



**International
Standard**

ISO 7986

**Hydraulic fluid power — Sealing
devices — Standard test methods to
assess the performance of rod seals
used in oil hydraulic reciprocating
applications**

*Transmissions hydrauliques — Dispositifs d'étanchéité —
Méthodes d'essai normalisées d'évaluation des performances
des joints utilisés dans des applications alternatives à l'huile
hydraulique*

**Second edition
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ISO copyright office
CP 401 • CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 are 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 Electro-technical Commission (IEC) on all matters of electro-technical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document is drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document 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 7986:1997), which has been technically revised.

The main changes are as follows:

- change the reference documents for the surface roughness to the latest edition;
- change key names to be clear;
- change the minimum pressure at return stroke 3 MPa to 5 % of test pressure;
- add the cross-sectional view of [Figure 3](#).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 General

It is widely recognised that the results from reciprocating seal testing can be unpredictable. The background research carried out in support of the preparation of document has demonstrated that this unpredictability is primarily a function of lack of control of critical variables affecting seal installation and operation.

In order to carry out direct comparisons of seal performance, it is necessary to control these variables to closer limits than may be normal in industrial practice. The major variables that can affect seal performance, often even within normal manufacturing tolerance ranges, are listed in [Clause 3](#).

0.2 Purpose

The purpose of the test is to provide comparative data on individual reciprocating rod seal designs and to provide a basis for the preliminary selection of seals based upon their relative performance. To achieve this, it is necessary to carry out the tests under strictly defined operating conditions. This document, therefore, defines standard values of speed, pressure, temperature and surface finish. The resulting specified characteristics are applicable to be published in manufacturer's literature to enable a direct comparison of seal performance.

The seal test is applicable to a single seal or a combination seal package.

To make the test results as useful as possible, a range of operating conditions has been provided so that the most appropriate conditions can be selected as a basis for comparison for initial seal selection.

The pressures are standard working pressures, selected from ISO 2944:

- 6,3 MPa (63 bar);
- 16 MPa (160 bar);
- 31,5 MPa (315 bar).

The speeds have been selected to include slow speed (where stick-slip and high wear may be issues), medium speed for general purpose hydraulics and a representative high speed.

The constraints on installation and operation in this procedure have been proved by research, primarily carried out at BHR Group in the United Kingdom, under sponsorship from European companies and international round robin seal tests to be necessary to achieve repeatable results¹⁾. Any departure from the standard operating condition and installation criteria cannot be considered a standard test.

0.3 Factors affecting seal performance

a) Installation:

- sealing system, i.e. design of bearing(s), seal(s) and leakage collection seal;
- installation tolerances including seal groove, rod and bearings, extrusion gap;
- rod material and hardness;
- surface finish of the rod, variations of surface finish outside the range of Ra 0,08 μm to Ra 0,15 μm , or greater than Rz 1,2 μm or greater than Rt 1,5 μm , can significantly affect seal performance. Different seal materials also have significantly varying requirements for the optimum surface finish;

1) This research report is reported by the following.

- Performance Variation in Reciprocating Rubber Seals', R.K.Flitney and B.S. Nau, Lubrication Engineering, VR44, 12, 993-1000, December 1988.
- Factors affecting Reciprocating Seal Performance', R.K.Flitney, 10th International Conference on Fluid Power, BHR Group, April 1993.

- surface finish of the groove surfaces must be less than Ra 0,8 μm , or Rz 3,2 μm , to avoid static leakage and wear of the seal during pressure cycles;
- bearing material including its effects on rod texture and boundary layer;
- assembly cleanliness;

b) Operation:

- fluid, i.e. viscosity, lubricity, compatibility with seal material including additives and contamination level;
- pressure including pressure cycle;
- speed, especially speed cycle;
- speed/pressure cycle, i.e. stop-start conditions;
- stroke, especially short strokes ($2 \times$ the seal contact widths or less) which prevent formation of a lubricant film;
- temperature, i.e. its effect on viscosity and seal material properties;
- external environment.

It is necessary to consider all the above factors and their potential effect on seal performance when comparing potential seal performance in an actual application to results obtained from the standard test

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Hydraulic fluid power — Sealing devices — Standard test methods to assess the performance of rod seals used in oil hydraulic reciprocating applications

1 Scope

This document defines the test conditions and methods for assessing the performance of seals used in oil hydraulic reciprocating applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 683-2, *Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering*

ISO 1629, *Rubber and latices — Nomenclature*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ISO 21920-3, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 3: Specification operators*

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

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 10766, *Hydraulic fluid power — Cylinders — Housing dimensions for rectangular-section-cut bearing rings for pistons and rods*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 5598 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Letter symbols

Letter symbols used in this document are as follows:

Symbol	Quantity	Unit
d	rod diameter	mm
d_c	relative level of intersection (see ISO 21920-2, ISO 21920-3)	
d_h	seal heel inside diameter	mm
d_l	seal lip inside diameter	mm
D	bore diameter (outside diameter of the seal housing)	mm
E	seal length	mm
F	friction force	N
F_i	the inherent total friction at mid-stroke of the test rig only (see 8.2.2.1)	N
F_s	the mean mid-stroke value of forward stroke and return stroke friction forces of each seal under test	N
F_T	the sum of the friction at mid-stroke of the test rig for two test seals on the forward and return strokes	N
l	leakage	ml
L	seal housing length	mm
p_{return}	return pressure (return stroke)	MPa
p_{test}	test pressure (forward stroke)	MPa
Ra	rod surface texture, arithmetical mean deviation (Ra) (see ISO 21920-2 and ISO 21920-3)	μm
$R_{mr}(p, d_c)$	relative material ratio (Rmr) (see ISO 21920-2 and ISO 21920-3)	
Rt	rod surface texture, total height of the surface profile (Rt) (see ISO 21920-2 and ISO 21920-3)	μm
Rz	rod surface texture, maximum height of the surface profile (Rz) (see ISO 21920-2 and ISO 21920-3)	μm
S_h	radial seal section - heel	mm
S_l	radial seal section - lip	mm
v	test speed	m/s
W	leakage collection zone	mm

5 Test installation

5.1 General

5.1.1 A typical test seal, a single acting rod seal, is shown in [Figure 1](#). The tests described in this document shall be conducted using a suitable test rig possessing the features shown in [Figure 2](#).

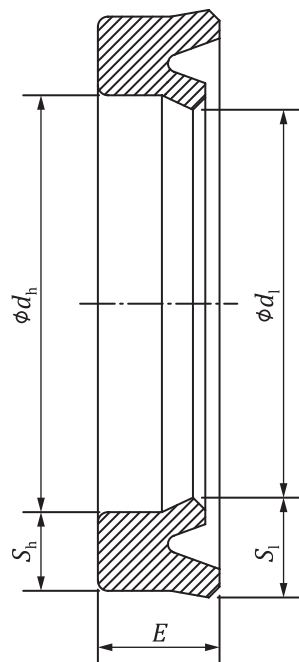


Figure 1 — Dimensions of typical test seal

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