BS ISO 6627:2011

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Internal combustion engines — Piston rings — Expander/ segment oil-control rings

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National foreword

This British Standard is the UK implementation of ISO 6627:2011.

The UK participation in its preparation was entrusted to Technical Committee MCE/14/-/10, RIC engines - Cylinders, pistons and rings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 6627

Second edition
2011-08-01

Internal combustion engines — Piston rings — Expander/segment oil-control rings

Moteurs à combustion interne — Segments de piston — Segments racleurs régulateurs d'huile/Ressorts d'expansion

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6627 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

This second edition cancels and replaces the first edition (ISO 6627:2000), which has been technically revised.

Introduction

ISO 6627 is one of a series of International Standards dealing with piston rings for reciprocating internal combustion engines. Others are ISO 6621, ISO 6622, ISO 6623; ISO 6624, ISO 6625 and ISO 6626 (see Clause 2 and the Bibliography).

The common features and dimensional tables included in ISO 6627 represent a broad range of variables. In selecting a ring type, the designer will above all need to consider the particular operating conditions. Moreover, it is essential that the designer refer to the specifications and requirements of ISO 6621-3 and ISO 6621-4 before completing the selection.

Internal combustion engines — Piston rings — Expander/segment oil-control rings

1 Scope

This International Standard specifies the essential dimensional features of expander/segment oil-control rings, without providing a complete product description (because expander-spacer design varies from piston-ring manufacturer to piston-ring manufacturer, the interaction between the manufacturer and the client will determine specific design details).

This International Standard applies to expander/segment oil-control rings of nominal diameters ranging from 40 mm to 125 mm for reciprocating internal combustion engines for road vehicles and other applications. It also applies to piston rings for compressors working under analogous conditions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6621-2, *Internal combustion engines — Piston rings — Part 2: Inspection measuring principles*

ISO 6621-3, *Internal combustion engines — Piston rings — Part 3: Material specifications*

ISO 6621-4, *Internal combustion engines — Piston rings — Part 4: General specifications*

ISO 6626, *Internal combustion engines — Piston rings — Coil-spring-loaded oil control rings*

3 Symbols and abbreviated terms

For the purposes of this International Standard, the symbols and abbreviated terms in Table 1 apply.

Table 1 — Symbols and abbreviated terms

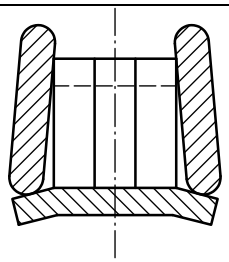
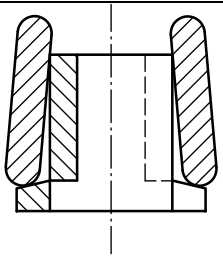
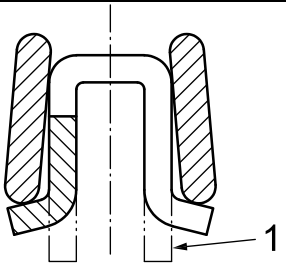
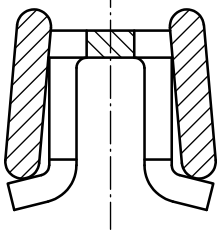
Symbol abbreviated terms	Description
a_1	Segment radial wall thickness
a_8	Spacer radial thickness
a_9	Expander radial thickness
a_{11}	Assembly radial thickness
a_{14}	Seating tab height
d_1	Nominal ring assembly diameter (nominal diameter)
h_1	Nominal assembly width

Table 1 (*continued*)

Symbol abbreviated terms	Description
h_{24}	Segment contact face width
h_9	Expander width
h_{10}	Segment width near inside diameter (ID), after coiling
h_{11}	Segment width near outside diameter (OD), after coiling and surface treatment or plating
h_{12}	Nominal segment width
h_{13}	Spacer width
p_o	Nominal contact pressure
p_{ou}	Unit contact pressure
s_1	Segment closed gap; stagger gap
F_t	Tangential force
F_{tc}	Specific tangential force
θ	Tab angle
CR1...CR2	Chromium-plating thickness
LM	Piston rings with partly cylindrical machined peripheral faced
LP	Piston rings with lapped stripe over the whole circumference
ES1...ES4	Types of expander/segment oil-control rings
PNH	High nominal pressure
PNL	Low nominal pressure
PNM	Medium nominal pressure
PNR	Reduced nominal pressure
PNV	Very high nominal pressure
TT00…TT30	Nominal seating tab angle
NS010…NS050	Nitrided surface (segment)
NX003…NX025	Nitrided surface (expander-spacer)

4 Ring types and designations

4.1 Types of expander/segment oil-control rings

ES1	
ES2	
ES3	
ES4	

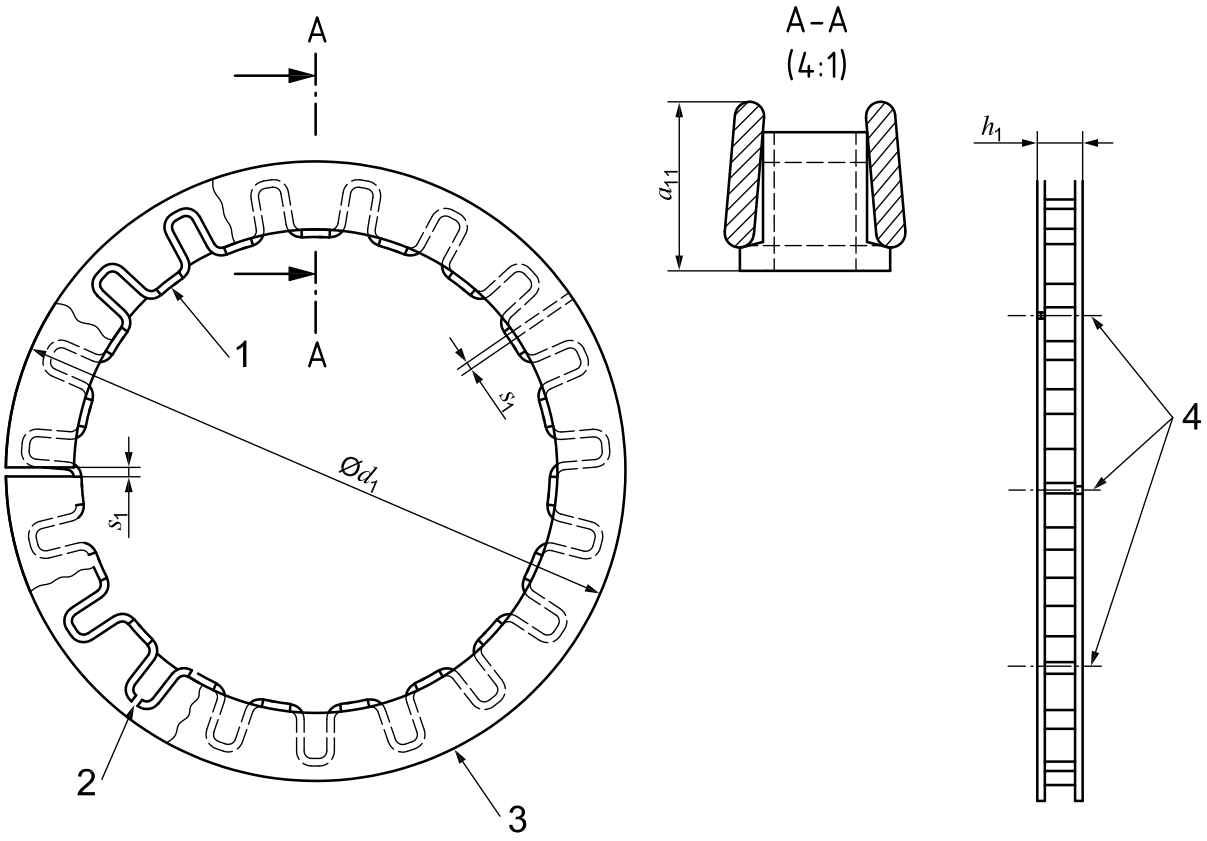
Key

1 centring pad (optional)

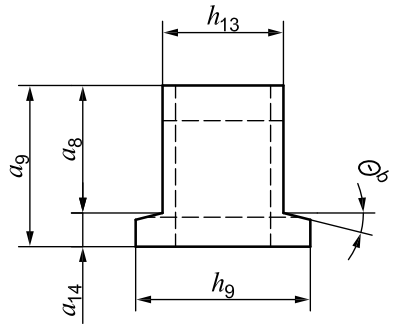
Figure 1 — Expander/segment oil-control ring designs

4.2 General features

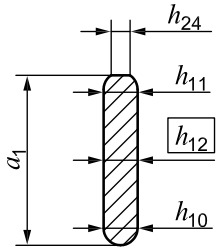
The expander/segment assembly shall be in accordance with Figure 2.



a) Assembly



b) Expander-spacer



c) Segment

Key

1 seating tab
2 expander-spacer ends
3 peripheral surface
4 stagger segments gaps and expander ends (all three components); stagger angle should be larger than 30°[a]

a For assembly arrangement regarding tangential force, see ISO 6621-2.

b Seating tab angle dimensions are defined in Table 3.

NOTE This is a schematic drawing of the four spring types shown in Figure 1.

Figure 2 — Expander/segment assembly

4.3 Designation examples

The following are examples of piston ring designations in accordance with this International Standard.

EXAMPLE 1 Expander/segment oil-control ring type ES1 (ES1) of nominal diameter d_1 = 90 mm (90) and nominal assembly width h_1 = 3 mm (3,0), with segments made of unalloyed steel subclass 68 (MC68), a chromium-plated peripheral surface of minimum thickness 0,05 mm (CR1), and with an expander made of 16 % Cr (min.) austenitic steel, of material subclass 67 (MC67) and tangential force, F_t, according to the medium nominal contact pressure class (PNM):

Piston ring ISO 6627 - ES1-90 × 3,0-MC68/CR1-MC67/PNM

EXAMPLE 2 Expander/segment oil-control ring type ES2 (ES2) of nominal diameter d_1 = 90 mm (90) and nominal assembly width h_1 = 2,5 mm (2,5), with segments made of 11 % Cr (min.) martensitic steel, subclass 65 (MC65), nitrided on the peripheral and inside surfaces (NS020) to a minimum depth of 0,020 mm on the peripheral surface, and with an expander made of 16 % Cr (min.) austenitic steel, of material subclass 67 (MC67), nitrided on the surface (NX), and tangential force, F_t, according to the reduced nominal contact pressure class (PNR):

Piston ring ISO 6627 - ES2-90 × 2,5-MC65/NS020-MC67/NXPNR

EXAMPLE 3 Expander/segment oil-control ring type ES3 (ES3) of nominal diameter d_1 = 90 mm (90) and nominal assembly width h_1 = 4,0 mm (4,0), with segments made of unalloyed steel subclass 68 (MC68), a chromium-plated peripheral surface of minimum thickness 0,05 mm (CR1) with lapped stripe (h24) of 0,30 mm, and with an expander made of 16 % Cr (min.) austenitic steel, of material subclass 67 (MC67) and tangential force, F_t, according to the high nominal contact pressure class (PNH):

Piston ring ISO 6627 - ES3-90 × 4,0-MC68/CR1-MC67/PNH

5 Common features

5.1 Expander-spacer

5.1.1 Design considerations

In order to optimize the fit of the oil ring assembly into the engine cylinder bore, the following should be considered in the design of the expander/segment oil-control rings:

— total circumferential deflection of the expander;

— piston groove depth;

— features on the lands adjacent to the oil ring groove;

— groove-corner radius.

5.1.2 Without surface treatment

The expander-spacer without surface treatment is typically used together with chromium-plated segments (see 5.2.1).

5.1.3 Nitrided surface (NX)

The expander-spacer with a nitrided surface is typically used together with nitrided segments (see 5.2.2).

Table 2 — Expander-spacer nitrided case

Dimensions in millimetres

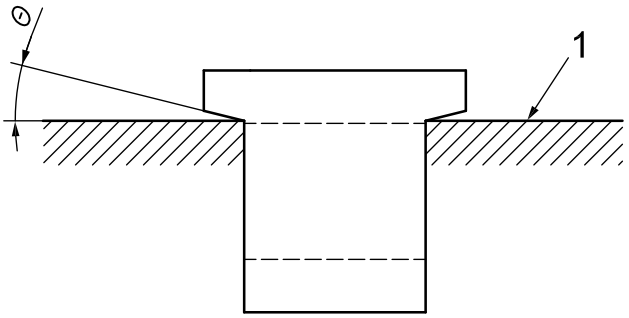
Code	Nitrided case depth	Tolerance
NX003	0,003	+ 0,012 0
NX010	0,010	
NX015	0,015	
NX020	0,020	
NX025	0,025	

NOTE 1 The tolerance for NX applies at the contact area between the segment internal diameter and the expander.

NOTE 2 For the definition of the nitrided case depth, see ISO 6621-2.

5.1.4 Seating tab angle

The expander-spacer is usually designed with the seating tabs at a slight angle. These results in side sealing between the segment and the side of the piston groove (see Figure 3). Table 3 presents the recommended tab angles.



Key

1 reference plane

Figure 3 — Expander-spacer seating tab angle

Table 3 — Seating tab angle θ

Values in degrees

Code	Nominal value	Tolerance
TT00	0	+ 5
TT05	5	± 5
TT10	10	
TT15	15	
TT20	20	
TT25	25	
TT30	30	

NOTE Code TT00 is only applicable for ES2 type expander.

5.1.5 Expander-spacer dimensions

No values are given for features a_8, a_9, a_{14}, h_9 and h_{13} (see Figure 2), as these dimensions depend on the expander-spacer design and shall be defined by the manufacturer.

5.2 Segment features

5.2.1 Chromium-plated peripheral surface

The common features of a chromium-plated segment are shown in Figure 4, with chromium-plating thickness given in Table 4.

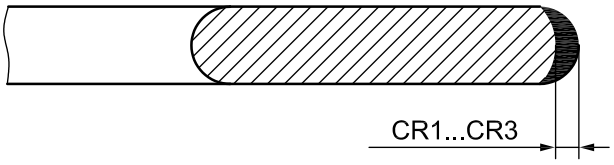


Figure 4 — Chromium-plated segment

Table 4 — Chromium-plating thickness

Dimensions in millimetres

Code	Thickness min.
CR1	0,05
CR2	0,10

5.2.2 Nitrided surface codes NS010 to NS050

The common features of a nitrided segment are shown in Figure 5. The nitriding case depth (NS010 to NS050) is specified according to its reference to the peripheral surface, inside surface or the sides of the segment (see Table 5).

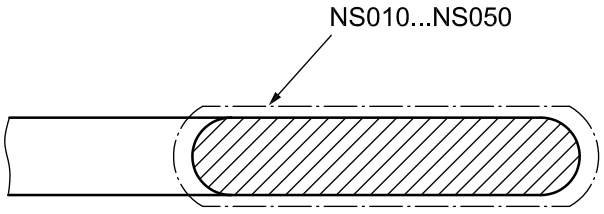


Figure 5 — Nitrided segment

Table 5 — Nitrided case depth

Dimensions in millimetres

Code	Nitrided case depth[a]		
	Peripheral surface min.	**Inside surface** min.	**Side faces**
NS010	0,010	0,005	nitrided surface permissible
NS020	0,020	0,005	
NS030	0,030	0,010	
NS050	0,050	0,020	

[a] For tolerances, see ISO 6621-4.

5.2.3 Segment dimensions

The nominal segment width (h_{12}) is defined as the width at the mid-point of the segment radial-wall thickness. The segment width defined near the internal diameter of the segment (h_{10}) and the outside diameter (h_{11}) is shown in Figure 6, while typical values are given in Table 7.

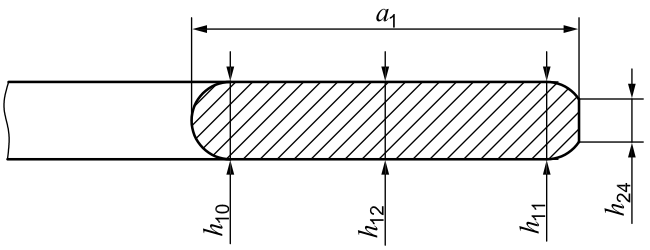


Figure 6 — Segment width

Table 6 — Typical ring width and segment width combinations

Dimensions in millimetres

h_1	h_{12}					
	0,30	0,35	0,40	0,45	0,50	0,60
1,5	x	x	x			
2,0		x	x	x		
2,5			x	x		
3,0			x	x	x	
3,5				x	x	x
4,0					x	x

Table 7 — Typical segment width and segment radial wall thickness combinations

Dimensions in millimetres

h_{12}	a_1								
	1,50	1,70	1,85	2,00	2,10	2,30	2,50	2,70	3,00
0,30	x	x	x	x					
0,35	x	x	x	x	x	x			
0,40	x	x	x	x	x	x			
0,45				x	x	x	x	x	x
0,50				x	x	x	x	x	x
0,60					x	x	x	x	x

Table 8 — Typical ring width and segment radial wall thickness combinations

Dimensions in millimetres

h_1	a_1								
	1,50	1,70	1,85	2,00	2,10	2,30	2,50	2,70	3,00
1,5	x	x	x	x					
2,0	x	x	x	x	x	x	x		
2,5	x	x	x	x	x	x	x		
3,0				x	x	x	x	x	x
3,5								x	x
4,0								x	x

Table 9 — Segment width due to processing

Dimensions in millimetres

h_{12}	Plated segment width max.			Nitrided segment width max.		
	h_{10}	h_{11}	h_{24}	h_{10}	h_{11}[a]	h_{24}
0.30	0.34	0.36	0.20	0.34	0.33	0.20
0.35	0.39	0.41	0.25	0.39	0.38	0.25
0.40	0.44	0.46	0.25	0.44	0.43	0.25
0.45	0.49	0.51	0.25	0.49	0.48	0.25
0.50	0.54	0.56	0.30	0.54	0.53	0.30
0.60	0.64	0.66	0.30	0.64	0.63	0.30

NOTE h_{24} is applicable only for segments with specified segment contact face width.

[a] Dimension h_{11} optional.

The radial wall thickness of the segment will vary in accordance with the expander-spacer design. Common ratios d_1/a_1 are between 45 and 20.

The common tolerance for the radial wall thickness (a_1) of the nitrided segments is ± 0,05 mm, and the chromium-plated segments CR1 and CR2, is ± 0,08 mm.

For lapped contact face, h_{24} shall be at least 0,05 mm.

5.3 Expander/segment assembly

The nominal expander/segment assembly width (h_1) is shown in Table 10 with the specific tangential force (F_{tc}).

The radial thickness of the selected assembly (a_{11}) depends on its design (expander and segments) and shall be defined by the manufacturer.

6 Dimensions

Table 10 — Dimensions of expander/segment oil-control rings

Dimensions in millimetres

Nominal diameter d_1	Segment width h_{12} (Column)						Segment closed gap s_1		Specific tangential force $F_{tc}[N]$ (ρou = 1 N/mm2) (Column)							Nominal assembly width h_1 (using available h_{12}) (Column)					
	1	2	3	4	5	6		Tolerance	1	2	3	4	5	6	Tolerance	1-2-3	2-3-4	3-4	3-4-5	4-5-6	5-6
40									12,00	14,00	16,00	18,00	20,00								
41									12,30	14,35	16,40	18,45	20,50								
42									12,60	14,70	16,80	18,90	21,00								
43									12,90	15,05	17,20	19,35	21,50								
44									13,20	15,40	17,60	19,80	22,00								
45									13,50	15,75	18,00	20,25	22,50								
46									13,80	16,10	18,40	20,70	23,00								
47									14,10	16,45	18,80	21,15	23,50								
48									14,40	16,80	19,20	21,60	24,00								
49									14,70	17,15	19,60	22,05	24,50		± 20 % if F_{tc} > 25 N ± 5 N if F_{tc} ≤ 25 N						
50	0,30	0,35	0,40	0,45	0,50	0,60	0,15	+0,50 0	15,00	17,50	20,00	22,50	25,00	—		1,5	2,0	2,5	—	—	—
51									15,30	17,85	20,40	22,95	25,50								
52									15,60	18,20	20,80	23,40	26,00								
53									15,90	18,55	21,20	23,85	26,50								
54									16,20	18,90	21,60	24,30	27,00								
55									16,50	19,25	22,00	24,75	27,50								
56									16,80	19,60	22,40	25,20	28,00								
57									17,10	19,95	22,80	25,65	28,50								
58									17,40	20,30	23,20	26,10	29,00								
59									17,70	20,65	23,60	26,55	29,50								

Table 10 (*continued*)

Dimensions in millimetres

Nominal diameter d_1	Segment width h_{12} (Column)						Segment closed gap s_1		Specific tangential force $F_{tc}[N]$ (ρou = 1 N/mm2) (Column)							Nominal assembly width h_1 (using available h_{12}) (Column)					
	1	2	3	4	5	6		Tolerance	1	2	3	4	5	6	Tolerance	1-2-3	2-3-4	3-4	3-4-5	4-5-6	5-6
60									18,00	21,00	24,00	27,00	30,00	36,00							
61									18,30	21,35	24,40	27,45	30,50	36,60							
62									18,60	21,70	24,80	27,90	31,00	37,20							
63									18,90	22,05	25,20	28,35	31,50	37,80							
64									19,20	22,40	25,60	28,80	32,00	38,40							
65									19,50	22,75	26,00	29,25	32,50	39,00							
66									19,80	23,10	26,40	29,70	33,00	39,60							
67							0,20		20,10	23,45	26,80	30,15	33,50	40,20							
68									20,40	23,80	27,20	30,60	34,00	40,80							
69									20,70	24,15	27,60	31,05	34,50	41,40							
70									21,00	24,50	28,00	31,50	35,00	42,00							
71									21,30	24,85	28,40	31,95	35,50	42,60							
72									21,60	25,20	28,80	32,40	36,00	43,20							
73									21,90	25,55	29,20	32,85	36,50	43,80							
74								+0,75 0	22,20	25,90	29,60	33,30	37,00	44,40							
75									22,50	26,25	30,00	33,75	37,50	45,00							
76									22,80	26,60	30,40	34,20	38,00	45,60							
77	0,30	0,35	0,40	0,45	0,50	0,60			23,10	26,95	30,80	34,65	38,50	46,20		1,5	2,0	2,5	3,0	3,5	4,0
78									23,40	27,30	31,20	35,10	39,00	46,80							
79									23,70	27,65	31,60	35,55	39,50	47,40							
80									24,00	28,00	32,00	36,00	40,00	48,00							
81									24,30	28,35	32,40	36,45	40,50	48,60							
82							0,25		24,60	28,70	32,80	36,90	41,00	49,20							
83									24,90	29,05	33,20	37,35	41,50	49,80							
84									25,20	29,40	33,60	37,80	42,00	50,40							
85									25,50	29,75	34,00	38,25	42,50	51,00							
86									25,80	30,10	34,40	38,70	43,00	51,60							
87									26,10	30,45	34,80	39,15	43,50	52,20							
88									26,40	30,80	35,20	39,60	44,00	52,80							
89									26,70	31,15	35,60	40,05	44,50	53,40							
90									27,00	31,50	36,00	40,50	45,00	54,00							
91										31,85	36,40	40,95	45,50	54,60	± 20 % if $F_{tc} > 25$ N ± 5 N if $F_{tc} \leq 25$ N						
92							0,30	+0,75 0	—	32,20	36,80	41,40	46,00	55,20							
93										32,55	37,20	41,85	46,50	55,80							
94										32,90	37,60	42,30	47,00	56,40							

Table 10 (*continued*)

Dimensions in millimetres

Nominal diameter d_1	Segment width h_{12} (Column)						Segment closed gap s_1		Specific tangential force $F_{tc}[N]$ (pou = 1 N/mm2) (Column)							Nominal assembly width h_1 (using available h_{12}) (Column)					
	1	2	3	4	5	6		Tolerance	1	2	3	4	5	6	Tolerance	1-2-3	2-3-4	3-4	3-4-5	4-5-6	5-6
95										33,25	38,00	42,75	47,50	57,00							
96										33,60	38,40	43,20	48,00	57,60							
97										33,95	38,80	43,65	48,50	58,20							
98										34,30	39,20	44,10	49,00	58,80							
99										34,65	39,60	44,55	49,50	59,40			2,0	2,5			
100										35,00	40,00	45,00	50,00	60,00							
101										35,35	40,40	45,45	50,50	60,60							
102										35,70	40,80	45,90	51,00	61,20							
103										36,05	41,20	46,35	51,50	61,80							
104										36,40	41,60	46,80	52,00	62,40							
105											42,00	47,25	52,50	63,00							
106											42,40	47,70	53,00	63,60							
107											42,80	48,15	53,50	64,20							
108											43,20	48,60	54,00	64,80							
109											43,60	49,05	54,50	65,40							
110	0,30	0,35	0,40	0,45	0,50	0,60		+0,75 0	—		44,00	49,50	55,00	66,00		—			3,0	3,5	4,0
111											44,40	49,95	55,50	66,60							
112											44,80	50,40	56,00	67,20							
113											45,20	50,85	56,50	67,80							
114											45,60	51,30	57,00	68,40							
115										—	46,00	51,75	57,50	69,00			—				
116											46,40	52,20	58,00	69,60							
117											46,80	52,65	58,50	70,20							
118							0,35				47,20	53,10	59,00	70,80							
119											47,60	53,55	59,50	71,40							
120											48,00	54,00	60,00	72,00							
121											48,40	54,45	60,50	72,60							
122											48,80	54,90	61,00	73,20							
123											49,20	55,35	61,50	73,80							
124											49,60	55,80	62,00	74,40							
125											50,00	56,25	62,50	75,00							

NOTE The specified F_{tc} values apply to oil ring assemblies which are evaluated with segments with mean radial wall thickness. Appropriate F_{tc} values for assemblies which are evaluated with segments of any radial wall thickness (within the specification) must be determined by manufacturer and client. In this case, careful consideration is to be given to the manufacturer's process capability in respect of expander load, expander deflection, and segment radial wall thickness.

7 Materials

7.1 Expander-spacer

The expander-spacer shall be made of steel, as specified in ISO 6621-3, either of subclass 67 or subclass 68, as agreed upon by the manufacturer and the client.

Nitrided expander-spacers shall be made of steel, as specified in ISO 6621-3, of subclass 67.

7.2 Segments

Chromium-plated segments shall be made of steel, as specified in ISO 6621-3, of subclass 68. Nitrided segments shall be made of steel, as specified in ISO 6621-3, of either subclass 65 or subclass 66.

8 Tangential force and nominal contact pressure

8.1 Tangential force

8.1.1 Tangential force, F_t

The tangential force, F_t, of an expander/segment oil-control ring is determined by the force produced by compressing the expander-spacer and the tangential force of the segments. It may be calculated using the formula:

$$F_t = ½\, d_1 \times 2h_{12} \times p_o$$

See Table 1 and Figure 2.

NOTE The portion of F_t attributable to the tangential force of the segments is negligible.

8.1.2 Specific tangential force, F_{tc}

F_{tc} is the specific tangential force required to maintain an expander/segment oil-control ring at a unit contact pressure of 1 N/mm2 (p_{ou}). It may be calculated using the formula:

$$F_{tc} = ½\, d_1 \times 2h_{12} \times p_{ou}$$

The specific tangential forces are given in Table 10.

8.1.3 Actual tangential force, F_t

The actual tangential force of an expander/segment oil-control ring can be calculated using the F_{tc} value and the required nominal contact pressure p_o taken from the equation:

$$F_t = \frac{p_o}{p_{ou}} \times F_{tc}$$

where $\frac{p_o}{p_{ou}}$ is the pressure multiplying factor (see Table 11).

8.2 Classes of nominal contact pressure

The tangential force (F_t) for selected unit pressures is calculated using the multiplying factors given in Table 11, which also gives the meanings of the pressure classes by category according to ISO 6626.

The nominal contact pressure p_o is defined as the required nominal contact pressure, assuming 100 % contact across the nominal segment-width (h_{12}).

Table 11 — Classes of nominal contact pressure

Pressure multiplying factor p_o/p_{ou}	Code	Meaning
1,5	PNV	very high
1,2	PNH	high
1,0	PNM	medium
0,8	PNR	reduced
0,6[a]	PNL	low

[a] Not recommended for $d_1 < 65$ mm.

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