



AEROSPACE INFORMATION REPORT

AIR887™**REV. C**

Issued 1968-05
Revised 2008-06
Reaffirmed 2021-04

Superseding AIR887B

(R) Liquid Filter Ratings, Parameters and Tests

RATIONALE

AIR887C has been reaffirmed to comply with the SAE five-year review policy.

TABLE OF CONTENTS

1.	SCOPE.....	3
2.	REFERENCES.....	3
2.1	Applicable Documents	3
2.1.1	SAE Publications.....	3
2.1.2	U.S. Government Publications.....	3
2.1.3	ISO Publications.....	4
3.	GENERAL DATA ON ISO TEST DUSTS	4
4.	FILTER RATINGS.....	4
4.1	Absolute Filtration Rating.....	4
4.2	Filtration Ratings	4
4.2.1	Nominal Rating.....	5
4.2.2	Filtration Ratio.....	5
4.3	Efficiency by Weight.....	7
5.	SIGNIFICANT FILTER TESTS	7
5.1	Clean Pressure Drop	7
5.2	Dirt Capacity.....	7
5.3	Collapse Pressure.....	8
5.4	Flow Fatigue.....	8
5.5	Reverse Flow	9
5.6	Media Migration.....	9
5.7	Material Compatibility.....	9
5.8	Cold Start Capability	9
5.9	Contaminant Retentivity.....	9
6.	FILTER ELEMENT TEST METHODS	9
6.1	Bubble Point Test.....	9
6.2	Maximum Particle Passed Test	10
6.3	Degree of Filtration Test	10
6.4	Multi-pass Filter Performance Test.....	11
6.4.1	Modified Multi-pass Tests	11
6.5	Clean Element Pressure Drop Test.....	11
6.6	Dirt Capacity Test.....	12

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

For more information on this standard, visit
<https://www.sae.org/standards/content/AIR887C/>

Documents

Document Sharing Hub

6.7	Collapse Test	12
6.8	Flow Fatigue Test.....	12
6.9	Reverse Flow Test	12
6.10	Media Migration Test	13
6.11	Cold Start Test	13
6.12	Material Compatibility Test.....	13
6.13	Dynamic Efficiency Test.....	13
7.	NOTES	14

1. SCOPE

This SAE Aerospace Information Report (AIR) identifies and explains the meaning of various ratings and terms used to describe the physical characteristics of liquid filter elements. The significance of various filter parameters is discussed. In addition, a number of filter test methods are briefly described. This AIR and the data presented are only applicable where the system liquid wets the filter elements.

2. REFERENCES

2.1 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.

2.1.1 SAE Publications

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

ARP24	Determination of Hydraulic Pressure Drop
ARP598	Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems
ARP901	Bubble-Point Test Method
ARP1827	Measuring Aircraft Gas Turbine Engine Fine Fuel Filter Element Performance
AS4059	Aerospace Fluid Power - Cleanliness Classification for Hydraulic Fluids
ARP4205	Aerospace Fluid Power - Hydraulic Filter Elements - Method for Evaluating Dynamic Efficiency with Cyclic Flow
ARP5454	Multi-Pass Method for Evaluating Filtration Performance of Fine Lube Filter Elements Utilized in Aerospace Power and Propulsion Lubrication Systems
AIR5455	Impact of Changes in Test Dust Contaminants and Particle Counter Calibration on Laboratory Filter Element Performance and Fluid Cleanliness Classes

2.1.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-F-8815	Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems General Specification For
MIL-PRF-5606	Hydraulic Fluid, Petroleum Based
MIL-PRF-83860	Filter Elements, Disposable, Fluid Pressure, Hydraulic Line, 5 Micron Absolute

2.1.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 12103-1 Road Vehicle - Test Dust for Filter Evaluation - Part 1 - Arizona Test Dust

ISO 16889 Hydraulic Fluid Power - Multi-pass Method for Evaluating Filtration Performance of a Filter Element

3. GENERAL DATA ON ISO TEST DUSTS

The new International Standard Organization (ISO) test dusts are manufactured from the same Arizona Road Dust as AC fine test dust (ACFTD), but processed with a jet mill and classified into well-controlled particle size distributions. Suspensions of the ISO medium test dust are certified by National Institute of Standards & Technology (NIST) as a reference material for Automatic Particle Counter (APC) calibration. The ISO fine test dust does not have a particle size distribution equivalent to ACFTD. The ISO test dust particles have been measured by projected area using an electron microscope and are not equivalent to the ACFTD particles measured by the longest dimension using ARP598 microscopic examination.

Filter efficiency ratings (see 4.2) and dirt capacity (see 5.2) test results can vary significantly when the new ISO test dusts are used in place of the AC test dusts. The main reason for these variations is the finer distribution and the greater number of small particles in ISO test dusts.

4. FILTER RATINGS

Filter ratings were created to provide a technical method to establish how efficient the filter element is in the removal of particulate from a test system, and to differentiate performance between filter elements. Many factors are considered in establishing a filter rating procedure, such as sensitivity, repeatability between tests and reproducibility between laboratories. While each filter rating measures a parameter, which attempts to correlate with system performance, the rating procedures can only simulate rather than reproduce system conditions.

4.1 Absolute Filtration Rating

The absolute filter rating is defined as the diameter of the largest hard spherical particle, which will pass through the filter element under specified test conditions. This is an indication of the largest opening in the filter element. The Absolute rating is determined by the "Maximum Particle Passed Test" (see 6.2) in which a volume of fluid containing various sizes of spherical particles is passed through the filter element. The effluent is then passed through a membrane analysis filter, which is then examined under a microscope to determine the largest spherical particle which passed through the filter element.

Since contaminants are rarely spherical, the absolute rating cannot be correlated with other efficiency ratings and is usually less significant in defining filter performance than is the efficiency rating. Different types of filter media with the same absolute rating may have a significantly different efficiency at removing system contamination. However, in some systems an absolute filter rating may be applied in an attempt to ensure removal of particles of a size that could block a small orifice or passage.

4.2 Filtration Ratings

Filtration ratings attempt to assess the particulate removal capability of the filter. Several methods of expressing filtration ratings or efficiency that are in use are as follows:

4.2.1 Nominal Rating

The Nominal Rating is an arbitrary value established primarily by filter manufacturers. Generally, “nominal” means a high percentage removal of specific size particles. A 10-micrometer nominal element may be claimed to remove 90% or more of particles of size 10 micrometers or larger.

Since no established removal values or standard test procedures exist, the use of this rating is not recommended.

4.2.2 Filtration Ratio

A filtration ratio test defines the efficiency of a filter element in removing particles at various particle sizes under specified test conditions. The filtration ratio is the ratio of the number of particles larger than a given size flowing into a filter element to the number of particles larger than the same size simultaneously leaving the filter element. In this test, a predetermined mass of test contaminant, of specified characteristics and mixed with the test fluid into a slurry, is introduced into the test system at a steady rate until depleted. The filtration ratio is obtained by dividing the number of upstream particles greater than a given particle size by the number of downstream particles greater than the same particle size.

$$\text{Filtration Ratio (x)} = \frac{\text{No. of Upstream Particles Greater than (x) Micrometres}}{\text{No. of Downstream Particles Greater than (x) Micrometres}} \quad (\text{Eq. 1})$$

The filtration ratio can be expressed by the following:

$$FR_x = \frac{N_u}{N_d} \quad (\text{Eq. 2})$$

where:

FR_x = Filtration ratio for contamination > x μm

N_u = Number of particles greater than size (x μm) per unit volume of fluid upstream of the filter

N_d = Number of particles greater than size (x μm) per unit volume of fluid downstream of the filter

Example: For particles 10 μm and greater in size

$N_u = 3760$

$N_d = 68$

Then:

$$FR_{10} = \frac{3760}{68} = 55$$

Filtration ratio values are obtained throughout the test at designated intervals while the test is in progress. The test must proceed from start to completion without interruption. In this test, a predetermined mass of specified test contaminant is ingressed continuously in slurry form into the test system. Conditions of fluid temperature, system fluid volume, and flow through the test filter are maintained constant during the test while the filter element pressure differential is monitored. Filtration ratios are determined throughout the test, at designated intervals, by counting particles at specified size ranges from samples of test fluid withdrawn simultaneously upstream and downstream of the element. Since the filtration ratio varies during the filtration ratio test, an average of the measured filtration ratios for particles greater than any size of interest is used rather than the minimum value. The average beta ratio is calculated in accordance with ISO 16889, ARP1827 or ARP5454. The test contaminants, the test system, and method are described under multi-pass test in 6.4.