
**Methods of test for full-flow
lubricating oil filters for internal
combustion engines —**

**Part 5:
Test for cold start simulation and
hydraulic pulse durability**

*Méthodes d'essai des filtres à huile de lubrification à passage intégral
pour moteurs à combustion interne —*

*Partie 5: Essai pour simulation de démarrage à froid et de résistance
aux impulsions hydrauliques*





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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.

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. www.iso.org/directives

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The committee responsible for this document is ISO/TC 70, *Internal combustion engines*, Subcommittee SC 7, *Tests for lubricating oil filters*.

This second edition cancels and replaces the first edition (ISO 4548-5:1990), of which it constitutes a minor revision.

ISO 4548 consists of the following parts, under the general title *Methods of test for full-flow lubricating oil filters for internal combustion engines*:

- *Part 1: Differential pressure/flow characteristics*
- *Part 2: Element by-pass valve characteristics*
- *Part 3: Resistance to high differential pressure and to elevated temperature*
- *Part 4: Initial particle retention efficiency, life and cumulative efficiency (gravimetric method)*
- *Part 5: Test for cold start simulation and hydraulic pulse durability*
- *Part 6: Static burst pressure test*
- *Part 7: Vibration fatigue test*
- *Part 9: Inlet and outlet anti-drain valve tests*
- *Part 12: Filtration efficiency using particle counting, and contamination retention capacity*

The following parts are under preparation:

- *Part 13: Static burst pressure test for composite filter housings*
- *Part 14: Cold start simulation and hydraulic pulse durability for composite filter housings*
- *Part 15: Vibration fatigue test for composite filter housings*

Introduction

ISO 4548 (all parts) establishes standard test procedures for measuring the performance of full-flow lubricating oil filters for internal combustion engines. The series has been prepared in separate parts, each part relating to a particular performance characteristic.

Together the tests provide the information necessary to assess the characteristics of a filter, but if agreed between the purchaser and the manufacturer, the tests can be conducted separately.

Methods of test for full-flow lubricating oil filters for internal combustion engines —

Part 5:

Test for cold start simulation and hydraulic pulse durability

1 Scope

This part of ISO 4548 specifies a method of testing the ability of full-flow lubricating oil filters for internal combustion engines to withstand an internal pressure surge such as occurs when an engine is started from cold, and cyclic internal pressure variations experienced during operation.

These tests are intended for application to spin-on type filters and detachable filters with disposable elements with a maximum flow rate of 100 l/min.

The tests can be applied to other filters, if thought applicable, by agreement between the filter manufacturer and the purchaser.

NOTE This test is not intended to replace simulated environmental testing (e.g. at very low temperatures). If such testing is required, it will be the subject of negotiation between the supplier and customer.

2 Normative references

The following documents, in whole or in part, are normative 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 1219, *Fluid power systems and components — Graphic symbols*

ISO 4548-1, *Methods of test for full-flow lubricating oil filters for internal combustion engines — Part 1: Differential pressure/flow characteristics*

3 Terms and definitions and graphical symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4548-1 apply.

3.2 Graphical symbols

For the purposes of this document, the graphical symbols given in ISO 1219 apply.

4 Operational characteristics to be tested

Filters are subjected in service to pressure fluctuations caused by engine cold starting conditions. The test specified in [Clause 8](#) verifies the ability of the filter canister and seal to withstand these high pressure fluctuations for a given number of start conditions.

Filters are also subjected to cyclic pressure variations during normal operation. The test given in [Clause 9](#) verifies the ability of the filter canister and seal to withstand these pressures for a given number of cycles.

5 Test rig

The test rig shall comprise the following components, together with the necessary tubing, connectors and supports (see [Figure 1](#)):

- a) oil reservoir;
- b) pump assembly;
- c) filter to be tested;
- d) inlet pressure control valve;
- e) solenoid valves;
- f) outlet pressure control valve;
- g) pressure gauge;
- h) solenoid sequence timer and counter;
- i) cooling coils (heat exchanger);
- j) thermostat (to operate the cut-out switch).

An alternative test rig, which produces the pressure pulse waveforms shown in [Figure 2](#), may be used.

6 Test liquid

The test liquid shall be oil with a kinematic viscosity of $10 \text{ mm}^2/\text{s} \pm 5 \text{ mm}^2/\text{s}$ ($10 \text{ cSt} \pm 5 \text{ cSt}$) throughout the test (viscosity class ISO VG 22 at $63 \text{ }^\circ\text{C}$ or SAE 5W at $68 \text{ }^\circ\text{C}$ ^{[1][5]}).

7 Accuracy

7.1 The measuring instruments shall be capable of measuring to the levels of accuracy given in [Table 1](#). The last column in the table gives the limits within which the test conditions shall be maintained.

Table 1 — Instrument accuracy and test condition variation

Test condition	Unit	Measurement accuracy	Permissible test condition variation
Pressure	Pa	$\pm 5 \%$	–
Time	S	$\pm 0,002 \text{ s}$	–
Temperature	C	$\pm 1^\circ\text{C}$	$\pm 2 \text{ }^\circ\text{C}$

7.2 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 to –3 dB.

7.3 Pressure transducer(s) shall be mounted directly into the test component, or as nearly 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.

7.4 Instruments and procedures should conform to ISO 9110-1^[2] and ISO 9110-2^[3]

8 Cold start simulation test (see [Figure 1](#))

8.1 Fit the filter on an appropriate adaptor and apply the filter manufacturer's recommended tightening torque or angle of rotation for the filter to be tested.

8.2 Connect the test adaptor to the pipe work system of the test rig.

8.3 Start the pump, ensuring that regulating valves 4 and 7 and solenoid valves 5 and 6 are fully open.

8.4 Allow the rig to run until all air has been purged from the system. Close solenoid valves 5 and 6 and adjust valve 4 until the pressure agreed with the customer is obtained. In the absence of such an agreement, one of the values given in [Annex A](#) shall be used.

Switch on solenoid valves 5 and 6 to obtain a pressure waveform as indicated in [Figure 2](#).

Valve 7 shall be adjusted to give a pressure differential of 10 kPa to 20 kPa to avoid negative pulses of outlet pressure. Any further adjustments during the test should be made as necessary during periods when solenoid valves 5 and 6 are closed.

An oscilloscope or an alternative device shall be provided to monitor the pressure waveform and cycle times.

8.5 Set the counter to zero.

8.6 Open the inlet and return valves of the water cooling system and adjust the water flow to regulate the reservoir oil temperature to maintain the required viscosity (see [Clause 6](#)).

8.7 Allow the test to continue, making visual checks for signs of failure at frequent intervals, until failure occurs or until the number of cycles agreed with the engine manufacturer has been applied. In the absence of such an agreement, the value given in [Annex A](#) for the test pressure chosen shall be used.

8.8 To stop the test, fully open valve 4 and switch off the pump and the solenoid valve control switch.

8.9 Check and record the tightening torque (i.e. turn in the tightening direction).

8.10 Remove the filter, allow to drain, and visually examine the unit to determine the failure point and type of failure, if any.

9 Hydraulic pulse durability test (see [Figure 1](#))

9.1 Fit a new filter on an appropriate adaptor and apply the filter manufacturer's recommended tightening torque or angle of rotation for the filter to be tested.

9.2 Connect the test adaptor to the pipe work system of the pulse test rig.

9.3 Start the pump, ensuring that regulating valves 4 and 7 and solenoid valves 5 and 6 are fully open.

9.4 Allow the rig to run until all air has been purged from the system. Close solenoid valves 5 and 6 and adjust valve 4 until the pressure agreed with the customer is obtained. In the absence of such an agreement, the value given in [Annex A](#) for the appropriate category shall be used.

Switch on solenoid valves 5 and 6 to obtain a pressure waveform as indicated in [Figure 2](#).

Valve 7 shall be adjusted to give a pressure differential of 10 kPa to 20 kPa to avoid negative pulses of outlet pressure. Any further adjustments during the test should be made as necessary during periods

when solenoid valves 5 and 6 are open or closed. An oscilloscope or an alternative device shall be provided to monitor the pressure waveform and cycle times.

9.5 Set the counter to zero.

9.6 Open the inlet and return valves of the water cooling system and adjust the water flow to regulate the reservoir oil temperature to maintain the required viscosity (see [Clause 6](#)).

9.7 Allow the test to continue, making visual checks for signs of failure at frequent intervals, until failure occurs or until the number of cycles agreed with the engine manufacturer has been applied. In the absence of such an agreement, the value given in [Annex A](#) for the appropriate category shall be used.

9.8 To stop the test, fully open valves 4 and 7 and switch off the pump and the solenoid valve control switch.

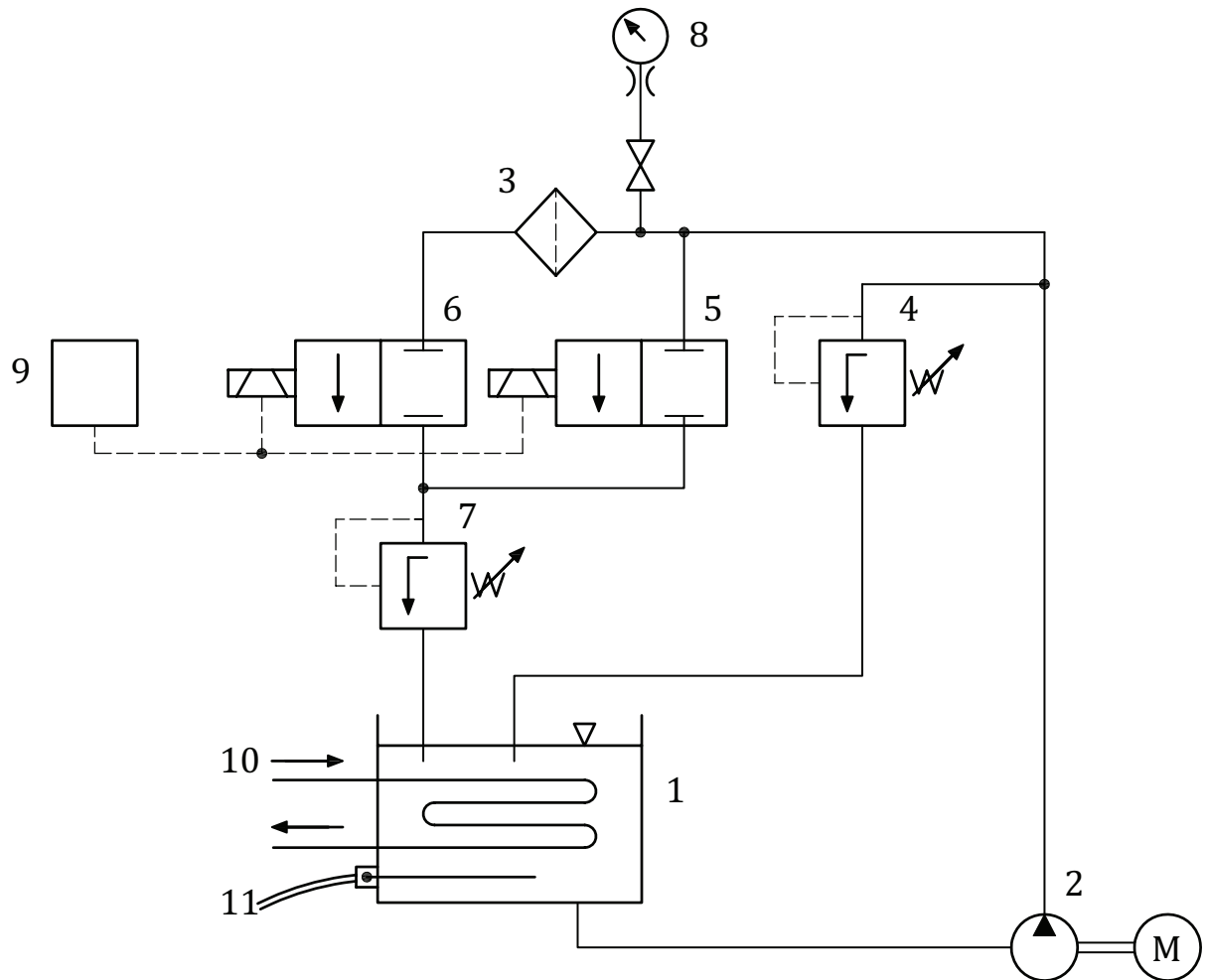
9.9 Check and record the tightening torque (i.e. turn in the tightening direction).

9.10 Remove the filter; allow to drain, and visually examine the unit, after dismantling if necessary, to determine the failure point and type of failure, if any.

10 Test report

The test report shall include at least the following:

- a) the name of the test establishment;
- b) the filter type (manufacturer, model number and batch number);
- c) the date of the test;
- d) a description of the filter and whether it is new or used; if it is used, the approximate period of service;
- e) the category of filter (see [Annex A](#));
- f) the rated flow, in litres per minute;
- g) the test pressure, in kilopascals (see [8.4](#) and [9.4](#));
- h) the test cycle rate, in hertz. (see [8.4](#) and [9.4](#));
- i) the test fluid;
- j) the test temperature;
- k) the mode of failure and its location;
- l) the torque applied initially and at the end of the test, in newton metres (see [8.1](#) and [8.9](#), [9.1](#) and [9.9](#));
- m) the number of cycles to failure or the number of cycles completed (see [8.7](#) and [9.7](#)).

**Key**

- | | | | |
|---|------------------------------|----|--|
| 1 | oil reservoir | 7 | outlet pressure control valve |
| 2 | pump assembly | 8 | pressure gauge |
| 3 | filter to be tested | 9 | solenoid sequence timer and counter valves for key items 5 and 6 |
| 4 | inlet pressure control valve | 10 | cooling coils (heat exchanger) |
| 5 | solenoid valve | 11 | thermostat (to operate the cut-out switch) |
| 6 | solenoid valve | | |

Figure 1 — Test rig for cold start simulation and hydraulic pulse test

Annex A (normative)

Values to be used for tests if no agreement is reached with the manufacturer

[Table A.1](#) gives the pressure and number of cycles to be used in the cold start simulation test and the hydraulic pulse durability test for the chosen category of filter.

Table A.1 — Pressure and number of cycles to be used for tests

Filter type	Category	Cold start simulation test		Hydraulic pulse durability test	
		Pressure kPa	Number of cycles	Pressure kPa	Number of cycles
Spin-on (light duty)	A	1 000 ± 30	1 000	500 ± 20	25 000
Spin-on (heavy duty)	B	1 300 ± 30	3 000	700 ± 20	50 000
Detachable with disposable element	C	1 600 ± 50	5 000	900 ± 30	75 000

Bibliography

- [1] ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*
- [2] ISO 9110-1, *Hydraulic fluid power — Measurement techniques — Part 1: General measurement principles*
- [3] ISO 9110-2, *Hydraulic fluid power — Measurement techniques — Part 2: Measurement of average steady-state pressure in a closed conduit*
- [4] ISO 10771-1, *Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes — Part 1: Test method*
- [5] SAE J300c, *Engine oil viscosity classification*

