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**Rotary shaft lip-type seals incorporating  
elastomeric sealing elements —**

Part 1:  
**Nominal dimensions and tolerances**

*Bagues d'étanchéité à lèvres pour arbres tournants incorporant des  
éléments d'étanchéité en élastomère —*

*Partie 1: Dimensions nominales et tolérances*



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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 6194-1 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 7, *Sealing devices*.

This second edition cancels and replaces the first edition (ISO 6194-1:1982), which has been technically revised.

ISO 6194 consists of the following parts, under the general title *Rotary shaft lip-type seals incorporating elastomeric sealing elements*:

- *Part 1: Nominal dimensions and tolerances*
- *Part 2: Vocabulary*
- *Part 3: Storage, handling and installation*
- *Part 4: Performance test procedures*
- *Part 5: Identification of visual imperfections*

## Introduction

Rotary shaft lip-type seals are used to retain fluid, e.g. lubricant, in equipment where the differential pressure is relatively low. Typically the shaft rotates, and the housing is stationary, although in some applications the shaft is stationary, and the housing rotates.

Dynamic sealing is normally the result of a designed interference-fit between the shaft and a flexible element incorporated in the seal.

Similarly, a designed interference-fit between the outside diameter of the seal, and the diameter of the housing bore, retains the seal and prevents static leakage.

Careful storage, handling, and proper installation of all seals are necessary to avoid hazards, both prior to and during installation, which would adversely affect service life.



# Rotary shaft lip-type seals incorporating elastomeric sealing elements —

## Part 1: Nominal dimensions and tolerances

### 1 Scope

This part of ISO 6194 describes seals utilising elastomeric sealing elements. They are considered suitable for use under low-pressure conditions (see 6.1).

This part of ISO 6194 shows seal types and examples. It also specifies the nominal dimensions and tolerances of the seals, shafts and housings, as well as a dimensional identification code.

NOTE ISO 6194 is complementary to ISO 16589 which covers seals incorporating thermoplastic sealing elements.

### 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 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6194-2, *Rotary shaft lip-type seals — Part 2: Vocabulary*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and ISO 6194-2 apply.

### 4 Symbols

The symbols used in this part of ISO 6194 are as follows:

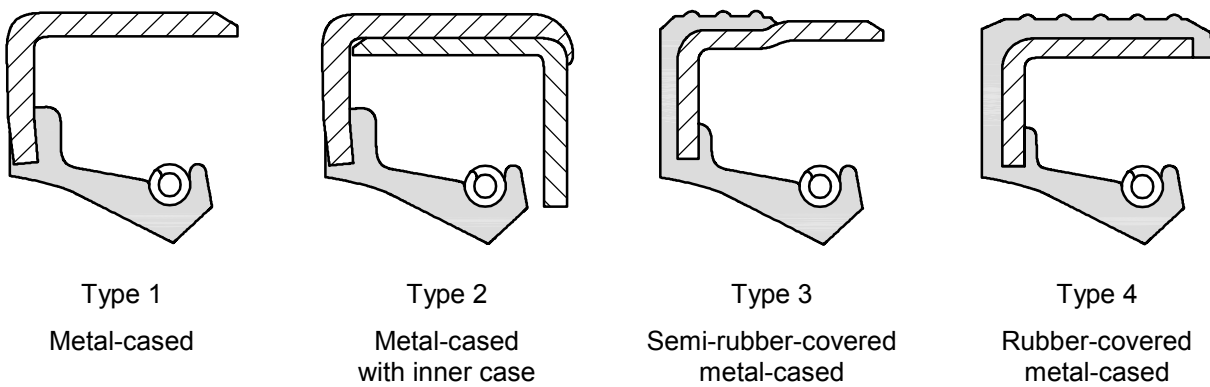
- a* housing-bore depth;
- d* nominal inside diameter of the inner case;
- b* nominal seal width;
- c* housing chamfer length;

- $D_1$  nominal diameter of the shaft to be used with the seal;
- $d_m$  minor diameter at the shaft lead-in chamfer;
- $D_2$  nominal diameter of the housing bore and outer diameter of the seal;
- $r$  housing corner radius.

## 5 Seal types and examples

### 5.1 Seal outside-diameter construction

The constructions shown in Figure 1 show four basic types.



NOTE Because of some variations in design details, or seals made by different manufacturers, the constructions shown are intended only to be representative of the basic types.

Figure 1 — Four basic types of outside-diameter construction

### 5.2 Sealing lip arrangements

Examples of sealing lip arrangements are shown in Figure 2.

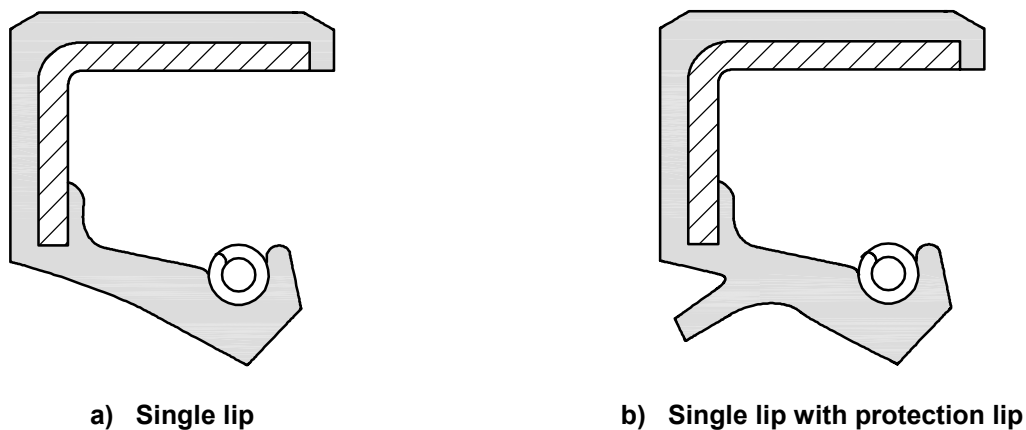


Figure 2 — Sealing lip arrangements



The sealing lip arrangements shown in Figure 2 can be used with each seal outside-diameter construction shown in Figure 1.

Hydrodynamic aids on the main lip may be incorporated by some manufacturers in certain applications.

The design of the sealing lip should be agreed between the manufacturer and purchaser.

NOTE In view of some variations in design detail, or seals made by different manufacturers, the constructions shown are intended only as representative examples of the basic types.

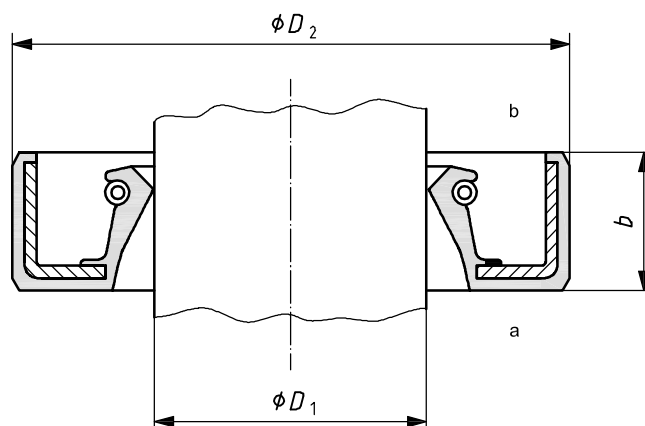
## 6 Pressure and nominal dimensions

### 6.1 Pressure

Seals of this type are normally used with atmospheric pressure on the air side, and sealing fluids at pressures from 0 kPa to 30 kPa (0,3 bar) above atmospheric pressure. The user should consult the seal manufacturer regarding use at other pressures.

### 6.2 Nominal dimensions

The nominal dimensions of the seals are shown in Figure 3 and given in Table 1.



#### Key

$D_1$  nominal diameter of the shaft to be used with the seal

$D_2$  nominal diameter of the housing bore and outer diameter of the seal

$b$  nominal seal width

a Air side.

b Fluid side.

Figure 3 — Seal

**Table 1 — Nominal dimensions**

Dimensions in millimetres

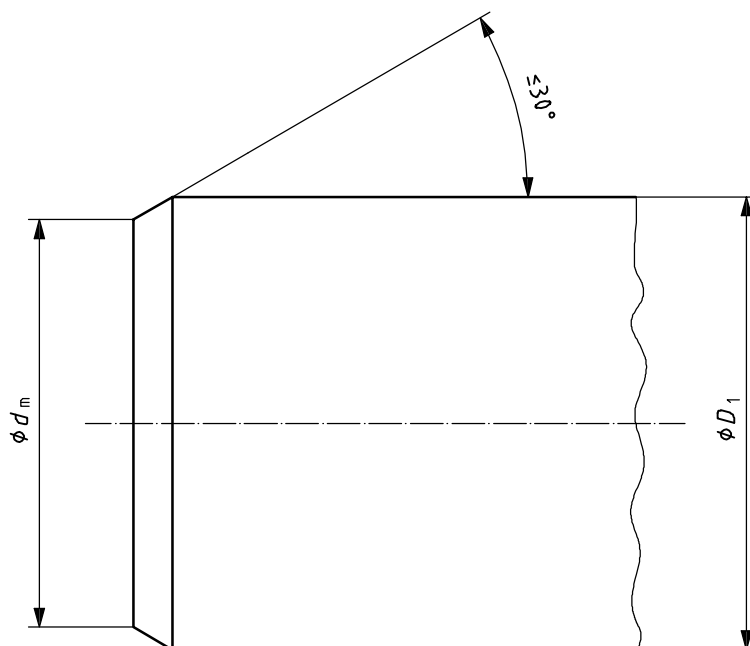
$D_1$	$D_2$	$b^a$	$D_1$	$D_2$	$b^a$	$D_1$	$D_2$	$b^a$	$D_1$	$D_2$	$b^a$
6	16	7	25	52	7	45	65	8	120	150	12
6	22	7	28	40	7	50	65	8	130	160	12
7	22	7	28	47	7	50	72	8	140	170	15
8	22	7	28	52	7	55	72	8	150	180	15
8	24	7	30	42	7	55	80	8	160	190	15
9	22	7	30	47	7	60	80	8	170	200	15
10	22	7	30	52	7	60	85	8	180	210	15
10	25	7	32	45	8	65	85	10	190	220	15
12	24	7	32	47	8	65	90	10	200	230	15
12	25	7	32	52	8	70	90	10	220	250	15
12	30	7	35	50	8	70	95	10	240	270	20
15	26	7	35	52	8	75	95	10	260	300	20
15	30	7	35	55	8	75	100	10	280	320	20
15	35	7	38	55	8	80	100	10	300	340	20
16	30	7	38	58	8	80	110	10	320	360	20
18	30	7	38	62	8	85	110	12	340	380	20
18	35	7	40	55	8	85	120	12	360	400	20
20	35	7	40	62	8	90	120	12	380	420	20
20	40	7	42	55	8	95	120	12	400	440	20
22	35	7	42	62	8	100	125	12	450	500	25
22	40	7	45	62	8	110	140	12	480	530	25
22	47	7									
25	40	7									
25	47	7									

<sup>a</sup>  $b$  may be increased to permit the use of more complex seal configurations.

## 7 Shafts

### 7.1 Shaft ends

The end of the shaft shall be provided with a lead-in chamfer as shown in Figure 4 and given in Table 2 and shall be free from burrs, sharp edges or rough machining marks.

**Key**

$d_m$  minor diameter at the shaft lead-in chamfer

$D_1$  nominal diameter of the shaft to be used with the seal

**Figure 4 — Shaft lead-in chamfer****Table 2 — Shaft lead-in chamfer**

Dimensions in millimetres

Shaft diameter		Shaft diameter	
$D_1$	$d_m$ max.	$D_1$	$d_m$ max.
$D_1 \leq 10$	$D_1 - 1,5$	$50 < D_1 \leq 70$	$D_1 - 4,0$
$10 < D_1 \leq 20$	$D_1 - 2,0$	$70 < D_1 \leq 95$	$D_1 - 4,5$
$20 < D_1 \leq 30$	$D_1 - 2,5$	$95 < D_1 \leq 130$	$D_1 - 5,5$
$30 < D_1 \leq 40$	$D_1 - 3,0$	$130 < D_1 \leq 240$	$D_1 - 7,0$
$40 < D_1 \leq 50$	$D_1 - 3,5$	$240 < D_1 \leq 480$	$D_1 - 11,0$

Assembly tools are specified in ISO 6194-3 and should be used to ensure that the sealing lip is not damaged.

If a radius is used instead of a lead-in chamfer, its value shall be between 1,8 mm and 3,0 mm.

**7.2 Diametral tolerance**

The shaft shall have a diametral tolerance not greater than h11 (see ISO 286-2).

## 7.3 Surface roughness and hardness

### 7.3.1 Surface roughness

The seal contact surface of a ground shaft shall be finished to a surface roughness, measured in the axial direction of between  $R_a$  0,2  $\mu\text{m}$  and  $R_a$  0,5  $\mu\text{m}$ , and between  $R_z$  1,2  $\mu\text{m}$  and  $R_z$  3,0  $\mu\text{m}$ .

Some surface finish processes will not provide roughness values that fall within the limits given in this part of ISO 6194. Surface roughness requirements shall be determined between the manufacturer of the surface and the seal supplier.

The seal contact surface shall normally be free of machining leads.

Ground and polished shafts may require other grades of surface texture, in which case they should be subject to agreement between the manufacturer and user.

Exceptional service conditions may necessitate the selection of other grades of surface texture, in which case they should be subject to agreement between the manufacturer and user.

### 7.3.2 Surface hardness

Unless otherwise agreed on between the manufacturer and user, the surface hardness of the shaft should be a minimum of 30 Rockwell C. If the shaft could be subject to damage during handling, this should be increased to 45 Rockwell C.

## 8 Housings

### 8.1 Dimensions

**8.1.1** Where the housing is a rigid fully machined ferrous part, the housing bore shall conform to 8.2 and 8.3.

**8.1.2** The housing bore shall be provided with a lead-in chamfer, free from burrs, as shown in Figure 5 and specified in Table 3.

**8.1.3** The housing-bore depth and corner radius shall be as shown in Figure 5 and specified in Table 3.

If the housing is not in accordance with 8.1.1 to 8.1.3 (e.g. non-ferrous or non-metallic material, pressing of ferrous or non-ferrous material), the dimensions, tolerances and lead-in configuration should be agreed between the purchaser and manufacturer.

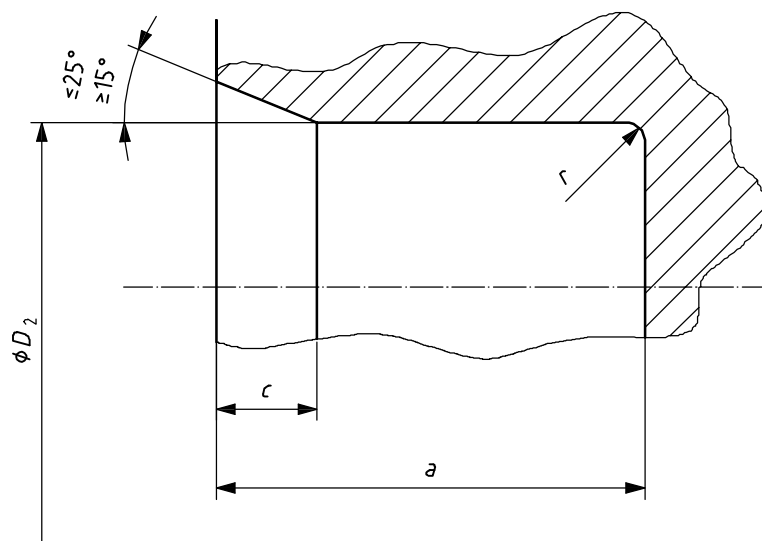


Figure 5 — Housing bore

Table 3 — Housing-bore dimensions

Dimensions in millimetres

Nominal seal width $b$	Minimum housing bore depth $a$	Chamfer length $c$	Maximum housing-bore corner radius $r$
$\leq 10$	$b + 1,2$	0,7 to 1	0,5
$> 10$	$b + 1,5$	1 to 1,3	0,75

## 8.2 Housing-bore tolerance

The housing bore shall have a diametral tolerance not greater than H8 (see ISO 286-2).

## 8.3 Housing-bore surface roughness

The surface roughness of the housing bore, measured in the axial direction, shall be between  $Ra$  1,6  $\mu\text{m}$  and  $Ra$  3,2  $\mu\text{m}$ , and between  $Rz$  6,3  $\mu\text{m}$  and  $Rz$  12,5  $\mu\text{m}$ .

No visible surface imperfections are allowed.

The housing-bore surface roughness may require lower values when metal cased seals are used, in which case they should be subject to agreement between the manufacturer and user.

## 9 Seal tolerances

### 9.1 Seal width

The recommended seal width tolerances are listed below in Table 4.

**Table 4 — Seal width tolerance**

Dimensions in millimetres

Nominal seal width <i>b</i>	Tolerance
$b \leq 10$	$\pm 0,3$
$10 < b \leq 14$	$\pm 0,4$
$14 < b \leq 18$	$\pm 0,5$
$18 < b \leq 25$	$\pm 0,6$

**9.2 Seal outside diameter**

To provide an interference-fit between the seal outside surface and the housing-bore surface, the recommended tolerances for the outside diameter of the seal shall be as shown in Table 5.

The seal outside diameter tolerances in Table 5 are to be used for ferrous housings only. If non-ferrous housing materials are used, the seal manufacturer shall be consulted. The seal manufacturer provides the proper recommendations regarding the interference fit between the seal and the non-ferrous housing.

NOTE Since the interference between the seal outside surface and the housing-bore surface is a characteristic related to the design of the seal, it may be necessary for agreement to be reached between the purchaser and manufacturer on the limits to be used. See Annex A for the recommended form.

**Table 5 — Seal outside-diameter tolerances**

Dimensions in millimetres unless otherwise specified

Nominal outside diameter <i>D</i> <sub>2</sub>	Diametral tolerance		Roundness tolerance <sup>a</sup>	
	Metal cased	Rubber covered <sup>b, c</sup>	Metal cased	Rubber covered
$D_2 \leq 50$	+ 0,20 + 0,08	+ 0,30 + 0,15	0,18	0,25
$50 < D_2 \leq 80$	+ 0,23 + 0,09	+ 0,35 + 0,20	0,25	0,35
$80 < D_2 \leq 120$	+ 0,25 + 0,10	+ 0,35 + 0,20	0,3	0,5
$120 < D_2 \leq 180$	+ 0,28 + 0,12	+ 0,45 + 0,25	0,4	0,65
$180 < D_2 \leq 300$	+ 0,35 + 0,15	+ 0,45 + 0,25	0,25 % of outside diameter	0,8
$300 < D_2 \leq 530$	+ 0,45 + 0,20	+ 0,55 + 0,30	0,25 % of outside diameter	1

- a The roundness tolerance is equal to the difference between the maximum diameter and the minimum diameter derived from three or more equally spaced measurements.
- b Rubber-covered and semi-rubber-covered seals having a wave-profile outside surface are acceptable but will require different tolerances, to be agreed upon between the manufacturer and purchaser.
- c Rubber-covered and semi-rubber-covered seals employing certain materials other than nitrile may require different tolerances, to be agreed upon between the manufacturer and purchaser.

## 10 Size identification code

The size identification code shall consist of the nominal dimensions of the shaft and housing, as given in Table 1.

Examples of the size identification code are given in Table 6.

**Table 6 — Examples of size identification code**

Dimensions in millimetres

$D_1$	$D_2$	<b>Size code</b>
6	16	006016
70	90	070090
400	440	400440

## 11 Identification statement (Reference to this part of ISO 6194)

Manufacturers are strongly recommended to use the following statement in test reports, catalogues and sales literature when electing to comply with this part of ISO 6194:

*“The nominal dimensions and tolerances of the seals, shafts and housings conform to ISO 6194-1, Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 1: Nominal dimensions and tolerances.”*

## **Annex A** (informative)

### **Seal specification**

**A.1** For the convenience of both the purchaser and manufacturer, it is recommended that the purchaser complete a form such as the one given in Table A.1, to supply the necessary information to the manufacturer to ensure the supply of a seal suitable for the application.

**A.2** It is also recommended that the manufacturer complete a form such as the one given in Table A.2, to supply the purchaser with the necessary information to ensure that the seal is in accordance with the equipment design and application requirements, to enable the purchaser to carry out inspection or quality control on the seals supplied by the manufacturer.



**Table A.1 — Purchaser's information**

Purchaser:	Reference:
Application:	Assembly drawing:

**1 Shaft information**

a) Diameter ( $D_1$ ) ..... mm max. .... mm min.

b) Material .....

c) Surface roughness  $Ra$  .....  $\mu\text{m}$        $Rz$  .....  $\mu\text{m}$

d) Type of finish .....

e) Hardness .....

f) Chamfer information .....

g) Rotation

1) Direction of rotation <sup>a</sup>

    — Clockwise .....

    — Anti-clockwise .....

    — Bi-rotational .....

2) Rotation speed .....  $\text{min}^{-1}$

3) Rotation cycles (Time on ..... Time off .....)

h) Other shaft motion (if applicable)

1) Axial reciprocation

    — Length of stroke ..... mm

    — Cycles per minute .....

    — Reciprocation cycles (Time on ..... Time off .....)

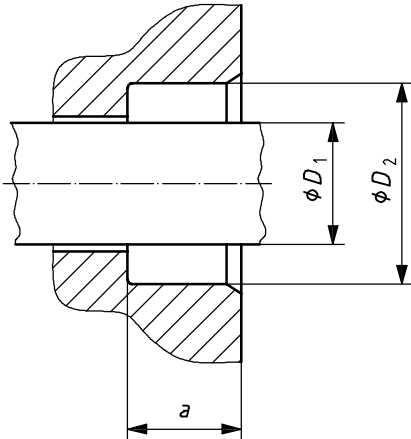
2) Circumferential oscillation

    — Magnitude of oscillation ..... Degrees

    — Cycles per minute .....

    — Oscillation cycles (Time on ..... Time off .....)

i) Additional information (i.e. splines, holes, keyways, shaft lead, etc.)



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**2 Housing information**

a) Bore diameter ( $D_2$ ) ..... mm max. .... mm min.

b) Bore depth ( $a$ ) ..... mm max. .... mm min.

c) Material .....

d) Surface roughness  $Ra$  .....  $\mu\text{m}$        $Rz$  .....  $\mu\text{m}$

e) Chamfer information .....

f) Housing rotation (if applicable)

1) Direction of rotation <sup>a</sup>

    — Clockwise .....

    — Anti-clockwise .....

    — Bi-rotational .....

2) Rotation speed .....  $\text{min}^{-1}$

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**3 Contained fluid information**

a) Type of fluid ..... Grades .....

b) Fluid temperature      Normal .....  $^{\circ}\text{C}$       Max. ....  $^{\circ}\text{C}$       Min. ....  $^{\circ}\text{C}$

c) Temperature cycles .....

d) Fluid level .....

e) Fluid pressure ..... kPa ..... bar

f) Pressure cycle .....

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**4 Alignment**

a) Housing-bore eccentricity ..... mm

b) Shaft runout (FIM) ..... mm

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**5 External conditions**

a) External pressure ..... kPa ..... bar

b) Materials to be excluded (i.e. dust, mud, water, etc.) .....

<sup>a</sup> Direction of rotation viewed from the air side.

Table A.2 — Manufacturer's information

---

Manufacturer: ..... Part No. ....

Issue No. .... Date .....

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Seal specification:

Type: ..... Nominal shaft diameter ( $D_1$ ): .....

Outside diameter ( $D_2$ ): ..... mm max ..... mm min.

Seal width ( $b$ ): ..... mm max ..... mm min.

Inner case diameter ( $d$ ): ..... mm max ..... mm min.

Sealing lip description (delete where not applicable):

Plain lip Lip incorporating hydrodynamic aids

Uni-directional RH/LH Bi-directional

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Sealing lip material .....

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Case specifications:

Outer case material ..... Inner case material .....

Outer case thickness ..... Inner case thickness .....

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Spring material.....

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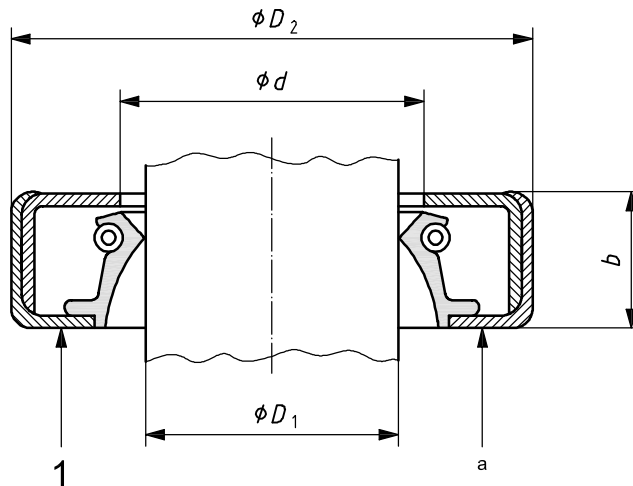
Optional information.....

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Test specification: .....

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Example drawing:



**Key**

- 1 preferred identification location
- $D_1$  nominal diameter of the shaft to be used with the seal
- $D_2$  nominal diameter of the housing bore and outer diameter of the seal
- $d$  nominal diameter of the inner case
- $b$  nominal seal width
- a Direction of rotation indicator viewed from air side.

## Bibliography

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- [6] ISO 6194-4, *Rotary shaft lip type seals — Part 4: Performance test procedures*
- [7] ISO 6194-5, *Rotary shaft lip type seals — Part 5: Identification of visual imperfections*
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- [11] ISO 16589-3:2001, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 3: Storage, handling and installation*
- [12] ISO 16589-4:2001, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 4: Performance test procedures*
- [13] ISO 16589-5:2001, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 5: Identification of visual imperfections*

