BRITISH STANDARD

BS 7268:1990

Method for

Determination of fatigue pressure rating of metal pressure containing envelopes in hydraulic fluid power systems

UDC 62-522.2:621.3.016.2:669.1.2/.8:620.173:620.178.3

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Machinery and Components Standards Policy Committee (MCE/-) to Technical Committee MCE/18, upon which the following bodies were represented:

Advanced Manufacturing Technology Research Institute
Association of British Mining Equipment Companies
Bath University Library
British Compressed Air Society
British Fluid Power Association
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The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Railways Board
Society of Motor Manufacturers and Traders Ltd.

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Amendments issued since publication

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Contents

Foreword

This British Standard has been prepared under the direction of the Machinery and Components Standards Policy Committee.

The method of test described in this British Standard is the result of research carried out by the British Hydraulics Research Association and member companies of the British Fluid Power Association during which it became apparent that pressure cycle rate has a pronounced effect on the fatigue life of hydraulic fluid power components. It has also shown that sufficient time is required to be given for the pressurizing fluid to flow into and out of fatigue cracks that may develop during the test.

Since a basic requirement of hydraulic fluid power components is that they shall be capable of safely and efficiently operating and containing the working fluid at the necessary pressures, this test method provides a rational and practical method of determining the ability of series produced metal pressure containing components to withstand the required internal working pressures. To this end it provides a method for establishing the component's fatigue pressure rating. The standard is not intended to cover components manufactured in small quantities.

It is intended that further details of exceptions and variations to the general method of test described in section 1 of the standard will be added by amendment action to cover requirements for hydraulic accumulators. BS 7201-1 covers the production testing of seamless steel hydro-pneumatic accumulator bodies.

Ratings established in accordance with this standard do not replace pressure ratings based on considerations such as performance, bearing capacity, leakage and heat rejection. The ratings are intended to supplement those provided by present practice and may be numerically different from prior ratings.

Pressure rating standards, based on structural integrity already existing for hose and non-metallic components such as seals and accumulator bladders which are subject to failure mechanisms that are different from those of metals, are not covered by this test method.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This British Standard describes a method of establishing ratings for the fatigue strength of pressure containing envelopes of components used in hydraulic fluid power systems under sustained cyclic and steady internal pressure loads. It applies to all hydraulic fluid power components.

Exceptions and variations to the general method of test described in section 1 are detailed in subsequent sections 2 to 5, as follows.

Section 2	Hydraulic filter housings
Section 3	Hydraulic directional control valves
Section 4	Hydraulic pumps and motors
Section 5	Hydraulic cylinders

Exceptions and variations relating to hydraulic accumulators are not detailed (see foreword).

In this standard it is assumed that the component pressure containing envelopes will:

a) be manufactured from ferrous or non-ferrous metals;

b) be subject to pressure induced stresses;

c) not be subject to loss of strength due to corrosion or other chemical action;

d) not be subject to significant loss of strength over a temperature range of – 30 °C to 100 °C.

NOTE The title of the publication referred to in this standard is given on the inside back cover.

1.2 Definitions

For the purposes of this British Standard the following definitions apply.

1.2.1
fatigue pressure rating

the specified cyclic pressure range at which a specified number of components have been tested to a specified number of cycles at a specified cycling rate

1.2.2
pressure cycle

the pressure wave form which is continuously repeated to test the component and defines the outline commencing from cyclic lower pressure rising by the specified cyclic pressure range, maintains pressure and then decays to the cyclic lower pressure to the point where the cycle is ready to repeat (see Figure 1)

1.3 Test conditions

1.3.1 All entrapped air shall be bled from the test component and circuit before starting each test.

1.3.2 The temperature of the test fluid (**1.4.2**) shall be maintained at 60 ± 10 °C.

1.3.3 Different pressures shall be applied to separate portions of the test component, as dictated by design specifications.

1.3.4 All leakage drain ports of the test component shall be open to atmosphere during pressure cycling.

1.3.5 All test components shall be typical production units.

1.3.6 All components shall have been subjected to normal production acceptance tests only, prior to fatigue evaluation. No other tests shall have been applied.

1.3.7 At least three components shall be subjected to this test.

1.3.8 The cyclic pressure range for the test shall be that specified by the manufacturer.

1.4 Test equipment

1.4.1 The test equipment and circuit shall be capable of generating and repeating the pressure cycle shown in Figure 1 within the following limits:

a) test pressure shall exceed the cyclic upper pressure for at least 30 % of the cycle time, and shall be below the cyclic lower pressure for at least 30 % of the cycle time;

b) the cyclic lower pressure shall not exceed 10 % of the cyclic pressure range and shall be not greater than 16 bar[1)].

1.4.2 Any suitable non-corrosive fluid, having a maximum viscosity of 60 centistokes[2)] at the test temperature, shall be used as the pressurizing medium.

1.4.3 Pressure measuring transducers shall be mounted directly into the test component, or as near as possible so as to record the pressure applied to the component.

1.5 Accuracy

1.5.1 Instrumentation used shall be capable of measuring the following systematic reading errors:

Pressure range:	± 2.5 %
Time:	± 0.002 second resolution
Temperature:	± 2 °C.

[1)] 1 bar = 10^5 N/m^2 = 100 kPa.
[2)] 1 cSt = 1 mm^2/s.

1.5.2 Measuring equipment shall be calibrated before the test. Additional calibration shall be made if experience shows this to be necessary.

1.6 Test procedure

1.6.1 If necessary, place ball bearings or other loosely fitting metal pieces within the test component to reduce the volume of pressurized fluid, providing that any such pieces do not prevent pressure of the correct magnitude from reaching areas to be tested.

1.6.2 Replace gaskets, seals and other expendable items which fail during test providing that re-assembly of the unit does not increase fatigue life. Record all such replacements.

1.6.3 Cycle the pressure at any rate up to 3 Hz that permits stable operation in the pressure range specified in **1.4.1**. Ensure that the dynamic stresses induced in all parts of the component under cyclic test pressure are equivalent to those encountered under static pressure conditions.

1.6.4 Maintain the pressure cycle, as indicated in **1.4.1** throughout the test.

1.6.5 Providing that failure does not occur earlier, continue the test for 10^6 cycles, unless otherwise specified by the manufacturer.

1.7 Criteria for determination of fatigue pressure rating

1.7.1 Structural fracture of any test component shall be considered a failure.

1.7.2 Any crack produced by metal fatigue due to pressure cycling, as verified by normal crack detection techniques, shall be considered a failure.

1.8 Presentation of test results

The fatigue pressure rating of the component shall be declared by stating:

a) the number of units tested;

b) the number of pressure cycles, if other than 10^6;

c) the cyclic pressure range, in bars;

d) the number of this British Standard;

e) other relevant details (see **4.4**).

An example of such a declaration is as follows:

"Fatigue pressure rating: 5 at 2×10^6 at 315 bar in accordance with BS 7268",

indicating that five units have been tested at less than 3 Hz without failure for 2×10^6 cycles over a cyclic pressure range of 315 bar.

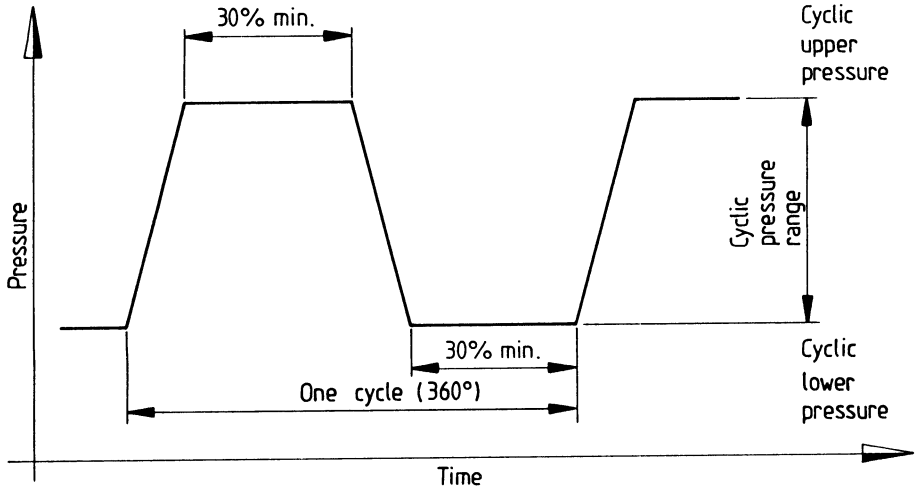

Figure 1 — Pressure cycle (see **1.4.1**)

Section 2. Hydraulic filter housings

2.1 General

The requirements specified in section 1 shall apply, subject to the variation given in **2.2**.

2.2 Test conditions

The pressure cycling rate specified in **1.6.3** shall not exceed 1.5 Hz.

Section 3. Hydraulic directional control valves (excluding cartridge valves)

3.1 General

The requirements specified in section 1 shall apply, subject to the variations given in **3.2** and **3.3**.

3.2 Test equipment

The test equipment and circuit specified in **1.4.1** shall include facilities to enable the tests specified in **3.3** to be carried out.

3.3 Test procedure

3.3.1 General test procedure

Carry out, on valves taken at random from production units and mounted by normal fixing means provided, the tests described in **3.3.2** and **3.3.3**.

3.3.2 Pressure vessel test

Subject the whole of the interior chamber of the unit (with the exception of drain lines) to simultaneous pressure cycles.

3.3.3 Diaphragm strength test

Subject the internal sections between the service ports (A and B) and the pressure and return ports (P and T respectively) to pressure cycles which are 180° out of phase with each other.

Section 4. Hydraulic pumps and motors

4.1 General

The requirements specified in section 1 shall apply, subject to the variations given in **4.2** to **4.5**.

4.2 Test conditions

The temperature of the test fluid (**1.4.2**) shall be maintained at 60 ± 20 °C.

4.3 Test equipment

The test equipment and circuit specified in **1.4.1** shall include facilities to enable the tests specified in **4.4** to be carried out.

4.4 Test procedure

4.4.1 General test procedure

Carry out, as appropriate, one or more of the tests described in **4.4.2**, **4.4.3** and **4.4.4**.

4.4.2 Unidirectional operation without reverse pressurization

Where the pump/motor is intended for unidirectional operation without reverse pressurization, apply cyclic pressure to the high pressure port. Maintain both the low pressure port and drain ports at, or below, the cyclic lower pressure.

Run the pump/motor within its normal operating range and in its normal direction of rotation throughout the test.

If under certain circumstances it is necessary to conduct this test with the pump/motor held stationary, state such a condition.

4.4.3 Bidirectional operation or reverse pressurization (ports never simultaneously pressurized)

Where the pump/motor is intended for bidirectional or reverse operation and where the inlet and outlet ports can never be simultaneously pressurized, apply cyclic pressure alternately to the inlet and outlet ports (A and B).

Maintain the cyclic upper pressure for a minimum of 10 % of a cycle at both stages in the sequence. Simultaneously maintain the unpressurized port at or below the cyclic lower pressure.

Maintain the drain ports at or below the cyclic lower pressure at all times.

Run the pump/motor within its normal operating range and in its normal direction(s) of rotation throughout the test.

If under certain circumstances it is necessary to conduct this test with the pump/motor held stationary, state such a condition.

4.4.4 Bidirectional operation or reverse pressurization (ports simultaneously pressurized)

Where the pump/motor is intended for bidirectional or reverse operation and where the inlet and outlet ports can be simultaneously pressurized apply pressure pulses to the inlet and outlet ports “A” and “B” in the following sequence:

a) port A;

b) ports A + B;

c) port B;

d) ports A + B.

Maintain the cyclic upper pressure for a minimum of 10 % of a cycle at each stage in the sequence. At stages a) and c) simultaneously maintain the unpressurized port at or below the cyclic lower pressure.

Maintain the drain ports at or below the cyclic lower pressure at all times. Run the pump/motor within its normal operating range and in its normal direction(s) of rotation at all times during the test.

If under certain circumstances it is necessary to conduct this test with the pump/motor held stationary, state such a condition.

4.5 Presentation of results

The declaration specified in **1.8**, shall also state which test has been carried out (i.e. **4.4.2**, **4.4.3** or **4.4.4**).

A unit completing test **4.4.3** shall be assumed to have also fulfilled the requirements of test **4.4.2**. A unit completing test **4.4.4** shall be assumed to have also fulfilled the requirements of tests **4.4.2** and **4.4.3**.

NOTE Fatigue pressure ratings may, if desired, be established for more than one test condition and declared accordingly.

Section 5. Hydraulic cylinders

5.1 General

Section 1 relates to the pressure containing envelope only. Most fatigue failures in hydraulic cylinders occur at the mounting connections or associated parts. Even when there is a failure at the pressure containing envelope, this can be caused due to stresses transferred from a mounting face. It would therefore be most misleading to give a pressure fatigue rating based on the pressure containing envelope for a catalogue range of cylinders covering differing mounting styles, stroke lengths and applications.

Some of the factors that have to be taken into account when testing hydraulic cylinders to determine their fatigue pressure rating are as follows:

a) *Mounting style and method of mounting.* Most hydraulic cylinders can be considered as a structural element in a machine frame. Therefore the method of mounting, the stiffness of the machine frame, tightness of the mounting bolts, side loading on the rod, etc., all affect the fatigue rating.

b) *Stroke length.* The stroke of the cylinder and the position of the piston within the cylinder affect the stress and range of stresses in the tie rods of a tie rod constructed cylinder.

c) *Pressure intensification.* The actual pressure within a hydraulic cylinder can be many times higher than the pump pressure, due to the load on the cylinder, inertia loads, cushioning, rod to full bore area ratios, circuitory details and transient pressures.

5.2 Test requirements

If a realistic fatigue rating is required for a hydraulic cylinder it shall be tested in accordance with section 1 on a test rig which simulates the stiffness, inertia loads, etc., of the actual design and application of the cylinder.

Publication referred to

BS 7201, *Hydro-pneumatic accumulators for fluid power purposes*[3)].
BS 7201-1, *Specification for seamless steel accumulator bodies above 0.5 L water capacity*.

[3)] Referred to in the foreword only.

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