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Aerospace series — Hydraulic filter elements — Test methods —

Part 2: Conditioning

Série aérospatiale — Eléments filtrants hydrauliques — Méthode d'essais —

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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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

ISO 14085 consists of the following parts, under the general title *Aerospace series — Hydraulic filter elements — Test methods*:

— *Part 1: Test sequence*

— *Part 2: Conditioning*

— *Part 3: Filtration efficiency and retention capacity*

— *Part 4: Verification of collapse/burst pressure rating*

— *Part 5: Resistance to flow fatigue*

— *Part 6: Initial cleanliness level*

Introduction

In aerospace hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure. The liquid is both a lubricant and power-transmitting medium. The presence of solid contaminant particles in the liquid interferes with the ability of the hydraulic fluid to lubricate and causes wear and malfunction of the components. The extent of contamination in the fluid has a direct bearing on the performance, reliability, and safety of the system, and needs to be controlled to levels that are considered appropriate for the system concerned.

Different principles are used to control the contamination level of the fluid by removing solid contaminant particles; one of them uses a filter element enclosed in a filter housing. The filter element is the porous device that performs the actual process of filtration. The complete assembly is designated as a filter.

Filter elements are designed to withstand a range of thermal stresses, such as low and high temperature extremes, and system demands at low temperature (cold starts) whereby hydraulic fluid passes through the element at a greatly increased viscosity. These thermal stresses test both the chemical and thermal stability of the filter element. These cold starts test the ability of the filter element to withstand the high differential pressures and potential weakness at low temperatures without subsequent loss of integrity or performance.

These stresses will be encountered within the lifetime of any filter element fitted in an aerospace hydraulic system. It is, therefore, necessary to check that having been subjected to such conditions; the filter element continues to provide adequate filtration, while also maintaining structural integrity.

This part of ISO 14085 provides a procedure by which to introduce such thermal stresses and to condition a filter element prior to any subsequent qualification testing. This enables the purchaser of the filter element to be secure in the knowledge that the product will withstand such thermal stresses in addition to other qualification requirements without failure.

Aerospace series — Hydraulic filter elements — Test methods —

Part 2: Conditioning

1 Scope

This part of ISO 14085 specifies

— a procedure to thermally condition a hydraulic filter element to presumed aerospace hydraulic system stresses,

— a test procedure to complete cold soaks, hot soaks, and temperature variation in a combined manner, and

— a test procedure to simulate cold starts.

This part of ISO 14085 is not intended to qualify a filter element under replicate conditions of service; this can only be done by a specific test protocol developed for the purpose, including actual conditions of use, for example the operating fluid or contamination.

This part of ISO 14085 is intended to provide a test procedure that yields reproducible thermal test conditioning of a hydraulic filter element, for simulation of the thermal stresses typically encountered in an aerospace hydraulic system.

The conditioning test procedures defined in this part of ISO 14085 are intended to be used prior to performance tests as specified in other parts of this International Standard.

The tests data resulting from application of this part of ISO 14085 can be used to compare the performance of aerospace hydraulic filter elements.

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 1219-1, *Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications*

ISO 2942, *Hydraulic fluid power — Filter elements — Verification of fabrication integrity and determination of the first bubble point*

ISO 4021, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*

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

3 Terms and definitions

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

3.1
cold soak
prolonged immersion of a filter element in stationary fluid at the lowest expected system fluid temperature

3.2
cold start
application of a rapid increase in flow and *differential pressure* (3.3), followed by a brief maintaining of the *differential pressure* (3.3), with cold fluid at a high viscosity

3.3
differential pressure
Δp
difference between the inlet and outlet pressures of the component under test, as measured under specified conditions

3.4
fabrication integrity
physical acceptability of a filter element to meet the specification designated by the filter supplier

3.5
hot soak
prolonged immersion of a filter element in stationary fluid at the highest expected system fluid temperature

3.6
material safety data sheet
MSDS
specification sheet defining physical aspects, characteristics, and health and safety data for a substance

4 Symbols

The graphical symbols used in this part of ISO 14085 are in accordance with ISO 1219-1.

5 Test equipment and materials

5.1 Hot and cold soak test fluid, shall be the same as the system operating fluid, or shall be another compatible fluid agreed upon between the supplier and purchaser.

5.2 Cold start test fluid, may be the same as the cold soak test fluid, but an alternative may also be selected with a higher cold temperature viscosity, if agreed upon between the supplier and purchaser.

Using a higher viscosity can reduce the volume of fluid required to conduct the cold start test because a lower flow is required to achieve the required differential pressure. If an alternative fluid is chosen, it shall be fully compatible with the filter element and all materials to which it is exposed.

5.3 Differential pressure transducer shall be

a) positioned such that the upstream and downstream connections conform to ISO 3968, with no bends or restrictions included in the measurement. Pressure taps in accordance with ISO 3968, and

b) connected to a data recording system.

5.4 Temperature transducer shall be

a) located such that the sensing part is located in the internal fluid volume,

b) positioned so that it measures the temperature of the test fluid as close as possible to the upstream part of the test element,

c) positioned so that the sensor part does not touch the filter element or any part of the filter element container,

d) connected to a data recording system, and

e) able to withstand the upstream pressure generated during the cold start test.

5.5 Filter element container, used for thermal conditioning tests shall

a) be large enough (in length and width, or diameter) to accommodate at least one test filter element,

If using an open container, the container shall be deep enough for fluid to fully cover the test filter element by a minimum of 10 mm.

b) have a construction suitable for testing over the full temperature range,

c) have a cover for the container, or shall be a sealed or unsealed housing,

If the container is sealed, it shall either be capable of withstanding any increase in pressure due to expansion of fluid as it heats up, or shall have a means of venting any increase in pressure.

d) be compatible with all the fluids used in the process, and

e) have a means for inserting a temperature transducer into the test fluid.

5.6 Environmental chamber, capable of achieving and maintaining the required temperatures within the stated limits and capable of holding the filter element containers (see 5.5). The chamber shall have suitable thermal controls with a calibrated feedback loop to allow precise control of the chamber temperature.

Alternatively, the hot and cold soaks can be performed using separate oven and freezer units, but the same limits apply. If separate oven and freezer units are used, thermal shocks shall be avoided.

NOTE The environmental chamber is the preferred option, as this reduces the possibility of thermal shocks and enables the thermal cycling tests to be performed more quickly as heating and cooling is more effective. It is also a safer option as it overcomes the need to transfer the thermal container and hence removes the possibility of fluid spillage or physical contact with the hot or cold surfaces.

5.7 Cold start test equipment. See Annex A for a list of typical equipment necessary to perform the cold start test.

6 Accuracy of measuring instruments and test conditions

Use and maintain measuring instrument accuracy and test condition variations within the limits given in Table 1.

Table 1 — Accuracy of measuring instruments and allowed test conditions variations

Test parameter	SI Unit	Instrument accuracy (± of actual value)	Permitted variations in test conditions (± of target value)
Differential pressure	kPa [a]	2 %	+5 %/-0 %
Gauge pressure	kPa [a]	2 %	5 %
Flow rate	L/min	2 %	
Temperature	°C	0,1 °C	0 °C/+4 °C for max. temp -4 °C/0 °C for min. temp

[a] 100 kPa = 1 bar

7 Summary of information required prior to testing

Prior to applying the requirements of this part of ISO 14085 to a particular hydraulic filter element, establish the

a) fabrication integrity test pressure (see ISO 2942),

b) required maximum element differential pressure for the cold start test agreed upon between purchaser and supplier, and

c) required hot and cold test temperatures for the soak test agreed between purchaser and supplier.

8 Thermal conditioning test

8.1 Preliminary preparation

8.1.1 Visually inspect the filter element for any obvious damage.

8.1.2 Carry out a fabrication integrity test on each element in accordance with ISO 2942, if not already done. Reject the filter element if it is damaged or fails to meet the required minimum bubble point pressure and restart with a fresh element.

8.1.3 Ensure that the filter element is dry of any fluid before proceeding to 8.1.4.

8.1.4 Place or fit the filter element into the container (see 5.5).

8.1.5 Fill the selected container with clean test fluid, ensuring that the filter element is completely submerged by at least 10 mm of test fluid, and all air has been purged from the filter element.

If the MSDS for the chosen fluid states that inhalation of vapours is harmful, any vapour from the fluid should be extracted external to the workplace when testing with the fluid at temperatures above ambient. If extraction is unavailable, then the test should be conducted in an enclosed vessel or housing with suitable pressure rating.

8.1.6 Place the filter element container in the environmental chamber.

8.1.7 Close the chamber doors and ensure the chambers are sealed to atmosphere at any open ports.

8.2 Thermal conditioning test procedure

8.2.1 Ensure that the data recording device is running and that the temperature transducer outputs are being monitored by the device.

8.2.2 Run the thermal chamber to follow the cycle defined below:

8.2.2.1 Stabilize and maintain the chamber temperature for 30 min at an ambient temperature selected from between 15 °C to 35 °C. The temperature shall be chosen on the basis of the filter element ambient temperature in service or for the test lab standard in which the test is completed. This selected ambient temperature shall be used throughout the test.

8.2.2.2 Increase the chamber temperature to the specified upper temperature, at a slow rate, not to exceed 5 °C per minute.

8.2.2.3 Stabilize the chamber temperature until the temperature transducer reading is stabilized at the upper temperature 0 °C/-4 °C.

If the transducer temperature is not stabilizing between the prescribed temperature limits, then the chamber temperature should be modified to achieve a fluid temperature between the limits.

NOTE Temperature stabilization could take several hours depending on the volume of the test fluid and the upper temperature.

8.2.2.4 Maintain the fluid temperature within limits for a minimum duration of 24 h.

8.2.2.5 Reduce the chamber temperature slowly to the lower test temperature, typically -55 °C, at a slow rate, not exceeding 5 °C per minute.

8.2.2.6 Stabilize the chamber temperature until the transducer reading is stabilized at the lower test temperature -4 °C/0 °C.

If the transducer temperature is not stabilizing between the prescribed temperature limits, then the chamber temperature should be modified to achieve a fluid temperature between the limits.

NOTE Temperature stabilization could take several hours depending on the volume of the test fluid and the lower temperature.

8.2.2.7 Maintain the fluid temperature within limits for an additional duration of 24 h.

8.2.2.8 Repeat 8.2.2.2 to 8.2.2.7 for three further cycles, until a total of 96 h at both the high and low temperatures has been accumulated, then proceed to 8.2.2.9.

8.2.2.9 Increase the chamber temperature to the ambient set-point and wait for the fluid temperature to reach the ambient set-point.

8.2.3 Remove the filter element and allow it to drain, then visually inspect the filter element for any obvious damage.

8.2.4 If the element is not to be used immediately, it should be stored wetted in the operating fluid at room temperature, or 20 °C to 32 °C, and placed in a suitable clean non-shedding container for protection, for example a polyethylene bag. Seal the container and mark it with a suitable comment or code.

NOTE If the element is stored within a polyethylene bag, it is also recommended that the element is boxed to ensure that any possibility of damage to the pleats is minimized.

9 Cold start test

9.1 Preliminary preparation

9.1.1 Determine whether the designated housing for the filter element is designed with a bypass component fitted. If a bypass is fitted as standard, then the bypass component shall be disabled or replaced with a plug, or the cold start test procedure shall be conducted in an alternative non-bypass type housing.

If the designated housing is not available, then fit the filter element within an alternative housing that has an internal diameter at least as large as that of the designed housing and in which a bypass component does not exist or which shall be disabled. The alternative housing should not be smaller in internal diameter than the designed housing as this may cause bias to the flow direction, thereby causing an uneven distribution of pressure stress in the filter medium in the biased area.

9.1.2 Prepare the cold test rig for the cold start test. If the test circuit in Annex A is used, perform the following procedures:

9.1.2.1 Shut all sampling valves.

9.1.2.2 Insert a piece of pipe or test block in place of the test housing and run the hydraulic power circuit pump to empty fluid from the transfer cylinders at a suitable flow rate.

9.1.2.3 Fill the test housing with test fluid and install the test housing onto the cold start test rig.

9.1.2.4 Run the cold circuit pump to refill the transfer cylinders with filtered fluid, and to filter the hydraulic power circuit fluid.

NOTE Use a suitable flow rate that does not cause clean-up filter to exceed its rated differential pressure.

9.1.2.5 Extract a sample from upstream of the test filter housing.

9.1.2.6 Analyse the contamination level of the sample and verify it is cleaner than class 3 per ISO 11218.

9.1.2.7 If the cleanliness is above class 3, continue to cycle the transfer cylinders and clean the test fluid until it meets the class 3 requirement.

9.1.2.8 Install the test filter element into the test housing.

NOTE A trial element can be used to carry out a cold start dummy run to ensure that the cold start flow cycle can be achieved.

9.1.2.9 Run the hydraulic power circuit pump briefly to bleed any air pockets in the test housing and surrounding pipework to the cold circuit reservoir.

9.1.2.10 Run the cold circuit pump to refill the transfer cylinders with filtered fluid.

9.1.3 Program the hydraulic power circuit pump controller so that it provides a test filter element differential pressure waveform as follows:

9.1.3.1 Increase the hydraulic power circuit flow rate such that the filter differential pressure increases, within 2-4 s, to the required maximum value (+5 %/-0 %) (see Clause 7 b).

9.1.3.2 Maintain the maximum differential pressure for 10 s to 11 s.

9.1.3.3 Reduce the flow rate such that the filter differential pressure reduces to 1 % to 3 % of the maximum differential pressure within 1 s to 2 s.

9.1.3.4 Maintain the differential pressure at 1 % to 3 % of the maximum value until the next cycle starts for a minimum of 2 s.

9.1.3.5 The filter differential pressure waveform for the test shall be in accordance with Figure 1.

9.1.3.6 The overall cycle time (1+2+3 in Figure 1) shall be 15 s ± 1 s in duration.

9.1.4 Set the chamber temperature to the specified minimum test temperature and monitor the fluid temperature for stabilization within the specified limits.

9.1.5 If stabilization between these limits is not achieved, modify the chamber temperature accordingly to achieve the required fluid temperature upstream of the test housing.

9.2 Cold start test procedure

9.2.1 Ensure that the fluid temperature in the cold circuit has been stabilized at the designated minimum test temperature for a minimum period of four hours.

9.2.2 Start the data recording system and continuously record the following:

a) system flow rate;

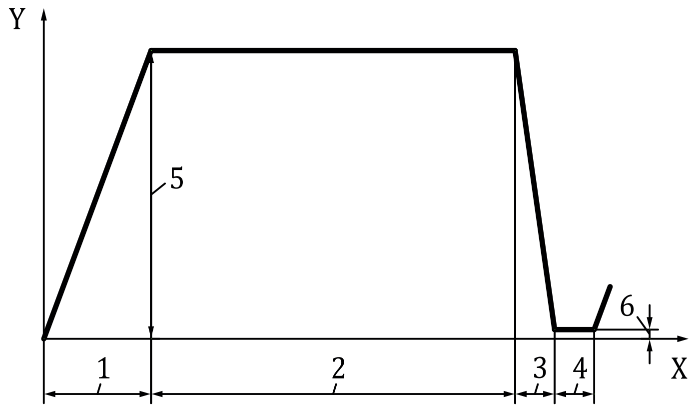
b) differential pressure across the filter assembly;

c) temperature transducer reading, upstream of the test filter.

9.2.3 Set the hydraulic power circuit pump to run the cold start cycle in accordance with Figure 1, and complete 10 total cycles, while maintaining the test temperature within the designated limits.

9.2.4 After completion of 10 cold start cycles, remove the test filter from the housing and allow both the housing and filter element to drain.

NOTE The test chamber temperature can be allowed to increase to ambient if desired prior to the element removal.



Key

X test time, seconds (s)

Y filter differential pressure

1 differential pressure rise time = 2 s to 4 s

2 time at maximum differential pressure = 10 s to 11 s

3 differential pressure fall time = 1 s to 2 s

4 time at minimum differential pressure = no less than 2 s

5 maximum filter differential test pressure (+5 %/-0 %)

6 differential pressure between cycles = 1 % to 3 % of maximum filter differential pressure

Figure 1 — Cold Start Differential Pressure Waveform

9.2.5 When the filter element has drained, remove all traces of oil from the filter element using a compatible solvent and allow to dry in a fume extraction cabinet or similar.

9.2.6 Visually inspect the filter element for any physical damage.

9.2.7 Ensure that the filter element is dry of any fluid.

9.2.8 Store the elements in the operating fluid at room temperature, or 20 °C to 32 °C, and maintain fully sealed until subsequent testing is performed.

10 Reporting

The results of both conditioning tests shall be reported on a results sheet containing, at least, the information shown in the example results sheet within Annex B. A trace of the ten pressure cycles (differential pressure versus time) shall be included in the report.

11 Identification statement

Use the following statement in test reports, catalogues, and sales literature when electing to comply with this part of ISO 14085

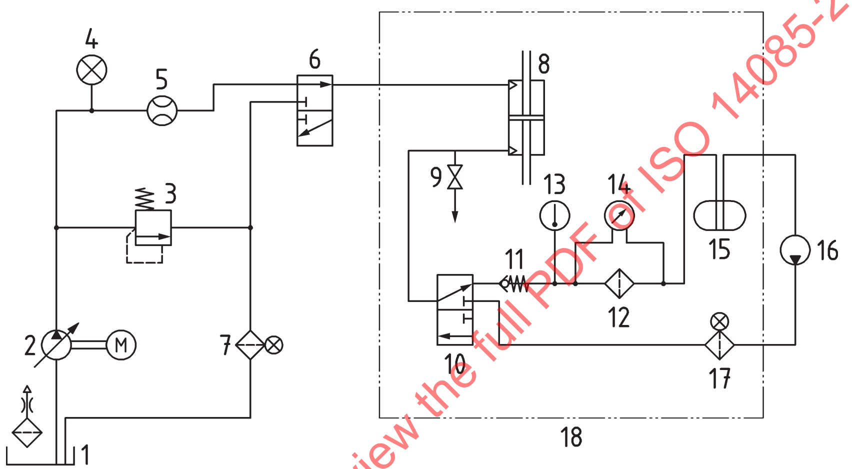
"Method for conditioning filter elements in accordance with ISO 14085-2, *Aerospace series — Hydraulic Filter elements - Test methods — Part 2: Conditioning*".

Annex A
(informative)

Cold Start Test Equipment

A.1 Test circuit

A suggested test circuit schematic for the entire cold start test rig is given in Figure A1. Other circuits may be used as long as the differential pressure waveform of Figure 1 is achieved.



Key

1 hydraulic power circuit reservoir
2 hydraulic power circuit pump and drive
3 system pressure relief valve
4 system pressure transducer / pressure gauge
5 flowmeter
6 3-way directional valve
7 power circuit filter
8 transfer cylinder
9 sample valve
10 3-way directional valve
11 check valve
12 test filter
13 temperature transducer
14 differential pressure transducer
15 cold circuit reservoir
16 cold circuit pump
17 cold circuit clean-up filter
18 cold test chamber

Figure A.1 — Suggested Cold Start Test Circuit

The circuit in Figure A.1 consists of two sections. The power supply circuit is used for generating precisely controlled flow and pressure under ambient conditions to drive the transfer cylinder within the cold chamber. The test circuit within the cold chamber uses cold fluid from the transfer cylinder to generate the differential pressure required across the filter, with the fluid then collected in a cold circuit reservoir.

During the recharge cycle, valves 6 and 10 are shifted, and the cold circuit pump is used to drive cold oil back into the transfer cylinders, thereby forcing power circuit fluid back into the power supply reservoir. In both circuits, the fluid is forced through clean-up filters to maintain fluid cleanliness.

A.2 Test circuit components

A.2.1 Hydraulic power circuit pump and drive

The pump should be capable of providing sufficient fluid displacement to drive cold fluid through the test filter at the flow rate and pressure required to achieve the waveform of Figure 1. A servo-controlled variable displacement pump is recommended, which uses the test filter differential pressure as the feedback loop control.

A.2.2 Hydraulic power circuit reservoir

A.2.2.1 A reservoir suitable of containing fluid in a clean environment, fitted with a lid to stop particulate or contaminant from entering the fluid.

A.2.2.2 The reservoir should be fitted with high and low fluid level sensors, and the fluid lines should be located below the low level sensor to prevent aeration of the fluid.

A.2.2.3 The reservoir should be large enough to charge the hydraulic power circuit and the transfer cylinders without the reservoir low level sensor operating.

A.2.3 System pressure relief valve

The system pressure relief valve should be set to relieve pressure at a suitable system pressure in order to protect the equipment with the lowest rated pressure.

A.2.4 System pressure transducer/pressure gauge

A suitably ranged and calibrated gauge type pressure transducer/gauge that can be connected to a data recording system, to continuously record the system pressure.

A.2.5 Flowmeter

A flowmeter capable of measuring the flow rate through the hydraulic circuit is required, with an electronic signal output for continuous logging and display of the flow rate with a data recording system.

A.2.6 3-way directional valves

3-way directional control valves are recommended for changing the mode of operation from normal testing to recharging mode for refilling the transfer cylinders in preparation for another test. The 3-way valves may utilize either automatic or manual controls.

A.2.7 Clean-up filters

A.2.7.1 Clean-up filters are required that are capable of filtering the fluid to a cleanliness level of better than ISO 11218, class 3.

A.2.7.2 The clean-up filter fitted in the cold circuit should be suitably sized for the high viscosity conditions at the location chosen, and to give an adequate life.

A.2.7.3 It is suggested that a differential pressure transducer/gauge is fitted across the clean-up filters to ensure the rated differential pressure for the filters is not exceeded

A.2.8 Transfer cylinder

A cylinder or accumulator with two compartments separated by a sealing piston or diaphragm is recommended to isolate the higher temperature power supply fluid from the test fluid in the cold

