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Internal combustion engines — Piston rings —

Part 5 :
Quality requirements

Moteurs à combustion interne — Segments de piston —

Partie 5 : Exigences de qualité

Reference number
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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6621-5 was prepared by Technical Committee ISO/TC 22, *Road vehicles.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Internal combustion engines — Piston rings —

Part 5 : Quality requirements

0 Introduction

ISO 6621 is one of a series of International Standards dealing with piston rings for reciprocating internal combustion engines :

ISO 6621, *Internal combustion engines — Piston rings —*

Part 1 : Vocabulary.

Part 2 : Measuring principles.

Part 3 : Material specifications.

Part 4 : General specifications.

Part 5 : Quality requirements.

ISO 6622, *Internal combustion engines — Piston rings —*

Part 1 : Rectangular rings.

Part 2 : Rectangular rings with narrow ring width. [1)]

ISO 6623, *Internal combustion engines — Piston rings — Scraper rings.*

ISO 6624, *Internal combustion engines — Piston rings —*

Part 1 : Keystone rings.

Part 2 : Half keystone rings. [1)]

ISO 6625, *Internal combustion engines — Piston rings — Oil control rings.*

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

The difficulty of trying to define in absolute terms the quality attainable in normal commercial manufacture of piston rings is well known. In this part of ISO 6621, 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 number are inadmissible.

1 Scope and field of application

This part of ISO 6621 specifies those quality aspects which are capable of definition but not normally found on a drawing specification.

It covers the following :

— single-piece piston rings of grey, carbidic, malleable, spheroidal graphite cast iron or steel;

— multi-piece piston rings (oil control rings) consisting of cast iron parts and spring components;

— single-piece and multi-piece 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 of the limits of acceptance relating to inspection measuring principles (covered by ISO 6621-2), this part of ISO 6621 also covers those features for which no recognized quantitative measurement procedures exist and which are only checked visually with normal eyesight (spectacles if worn normally) and without magnification. Such features (superficial defects) are additional to the standard tolerances of ring width, radial wall thickness and closed gap.

This part of ISO 6621 does not establish acceptable quality levels (AQL), it being left to manufacturer and purchaser to decide the appropriate levels jointly. In this case the recommendations of ISO 2859 should be followed.

The requirements of this part of ISO 6621 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) Part published as a Technical Report (ISO/TR 6622-2 and ISO/TR 6624-2).

2 References

ISO 2859, *Sampling procedures and tables for inspection by attributes.*

ISO 6621, *Internal combustion engines — Piston rings —*

Part 1 : Vocabulary.

Part 3 : Material specifications.

Part 4 : General specifications.

3 Terminology

The terminology used in this part of ISO 6621 is as given in ISO 6621-1.

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, burrs and cracks.

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.

4.3 Scratches, indentations, depressions and cracks

4.3.1 Scratches

Isolated scratches are permissible provided that

— no burrs are produced exceeding the permissible values given in 4.4.1.1;

— 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;

— on the side faces they are not deeper than 0,01 mm;

— on other surfaces they are not deeper than 0,06 mm.

4.3.2 Indentations, depressions

Indentations and depressions are permissible provided that

— the values given in table 1 for number and spacing of defects are met;

— no burrs are produced exceeding the permissible values given in 4.4.1.1;

— 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.

4.3.3 Cracks

No cracks are permissible.

See also 4.5.4 for chromium-plated peripheries.

Table 1 — Permissible values of size, number and spacing of pores, cavities and sand inclusions

Dimensions in millimetres

Nominal diameter d_1	Defect size max.				Number per ring max.	Spacing[3] min.
	on periphery[1]	on other surfaces[1]	on peripheral edges	on other edges[2]		
$30 \leqslant d_1 < 60$	0,1	0,3	0,1	0,1	2	4
$60 \leqslant d_1 < 100$	0,15	0,5	0,1	0,2	4	4
$100 \leqslant d_1 < 150$	0,2	0,5	0,1	0,3	6	8
$150 \leqslant d_1 \leqslant 200$	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.

Table 2 — Permissible size of indentations and depressions

Dimensions in millimetres

Nominal diameter d_1	Defect size max.		Depth max.
	on periphery	on side face	
$30 \leqslant d_1 < 100$	0,3	0,6	10 % of corresponding max. defect size surface
$100 \leqslant d_1 \leqslant 200$	0,5	1	

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 in millimetres

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 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 in millimetres

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 at 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, coated 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.)

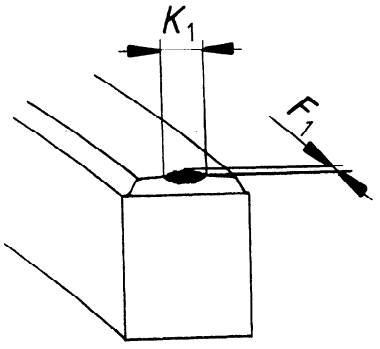

Figure 1 — Chipping on peripheral edges of the gap

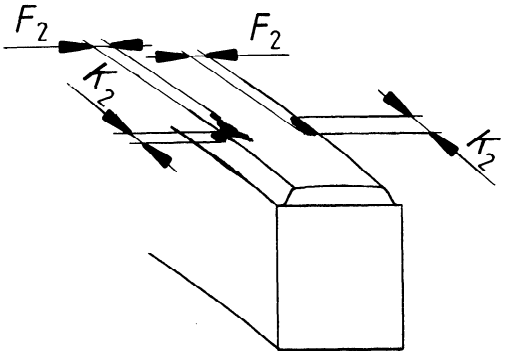

Figure 2 — Chipping on peripheral edges

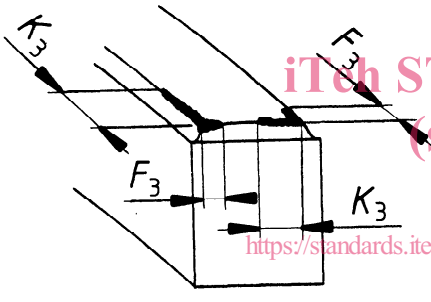

Figure 3 — Chipping on outside gap corners

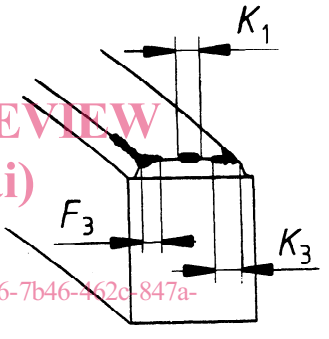

Figure 4 — Combination of figures 1 and 3

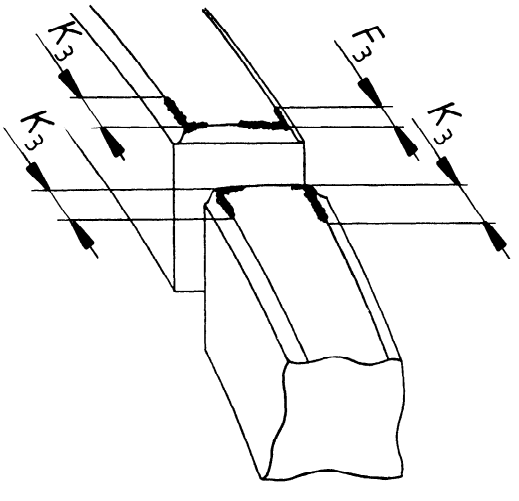

Figure 5 — Chipping on opposite gap corners

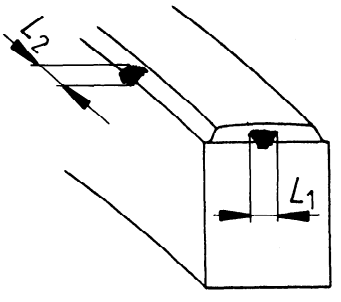

Figure 6 — Chipping on chamfers

4.4.2.2 In figures 1 to 6

K_1, K_2, K_3 are always the dimensions of the defect measured along the edge cut by the defect;

F_1, F_2, F_3 are always the dimensions of the defect measured normal to the edge cut by the defect.

However, when chipping or other defects occur on outside gap corners, i.e. when the defect crosses the intersecting edges of the peripheral edge and the peripheral edge of the gap, a convention is required.

The defect is taken as appropriate to the edge that contains the larger amount of the defect. For example in figure 3, most of the left side defect is on the peripheral edge and therefore the defect is appropriate to that edge. Hence the K value lies along the peripheral edge and is denoted K_3 while the F value, although it lies along the peripheral edge of the gap, is taken as the dimension measured normal to the peripheral edge and is denoted F_3.

In the case of the defect on the right side corner, most of the defect lies along the peripheral edge of the gap and the defect is therefore appropriate to this edge. The measurement K_3 in this case therefore is measured along the peripheral edge of the gap and F_3 is its dimension normal to the edge of the gap.

4.4.2.3 The limitations for chipping and similar defects on peripheral edges, peripheral edges of the gap and opposite gap corners are given in a) to c).

a) Peripheral edges :

Defects to be included in the assessment of the peripheral edge are all values of F_2 and K_2 as well as the F_3, K_3 values of outside gap corner defects if these are appropriate to the peripheral edges, e.g. the left hand defect illustrated in figure 3.

Maximum sizes are given in tables 5, 6 and 7 (peripheral edge column).

b) Peripheral edges of the gap :

Defects to be included in the assessment of the peripheral edges of the gap are all values of F_1 and K_1 as well as the F_3, K_3 values of outside gap corner defects if these are appropriate to the peripheral edges of the gap, e.g. the right hand defect illustrated in figure 3.

Maximum sizes are given in tables 5, 6 and 7 (peripheral edge of gap column).

However, an additional limitation is that the sum of the defect sizes measured in the axial direction, i.e. along the peripheral edge of the gap, shall not exceed the values given in tables 5, 6 and 7.

The defects to be added taken from the examples in figure 4 are K_3 (right hand corner) + K_1 + F_3 (left hand corner).

c) Opposite gap corners :

Defects at outside gap corners are accounted for in the assessments shown in a) and b) either as peripheral edge defects or as peripheral edge of the gap defects.

However an additional limitation is that the sum of the defects measured circumferentially on opposite corners shall not exceed the values given in tables 5, 6 and 7.

The defects to be added in figure 5 are the K_3 value of the left hand corner plus the K_3 value on the opposite corner and the F_3 value of the right hand corner plus the K_3 value of the opposite corner.

Table 5 — Permissible size of chipping and defects on uncoated rings on peripheral edges, peripheral edges of the gap and outside gap corners[1)]

Dimensions in millimetres

Ring width h_1	Land width h_4 or h_5	Defect in direction normal to periphery[2)]		Defect in direction along edge[2)]	
		on peripheral edge of gap F_1, F_3	on peripheral edge F_2, F_3	on peripheral edge of gap[3)] K_1, K_3	on peripheral edge K_2, K_3
$h_1 < 2$	—	0,2		0,5	
$2 \leqslant h_1 < 4$	—	0,2		0,6	
$4 \leqslant h_1 \leqslant 6$	—	0,3		0,8	
—	h_4, $h_5 < 0,5$	0,1		0,1	0,6
—	h_4, $h_5 \geqslant 0,5$	0,2		0,2	0,8

1) Number and spacing of defects to be in accordance with table 1.

2) See figures 1, 2, 3, 4 and 5.

3) Subject to a maximum of one-third of peripheral width of ring or land.

Table 6 — Permissible size of chipping and defects on coated rings with chromium-plated periphery, on peripheral edges, peripheral edges of the gap and outside gap corners[1)]

Dimensions in millimetres

Ring width h_1	Land width h_5	Defect in direction normal to periphery[2)]		Defect in direction along edge[2)]	
		on peripheral edge of gap F_1, F_3	on peripheral edge F_2, F_3	on peripheral edge of gap[3)] K_1, K_3	on peripheral edge K_2, K_3
$h_1 < 2$	—	0,2		0,3	
$2 \leqslant h_1 < 4$	—	0,2		0,4	
$4 \leqslant h_1 \leqslant 6$	—	0,3		0,4	
—	$h_5 < 0,5$	0,1	0,1	0,1	0,6
—	$h_5 \geqslant 0,5$	0,2	0,1	0,2	0,6

1) Number and spacing of defects to be in accordance with table 1.

2) See figures 1, 2, 3, 4 and 5.

3) Subject to a maximum of one-third of peripheral width of ring or land.

Table 7 — Permissible size of chipping and defects on spray-coated rings on peripheral edges, peripheral edges of the gap and outside gap corners[1)]

Dimensions in millimetres

Ring width h_1	Defect in direction normal to periphery[2)]		Defect in direction along edge[2)]	
	on peripheral edges of the gap F_1, F_3	on peripheral edges[3)] F_2, F_3	on peripheral edge of the gap[4)] K_1, K_3	on peripheral edge[3)] K_2, K_3
$h_1 < 2$	0,3		0,5	
$2 \leqslant h_1 < 4$	0,3		0,6	
$4 \leqslant h_1 \leqslant 6$	0,4		0,8	

1) Number and spacing of defects to be in accordance with table 1.

2) See figures 1, 2, 3, 4 and 5.

3) Only for fully faced and semi-inlaid design.

4) Subject to a maximum of one-third of peripheral width of ring or coating.

4.4.2.4 The limitations for chipping and similar defects on the chamfers at the peripheral edge and at the peripheral edge of the gap are as follows.

This type of defect is illustrated in figure 6 and is more likely to occur on chromium-plated chamfers (machined or un-machined), on machined chamfers on metal-sprayed rings (fully coated), and on machined chamfers on grey iron rings. The maximum values of the defects allowable are given in table 8 and are the same for all rings with chamfers on peripheral edge and peripheral edge of the gap.

Defects counted as on the chamfers shall not cut peripheral edges or peripheral edges of the gap but may just cut side faces or gap faces.

Table 8 — Permissible size of chipping and defects on chamfers at the peripheral edge and peripheral edge of the gap[1)]

Dimensions in millimetres

Ring width h_1	Size of defect L_1/L_2 max.
$h_1 < 2$	0,5
$2 \leqslant h_1 < 4$	0,8
$4 \leqslant h_1 \leqslant 6$	1,2

1) Number and spacing of defects to be in accordance with table 1.

4.4.3 Chipping and defects on inner edges and other edges

Chipping and defects on inner edges and other edges are permissible provided that

— no burrs are produced exceeding the values given in 4.4.1.1;

— they do not exceed the maximum established values given in table 1 for pores, cavities and sand inclusions.

4.4.4 Chipping and defects on inside gap corners

Chipping and defects on inside gap corners are permitted provided that

— no burrs are produced exceeding the values given in 4.4.1.1;

— the rings do not have an internal notch;

— they do not exceed 0,3 mm in the radial direction and 0,5 mm in the circumferential and axial directions for coil-spring-loaded oil control rings;

— they do not exceed the values given in table 9 for remaining ring designs.

4.5 Other characteristics subject to visual inspection only

4.5.1 Discolouring or staining of surface

Discolouring or staining spread evenly or unevenly over the ring surfaces is permissible : this does not include rust.

4.5.2 Casting skin and deposits on inside surface

The following defects are permitted :

— unmachined (NCU) areas within 5° of the gap ends;

— firmly adherent deposits arising from processing of the ring.

4.5.3 Chipping on uncoated surfaces

This is permissible provided the chip sizes do not exceed the maximum values established in table 1 for pores, cavities and sand inclusions.

4.5.4 Chromium-plated periphery

The chromium plating shall be fully coherent, i.e. there shall be no visible macro-cracks, pores, blisters, chromium beads (undercut bulge in the surface) or pin holes.

Exceptions with regard to pin holes may be agreed upon between manufacturer and purchaser.

4.5.5 Spray-coatings

Spray-coatings are not homogeneous. The acceptance conditions may be agreed between manufacturer and purchaser : otherwise manufacturer's specifications apply.

5 Material

5.1 Specifications

The basic material specifications are given in ISO 6621-3.

The detail specifications and acceptance conditions may be agreed between manufacturer and purchaser : otherwise the manufacturer's specifications apply.

5.2 Loss of tangential force under temperature effects

Some loss of tangential force at engine operating conditions is acceptable; for the purposes of establishing quality, test conditions and loss of tangential force with the ring closed to nominal diameter are given in table 10.

Table 9 — Permissible size of chipping and defects on inside gap corners

Dimensions in millimetres

Nominal diameter d_1	Size of defect measured		
	axially[1)]	radially[1)]	circumferentially
$30 \leqslant d_1 < 100$	0,6	0,8	1
$100 \leqslant d_1 \leqslant 200$	0,8	1	1,5

1) Subject to a maximum of one-third of the ring width or radial wall thickness.