SAE INTERNATIONAL

AEROSPACE RECOMMENDED PRACTICE

ARP1827™ REV. D

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Superseding ARP1827E

(R) Measuring Aircraft Gas Turbine Engine Fine Fuel Filter Element Performance

RATIONALE

The proper performance of the engine fuel filter element is important in protecting engine fuel system components from particulate contamination that could lead to accelerated component wear, fuel system malfunction, and premature component failure. This SAE Aerospace Recommended Practice (ARP) provides a standard test method for determining the filtration efficiency and dirt capacity of engine main fuel filter elements. This will allow both manufacturer and customer a common means to evaluate the performance of engine main fuel filter elements.

The standard has been revised to: (1) clarify the scope in terms of the applicability of the procedure to fuel filter elements rated at 25 µm(c) or finer, (2) include an update on the current status of the standard reference material (SRM) used for calibration of automatic particle counters per ISO 11171, (3) update the dirt capacity test setup validation procedure for clarity and to include the option of using a suitable validation filter element, (4) specify periodic determination of the water content in the jet fuel during the dirt capacity test, and (5) include editorial changes for clarity.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) delineates two complementary filter element performance parameters: (1) dirt capacity, and (2) filtration efficiency, and corresponding test procedures. It is intended for non-cleanable (disposable), fine fuel filter elements, rated at 25 µm(c) or finer, used in aviation gas turbine engine fuel systems.

1.1 Purpose

Variation in fuel filter element testing methods and requirements make comparison of performance results difficult. In order to minimize these problems, this document describes standard filtration ratings and test procedures. Both manufacturer and customer will have a common means to evaluate fuel filter elements.

1.2 Filter Element Performance Ratings

1.2.1 Filter Element Dirt Capacity

The mass of test contaminant added to the filter element test system, under the test conditions specified herein, to produce a prescribed terminal filter element differential pressure. The dirt capacity is determined in a specified test fluid.

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For more information on this standard, visit
https://www.sae.org/standards/content/ARP1827D/

1.2.2 Filter Element Efficiency

Filter element efficiency is the ability of a filter element to remove (and retain) contaminant particles from the fluid stream. This procedure determines the particle removal efficiency of the filter element as a function of particle size. The particle removal efficiencies for the various particle size ranges (“x”) are expressed as filtration ratios, termed beta ratios (β_x). The filtration ratio at a specified particle size is the ratio of the number of particles larger than the specified size entering the filter element (U_x) to the number of particles larger than the same size leaving the filter element (D_x).

$$\text{Filtration ratio at particle size “x”} = \beta_x = U_x/D_x \quad \text{(Eq. 1)}$$

The techniques specified in this document allow measurement of filtration ratios up to 1000 (99.9% particle removal efficiency) for the particle size range 4 to 25 µm(c), as defined in ISO 11171.

1.3 Test Contaminant and Particle Counter Calibration

1.3.1 Dirt Capacity

Historically, AC Test Dusts (AC Fine Test Dust and AC Coarse Test Dust) were specified, either as a component of the test contaminant for the Dirt Capacity test or, in some applications, as the principal test contaminant.

Replacement test dusts for the AC Test Dusts, no longer available, were specified by ISO (ISO 12103-1) in the late 1990s. The corresponding ISO Test Dust for AC Fine Test Dust is ISO Fine Test Dust (designated ISO 12103-A2) and the corresponding ISO Test Dust for AC Coarse Test Dust is ISO Coarse Test Dust (designated ISO 12103-A4).

The change to ISO Test Dusts can result in dirt capacity test results that may differ from test results obtained with the corresponding AC Test Dusts. It is necessary for users to take this into account when comparing historic dirt capacity test data generated per ARP1827 with data generated per subsequent revisions, and when comparing dirt capacity test results to historic specification requirements for dirt capacity. Additional information may be found in AIR5455.

1.3.2 Filtration Efficiency

Historically, AC Fine Test Dust was the test contaminant specified for the filtration efficiency test, and the calibration of automatic particle counters was in accordance with ISO 4402 (1991). As stated in 1.3.1, ISO Fine Test Dust (ISO 12103-A2) was selected as the replacement test dust for AC Fine Test Dust. In addition, ISO also specified a calibration procedure, ISO 11171, for automatic particle counters to replace the ISO 4402 (1991) calibration procedure which utilized AC Fine Test Dust. The ISO 11171 calibration procedure uses a batch of ISO Medium Test Dust (ISO 12103-A3), certified by the National Institute of Standards and Technology (NIST), as the standard reference material (SRM) instead of AC Fine Test Dust; the original NIST certified batches were designated SRM 2806 and SRM 2806a.

The definition of particle sizes per the calibration procedure ISO 11171 differs very significantly from the particle sizes defined in the historic calibration procedure ISO 4402 (1991). In order to distinguish the particle sizes defined in ISO 11171, they were designated as µm(c) or micrometer(c) for the original reference batches SRM 2806 and SRM 2806a.

The change in test contaminant and the automatic particle counter calibration procedure has resulted in filter element efficiency test results that are significantly different from test results obtained previously with AC Fine Test Dust and ISO 4402 calibration. It is necessary for users to take this into account when comparing historic filter element efficiency test data generated per ARP1827, Rev. None, with data generated per subsequent revisions, and when comparing filter element efficiency test results to historic specification requirements for filter element efficiency. AIR5455 discusses the impact of the change in test dusts and automatic particle counter calibration on laboratory filter performance and filter ratings.

Around 2016, NIST certified a new reference batch of ISO Medium Test Dust, SRM 2806b, for particle counter calibration since the original reference batches, SRM 2806 and SRM 2806a, were depleted. The size distribution of SRM 2806b determined by NIST differed from the original reference batches of ISO Medium Test Dust (SRM 2806 and SRM 2806a) resulting in a redefinition of particle sizes. Industry designated the particle sizes as µm(b) to coincide with the reference batch SRM 2806b. However, there is consensus in the industry that redefining particle sizes with each certified reference batch of ISO Medium Test Dust leads to confusion in the industry in setting specification requirements and complicates comparison of data determined with particle counters calibrated with different reference batches. In order to alleviate this, going forward, all particle sizes will be expressed in terms of the original particle sizes µm(c) defined for SRM 2806 and SRM 2806a. At the time of this publication, NIST was completing certification of a new batch of ISO Medium Test Dust as the new standard reference material (SRM 2806d) due to the depletion of SRM 2806b.

1.4 Test Fluids (Dirt Capacity)

Historically, test fluids have included MIL-PRF-7024 calibration fluid and petroleum based jet fuels. For commercial applications, fuels such as ASTM D1655 Grades Jet A and Jet A-1 have been used and, more recently, fuels complying to Russian and Chinese national standards and semi and fully synthetic fuels. For military applications, fuels such as MIL-DTL-5624, Grades JP-4 and JP-5, and MIL-DTL-83133, Grade JP-8, have been used. Fuels containing synthetic hydrocarbons, i.e., hydrocarbons derived from non-petroleum based feedstocks, are also being approved. For example, fuels produced per ASTM D7566 are permitted to be re-certified as ASTM D1655 or UK Defence Standard 91-91 fuels in the proper admixture with petroleum based jet fuels. Once re-certified, the fuels are indistinguishable from fuels produced solely from petroleum based feedstocks. Other national standards allow synthetic hydrocarbons complying with one or more of the annexes of approved synthesized paraffinic kerosene within ASTM D7566 to be blended with petroleum based jet fuels up to 50% by volume as long as the final blend meets the requirements of the national standard.

The dirt capacity is dependent on test fluid properties (such as viscosity), the dispersion of solid contamination and the solubility and dispersion of water in the fluid phase, which are dependent on the chemical composition (including additives) and chemical/physical properties of the test fluid. The above should be kept in mind when comparing dirt capacities of filter elements in different test fluids.

1.5 Filter Element Conditioning

Filter element performance ratings can be adversely affected by harsh operating environments. Filter elements should, therefore, be subjected to procedures simulating these harsh operating conditions prior to performance testing. Conditioning is the term covering these procedures. This document does not cover conditioning requirements. They should be determined by the user and reported by the testing agency. AIR1666 discusses recommended filter element conditioning methods for gas turbine engine lubrication filter elements. The methods discussed in AIR1666 can also be applied to filter elements utilized in other aerospace fluid systems.

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.

AIR1666	Performance Testing of Lubricant Filter Elements Utilized in Aircraft 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
ARP24	Determination of Hydraulic Pressure Drop