	10,8	13,7	17	20	23,2	29,5	
84	3,5										8	9,5	11	14	17,2	20,4	23,7	30,1	
85	3,55									0,9	8,2	9,7	11,3	14,3	17,6	20,9	24,3	30,7	
86	3,6									$\pm 0,15$	8,4	9,9	11,5	14,6	18,1	21,3	24,7	31,4	
87	3,65										8,6	10,2	11,7	14,9	18,5	21,9	25,2	32	
88	3,65										8,4	9,9	11,5	14,6	18,5	21,9	25,2	32	
89	3,7										8,5	10,1	11,7	14,9	18,3	21,7	25,2	32	
90	3,75										10,3	11,9	15,1	18,1	22,1	25,6	32,5	39,9	
91	3,8										10,3	11,9	15,2	18,2	22,1	25,6	32,7	39,1	
92	3,85										10,5	12,1	15,4	18,5	22,6	26	33,1	39,8	
93	3,9										10,7	12,4	15,7	18,9	23	26,7	33,8	40,6	
94	3,9										10,5	12,1	15,4	18,5	22,6	26	33,1	39,8	
95	3,95									1	10,7	12,3	15,7	18,8	23	26,4	33,8	40,4	
96	4									$\pm 0,15$	10,9	12,6	16	19,2	23,4	27,1	34,4	41,3	
97	4,05										11,1	12,8	16,3	19,5	23,9	27,5	35	41,9	
98	4,1										11,3	13	16,6	19,9	24,3	28	35,7	42,8	
99	4,15										11,5	13,3	16,9	20,2	24,7	28,6	36,3	43,4	
100	4,15										16,5	19,8	23,1		35,5	42,6	49,7		
101	4,2										16,6	19,9	23,2		35,7	42,8	49,9		
102	4,25										16,8	20,2	23,6		36,1	43,4	50,7		
103	4,3										17,1	20,5	24		36,8	44,1	51,6		
104	4,3										16,8	20,1	23,5		36,1	43,2	50,5		
105	4,35									1,1	17	20,4	23,8		36,6	43,9	51,2		
106	4,4									$\pm 0,15$	17,3	20,7	24,2		37,2	44,5	52		
107	4,4										16,9	20,3	23,7		36,3	43,6	51		
108	4,45										17,2	20,6	24,1		37	44,3	51,8		
109	4,5										17,5	21	24,5		37,6	45,2	52,7		

This table is shown in ISO format. Commas represent decimal points.

TABLE 7—DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS [REGULAR]) (CONTINUED)

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "regular" a_1	Ring width h_1				Closed gap s_1	Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N				Toler-ance
		1	2	3	4		1	2	3	4		1	2	3	4	1	2	3	4	
110	4.55										1.1 ± 0.15	21.2	24.8	28.5		45.6	53.3	61.3		
111	4.55											20.8	24.3	28		44.7	52.2	60.2		
112	4.6											20.9	24.3	28.1		44.9	52.2	60.4		
113	4.65											21.2	24.7	28.5		45.6	53.1	61.3		
114	4.7											21.5	25.1	28.9		46.2	54	62.1		
115	4.7										1.2 ± 0.15	21.1	24.6	28.4		45.4	52.9	61.1		
116	4.75											21.4	25	28.8		46	53.8	61.9		
117	4.8											21.7	25.3	29.2		46.7	54.4	62.8		
118	4.8											21.3	24.9	28.7		45.8	53.5	61.7		
119	4.85					0.35 0						21.6	25.2	29.1		46.4	54.2	62.6		
120	4.9											21.9	25.6	29.5		47.1	55	63.4		
121	4.95											22.2	25.9	29.9		47.7	55.7	64.3		
122	4.95											21.8	25.5	29.4		46.9	54.8	63.2		
123	5											21.9	25.5	29.5		47.1	54.8	63.4		
124	5.05											22.2	25.9	29.9		47.7	55.7	64.3		
125	5.05											21.8	25.4	29.3		46.9	54.6	63		
126	5.1										1.3 ± 0.15	22.1	25.8	29.7		47.5	55.5	63.9		
127	5.15											22.4	26.1	30.1		48.2	56.1	64.7		
128	5.2											22.7	26.5	30.6		48.8	57	65.8		
129	5.2											22.3	26	30		47.9	55.9	64.5		
130	5.25											22.5	26.3	30.3		48.4	56.5	65.1		
131	5.3											22.8	26.6	30.7		49	57.2	66		
132	5.3											22.4	26.2	30.2		48.2	56.3	64.9		
133	5.35											22.7	26.6	30.6		48.8	57	65.8		
134	5.4											22.8	26.6	30.7		49	57.2	66		
135	5.4											22.4	26.2	30.2		48.2	56.3	64.9		
136	5.45											22.7	26.5	30.6		48.8	57	65.8		
137	5.5											22.8	26.8	31		49.5	57.6	66.7		
138	5.5											22.6	26.4	30.5		48.6	56.8	65.6		
139	5.55											22.9	26.7	30.9		49.2	57.4	66.4		
140	5.6					0.4 0					1.4 ± 0.15	27.1	31.3			58.3	67.3			
141	5.65											27.4	31.6			58.9	67.9			
142	5.65											27	31.1			58.1	66.9			
143	5.7											27.3	31.5			58.7	67.7			
144	5.75											27.7	31.9			59.6	68.6			
145	5.75											27.2	31.4			58.5	67.5			
146	5.8											27.3	31.5			58.7	67.7			
147	5.85											27.6	31.9			59.3	68.6			
148	5.85											27.2	31.4			58.5	67.5			
149	5.9											27.5	31.8			59.1	68.4			

This table is shown in ISO format. Commas represent decimal points.

TABLE 7—DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS [REGULAR]) (CONCLUDED)

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "regular" a_1	Ring width h_1				Closed gap s_1	Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N			
		Column					For h_1 shown in column					For h_1 shown in column				For h_1 shown in column			
		1	2	3	4		1	2	3	4		1	2	3	4	1	2	3	4
150	5.95																		
152	6										1.5 ± 0.2	27.6 31.9	27.6 31.8	27.5 31.7	27.8 32.1	59.3 68.6	59.3 68.4	59.1 68.2	—
154	6.05																		
155	6.1																		
156	6.15																		
158	6.2																		
160	6.25																		
162	6.35										1.6 ± 0.2	27.7 32	28.3 32.7	28.2 32.6	27.8 32.1	59.6 68.8	60.8 70.3	60.6 70.1	—
164	6.4																		
165	6.4																		
166	6.45																		
168	6.5																		
170	6.6																		
172	6.65																		
174	6.7																		
175	6.75																		
176	6.8																		
178	6.85																		
180	6.9																		
182	6.95																		
184	7.05																		
185	7.05																		
186	7.1																		
188	7.15																		
190	7.2										1.8 ± 0.2	28.4 32.9	28.7 33.2	28.6 33.1	28.4 32.8	61.1 70.5	61.3 70.7	61.7 71.2	—
192	7.25																		
194	7.35																		
195	7.35																		
196	7.4																		
198	7.45																		
200	7.5																		

NOTES:

- For intermediate sizes (for example repair sizes), the radial wall thickness of the next smaller nominal diameter should be applied.
- The values for F_d and F_t given in Table 6, apply to as cast grey cast iron with a typical modulus of elasticity (E_n) of 100 000 MPa. Multiplying factors for materials having a different modulus (E_n) are given in SAE J1591.
- Mean forces are calculated for nominal radial wall thickness (a_1) and mean ring width (h_1).
- For the sole purpose of this SAE document, the assumed average ratio F_d/F_t is 2.15. However, for rings up to 50 mm, the ratio F_d/F_t shall be determined between the manufacturer and client.

This table is shown in ISO format. Commas represent decimal points.

TABLE 8—DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS "D/22")

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "D/22"	Ring width h_1				Closed gap s_1	Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N			
		1	2	3	4		1	2	3	4		1	2	3	4	1	2	3	4
50	2.25											6.1	7.2	8.3	10.6	13.1	15.5	17.8	22.8
51	2.3											6.3	7.4	8.6	10.9	13.5	15.9	18.5	23.4
52	2.35										0.6	6.5	7.7	8.8	11.2	14	16.6	18.9	24.1
53	2.4										± 0.15	6.7	7.9	9.1	11.5	14.4	17	19.6	24.7
54	2.45											6.9	8.1	9.4	11.9	14.8	17.4	20.2	25.6
55	2.5											7	8.3	9.6	12.2	15.1	17.8	20.6	26.2
56	2.55											7.2	8.5	9.9	12.5	15.5	18.3	21.3	26.9
57	2.6											7.2	8.6	9.9	12.6	15.5	18.5	21.3	27.1
58	2.65											7.4	8.8	10.2	12.9	15.9	18.9	21.9	27.7
59	2.7											7.6	9	10.4	13.2	16.3	19.4	22.4	28.4
60	2.75											7.8	9.2	10.6	13.5	16.8	19.8	22.8	29
61	2.75										0.7	7.5	8.9	10.3	13	16.1	19.1	22.1	28
62	2.8										± 0.15	7.7	9.1	10.5	13.3	16.6	19.6	22.6	28.6
63	2.85											7.9	9.3	10.8	13.6	17	20	23.2	29.2
64	2.9											8.1	9.5	11	14	17.4	20.4	23.7	30.1
65	2.95											8.3	9.8	11.3	14.3	17.8	21.1	24.3	30.7
66	3											8.3	9.8	11.3	14.4	17.8	21.1	24.3	31
67	3.05											8.4	10	11.6	14.7	18.1	21.5	24.9	31.6
68	3.1											8.6	10.2	11.8	15	18.5	21.9	25.4	32.3
69	3.15											8.8	10.4	12.1	15.3	18.9	22.4	26	32.9
70	3.2											9	10.7	12.3	15.6	19.4	23	26.4	33.5
71	3.25											9.2	10.9	12.6	16	19.8	23.4	27.1	34.4
72	3.25											8.9	10.6	12.2	15.5	19.1	22.8	26.2	33.3
73	3.3											9.1	10.8	12.5	15.8	19.6	23.2	26.9	34
74	3.35											9.3	11	12.7	16.1	20	23.7	27.3	34.6
75	3.4											9.3	11	12.7	16.1	20	23.7	27.3	34.6
76	3.45											9.4	11.2	12.9	16.5	20.2	24.1	27.7	35.5
77	3.5											9.6	11.4	13.2	16.8	20.6	24.5	28.4	36.1
78	3.55											9.8	11.6	13.5	17.1	21.1	24.9	29	36.8
79	3.6											10	11.9	13.7	17.4	21.5	25.6	29.5	37.4
80	3.65											10.2	12.1	14	17.7	21.9	26	30.1	38.1
81	3.7											10.4	12.3	14.2	18	22.4	26.4	30.5	38.7
82	3.75											10.6	12.5	14.5	18.4	22.8	26.9	31.2	39.6
83	3.75											10.3	12.2	14.1	17.9	22.1	26.2	30.3	38.5
84	3.8											10.3	12.2	14.1	18	22.1	26.2	30.3	38.7
85	3.85											10.5	12.4	14.4	18.3	22.6	26.7	31	39.3
86	3.9											10.7	12.6	14.6	18.6	23	27.1	31.4	40
87	3.95											10.8	12.9	14.9	18.9	23.2	27.7	32	40.6
88	4											11	13.1	15.1	19.2	23.7	28.2	32.5	41.3
89	4.05											11.2	13.3	15.4	19.6	24.1	28.6	33.1	42.1

This table is shown in ISO format. Commas represent decimal points.

TABLE 8 -- DIMENSIONS FOR N, NM, E, AND EM SCRAPER RINGS (RADIAL WALL THICKNESS "D/2Z") (CONTINUED)

Dimensions in millimeters

Nominal diam-eter d_1	Radial wall thickness "D/2Z" a_1		Ring width h_1				Closed gap s_1	Axial width of step h_2				Radial depth of step a_2	Tangential force F_t , N				Diametral force F_d , N			
			Column	1	2	3		1	2	3	4		1	2	3	4				
90	4.1											1	13.4	15.5	19.8	23.7	28.8	33.3	42.6	51
91	4.15											± 0.15	13.7	15.8	20.1	24.1	29.5	34	43.2	51.8
92	4.2												13.7	15.8	20.1	24.2	29.5	34	43.2	52
93	4.25	± 0.15											13.9	16.1	20.5	24.5	29.9	34.6	44.1	52.7
94	4.25	Within a ring:	1.75	2	2.5	3		0.45	0.5	0.6	0.75		13.6	15.7	20	24	29.2	33.8	43	51.6
95	4.3	0.15						± 0.15	± 0.15	± 0.15	± 0.15	1.1	13.8	16	20.3	24.4	29.7	34.4	43.6	52.5
96	4.35	max.										± 0.15	14	16.2	20.6	24.8	30.1	34.8	44.3	53.3
97	4.4												14.2	16.5	20.9	25.1	30.5	35.5	44.9	54
98	4.45												14.4	16.7	21.3	25.5	31	35.9	45.8	54.8
99	4.5						0.3						14.7	17	21.6	25.9	31.6	36.6	46.4	55.7
100	4.55												21.9	26.3	30.6	34.6	47.1	56.5	65.8	
101	4.6												21.9	26.3	30.7	34.7	47.1	56.5	66	
102	4.65												22.2	26.6	31.1	35	47.7	57.2	66.9	
103	4.7												22.5	27	31.5	35	48.4	58.1	67.7	
104	4.75											1.2	22.7	27.3	31.9	35.8	48.8	58.7	68.6	
105	4.75											± 0.15	22.3	26.7	31.2	35.2	47.9	57.4	67.1	
106	4.8												22.6	27.1	31.6	35.6	48.6	58.3	67.9	
107	4.85												22.8	27.4	32	36	49	58.9	68.8	
108	4.9												23.1	27.8	32.4	36.4	49.7	59.8	69.7	
109	4.95												23.4	28.1	32.8	36.8	50.3	60.4	70.5	
110	5												28	32.7	37.8	42	60.2	70.3	81.3	
111	5.05												28.4	33.1	38.2	42.2	61.1	71.2	82.1	
112	5.1												28.7	33.5	38.7	42.7	61.7	72	83.2	
113	5.15												29	33.9	39.1	43.1	62.4	72.9	84.1	
114	5.2											1.3	29.4	34.3	39.5	43.5	63.2	73.7	84.5	
115	5.25											± 0.15	29.7	34.7	40	44	63.9	74.6	86	
116	5.25												29.1	34	39.2	43.2	62.6	73.1	84.3	
117	5.3												29.5	34.4	39.7	43.7	63.4	74	85.4	
118	5.35												29.8	34.8	40.1	44.1	64.1	74.8	86.2	
119	5.4												29.8	34.8	40.2	44.2	64.1	74.8	86.4	
120	5.45												30.1	35.2	40.6	44.6	64.7	75.7	87.3	
121	5.5												30.4	35.6	41	45	65.4	76.5	88.2	
122	5.55												30.8	35.9	41.5	45.5	66.2	77.2	89.2	
123	5.6											1.4	31.1	36.3	41.9	45.9	66.9	78	90.1	
124	5.65											± 0.15	31.4	36.7	42.3	46.3	67.5	78.9	90.9	
125	5.7												31.7	37.1	42.8	46.8	68.2	79.8	92	
126	5.75												32.1	37.5	43.2	47.2	69	80.6	92.9	
127	5.75												31.5	36.8	42.5	46.5	67.7	79.1	91.4	
128	5.8											1.5	31.5	36.8	42.5	46.5	67.7	79.1	91.4	
129	5.85											± 0.15	31.8	37.2	42.9	46.9	68.4	80	92.2	

This table is shown in ISO format. Commas represent decimal points.