



AEROSPACE RECOMMENDED PRACTICE

ARP5376™**REV. C**

Issued 1998-09

Revised 2021-05

Superseding ARP5376B

Methods, Locations and Criteria for System Sampling and Measuring the
Solid Particle Contamination of Hydraulic Fluids

RATIONALE

Revision C deletes the introduction, updates the Scope and sample volume requirements, improves the cleaning and reporting procedure, and adds dual units when applicable.

1. SCOPE

This Aerospace Recommended Practice (ARP) provides:

- Recommended methods for cleaning sample bottles, when used, and the solvents to be applied and how these solvents should be prepared.
- Recommendations for three measuring methods for determining the level of solid particle contamination of hydraulic fluids used in aerospace hydraulics.
- Recommendations for the selection of the sampling point, sampling method, and the sampling frequency.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP4285	Aerospace - Evaluation of Particulate Contamination in Hydraulic Fluid – Membrane Procedure
AS598	Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS4059	Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2021 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: [SAE ARP5376C](http://www.sae.org/standards/content/ARP5376C)

For more information on this standard, visit
<https://www.sae.org/standards/content/ARP5376C/>

Documents
Document Sharing Hub

2.2 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 3722	Hydraulic Fluid Power - Fluid Sample Containers - Qualifying and Controlling Cleaning Methods
ISO 4407	Hydraulic Fluid Power - Fluid Contamination - Determination of Particulate Contamination by the Counting Method Using an Optical Microscope
ISO 11171	Hydraulic Fluid Power - Calibration of Automatic Particle Counters for Liquids
ISO 11500	Hydraulic Fluid Power - Determination of the Particulate Contamination Level of a Liquid Sample by Automatic Particle Counting Using the Light-Extinction Principle
ISO 11943	Hydraulic Fluid Power - On-line Automatic Particle-Counting Systems For Liquids - Methods of Calibration and Validation

2.3 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

2.4 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

3. GENERAL CLEANLINESS

When establishing the level of solid particle contamination of hydraulic fluids, the test results may be adversely affected by not sufficiently taking account of the need for optimum cleanliness of the sampling and analysis equipment.

In order to obtain meaningful results reproducible at any place and at any time, it is essential to ensure that the preliminary conditions prevent any additional solid particle contamination of the hydraulic fluid sample taken.

Additional solid particle contamination can be caused by using apparatus inadequately cleaned for the measurement.

All apparatus used for sampling and determining the solid particle contamination level of hydraulic fluids should be thoroughly cleaned before use. The apparatus should be resistant to the solvent and the sample fluids.

4. USE OF SOLVENTS

The following solvents are recommended for the cleaning procedure:

1. Solvent A: De-mineralized, distilled or de-ionized water, or water from reverse osmosis.
2. Solvent B: 2-propanol (isopropyl alcohol), reagent-pure.
3. Solvent C: Petroleum ether or other suitable equivalents.

NOTE: Use precautions and consult applicable safety regulations when using flammable solvents.

5. FILTRATION OF SOLVENTS

5.1 Pressure Filtration

Pressure filtration of solvents using an inert gas pressurized solvent tank is generally the most convenient method to dispense clean solvent.

5.1.1 Typical Apparatus

It is recommended that the following typical apparatus be used:

1. Pressure tank, stainless steel;
2. Filter-jet spray gun, with filter attachment;
3. Membrane filter, having an aperture size less than or equal to 0.5 μm .

5.1.2 Procedure

The filter-jet spray gun (5.1.1.1), with a membrane filter (5.1.1.3) fitted, should be connected by a hose to the pressure tank (5.1.1.1) containing the solvent. The gun should produce a concentrated jet of filtered solvent for cleaning the surfaces. Precleaning is not required.

5.2 Vacuum Filtration

Vacuum filtration of solvents can be used as an alternative to pressure filtration; however, a final filter using a membrane filter (5.2.1.4) is still required on the dispensing wash bottle to ensure clean solvent is being dispensed.

5.2.1 Use the following typical apparatus:

1. Vacuum pump;
2. Filtration apparatus, stainless steel, or glass;
3. Wash bottles;
4. Membrane filter, having an aperture size less than or equal to 0.5 μm .

5.2.2 Procedure

For vacuum filtration of the solvent, the filtration apparatus (5.2.1.2) should be fitted with a membrane filter (5.2.1.4) and connected to the vacuum pump (5.2.1.1) by a hose. The solvent should be filtered through the membrane filter by the vacuum in the flask of the filtration apparatus. The filtrate collected in the flask should be transferred to the corresponding wash bottle (5.2.1.3). The wash bottle should only be used with a membrane filter (5.2.1.4) fitted.

6. SAMPLE BOTTLES

Sample bottles, when used, should preferably be made from glass, should have a nominal capacity of 250 mL and a minimum capacity of 150 mL, and should be sealed by means of caps (preferably of phenolic resin) which will not cause contamination. Otherwise a non-flaking plastic film compatible with the hydraulic fluid should be used. Bottles made of non-flaking polyethylene terephthalate (PET or PETG) have also been used with success.

6.1 General Cleaning Requirements

Before use, sample bottles and caps should be thoroughly cleaned in accordance with a qualified procedure such as the procedure described in 6.2 and 6.3. In carrying out steps d to f, care should be taken to ensure that the whole surface of the sample bottle is pressure-rinsed from top to bottom. Optionally, pre-cleaned sample bottles may be obtained from a qualified source adhering to the requirements of 6.3.

6.2 Recommended Cleaning Procedure for Sample Bottles

The following method has produced sample bottles with acceptable bottle cleanliness when completed by properly trained staff:

1. Rinse with a degreasing fluid;
2. Wash thoroughly in a filtered hot water solution of detergent;
3. Rinse twice with filtered hot water at a temperature of between 104 °F (40 °C) and 140 °F (60 °C);
4. Rinse twice with solvent A, filtered through a membrane filter having an aperture size less than or equal to 0.5 µm;
5. Rinse three times with solvent B, filtered through a membrane filter having an aperture size less than or equal to 0.5 µm, to remove water;
6. Rinse three times with solvent C, filtered through a membrane filter having an aperture size less than or equal to 0.5µm.

NOTE: Sample bottles for fluids per AS1241 should be rinsed with solvent B as the last rinse.

After the last rinse, a small amount (<10 mL) of solvent should remain in the sample bottle. The resultant gas pressure inside the sample bottle avoids contamination when the bottle is opened. When using a piece of plastic film, 100 x 100 mm, the film should be rinsed with filtered solvent and then placed over the mouth of the sample bottle with the edges of the film bent downwards and the cap screwed onto the bottle. The cap should not be tightened too hard to avoid breaking the plastic film.

6.3 Checking and Controlling Cleaning Methods

Check the cleaned sample bottles in accordance with ISO 3722. The required cleanliness level (RCL) for the bottles should be less than 1% of the expected cleanliness level of the system fluid to be sampled. If the expected cleanliness is unavailable, use an RCL corresponding to AS4059, Class 0.

7. LOCATION OF SAMPLING POINTS

Each hydraulic system in aerospace vehicles should have a permanent hydraulic fluid sampling point or points with convenient access, and located by the hydraulic system designer. The hydraulic system designer should select the hydraulic system sampling point(s) at the time of design for fleet standardization consistent with system cleanliness requirements. Users may require optional sampling points to satisfy their unique maintenance requirements.

The sampling point(s) should be located in a readily accessible area and should allow convenient use of on-line analysis or sample bottles.

The following sampling points relative to system filters will provide fluid from various points in the system with different cleanliness levels.

1. Upstream of the main return filter provides indication of contamination coming from system components and is the most useful sample for diagnosing system condition.
2. Upstream of the hydraulic pump case drain filter provides indication of contamination coming from the hydraulic pump. The pump case drain fluid can be the system's most heavily contaminated area due to pump generated wear particles.
3. Downstream of the main return filter and upstream of the hydraulic pump verifies return filter performance and provides indication of contamination going to the reservoir and pump: The case drain line may also contribute considerable contamination to the reservoir depending on system configuration.