

Internal Combustion Engines—Piston Rings Coil Spring Loaded Oil Control Rings

This SAE Standard is equivalent to ISO Standard 6626.

1. Scope and Field of Application—This SAE Standard is equivalent to ISO Standard 6626.

Differences, where they exist, are shown in the appendix with associated rationale.

This document specifies the essential dimensions of piston ring types DSF-C, DSF-CNP, SSF, GSF, DSF, DSF-NG, and SSF-L coil spring loaded oil control rings.

For the cast iron part the recommended material is class 10 according to SAE J1590. For special applications material classes 20 to 50 may be used.

Variation in face design and spring groove from these may be used, as recommended by individual manufacturers, in plain or chromed versions.

The tangential forces of coil spring loaded oil control rings can be varied over a wide range. Explanations and recommendations are given in Section 6.

The normal range for axial width of coil spring loaded oil control rings (3 to 8 mm inclusive) is divided into 0.5 or 1.0 mm steps. In Tables 9 to 14 dimensions are given for coil spring loaded oil control rings within an axial width of 4.75 mm (i.e., 3/16 in) for existing applications in inch units.

This document applies to coil spring loaded oil control rings up to 200 mm inclusive for reciprocating internal combustion engines. It may also be used for piston rings of compressors working under similar conditions.

1.1 Rationale—SAE J2003 is being discontinued because the content of this standard is also contained in ISO 6626. 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—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
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— 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
	ISO 1101	TECHNICAL DRAWINGS—Tolerancing of form, orienta- tion, location and run-out—Generalities, definitions, sym- bols indications on drawings

1. TR refers to Technical Report

3. Piston Ring Types and Designation Examples

3.1 Type DSF-C—Coil Spring Loaded Bevelled Edge Oil Control Ring, Chromium-Plated and Profile Ground

3.1.1 GENERAL FEATURES

NOTE—See Tables 9 and 15 for dimensions and forces.

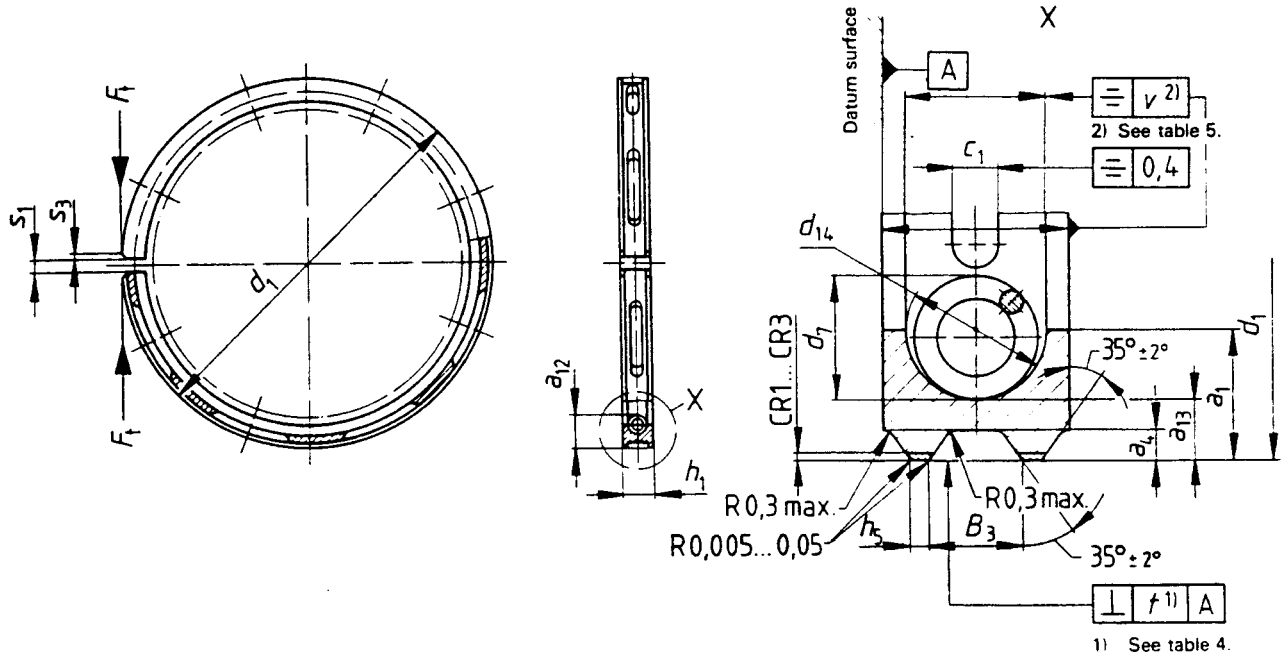


FIGURE 1—TYPE DSF-C

3.1.2 DESIGNATION EXAMPLE—Designation of a piston ring complying with the requirements of SAE J2003 being a coil spring loaded bevelled edge oil control ring, chromium-plated and profile ground (DSF-C), of nominal diameter $d_1 = 125$ mm (125), a nominal ring width $h_1 = 5$ mm (5), made of grey cast iron, nonheat-treated, material subclass 11 (MC 11). A selected closed gap of 0.2 mm (S02), a chromium layer thickness on the lands of 0.15 mm min (CR3) phosphated on all cast iron surfaces to depth of 0.002 mm min (PO), reduced slot length (WK), coil spring with reduced heat set (WF), and variable pitch with coil diameter d_7 ground (CSE), tangential force F_1 according to the medium nominal contact pressure class (PNM) and the ring marked with manufacturer's mark (MM).

3.2 Type DSF-CNP—Coil Spring Loaded Bevelled Edge Oil Control Ring, Chromium-Plated Not Profile Ground

3.2.1 GENERAL FEATURES

NOTE—See Tables 10 and 16 for dimensions and forces.

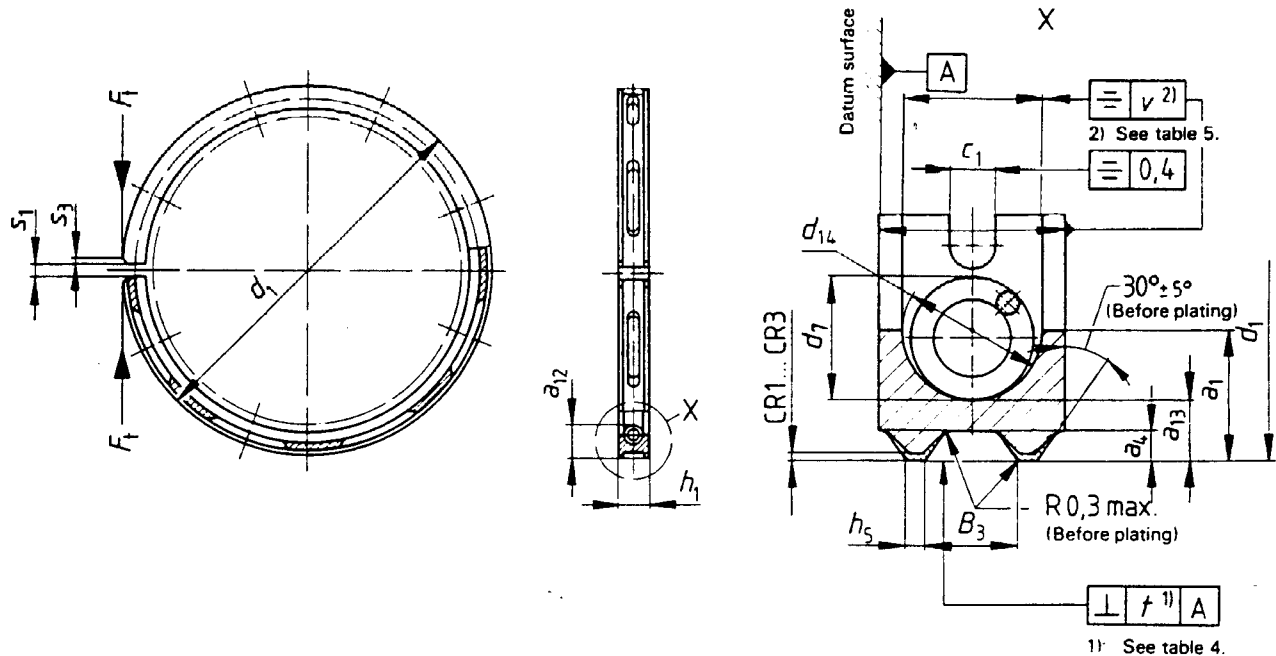


FIGURE 2—TYPE DSF-CNP

3.2.2 DESIGNATION EXAMPLE—Designation of a piston ring complying with the requirements of SAE J2003 being a coil spring loaded bevelled edge oil control ring, chromium-plated not profile ground (DSF-CNP), of nominal diameter $d_1 = 180$ mm (180) and nominal ring width $h_1 = 8$ mm (8), made of grey cast iron, nonheat-treated, material subclass 12 (MC12), a chromium layer thickness on the lands of 0.05 mm min (CR1), constant pitch spring (CSN) and tangential force F_t according to the high nominal contact pressure class (PNH).

3.3 Type SSF—Coil Spring Loaded Slotted Oil Control Ring

3.3.1 GENERAL FEATURES

NOTE—See Tables 11 and 17 for dimensions and forces.

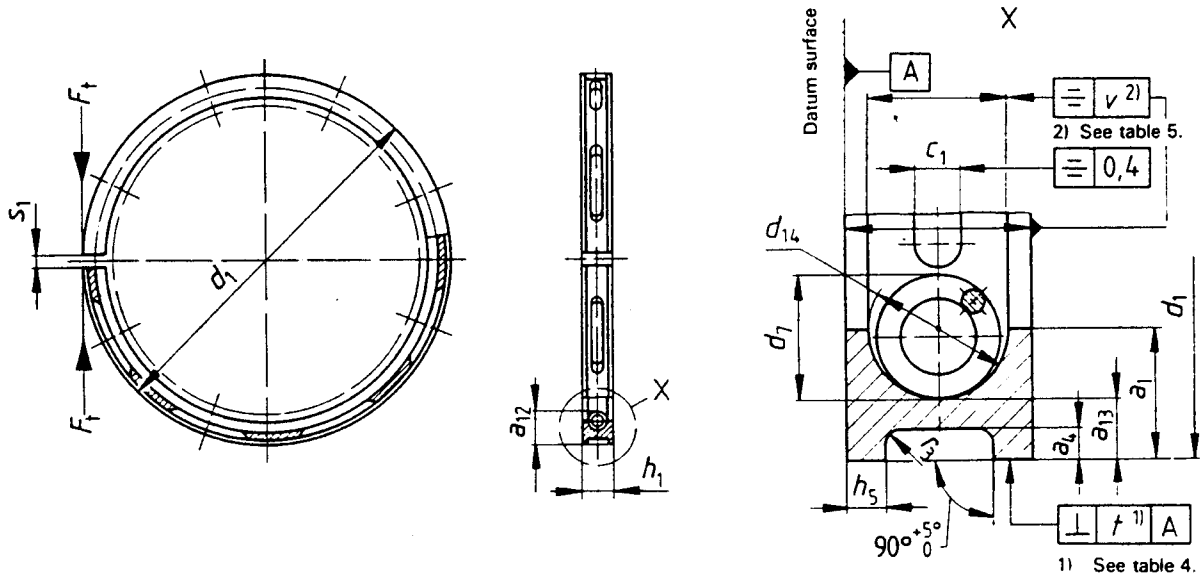


FIGURE 3—TYPE SSF

3.3.2 DESIGNATION EXAMPLE—Designation of a piston ring complying with the requirements of SAE J2003 being a coil spring loaded slotted oil control ring (SSF), of nominal diameter $d_1 = 80$ mm (80) and nominal ring width $h_1 = 4$ mm (4), made of grey cast iron, nonheat-treated, material subclass 12 (MC12), constant pitch spring (CSN) and tangential force F_t according to the low nominal contact pressure class (PNL).

Full document details: [SAE J2003_200806](#)

NOTE—See Tables 13 and 19 for dimensions and forces.



Full document details: [SAE J2003_200806](#)

3.7 Type SSF-L—Coil Spring Loaded Slotted Oil Control Ring With 0.6 mm Nominal Land Width

3.7.1 GENERAL FEATURES

NOTE—See Tables 14 and 20 for dimensions and forces.

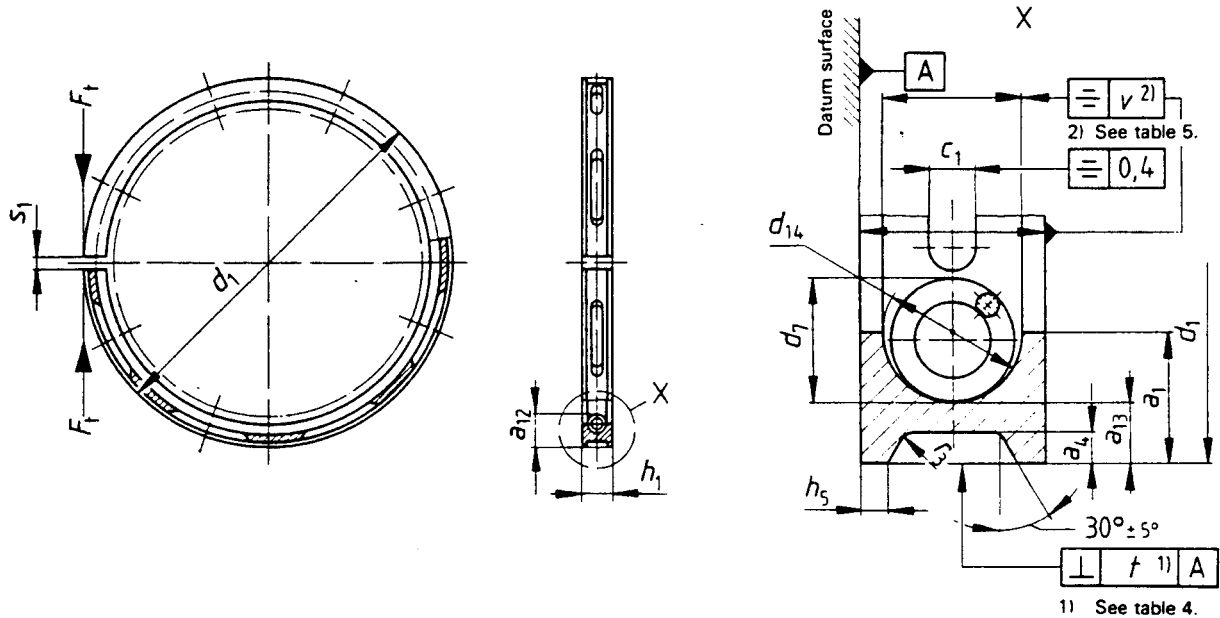


FIGURE 7—TYPE SSF-L

3.7.2 DESIGNATION EXAMPLE—Designation of a piston ring complying with the requirements of SAE J2003 being a coil spring loaded slotted oil control ring with 0.6 mm nominal land width (SSF-L), of nominal diameter $d_1 = 100$ mm (100) and nominal ring width $h_1 = 4.5$ mm (4.5), made of grey cast iron, nonheat-treated, material subclass 12 (MC12), constant pitch spring (CSN) and tangential force F_t according to the reduced nominal contact pressure class (PNR).

4. Common Features

4.1 Arrangement of Slots

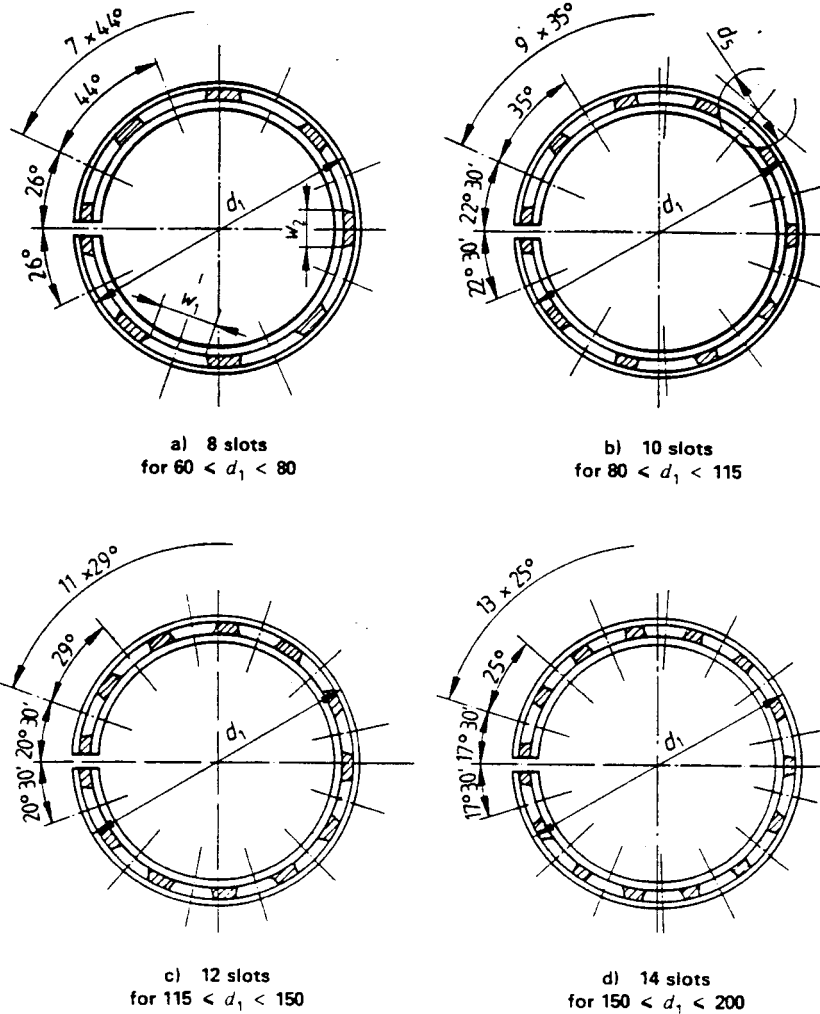


FIGURE 8—ARRANGEMENT OF SLOTS

TABLE 1—CUTTER DIAMETER

Dimensions are millimeters	
Nominal diameter d_1	Cutter diameter d_5 max
$60 \leq d_1 < 150$	60
$150 \leq d_1 \leq 200$	75

4.2 Slot Length

4.2.1 STANDARD SLOT LENGTH—Slot length, w_1 , equal to bridge length, w_2 . Tolerance on difference between w_1 and w_2 : 4 mm.

4.2.2 REDUCED SLOT LENGTH (RETAINING SAME NUMBER AND SPACING)

TABLE 2—REDUCED SLOT LENGTH

Dimensions are millimeters	
d_1	w_1
$60 \leq d_1 < 80$	8.5 ± 2.5
$80 \leq d_1 < 115$	10.5 ± 2.5
$115 \leq d_1 < 150$	12.5 ± 2.5
$150 \leq d_1 \leq 200$	15.0 ± 3.0

4.3 DSF-C and DSF-CNP—Layer Thickness

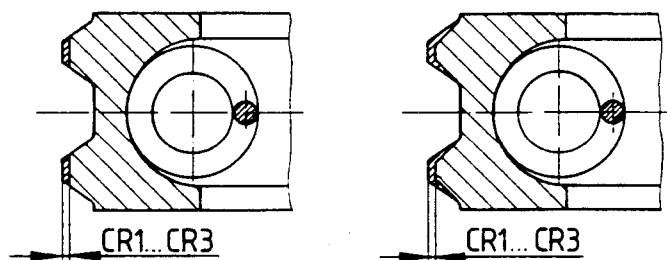


FIGURE 9—LAYER THICKNESS

TABLE 3—LAYER THICKNESS

Dimensions are millimeters	
Chromium	Thickness min
CR1	0.05
CR2	0.1
CR3	0.15

4.4 Tolerances of Spring Groove Offset and Land Offset

TABLE 4—LAND OFFSET TOLERANCE

Dimensions are millimeters	
h_1	t
$3 \leq h_1 < 5$	0.015
$5 \leq h_1 \leq 8$	0.025

TABLE 5—SPRING GROOVE OFFSET TOLERANCE

Dimensions are millimeters	
h_1	v
$h_1 < 3.5$	0.3
$h_1 \geq 3.5$	0.4

5. Coil Spring

5.1 Types—All values in the dimensional tables are based on cylindrical coil springs made of round wire. The three designs shown in 5.1.1 to 5.1.3 are common.

5.1.1 TYPE CSN—Coil Spring With Constant Pitch

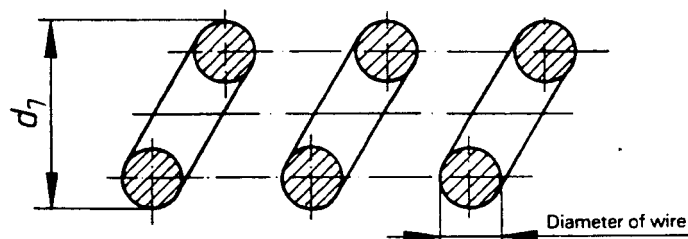


FIGURE 10—TYPE CSN COIL SPRING

5.1.2 TYPE CSG—COIL SPRING WITH CONSTANT PITCH (COIL DIAMETER, D_7 , GROUND)

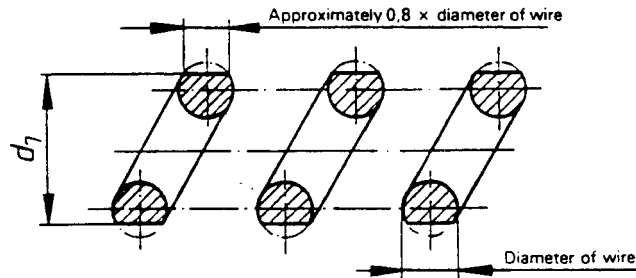


FIGURE 11—TYPE CSG COIL SPRING

5.1.3 TYPE CSE—COIL SPRING WITH VARIABLE PITCH (COIL DIAMETER, D_7 , GROUND)

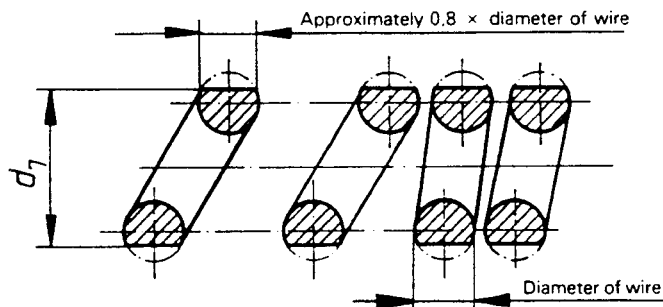


FIGURE 12—TYPE CSE COIL SPRING

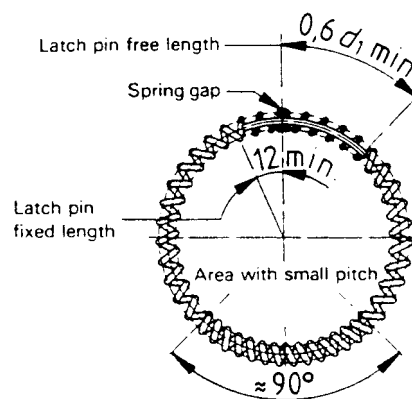


FIGURE 13—POSITION OF AREA WITH SMALL PITCH

NOTE—The use of different spring designs can be agreed between manufacturer and client. Changed spring groove configurations and dimensions may then be necessary.

5.2 Excursion—Coil spring excursion is the distance between the ends of the ring gap with unstressed ring, measured in the middle of the spring groove (see Figure 14).

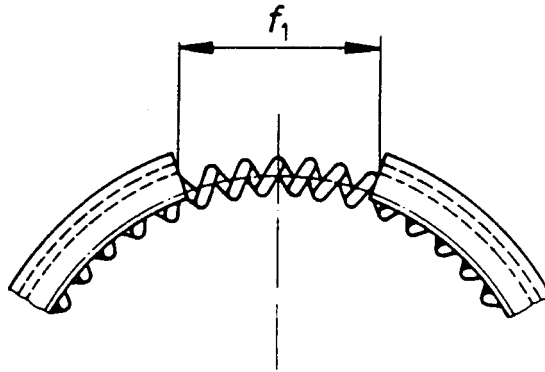


FIGURE 14—COIL SPRING EXCURSION

TABLE 6—COIL SPRING EXCURSION

Dimensions are millimeters	
d_1	f_1 max
$60 \leq d_1 < 125$	$0.13 \times d_1$
$125 \leq d_1 \leq 200$	$0.12 \times d_1$

5.3 Position of Coil Spring Gap and Fixing—The spring gap shall be approximately 180° from the ring gap and the spring gap ends fixed with a connecting or latch pin.

5.4 Material—Coil springs are made of valve spring wire, oil heat-treated. A suitable material for coil spring expanders is subclass 63 (see SAE J1590).

Springs are available with two different heat set resistance levels (loss of tangential force under load and temperature):

- Standard heat resistance
- Reduced heat set, code WF

The test conditions and the permissible loss of tangential forces are given in SAE J1996, Table 10.

6. Tangential Force and Nominal Contact Pressure

6.1 Tangential Force—The tangential force of coil spring loaded oil control rings is mainly determined by the force of the spring. The cast iron part itself has a very small tangential force due to its low radial wall thickness and the decreased ratio "total free gap/nominal diameter".

The tangential force measurement only can be used because of the flexible design of the cast iron part of coil spring loaded oil control rings.

6.2 Force Factors—Because of the small contribution of the cast iron part in the tangential force, force factors are not necessary when additional features and/or materials other than subclass 12 are being used (see SAE J1590).

6.3 Tangential Force, F_t —The tangential force, F_t , of a spring loaded oil control ring is determined by the following:

- a. Nominal diameter, d_1 , in millimeters
- b. Land width, h_5 , in millimeters
- c. Required nominal contact pressure, p_o , in newtons per square millimeter

and can be calculated from the following equation:

$$F_t = \frac{1}{2} \cdot d_1 \cdot 2h_5 \cdot p_o \quad (\text{Eq. 1})$$

The land width, h_5 , depends on ring type, nominal diameter and ring width. The nominal contact pressure, p_o , can be selected over a wide range to suit the application and the required oil scraping effect.

6.3.1 SPECIFIC TANGENTIAL FORCE, F_{tc} — F_{tc} is the specific tangential force required to maintain a spring loaded oil loaded oil control ring at a unit contact pressure p_{ou} , of 1 N/mm²:

$$F_{tc} = \frac{1}{2} \cdot d_1 \cdot 2h_5 \quad (\text{Eq. 2})$$

In Section 7, F_{tc} is tabulated for every ring type.

6.3.2 ACTUAL TANGENTIAL FORCE, F_t , AND TOLERANCE—The actual tangential force of a spring loaded oil control ring can be calculated with the F_{tc} value and the required nominal contact pressure from the following equation:

$$F_t = \frac{p_o}{p_{ou}} \cdot F_{tc} \quad (\text{Eq. 3})$$

The tolerance on F_t is the actual value $F_t \pm 20\%$.

6.4 Classes of Nominal Contact Pressure—The range of the nominal contact pressure has been subdivided into six classes, in accordance with Table 7.

TABLE 7—CLASSES OF NOMINAL CONTACT PRESSURE

Class	Meaning
PNE	very low nominal contact pressure
PNL	low nominal contact pressure
PNR	reduced nominal contact pressure
PNM	medium nominal contact pressure
PNH	high nominal contact pressure
PNV	very high nominal contact pressure

The nominal contact pressure, p_o , normally decreases with increasing nominal diameter. Figure 15 shows characteristic values of p_o depending on d_1 .

The range possible for the nominal contact pressure, p_o , varies according to the ring type, ring dimensions, and features of the contact lands (if plain or chromium-plated).

The classification given in Table 8 is taken from the dimensional tables in Section 7, where p_o values are given in the following three categories for every nominal diameter:

- "Low" category—Low friction design oil control rings
- "Mean" category—Normal design oil control rings
- "High" category—High contact pressure oil control rings for high oil scraping effect

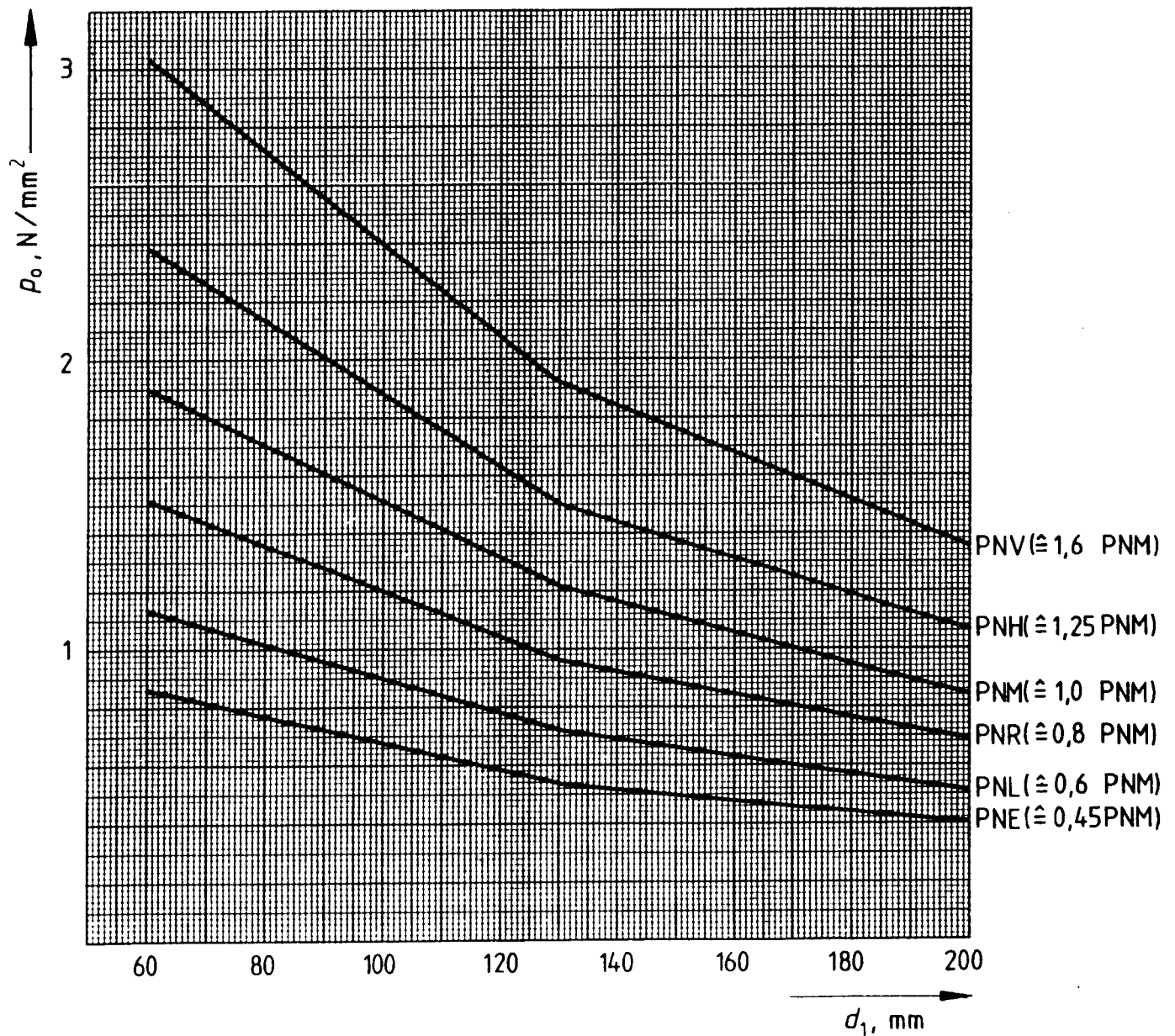
TABLE 8—OIL CONTROL RING PRESSURE CLASSES

Ring Type	Class According to Nominal Contact Pressure PNE	Class According to Nominal Contact Pressure PNL	Class According to Nominal Contact Pressure PNR	Class According to Nominal Contact Pressure PNM	Class According to Nominal Contact Pressure PNH	Class According to Nominal Contact Pressure PNV
DSF-C	(-)	Low	Mean	Mean	High	(x)
DSF-CNP	(-)	Low	Mean	Mean	High	(x)
SSF	Low	Mean	High	(x)	(-)	(-)
GSF	(x)	Low	Mean	High	(x)	(-)
DSF	(x)	Low	Mean	High	(x)	(-)
DSF-NG	(x)	Low	Mean	High	(x)	(-)
SSF-L	Low	Mean	High	(-)	(-)	(-)

NOTES:

(x) For special applications.

(-) This pressure class is not used with this ring type.

FIGURE 15—CHARACTERISTIC VALUES OF p_0 DEPENDING ON d_1