INTERNATIONAL STANDARD

**ISO 10771-1**

Second edition
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# Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes —

## Part 1: Test method

*Transmissions hydrauliques — Essais de fatigue des enveloppes métalliques sous pression —*
*Partie 1: Méthode d'essai*



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# Foreword

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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 was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.



The committee responsible for this document is ISO/TC 131, *Fluid power systems*, Subcommittee SC 8, *Product testing*.



This second edition cancels and replaces the first edition (ISO 10771-1:2002), which has been technically revised.

ISO 10771 consists of the following parts, under the general title *Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes*:

— *Part 1: Test method*

— *Part 2: Rating methods* [Technical Report]

Annex A to Annex D form a normative part of this part of ISO 10771.

# Introduction

In hydraulic fluid power systems, power is transmitted and controlled under pressure within an enclosed circuit. It is important for the manufacturer and user of hydraulic components to have information on their global reliability because of the importance of the fatigue failure mode and the relationship this has with the functional safety and service life of such components. This part of ISO 10771 provides a method for fatigue testing the pressure-containing envelope provided by hydraulic components.

During operation, components in a system can be subjected to loads that arise from the following:

— internal pressure;

— external forces;

— inertia and gravitational effects;

— impact or shock;

— temperature changes or gradients.

The nature of these loads can vary from a single static application to continuously varying amplitudes, repetitive loadings, and even shocks. It is important to know how a component can withstand these loads, but this part of ISO 10771 addresses only the loading due to internal pressure.

There are many ways in which internal pressure loads are imposed upon a component. This part of ISO 10771 considers a broad range of waveforms within prescribed time limits, temperatures, and environmental conditions, and only upon metals. It is expected that these limitations could still provide sufficient common ground for a method of fatigue pressure testing metal pressure-containing envelopes in hydraulic fluid power components. This method, therefore, provides the system designer with certain information to assist in a selection of components for an application. The system designer still has the responsibility of considering the other loading characteristics described above and determining how they could affect the component's pressure-retaining capability.

# Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes —

# Part 1: Test method

## 1 Scope

This part of ISO 10771 specifies a method of fatigue testing the pressure-containing envelopes of components used in hydraulic fluid power systems under sustained steady cyclic internal pressure loads.

This part of ISO 10771 is only applicable to component pressure-containing envelopes that

— are manufactured from metals,

— are operated at temperatures that exclude creep and low-temperature embrittlement,

— are only subjected to pressure-induced stresses,

— are not subjected to loss of strength due to corrosion or other chemical action, and

— might include gaskets, seals, and other non-metallic components; however, these are not considered part of the pressure-containing envelope being tested (see 5.7).



This part of ISO 10771 does not apply to piping as defined in ISO 4413 (i.e. connectors, hose, tubing, pipe). See ISO 6803 and ISO 6605 for methods of fatigue testing of piping devices.



This part of ISO 10771 establishes a general test method that is applicable for many hydraulic fluid power components, but additional requirements or more specific methods that can be required for particular components are contained in the annexes or other standards.

Test pressure is to be determined by the user. See ISO/TR 10771-2 for a possible rating method.

## 2 Normative references

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

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

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

ISO 9110-1, *Hydraulic fluid power — Measurement techniques — Part 1: General measurement principles*

ISO 9110-2, *Hydraulic fluid power — Measurement techniques — Part 2: Measurement of average steady-state pressure in a closed conduit*

## 3 Terms and definitions

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

**3.1**
**upper cyclic test pressure**
$p_U$
minimum value of the highest level of the specified test pressure cycle

**3.2**
**lower cyclic test pressure**
$p_L$
maximum value of the lowest level of the specified test pressure cycle

**3.3**
**cyclic test pressure range**
$\Delta_p$
difference between the upper and lower cyclic test pressures during a fatigue test

**3.4**
**pressure-containing envelope**
elements of a component that contain the pressurized hydraulic fluid and the means to secure the elements (bolts, welds, etc.)

Note 1 to entry: Gaskets and seals are not considered as part of the pressure-containing envelope.

Note 2 to entry: See annexes for component definitions.

## 4 Test conditions



**4.1** Remove entrapped air from the test component and circuit before starting each test.

**4.2** The temperature of the hydraulic fluid in the component shall be in the range of 15 °C to 80 °C. The temperature of the component shall be a minimum of 15 °C.



## 5 Test equipment and preparation

**5.1** The test equipment and circuit shall be able to generate and repeat the pressure cycle as specified in 7.1.

**5.2** Pressure transducer(s) shall be mounted directly into the test component, or as near as possible, so as to record the internal conditions applied to the component. Any restrictions between the transducers and the pressure-containing envelope being tested should be avoided.

**5.3** Any non-corrosive hydraulic fluid that has a kinematic viscosity not greater than 60 $mm^2/s$ at the test temperature shall be used as the pressurizing medium.

**5.4** Different pressures shall be applied to separate portions of the test components as dictated by design specifications.

**5.5** It shall be verified that the ratio of induced stress to pressure, under static loading conditions, is also attained at the test cycling rate, especially when

— pressures have to penetrate between close-fitting parts,

— large components are tested, and

— hysteresis in joints can significantly affect stresses.

Strain gauges can be used to verify this ratio and, if used, should be located externally in an area of high strain.

**5.6** It is permissible to make modifications to the test samples to facilitate cyclic or burst tests, provided that such modifications do not increase the pressure capabilities of the pressure-containing envelope.

**5.7** It is permissible to replace gaskets and seals that fail during the test, as long as preloads in stressed elements are the same after reassembly as they were before disassembly. It is possible that fastener preloads can decrease during fatigue testing. Fastener preloads should be set to this reduced level when seals or gaskets are replaced.

**5.8** Safety procedures shall be followed in order to protect personnel and test equipment during the test as specified in ISO 4413.

## 6 Accuracy

**6.1** Instrumentation shall be accurate to within the following limits:

— pressure: ± 1,0 % of the upper cyclic test pressure;

— strain: ± 1 % of the value obtained at the upper cyclic test pressure;

— time: ± 0,002 s resolution;

— temperature: ± 2 °C.

**6.2** Use pressure transducers, amplifiers, and recording devices with a combined system frequency response such that in the frequency range 0 kHz to 2 kHz, the amplitude ratio is within 0 dB and −3 dB.



**6.3** Instruments and procedures shall conform to ISO 9110-1 and ISO 9110-2.



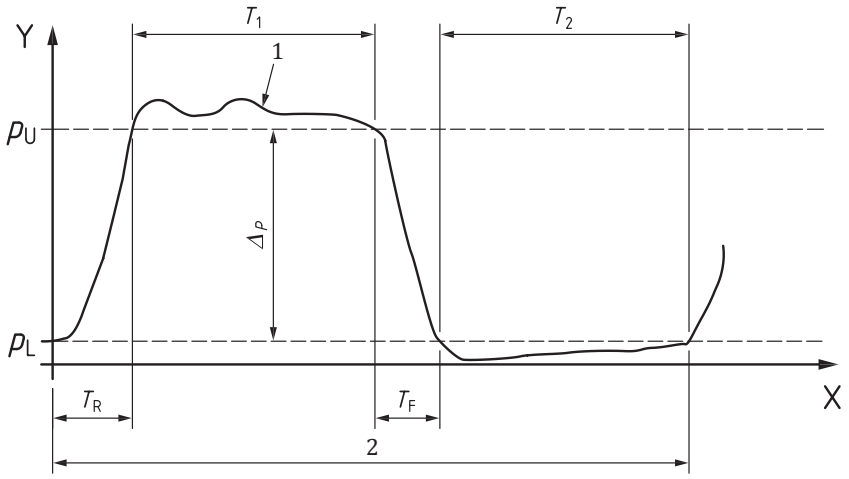
## 7 Test procedure

### 7.1 Cyclic pressure test

#### 7.1.1 Test pressure waveform

The test pressure waveform shall achieve the upper and lower levels for the time periods as specified in 7.1.2. The wave form is not specified and may be of any shape.

NOTE For the purposes of illustration only, a typical test pressure waveform is shown in Figure 1.




**Key**

1 actual test pressure

2 test period = $T = 1/\text{test frequency} = 1/f = T_R + T_1 + T_F + T_2$

X time

Y pressure

**Figure 1 — Test pressure waveform**



### 7.1.2 Pressure test cycle

a) Upper cyclic test pressure ($p_U$)



The actual test pressure shall equal, or exceed, the upper cyclic test pressure for a time period $T_1$ equal to or greater than $0{,}3T$.

b) Time period of pressure rise ($T_R$)

The actual test pressure shall rise to the upper cyclic test pressure within the time period $T_R$ so that

$$0{,}4T \leq \left(T_R + T_1\right) \leq 0{,}6T$$

c) Lower cyclic test pressure ($p_L$)

The lower cyclic test pressure shall not exceed 5 % of the upper cyclic test pressure unless specified otherwise in the annexes. The actual test pressure shall not exceed the lower cyclic test pressure in the time period in the cycle $T_2$, where $T_2$ is given by

$$0{,}9T_1 \leq T_2 \leq 1{,}1T_1$$

### 7.1.3 Number of test cycles

Select the number of test cycles required in the range of $10^5$ to $10^7$.

### 7.1.4 Test frequency and time period, $T_1$

Cycle the test pressure at the selected frequency of: $f = 1/T$.

The fatigue life of hydraulic components depends upon the time period, $T_1$, of the pressure variations at a given pressure amplitude. Consequently, the results of the test on a component at a given time

period cannot be used to predict the number of cycles that the component will successfully withstand at a different period. For a given test pressure, frequencies ($f$) of ≤ 3 Hz or time periods of $T_1$ ≥ 100 ms are to be used unless there is satisfactory experience of testing at a higher frequency. Such experience should be stated in the test report.

### 7.2 General

**7.2.1** Inspect all of the test components, using non-destructive methods, in order to verify conformity to the manufacturing specification.

**7.2.2** If required, place metal balls or other loosely-fitting pieces within the test components in order to reduce the volume of pressurized fluid, ensuring that any such pieces do not prevent the correct pressure from reaching all test areas and do not affect the fatigue life of the components (e.g. by shot peening the surfaces).

**7.2.3** When a hydraulic fluid power component has internal chambers that are designed for different pressure capabilities, the fatigue of the mechanical features forming the separation between these chambers shall also be tested as if it were part of the pressure-containing envelope (see component Annexes A, B, C and D).

## 8 Failure criteria



The following are criteria for failure:

— external leakage of any amount caused by fatigue (subject to the requirements of 5.5);

— internal leakage of any amount caused by fatigue (subject to the requirements of 5.5);



— material separation (e.g. cracks).