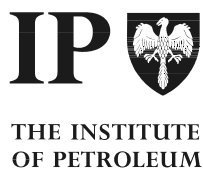


SPECIFICATIONS AND QUALIFICATION PROCEDURES
FOR AVIATION JET FUEL FILTER/SEPARATORS

API/IP SPECIFICATION 1581

Fifth edition
July 2002



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Published jointly by
American Petroleum Institute
and
The Institute of Petroleum, London
A charitable company limited by guarantee

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ISBN 0 85293 371 1

Published by The Institute of Petroleum

Further copies can be obtained from Portland Customer Services. Commerce Way,
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email: sales@portland-services.com

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FOREWORD

This publication is designed to provide comprehensive specifications and qualification test procedures for filter/separators used in systems that handle aviation jet fuel and is the result of collaboration between the American Petroleum Institute and the Institute of Petroleum. This publication is one of a series of joint standards related to aviation fuel handling.

The specifications in this publication are provided for the convenience of purchasers and manufacturers in fabricating and supplying filter/separators, but in no way prohibit either purchasers or manufacturers from purchasing or manufacturing equipment that meets other requirements.

Changes in construction, media, cross section of elements or in vessel design (general, profile and flow pattern) from that tested and qualified shall constitute a redesign, thereby nullifying previous approvals. Redesigned units shall be requalified.

Once an element model has been qualified, the manufacturer shall not change any aspect of element design or materials without prior approval from the purchaser(s) or requalifying the element in accordance with the conditions defined in this specification.

If the purchaser(s) is requested to approve a change to an element model then the purchaser(s) has the right to request a partial or complete retest of the filter/separator by the manufacturer to confirm its performance still complies with these specifications. Purchasers may also request partial or complete retests should they have reasonable grounds for believing the performance of the filter/separator has deteriorated from the original qualification tests.

A product quality assurance program shall be in place. As a minimum, such a program shall include the annual single-element testing of each element model by the test procedure in this publication using the fuel of the most stringent category for which the element was qualified. The test results shall be filed with the results of the qualification tests for the subject elements and shall be made available upon request.

Purchasers buying equipment in accordance with this publication should be aware that they have the right to conduct their own inspection independently of any supervisory inspection furnished by the manufacturer. Such an inspection should be based on the specifications of this publication. In addition, purchasers should avail themselves of audit reports of qualification tests and facilities inspections that may have been undertaken as part of an industry certification program.

The main change included in this 5th edition of API/IP 1581 is to remove Petronate L from all the test chemistries. Testing has shown that products currently qualified to the 4th edition meet 5th edition requirements for the category tested so that re-qualification is not required. This read-across from the 4th to the 5th edition applies only to the category tested and does not reduce the performance requirements of products produced to this publication.

The 4th edition of API/IP 1581 included a number of significant changes from the 3rd edition. While changes in the first three editions served mainly to improve the consistency of aviation filtration equipment, changes in the 4th edition were primarily designed to raise the level of performance and reduce the uncertainty inherent in aviation filtration. Specifically:

- The classes (A-C) of performance levels were eliminated. The analysis of data from the field indicated that product contained approximately the same magnitude of particulate through the entire handling system. This resulted in the conclusion that filtration needed to be equally effective at all points in the handling system. Water handling capacity of new systems on refuelling equipment was also enhanced. Finally, a coalescer element with minimal dirt handling capacity was specified, known as S-LD for low dirt, for use in intrinsically clean systems or in concert with microfilter systems.
- The group classification (I without and II with additives) of filter/separator systems was eliminated in favour of three new categories (M100 for JP-8+100, M for JP-8/JP-5, and C for Jet A/A1). That change brought commercial and military filtration requirements into a single specification.
- The composition of the test dirt was changed to ensure that it is a more consistent size (about 1 µm) than the dirt in the first three editions. This reduces the effect of agglomeration and provides for more consistent and realistic results.
- The inclusion of one or more additional stages to a filter/coalescer and separator system was explicitly permitted. Additional stages envisioned included a water absorbing or fuse stage located inside separators, and/or a prefilter stage located inside filter/coalescers.
- The testing protocol was changed to reduce the effort needed to qualify new elements. The individual runs are longer (water, dirt, water, 3 % water) but only one single-element test is needed for each model and configuration of filter/separator system. Multiple full-scale tests may reference one single-element test.
- Access to the information about the vessel and contents was improved by defining specific information on permanent labels affixed to the vessel.
- Access to the baseplate of new vessels was improved by decreasing the length versus diameter ratio of vessels.
- The similarity system was split into a separate document (API/IP 1582 *Specification for similarity for API/IP 1581 aviation jet fuel filter/separators*, February 2001) to permit the development of a more robust system.

As a result of the extensive changes from the 3rd to 5th editions, which enable significantly improved aviation filtration performance, delay is expected between the publication of this edition and the availability of elements qualified to it. The API Monogram Program will recognise the previous edition for one year after the publication of this edition. However, because of the benefits of this technology, it is recommended that API/IP 1581 5th edition elements be qualified and offered as soon as practical.

The American Petroleum Institute and The Institute of Petroleum are not undertaking to meet the duties of employers, manufacturers or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local and regional laws and regulations.

Nothing contained in any American Petroleum Institute or Institute of Petroleum joint publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring

anyone against liability for infringement of letters patent.

It is hoped and anticipated that this publication will assist both the manufacturers and purchasers of jet fuel filter/separators. Every effort has been made by the American Petroleum Institute and the Institute of Petroleum to assure the accuracy and reliability of the data contained in this publication; however, API and IP make no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaim 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 director of the Downstream segment, American Petroleum Institute, 1220 L Street, N. W., Washington, D.C. 20005, or the Technical Department, The Institute of Petroleum, 61 New Cavendish Street, London, W1G 7AR.

ACKNOWLEDGEMENTS

This publication was prepared on behalf of the API/IP Aviation Fuel Filtration Committee by Mr D. Hoskin (ExxonMobil Research and Engineering). Technical review and feedback were provided by representatives of the following companies:

AgipPetroli
Air BP Limited
Air Total
Aviation Fuel Services & Management GmbH
Caltex Corporation
Chevron Products Co.
Conoco Limited
Equilon Enterprises
ExxonMobil Aviation International Ltd.
ExxonMobil Research & Engineering
Facet International
Faudi Aviation Fuel Filtration GmbH
Fuel Technology Associates, L.L.C.
Kuwait Petroleum International Aviation Company Limited
Pall Corporation
Parker Hannifin Corporation
Phillips 66 Company
Shell Aviation Ltd.
Shell Global Solutions
Texaco Ltd.
United Airlines
Velcon Filters
Vic Hughes Associates Ltd.

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GENERAL

1.1 SCOPE

- (a) This publication specifies the minimum performance and mechanical requirements and the testing and qualification procedures for aviation jet fuel filter/separators with flow rates ranging up to 9 500 lpm (2 500 gpm).
- (b) This specification defines procedures to qualify filter/separators with and without multi-stages. It does not qualify the actual multi-stage device(s).
- (c) The inclusion of additive packages in this publication is for testing purposes only and does not constitute acceptance or rejection of these additives in jet fuels by API/IP.
- (d) The performance specifications in this publication are for testing purposes only and do not necessarily constitute recommendations by API/IP for specifications in any application of the filter/separators.
- (e) Filter/separator systems currently qualified to the 4th edition of this specification are qualified as meeting the performance requirements of this

edition for the category tested. This provision does not reduce the performance requirements of products stated to meet this specification.

1.2 REFERENCED PUBLICATIONS

The following publications are cited in this publication:
Note: For this standard, the latest available edition of each referenced publication applies.

API/IP¹

- 1582 *Specification for similarity for API/IP 1581 aviation jet fuel filter/separators*
- 1583 *Specifications and qualification procedures for aviation fuel filter monitors with absorbent type elements*

ASME²

Boiler and pressure vessel code, Section VIII: Rules for construction of boilers and pressure vessels

¹ Available from Portland Customer Services. Commerce Way, Whitehall Industrial Estate, Colchester, CO2 8HP. Tel: +44(0)1206 796 351, email: sales@portland-services.com; or API Publications, Global Engineering Documents, 15 Inverness Way East, M/S C303B, Englewood, CO80112-5776, USA. Tel: 303 397 7956, Fax: 303 397 2740, www.api.org

² ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org

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ASTM ³	U.S. Military Specifications ⁴
D 156 <i>Test method for saybolt color of petroleum products (Saybolt chromometer method)</i>	MIL-PRF-4556: <i>Coating kit, epoxy, for interior of steel fuel tanks</i>
D 381 <i>Test method for existent gum in fuels by jet evaporation</i>	MIL-C-5541: <i>Chemical conversion coatings on aluminum and aluminum alloys</i>
D 1094 <i>Test method for water reaction of aviation fuels</i>	MIL-PRF-25017: <i>Inhibitor, corrosion/lubricity improver, fuel soluble</i>
D 1655 <i>Specification for aviation turbine fuels</i>	MIL-DTL-83133: <i>Turbine fuels, aviation, kerosene types, NATO F-34 (JP-8), NATO F-35, and JP-8+100</i>
D 2276 <i>Test method for particulate contaminant in aviation fuel by line sampling</i>	MIL-DTL-5624: <i>Turbine fuel, aviation, grades JP-4, JP-5, and JP-5/8 ST</i>
D 2624 <i>Test method for electrical conductivity of aviation and distillate fuels</i>	
D 3240 <i>Test method for undissolved water in aviation turbine fuels</i>	Joint Inspection Group Specifications ⁵
D 3948 <i>Test method for determining water separation characteristics of aviation turbine fuels by portable separometer</i>	AFQRJOS <i>Aviation fuel quality requirements for joint operating systems</i>
D 4171 <i>Standard specification for fuel system icing inhibitors</i>	

³ ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org

⁴ Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. U.S. military specifications are also available online from the ASSIST database at <http://astimage.daps.dia.mil/quicksearch>

⁵ Available from the Joint Inspection Group, c/o 35 Abercorn Place, London, NW8 9DR, UK.

2

DESCRIPTION

2.1 GENERAL

2.1.1 Filter/separator

A filter/separator is a vessel containing filter/coalescer and separator elements that continuously removes dirt and water from aviation jet fuel to levels acceptable for servicing modern aircraft. A filter/separator can have either a vertical or a horizontal configuration. A filter/separator can consist of multiple stages.

2.1.1.1 A two-stage system consists of filter/coalescer and separator elements contained within a vessel. The fuel flows through the filter/coalescer element(s) into the vessel and then flows through the separator element(s) to exit the vessel.

2.1.1.2 A multi-stage system consists of a two-stage system that contains one or more additional stages. Additional stages may include currently qualified devices⁶ located within each separator element capable of shutting off fuel flow if the filter/coalescer and separator elements fail to remove water to an acceptable level. Additional stages may also include currently

qualified devices⁶ located within each coalescer element designed to remove dirt (prefilter) or contaminants (adsorption stage).

2.1.2 Filter/coalescer

A filter/coalescer is an element that is capable of removing dirt and of coalescing fine droplets of water in the fuel to sizes that can be removed in the filter/separator vessel. Filter/coalescers are classified as Type S and Type S-LD (low dirt) according to the amount of dirt the elements are capable of removing as defined in Section 2.3.

2.1.3 Separator

A separator is an element that prevents water droplets (coalesced by the filter/coalescer) from leaving the vessel in the effluent stream.

2.1.4 Filter/separators

For the purpose of this specification, filter/separators are qualified for one or more of the three categories defined in Section 2.2.

⁶ A qualified device is any device that meets a documented performance specification agreed to by purchaser and manufacturer.

2.1.5 Abbreviations

The following abbreviations and terms are used within:

cm:	centimetre
gallon:	U.S. gallon
gpm:	U.S. gallons per minute
kPa:	kilopascals (1 kPa = 0,144 psi)
l:	litre
lpm:	litre per minute
mg:	milligram
mg/l:	milligram per litre
ml:	millilitre
mm:	millimetre
pinhole leak:	A structural failure less than 1 mm in size. Discoloration on the sock of a filter/coalescer may indicate the presence of a pinhole leak but further investigation is necessary to ascertain
ppmv:	parts per million by volume
psi:	pounds per square inch (1 psi = 6,95 kPa)
pS/m:	picosiemens per metre (1 pS/m = 10^{-12} siemens/metre. 1 siemens = 1 mho = 1 ohm^{-1} = 1 ampere per volt)
rated flow:	Rated Flow is the flow rate used for testing the performance of a filter/separator system in accordance with this specification. Note that the rated flow of a filter/separator system (meeting all specification requirements) is the maximum flow rate for that system in field applications
rpm:	revolutions per minute
s/s:	start/stop

2.2 CATEGORIES

2.2.1 Category C

2.2.1.1 Category C filter/separators (for commercial aviation fuel) are tested with a fuel containing an additive package in accordance with the procedures described in Section 4.

2.2.1.2 Category C filter/separators, coalescer/separators and multi-stage systems are suitable for use with aviation turbine fuels that might contain surfactants but do not contain dispersant additives used in some military applications to enhance the thermal stability performance of jet fuel.

2.2.2 Category M100

2.2.2.1 Category M100 filter/separators (for thermal stability enhanced military aviation turbine fuels) are tested with fuel containing an additive package that includes a dispersant, used to enhance thermal stability, in accordance with the procedures described in Section 4.

2.2.2.2 Category M100 filter/separators, coalescer/separators and multi-stage systems are suitable for use primarily with military aviation turbine fuels that include dispersant additives such as those used to enhance thermal stability.

2.2.3 Category M

2.2.3.1 Category M filter/separators (for military aviation turbine fuels) are tested with fuel containing an additive package used in military fuels in accordance with the procedures described in Section 4.

2.2.3.2 Category M filter/separators, coalescer/separators and multi-stage systems are suitable for use primarily with military aviation turbine fuels that contain static dissipater additive, metal deactivator additive, anti-oxidant, corrosion inhibitor, and anti-icing additive.

2.3 USES AND QUALIFICATION REQUIREMENTS

2.3.1 Filter/separators

Filter/separators can be used at all filtration points in an aviation fuelling system.

2.3.2 Type S filter/separators

Type S filter/separators can be used at filtration points where significant levels of water and dirt in the product can be expected. The qualification requirements for Type S filter/separators are:

- (a) The Type S filter/separator shall have a solids holding capacity totalling 1,43 grams per lpm (19 mg/l for 75 minutes) (5,4 grams per gpm) of rated flow without exceeding the pressure drop and contamination of the effluent fuel as specified in Sections 3.1.3.1 and 3.1.1 respectively. Note that

maximum dirt-holding capacity is not tested in full-scale testing.

- (b) The filter/separator shall be able to effectively remove water from fuel without exceeding the effluent free-water levels specified in Section 3.1.1 when water is added according to the procedures specified in Section 4.

2.3.3 Type S-LD filter/separators

Type S-LD filter/separators (also known as coalescer/separators) can be used at all filtration points in an aviation fuelling system where significant levels of water but minimal amounts of dirt can be expected in the jet fuel. Examples of suitable locations could be immediately after a microfilter (used to remove dirt to acceptable levels) or at locations where acceptable dirt levels can be achieved without filtration. The qualification requirements for coalescer/separators are:

- (a) The Type S-LD filter/separator shall be able to maintain rated flow when it is contaminated with particulate to the level specified in Section 4 without the contamination in the effluent fuel exceeding the level specified in Section 3.1.1.
- (b) The Type S-LD filter/separator shall be able to effectively remove water from fuel without exceeding the effluent free-water levels specified in Section 3.1.1 when water is added according to the procedures specified in Section 4.

2.3.4 Multi-stage systems

2.3.4.1 Multi-stage systems can be used at all filtration points in an aviation fuelling system where two-stage filter/separators are used but where additional performance or assurance is desired. Multi-stage devices include pre-filters (upstream of filter/coalescers) and water absorbing elements (downstream of separators). Water absorbing elements can be used for additional assurance that effluent water

will not exceed the level specified in Section 3.1.1. Examples of such locations could be systems where surfactants or additives might impair filter/separator performance or on fuellers and hydrant servicers where an additional precaution may be desired to keep water from aircraft.

2.3.4.2 The qualification requirement for a multi-stage system is that the filter/separator shall be able to qualify under Section 2.3.2 or 2.3.3 when the multi-stage devices are installed.

Note: This specification applies only to the filter/separator portion of the system. No specific level of performance by a multi-stage system is implied by this specification.

2.4 QUALIFICATION FOR OTHER CATEGORY AND/OR TYPE SYSTEMS

2.4.1 Categories

2.4.1.1 Single-element testing

For single-element testing there is no automatic qualification between categories. Qualification for each category shall be established by testing.

2.4.1.2 Full-scale testing

- (a) Filter/separators qualified by testing to Category M100 also qualify for Category M at the test flow rate and conditions.
- (b) Filter/separators qualified by testing to Category M also qualify for Category C at the test flow rate and conditions.

Note: Category M100 testing does not qualify to Category C.

2.4.2 Filter/separators qualified as Type S

Filter/separators qualified as Type S by testing also qualify as Type S-LD at the tested flow rate and conditions.