EI 1599

# Laboratory tests and minimum performance levels for aviation fuel dirt defence filters

Third edition

energy institute

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# LABORATORY TESTS AND MINIMUM PERFORMANCE LEVELS FOR AVIATION FUEL DIRT DEFENCE FILTERS

Third Edition

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# FOREWORD

This publication provides general mechanical specifications for new dirt defence filter designs, first article qualification test procedures and minimum laboratory performance levels for selected aspects of the performance of dirt defence filter elements for use in aviation fuel handling systems.

The laboratory tests specified in this publication are intended to provide standard methods of evaluating selected aspects of the performance of new dirt defence filter element designs, which may be relevant to field service. They are not intended to predict the actual performance of dirt defence filters in field service. Aspects of field performance including dirt removal efficiency and service life vary with different operating environments. Users should work with their suppliers to ensure that their application of dirt defence filters provides the performance needed in the particular application. The aspects of performance selected for inclusion in this publication are primarily those where a laboratory test has been developed with sufficient experience to identify a minimum level of performance. No attempt is made to completely define all necessary tests or aspects of performance for products to be suitable for every application.

This publication addresses filters that are designed to remove DIRT ONLY from aviation fuel (but have a tolerance of water). DIRT DEFENCE FILTERS SHOULD IN NO WAY BE REPRESENTED OR CONSIDERED TO BE WATER REMOVAL DEVICES.

This publication is not in any way intended to prohibit either the purchase or the manufacture of dirt defence filter elements meeting other requirements. It is hoped and anticipated that this publication will assist those involved in manufacturing and purchasing dirt defence filter elements.

It is imperative for manufacturers, purchasers and users of dirt defence filters to be aware that the laboratory performance tests and minimum laboratory performance levels described herein may not predict in-service performance since it is not possible to replicate exactly in a laboratory the environmental and operational parameters to which a dirt defence filter system or elements may be exposed when in service in commercial aircraft fuelling applications.

**The use of dirt defence filters that meet the requirements of EI 1599 alone cannot provide assurance that fuel delivered to aircraft will meet minimum cleanliness requirements. It is envisaged that dirt defence filter systems will be used in conjunction with a quantitative electronic water sensor (EI 1598) that ensures free water content in fuel (if present) is within acceptable limits. Dirt defence filters that meet the requirements of EI 1599 are intended to be part of a comprehensive system to protect aviation fuel quality. They cannot be regarded as fail-safe devices on their own.** For further information, see EI 1550 *Handbook on equipment used for the maintenance and delivery of clean aviation fuel*.

This publication is intended to be applied to the first article qualification of a model of a dirt defence filter. The destructive nature of these laboratory tests renders them unsuitable for ‘every-element’ quality control testing.

The main revisions incorporated in this third edition of EI 1599 are:

– Inclusion in scope the laboratory qualification of a 125 mm (5 in.) nominal diameter element, that is specifically intended for low-pressure (LP), low flow rate, single-element applications (structural strength is tested to 515 kPa (5 bar/75 psi).
– Amendment of two qualification tests to enable them to be applied to dirt defence filter elements with nominal diameters of 125 mm (5 in.) for LP applications.

– Addition of a new clause on sustainability.
– Recognition of Copperas® Red Iron Oxide R9998T as a replacement for Copperas® Red Iron Oxide R9998.
– Clarification that a dirt defence filter element model that is qualified in a test vessel in accordance with EI 1599 may be deployed in either a vessel that conforms with EI 1596 (a multiple element system) or one that conforms with the requirements of EI 1587 *Recommended practice for single cartridge filtration units for aviation fuel*, Annex A (for single cartridge housings).
– Inclusion of a new test to expose an element to multiple stop/starts (100 using valve closure upstream of the test vessel; 100 using valve closure downstream of the test vessel) at rated flow, when the element is at 10 psi and 20 psi due to test dust loading.
– Inclusion of a new test to assess end cap adhesion integrity.
– Updating text throughout to maintain alignment with other EI filter specifications.

This is the third edition of this publication, which supersedes the previous edition. With the publication of the third edition of EI 1599, the second edition is hereby formally withdrawn from publication. The qualification testing requirements that were included in all previous editions of this publication for dirt removal performance have not been amended in this third edition. Therefore, existing qualifications to all previous editions are recognised as also meeting the requirements of this third edition (no requalification testing is required to claim qualification to this third edition).

Any manufacturer wishing to offer dirt defence filter elements stated to comply with this publication, or marketed as being 'qualified to EI 1599', shall comply fully with all the mandatory provisions included herein.

It is the responsibility of the manufacturer to further define any application and/or performance limitations that affect the serviceability of dirt defence filter systems in aircraft servicing. IN NO EVENT SHALL ANY MANUFACTURER REPRESENT A DIRT DEFENCE FILTER AS BEING 'FIT FOR PURPOSE' IN AVIATION FUELLING OPERATIONS ON THE SOLE BASIS OF MEETING THE MINIMUM LABORATORY PERFORMANCE LEVELS INCLUDED IN THIS PUBLICATION. Nor shall the minimum laboratory performance tests described in this publication be taken as the only aspects of performance that a user should investigate prior to the routine use in their operations of any equipment that meets the requirements of those tests.

Purchasers are advised to make any enquiries of the manufacturer to confirm that the product is acceptable and are strongly encouraged to conduct field testing before deeming a product acceptable. The purchaser should make any investigations and conduct any testing necessary to confirm that the manufacturer has conformed to this publication and that the equipment meets the purchaser's requirements. The purchaser should not rely solely on the manufacturer's representation that the manufacturer's dirt defence filter has been 'qualified to' 1599, or that its dirt defence filters otherwise 'meet' the standard, as laboratory testing cannot assess the long-term durability, mechanical integrity and performance of dirt defence filter systems or elements in service.

This publication uses the Système International d'Unités (International System of Units, or SI). In this system, the decimal point is a comma (,). In writing numbers of greater than three digits, thousands are demarcated by the use of a space, rather than a comma. US Customary Units are also given in parentheses after the SI unit.

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It is hoped and anticipated that this publication will assist both the manufacturers and the purchasers of dirt defence filters. Every effort has been made by the EI to assure the accuracy and reliability of the data contained in this publication; however, the EI makes no representation, warranty or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any local or regional laws or regulations with which this publication may conflict.

Suggested revisions are invited and should be submitted to the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR (e: technical@energyinst.org).

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Project co-ordination and editing were undertaken by Martin Hunnybun (EI).

# 1 INTRODUCTION AND SCOPE

## 1.1 INTRODUCTION

This publication describes laboratory tests and the minimum laboratory performance levels for selected aspects of the performance of dirt defence filter elements for use in aviation fuel[1] handling systems. A dirt defence filter system comprises a pressure vessel containing one or more dirt defence filter elements of any category. Dirt defence filter vessels may be oriented vertically or horizontally.

The intended performance of a dirt defence filter system is to continuously remove dirt from aviation fuel to levels acceptable for servicing modern aircraft. It is also intended that in service, a dirt defence filter system will restrict the flow of fuel before its capacity for dirt removal is exhausted.

A dirt defence filter system is not a fail-safe device for protecting aviation fuel quality. The performance of dirt defence filter elements that comply with the mandatory requirements of this publication may be sensitive to certain operational conditions, such as flow rate or stop-starts. Dirt defence filter elements may differ in design, in the selection of filtration materials and in construction. These issues should be separately addressed between the user and the manufacturer to ensure that the performance capabilities of the filtration equipment are suitable for the intended application.

**The use of dirt defence filters that meet the requirements of EI 1599 alone cannot provide assurance that fuel delivered to aircraft will meet minimum cleanliness requirements. It is envisaged that dirt defence filter systems will be used in conjunction with a quantitative electronic water sensor (EI 1598) that ensures free water content in fuel (if present) is within acceptable limits. Dirt defence filter systems shall therefore be regarded as only one component in a comprehensive system to protect aviation fuel quality.**

**In no event shall any manufacturer represent a dirt defence filter as being 'fit for purpose' in aviation fuelling operations on the sole basis of meeting the minimum laboratory performance levels included in this publication. Nor shall the minimum laboratory performance tests described in this publication be taken as the only aspects of performance that a user should investigate prior to the routine use in their operations of any equipment that meets the requirements of those tests.**

## 1.2 SCOPE

This publication provides minimum requirements for:

(1) selected aspects of dirt defence filter element performance;

1 Although the intended use of a dirt defence filter may be in aviation fuel conforming to various national/regional fuel specifications, the qualification testing procedures of this publication standardise on the use of a jet fuel conforming to ASTM D1655 or DEF STAN 91-091 only (but see also footnote to 5.2.1). Users generally consider dirt defence filter performance to be the same when used in jet fuels meeting other specifications. Note that dirt defence filter performance assessed by this publication is also applicable to dirt defence filter performance in any semi-synthetic or fully synthetic jet fuel that meets the requirements of ASTM D7556/D1655 or DEF STAN 91-091.

(2) the general mechanical specifications for dirt defence filter elements;

(3) laboratory tests and minimum performance requirements for the first article qualification of new dirt defence filter element models, and

(4) requalification and similarity.

This scope of this publication is limited to the dirt defence filter diameters as shown in Table 1.

**Table 1: Diameters of dirt defence filter elements within scope of EI 1599**

| Nominal diameter | Flow format | Design pressure | Qualification Test 2 minimum time to dP of 1,5 bar (10 mg/l solids removal at rated flow) |
|---|---|---|---|
| 50 mm (2 in.) | Out-to-in | High (HP) | 10 minutes |
| 125 mm (5 in.) | Out-to-in | Low (LP) | 50 minutes |
| 150 mm (6 in.) | Out-to-in | High (HP) | 50 minutes |
| 150 mm (6 in.) | In-to-out | High (HP) | 50 minutes |

This publication does not address:

– Specific material requirements for the dirt defence filter element (other than those known to have an effect on fuel compatibility).

– Nominal diameters of elements other than 50 mm (2 in.), 125 mm (5 in.) or 150 mm (6 in.).

– Particulate matter removal performance testing in low flash point fuels.[2]

– Maintenance or service life performance.

– Certain aspects of design and performance necessary to provide products that are fit for a particular purpose. Many aspects of the dirt defence filter system performance are neither measured nor controlled by this publication. Dirt defence filter elements may differ in design in the selection of filtration media used.

– Any filter element technology that is designed to intentionally remove free water from aviation fuel (the qualification tests contained in this publication do not include water removal performance).

## 1.3 DEFINITIONS

### 1.3.1 Dirt defence filter system

A dirt defence filter system is a pressure vessel containing dirt defence filter elements. A dirt defence filter system is not, by itself, a fail-safe device. Dirt defence filter systems shall be regarded as one component in a comprehensive system to protect aviation fuel quality.

2 Due to safety issues with the handling of low flash point fuels, the particulate matter removal tests use only jet fuels. Extending the applicability of EI 1599 dirt defence filter elements to aviation gasoline is based on historical use in ASTM D910/DEF STAN 91-090 filtration applications. These specifications contain leaded aviation gasoline grades that are hydrocarbon-based and have aromatics content that is similar to jet fuel (≤ 25 vol%). Aviation gasolines that are not hydrocarbon-based (e.g. contain heteroatoms) and/or are highly aromatic (e.g. some unleaded aviation gasolines) may require different material compatibility considerations that are outside the scope of this standard.

### 1.3.2 Dirt defence filter element

A dirt defence filter element[3] is the consumable component of a dirt defence filter system with dirt removal capabilities. Dirt defence filter element models are defined by this specification on the basis of their nominal diameter, the fuel flow direction through them and their design pressure, as shown in Table 1.

### 1.3.3 Qualified element model

A qualified element model is one of specific design and construction that is documented by a manufacturer, and confirmed by a representative of the purchaser/user, to meet all mandatory tests specified in this publication. Any design, construction, materials or manufacturing changes to the qualified element model that exceed those described in section 8 shall constitute the creation of a new element model requiring full qualification.

All production elements are required to be identical in their design, construction and materials to the qualified model.

Qualification testing may be undertaken with a test vessel in either vertical or horizontal orientation. The qualification testing qualifies the model of dirt defence filter for use in vessels in either orientation.

For a model of dirt defence filter that is intended to be deployed in a dirt defence filter system with one element only, the longest element in the dirt defence filter range is to be tested and all shorter elements automatically qualify.

The qualification of an element model is limited to the nominal diameter tested only. There is no automatic qualification between models of different nominal diameters. All nominal diameter models shall be qualified separately.

### 1.3.4 Single-element qualification test

A single-element qualification test is a test that is performed with one dirt defence filter element in a purpose-built pressure vessel (as opposed to a full-scale test), with fuel flowing in single-pass mode through the test facility. For a single-element qualification test, there has to be a sufficient volume of fuel in tank #1 to complete the test.

### 1.3.5 Dirt defence filter vessel

Dirt defence filter vessels for high-pressure, multi-element applications shall meet the requirements of EI 1596 *Design and construction of aviation fuel filter vessels*. Dirt defence filter housings for low-pressure, single-element applications should meet the requirements of EI 1587 *Recommended practice for single cartridge filtration units for aviation fuel*, Annex A.

3 The terms ‘element’ and ‘cartridge’ are synonymous.