AEROSPACE RECOMMENDED PRACTICE

ARP1400	REV. B

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Reaffirmed 2014-07

Superseding ARP1400A

(R) Recommended Practices for Lubricating Oil Filters, General Aviation Reciprocating Engine (Piston Type) Aircraft

RATIONALE

ARP1400B has been reaffirmed to comply with the SAE five-year review policy.

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1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) establishes the requirements for lubricating oil filters for general aviation reciprocating engine applications with lubricating oil systems normally operating in a pressure range of 345 to 689 kPa (50 to100 psig).

1.1 Purpose:

This document defines uniform parameters for the design, manufacture, and test of filters for general aviation lubricating oil systems for aircraft type piston engines.

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J363	Filter Base Mountings
SAE HS 806	SAE Oil Filter Test Procedure
ARP24	Determination of Hydraulic Pressure Drop
AS478	Identification Marking Methods
AS567	General Practices for Use of Lock Wire, Key Washers and Cotter Pins
ARP901	Bubble Point Test Method
SAE J1260	Standard Oil Filter Test Oil
SAE J1858	Full Flow Lubricating Oil Filters Multipass Method
SAE J1899	Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)
SAE J1966	Lubricating Oil, Aircraft Piston Engine (Non-Dispersant Mineral Oil)

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-595 Colors

MIL-STD-889	Dissimilar Metals
MIL-H-5606	Hydraulic Fluid, Petroleum Base

2.3 Industry Standards:

Available from American Society for Quality Control, 611 East Wisconsin Ave., Milwaukee, WI 53202.

ANSI/ASQC Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes

3. CLASSIFICATION OF FILTERS AND ACCESSORIES:

Lubricating oil filters shall be in accordance with the following categories:

3.1 Category IA:

Shell and bolt types (filter assemblies with reusable housings and noncleanable filter elements).

Consists of:

a. 1 Shell per Figure 1
b. 1 Bolt per Figure 2
c. 1 Cover Plate per Figure 3
d. 1 Cover to Shell Gasket per Figure 4
e. 1 Cover to Adapter Gasket per Figure 5
f. 1 Assembly Nut per Figure 6
g. 1 Filter Element per Figure 7
h. 1 Bolt to Shell Gasket per Figure 8
i. 1 Installation Instruction Sheet

3.2 Category IB:

Replacement Filter Element Kits for Shell and Bolt Type Filter Assemblies

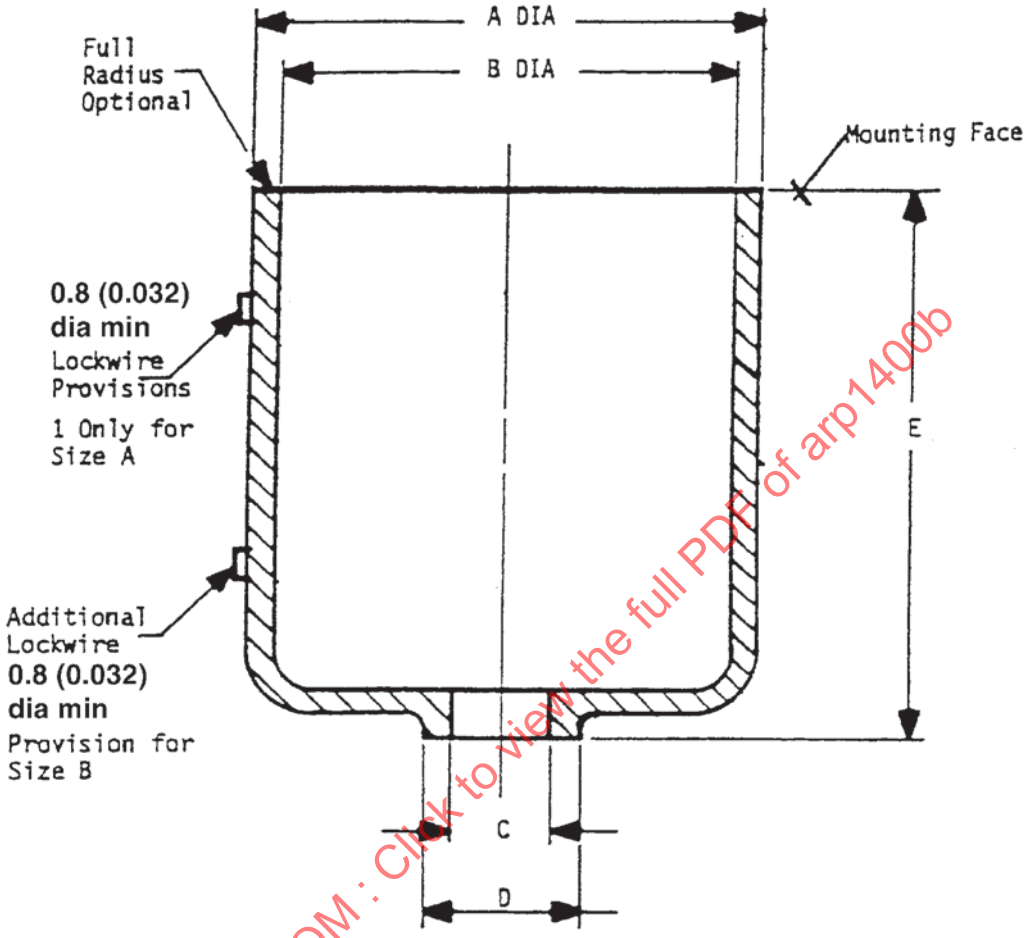
Consists of:

a. 1 Filter Element per Figure 7
b. 1 Cover to Shell Gasket per Figure 4
c. 1 Cover to Adapter Gasket per Figure 5
d. 1 Bolt to Shell Gasket per Figure 8
e. 1 Installation Instruction Sheet

3.3 Category II: Spin-on Types (Non-cleanable Filter Assemblies):

3.3.1 Category IIA consists of

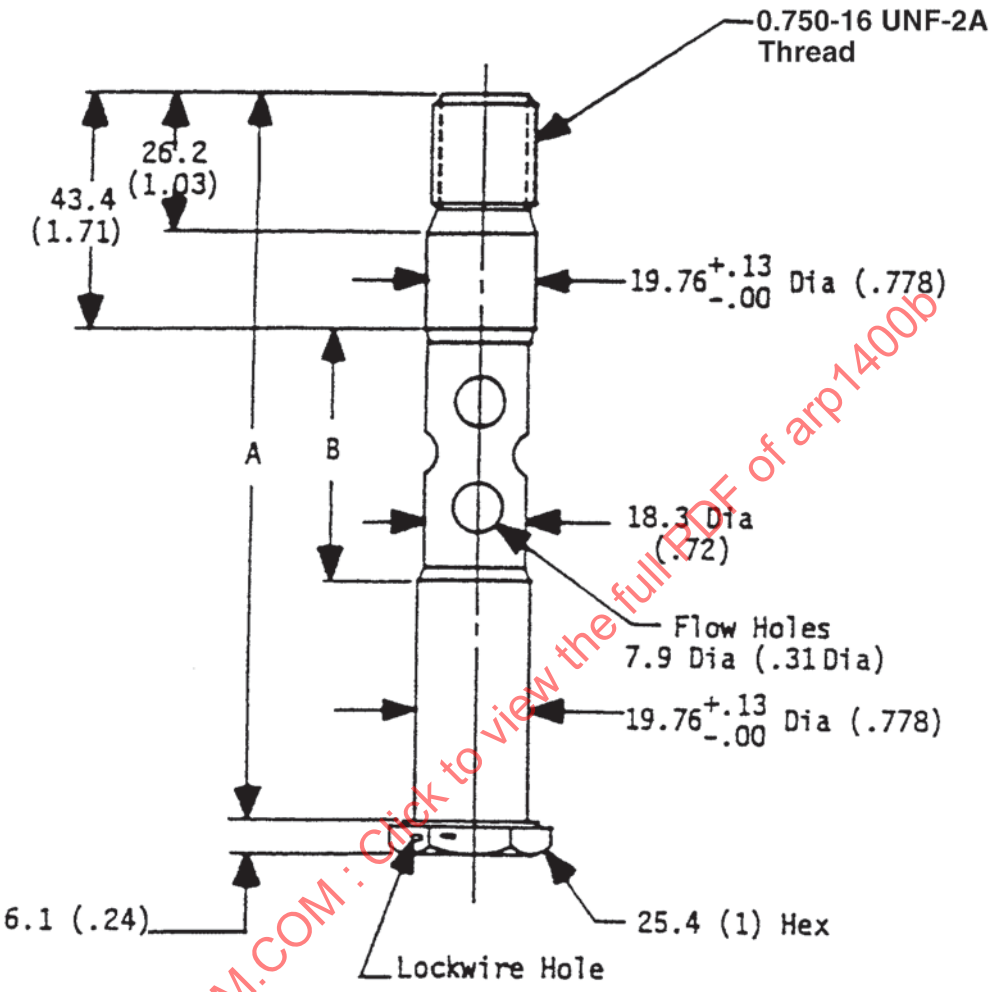
1 Female Threaded Non-cleanable Housing Containing Integral Filter Element and Attached Adapter-to-Filter Seal. See Figure 9.



SIZE	mm (inch) A(MAX.)	B	C	D	E
SHORT	101.1	92.7	$20.32^{+.25}_{-.13}$	30.2	110.2
	(3.98)	(3.65)	$0.8^{+.010}_{-.005}$	(1.19)	(4.34)
LONG	101.1	92.7	$20.32^{+.25}_{-.13}$	30.2	150.9
	(3.98)	(3.65)	$0.8^{+.010}_{-.005}$	(1.19)	(5.94)

ALL DIMENSIONS: mm (inch)

FIGURE 1 - Shell (Bolt-on Types) Category IA



	mm (inch)			
SIZE	A		B	
SHORT	131.8	(5.19)	45.2	(1.78)
LONG	172.0	(6.79)	85.9	(3.38)

ALL DIMENSIONS: mm (inch)

FIGURE 2 - Bolt (for Shell and Bolt Style Filters)

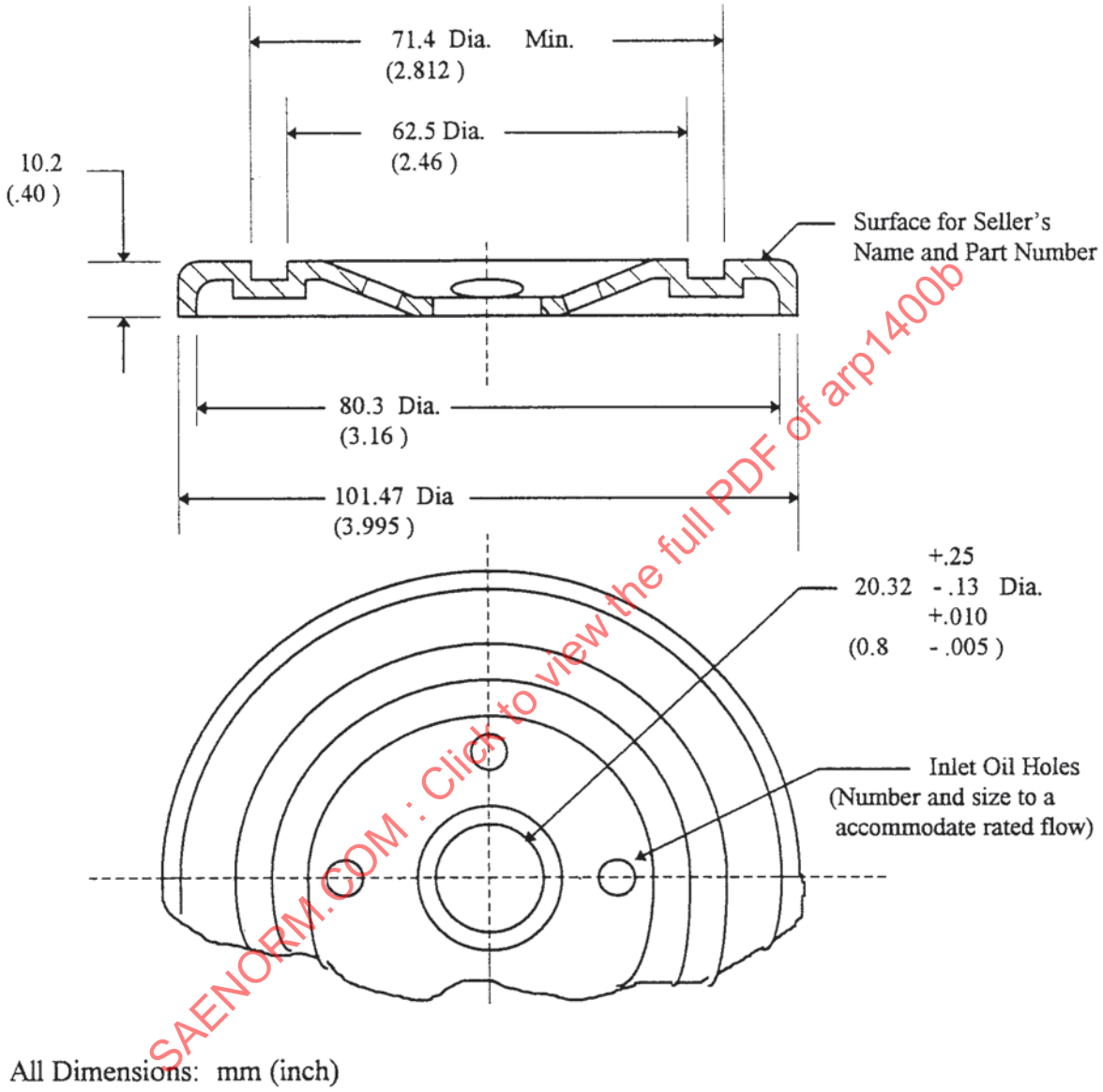


FIGURE 3 - Cover Plate (Category IA)

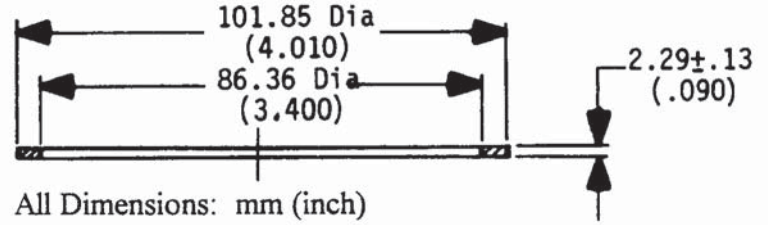


FIGURE 4 - Cover to Shell Gasket

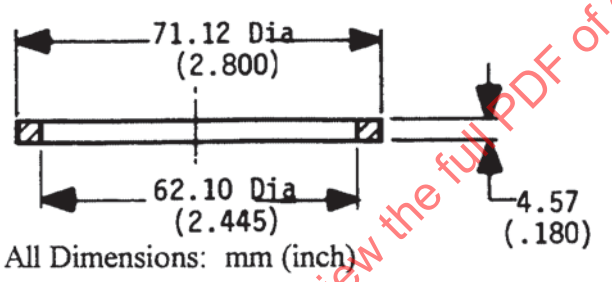


FIGURE 5 - Cover to Adapter Gasket

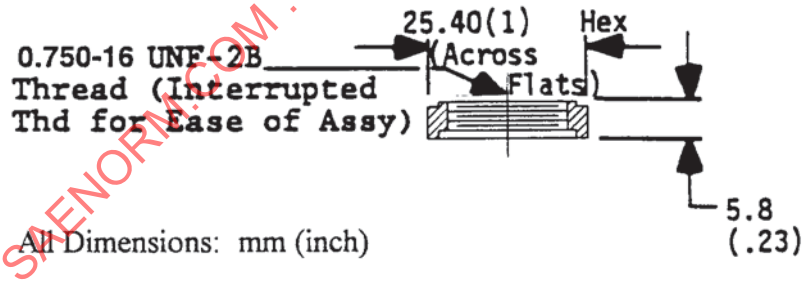
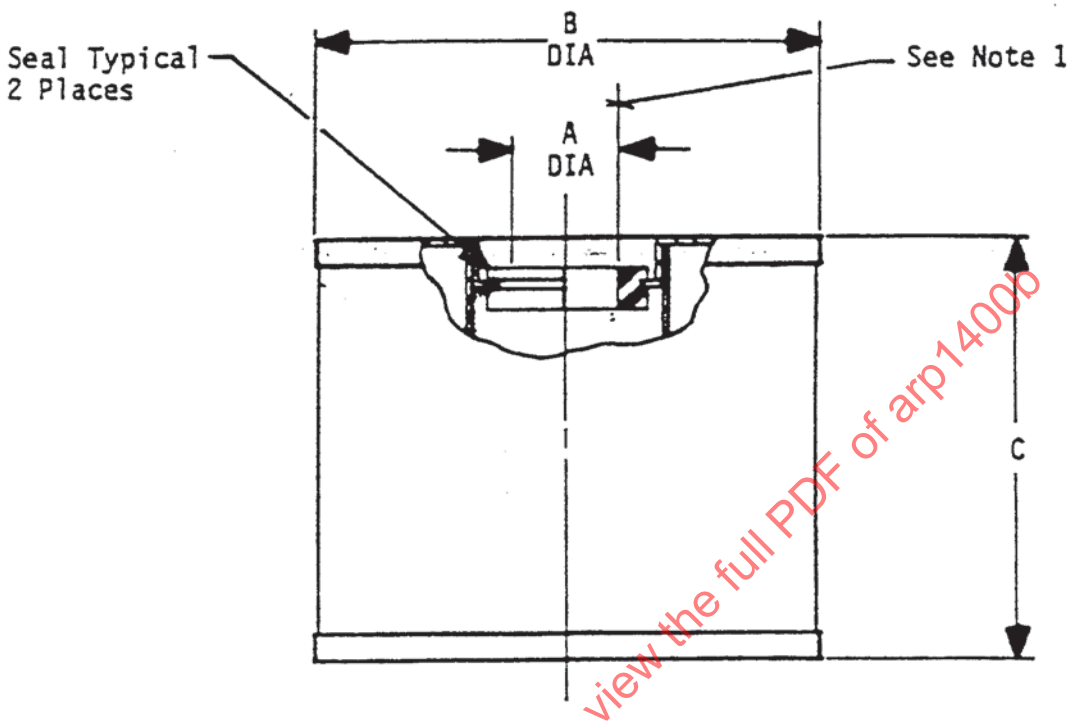


FIGURE 6 - Assembly Nut



Note 1: This installed seal diameter shall permit assembly on bolt per Figure 2 when lubricated with SAE 40 or 50 wt. aviation oil without extrusion or undue force. An oil tight seal shall be established between bolt and filter element.

Note 2: End caps must be perpendicular to filter media within 3.2 (0.126) over length of filter element.

	mm (inch)		
SIZE	A DIA.	B DIA.	C
SHORT	19.30 ± .13 (0.76 ± 0.005)	87.9 ± 1.0 (3.46 ± 0.04)	74.9 ± 1.5 (2.95 ± 0.06)
LONG	19.30 ± .13 (0.76 ± 0.005)	87.9 ± 1.0 (3.46 ± 0.04)	116.1 ± 1.5 (4.57 ± 0.06)

All Dimensions: mm (inch)

FIGURE 7 - Filter Element (Category IA and IB)

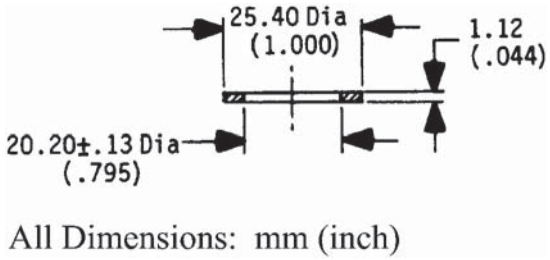
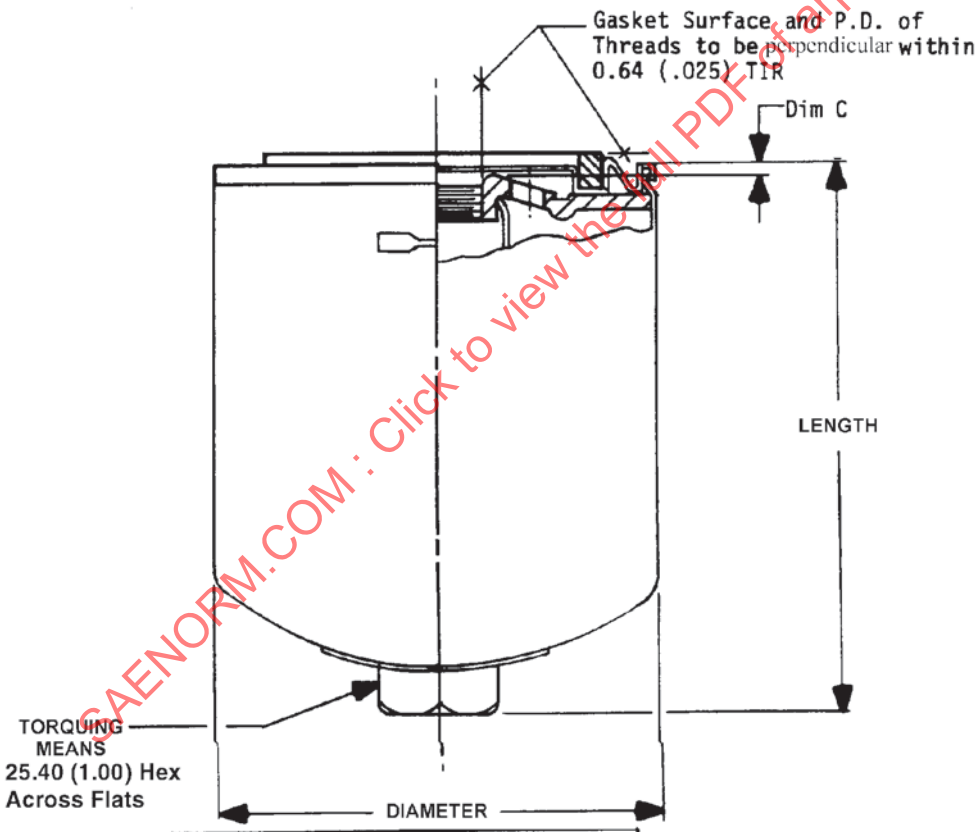


FIGURE 8 - Bolt to Shell Gasket



	mm (inch)			
SIZE	LENGTH (MAX)	DIA (MAX)	C (REF)	RECOM. THD SIZE
SHORT	124.0 (4.88)	99.1 (3.90)	4.06 (0.16)	0.750-16 UNF-2B
LONG	165.1 (6.50)	99.1 (3.90)	4.06 (0.16)	0.750-16 UNF-2B

All Dimensions: mm (inch)

FIGURE 9 - Spin-on Filter Assembly (Category IIA)

3.3.2 Category IIB[1] consists of:

1 Male Threaded Non-cleanable Housing Containing Integral Filter Element and Attached Adapter-to-Filter Seal. See Figure 10.

3.4 Category III: Converter Kit - for conversion from Bolt and Shell Type Filters (Categories IA and IB) to Spin-on type non-cleanable filter (Category II):

Consists of:

a. 1 Converter Plate Assembly
b. 1 Converter Stud
c. 1 Instruction Sheet

(See Interface Definition - Figure 11)

4. REQUIREMENTS:

4.1 Design and Construction:

4.1.1 Shell and Bolt Type Filter Assemblies (Category IA) shall be designed and constructed such that the filter elements and housing seals may be readily removed from and replaced in the filter housing without the use of special tools.

4.1.2 Spin-on Type Filter Assemblies (Category II) shall be designed such that the filter housing, filter element and mounting base seal are preferably discarded as a unit.

4.1.3 The filter assemblies covered by this document shall be of the full-flow type (i.e., the total pump outlet flow shall be filtered; not a partial flow “slip stream” filter).

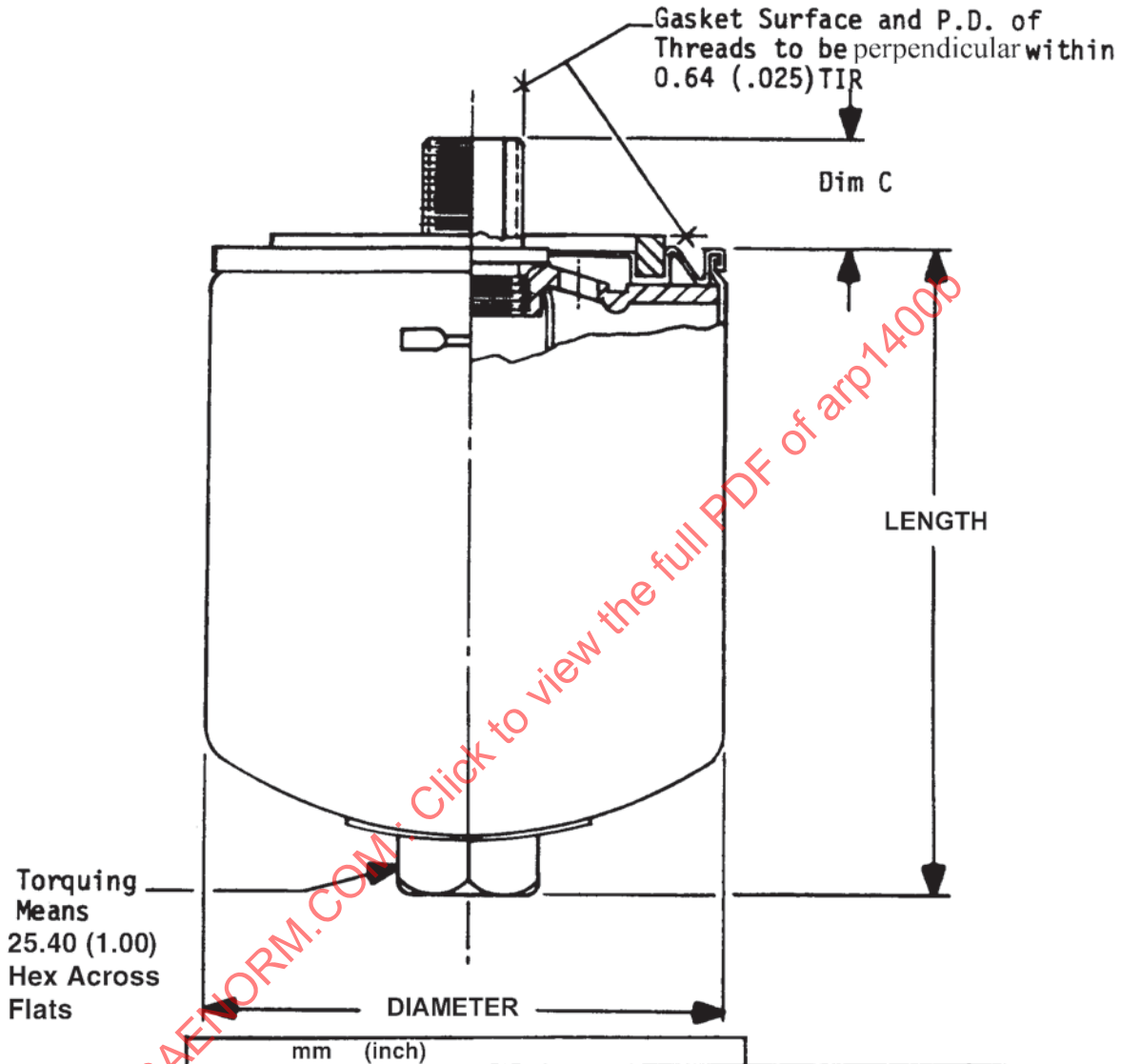
4.1.4 All filter assemblies shall incorporate suitable provisions for safety-wiring the filter assembly to the aircraft engine, if permitted by the procuring authority, otherwise an alternate secondary locking arrangement may be necessary. Lockwire shall be 0.8 mm (0.032 in) dia min.

4.1.5 AS567 shall be used as a guide for safety wiring requirements.

4.1.6 The weight of the filter assembly shall be kept to the practical minimum consistent with good design practice. The vendor shall specify the maximum weight of each filter assembly on the applicable drawing.

4.1.7 Wrench caps or nuts shall be designed to withstand 9.0 N·m (80 lbf-in) torque (minimum) without damage or permanent deformation (Category II Filters).

1. For usage, refer to filter or engine manufacturers’ catalogs.



SIZE	LENGTH (MAX)	DIA (MAX)	C (REF)	RECOM. THD SIZE
	mm (inch)			
SHORT	124.0 (4.88)	99.1 (3.90)	9.7 (0.38)	0.750-16 UNF-2A
LONG	165.1 (6.50)	99.1 (3.90)	9.7 (0.38)	0.750-16 UNF-2A

All Dimensions: mm (inch)

FIGURE 10 - Spin-on Filter Assembly (Category IIB)

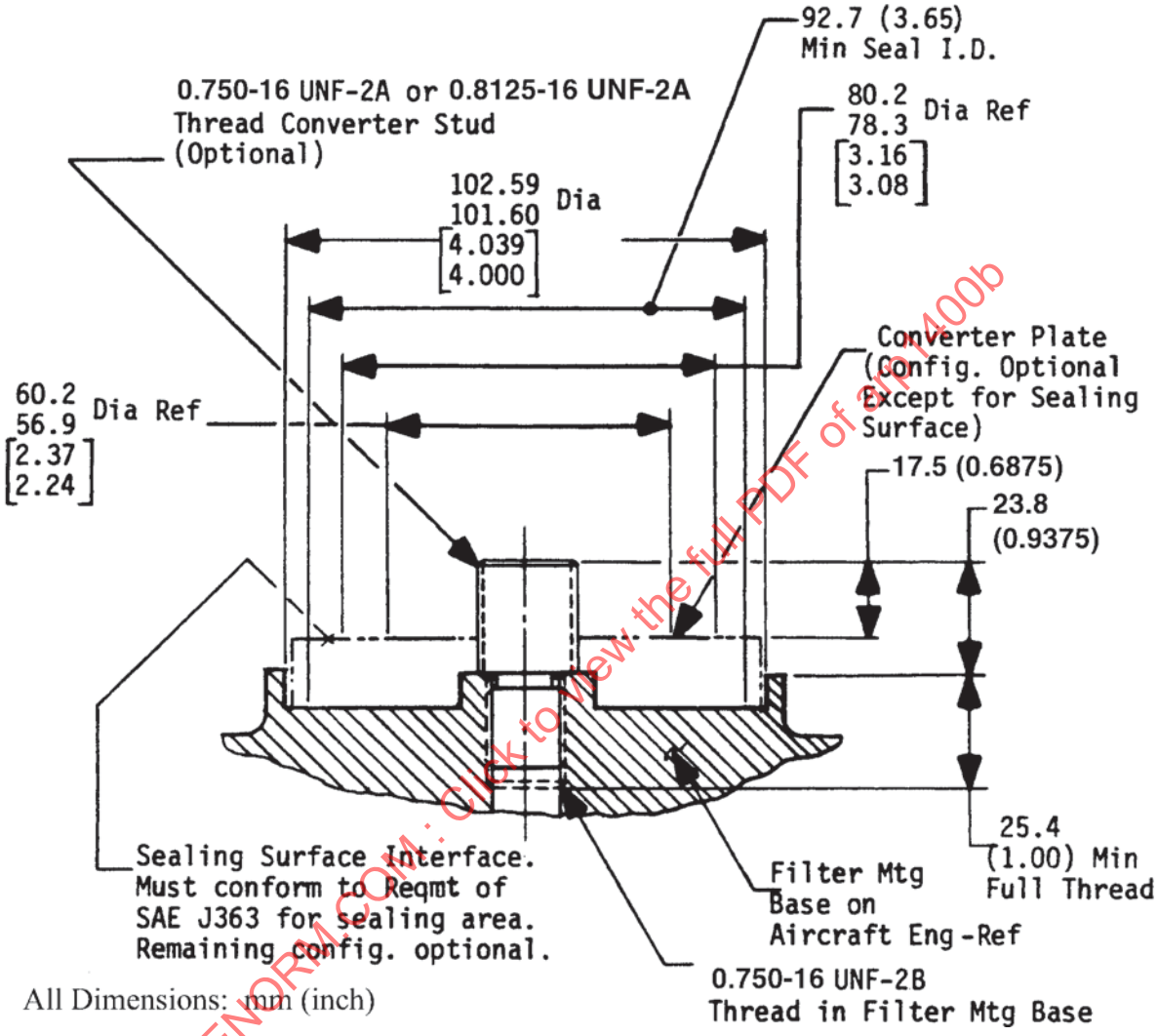


FIGURE 11 - Interface Definition for Conversion to Spin-on Filters
(from Shell & Bolt Filter Assemblies)

4.2 Materials:

4.2.1 All materials used shall be compatible with aircraft engine lubricating oil per SAE J1899 (or equivalent).

4.2.2 All materials used shall be capable of withstanding the installation, disassembly, and operating loads of the filter assembly.

4.2.3 All materials used shall be capable of withstanding the environmental and structural conditions imposed on the filter assembly during transit, storage, and operational usage.

4.2.4 All materials used shall be corrosion resistant or be suitably treated to inhibit corrosion (i.e.: paint, rust preventives, anodize, etc.).

4.2.5 Plating or other surface treatments which could peel, chip, flake, or otherwise deteriorate in such a way as to permit migration to the downstream side of the filter shall not be used on parts manufactured to this document.

4.2.6 Whenever possible materials which encourage galvanic corrosion shall not be used in combination. MIL-STD-889 shall be used on parts manufactured to this document.

4.3 Dimensional Requirements:

4.3.1 Shell and Bolt Type Filter Assemblies (Category IA) shall meet the dimensional requirements of Figure 1.

4.3.2 Filter Elements (Category IB) shall meet the dimensional requirements of Figure 7.

4.3.3 Spin-on Filter Assemblies (Category II, Types A and B) shall meet the dimensional requirements of Figures 9 and 10.

4.3.4 Converter Kits for conversion from Bolt and Shell Type Filters to Spin-on filters shall meet the interface requirements of Figure 11.

4.3.5 Filter mounting bases shall meet the dimensional requirements of Figures 12 and 13.

4.4 Convenience Devices - Optional:

4.4.1 Convenience devices, such as anti-drainback valves and standpipes, shall be considered optional except in cases where specific customer requirements exist for such devices.

4.4.2 Anti-drainback valves shall be designed to minimize lube-oil flow from the housing inlets (upstream side of filter element) when the filter housing is removed inverted (inlet and outlet down) after service.

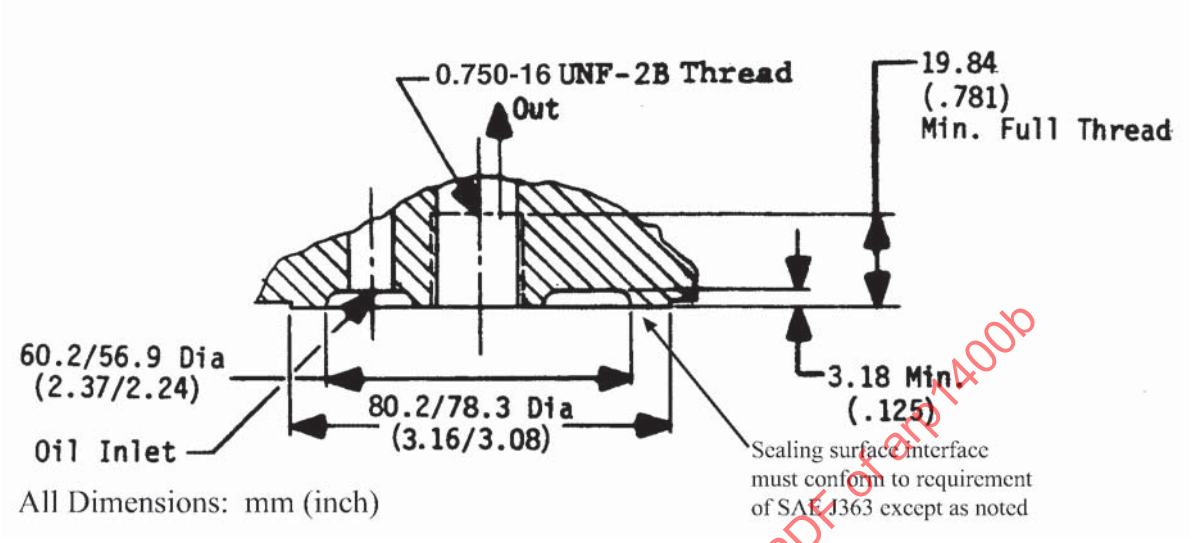


FIGURE 12 - Filter Mounting Base for Category IA with Cover Plate and IIB

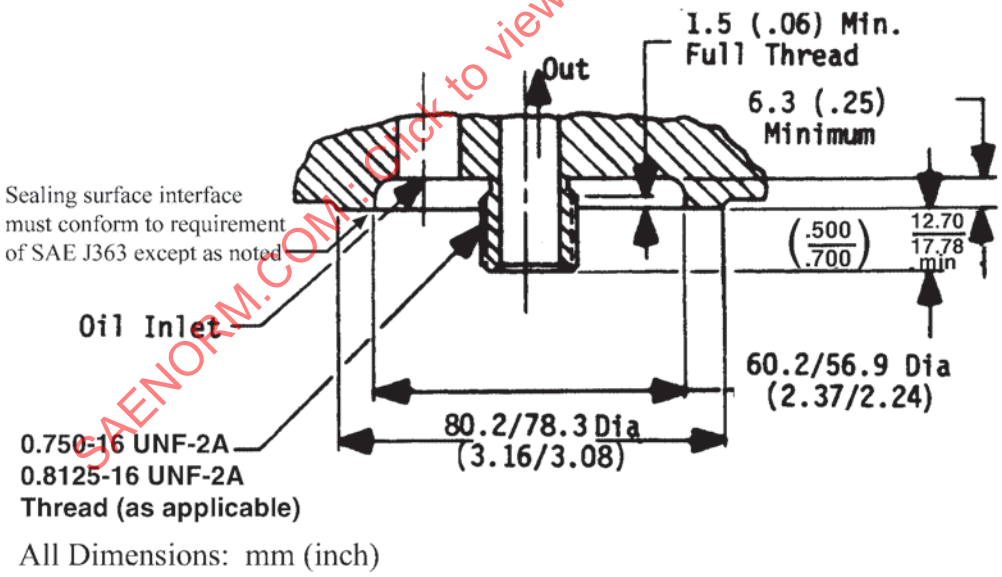


FIGURE 13 - Filter Mounting Base (Category IIA)

4.4.3 A standpipe anti-drain feature shall allow no more than 20% of the downstream (or outlet) side residual oil to flow from the filter housing outlet when the filter housing is removed inverted (inlet and outlet down) after service.

4.5 Performance Requirements:

4.5.1 Performance requirements for filter assemblies and filter elements shall be as defined in the following paragraphs. Conformance to these requirements shall be verified by evidence of satisfactory performance of the filter assemblies and filter elements when subjected to the environmental conditions and qualification tests of Section 5 of this document.

4.5.2 Initial Clean Filter Pressure Drop: Filter assemblies furnished under this document shall have an initial clean filter pressure drop no greater than shown in Table 1 when tested in accordance with 5.4.5.

TABLE 1

Size	Flow (L/s)	Initial Clean Pressure Drop (max) (kPa)
Short	0.50 (8 gpm)	(Per Filter Manufacturers' Specifications)[1]
Long	0.50 (8 gpm)	(Per Filter Manufacturers' Specifications)[1]

[1] Initial clean pressure drop, terminal pressure drop, and filter by-pass valve settings must be carefully coordinated with the engine manufacturers.

4.5.3 Pressure: The filter assemblies shall perform satisfactorily when subjected to the following pressures (all pressures are gage, unless otherwise specified).

4.5.3.1 Operating Pressure: Shall be 689 kPa (100 psig).

4.5.3.2 Proof Pressure: The proof pressure requirements shall be specified by the engine manufacturer. Recommended proof pressure value is 2758 kPa (400 psig) minimum. The filter shall exhibit no external leakage or permanent deformation when tested per 5.4.4.

4.5.3.3 Burst Pressure: The burst pressure shall be 3447 kPa (500 psig) minimum. When tested per 5.4.11, there shall be no leakage greater than 1 drop up to the specified minimum burst pressure.

4.5.4 Temperature: The filter assemblies shall be designed to perform satisfactorily when subjected to the following temperatures:

4.5.4.1 Fluid: -12 to 149 °C (+10 to +300 °F)

4.5.4.2 Ambient: -54 to +121 °C (-65 to +250 °F)

4.5.5 Filtration Efficiency: The filter assembly, when tested per 5.4.15, shall have a minimum time weighted average filtration ratio as follows:

"90% Cumulative Rating" $\geq$40 µm ($\beta_{40} \geq 10$)
"75% Cumulative Rating" $\geq$25 µm ($\beta_{25} \geq 4$)

4.5.6 Contaminant Capacity: The filter assembly, when tested per 5.4.7, shall have a minimum contaminant capacity, as shown below in Table 2:

TABLE 2

Element Size	Flow Rate (L/s)	Base Upstream Gravimetric (mg/l)	Capacity, min (g)	Terminal P (kPa)
Short (no internal relief valve)	0.50 (8 gpm)	15	15	138 (20 psi)
Long (no internal relief valve)	0.50 (8 gpm)	15	20	138 (20 psi)
Short (with internal relief valve)	0.50 (8 gpm)	15	15	55 (8 psi)
Long (with internal relief valve)	0.50 (8 gpm)	15	20	55 (8 psi)

4.5.7 Filter Element Collapse: Filter elements furnished under this document shall have a minimum filter element collapse pressure differential of 689 kPa (100 psid) as measured by the test described in 5.4.14.

4.5.8 Pressure Impulse: Filter assemblies furnished under this document shall exhibit no structural failure or leaks greater than 1 drop when subjected to the pressure impulse test as described in 5.4.12 of this document.

4.5.9 Vibration: Filter assemblies furnished under this document shall exhibit no leaks greater than 1 drop or structural failure when subjected to the vibration test as described in 5.4.13 of this document.

4.5.10 Anti-drainback Leakage: Filter assemblies which include anti-drainback valves shall be tested for anti-drainback valve leakage per 5.4.16, both before and after hot oil soak (aging). Maximum allowable leakage shall be 36 ml over a 3 h test period.

4.5.11 Hot Oil Soak: The filter assembly shall show no signs of deterioration, such as gasket cracking or paint peeling, at the completion of testing per 5.4.8. Upon removal of the filter from the test fixture, the gasket must be retained in the filter (Category II). The torque required to remove the filter assembly from the test fixture may be no greater than 67.8 N·m (50 lbf-ft). Element bond testing per 5.4.17 must result in filter media tearing or separation. End cap bond failure may not occur.

4.5.12 Cold Start:

NOTE: Cold start test applies only to Category IIA and IIB spin-on filter assemblies with internal relief valves.

The filter element shall show no signs of structural failure when tested per 5.4.18.

4.6 Identification and Marking of Product:

Filter assemblies, replacement filter elements, and accessories such as converter assemblies, bolts, and converter studs furnished under this document shall have the following minimum identification and marking characteristics whenever possible.

4.6.1 Manufacturer's Identification: Filter assemblies, filter elements, and accessories furnished under this document shall have the manufacturer's trademark and/or name clearly visible on the product. Mark in accordance with AS478.

4.6.2 Manufacturer's Part No.: Filter assemblies, replacement filter elements, and accessories furnished under this document shall have the manufacturer's complete part number clearly visible on the product and product container. Mark in accordance with AS478.

4.6.3 Approvals: Filter assemblies, replacement filter elements, and accessories furnished under this document shall display the appropriate Government approval such as FAA-PMA (Federal Aviation Authority-Parts Manufacturers Approval), STC (Supplemental Type Certificate) or TSO (Technical Standard Order) (whichever is applicable).

4.6.4 Marking of Installation Instructions:

4.6.4.1 Category IA: Shell and Bolt type filter assemblies in this category shall have printed on the shell:

1. Installation Torque
2. Replacement Element Part No.

4.6.4.2 Category IB: Replacement Filter Element: Filter elements in this category shall have included in the packaging an instruction sheet describing the procedure for installing the replacement element in the shell and bolt filter assembly.

4.6.4.3 Category IIA and IIB: Spin-on Filters: Filter assemblies in this category shall be painted white per FED-STD-595 color #17925 and have installation instructions printed on the outside diameter.

Example:

1. Lubricate Gasket with clean Engine Oil only
2. Torque Filter to 21.7 to 24.4 N.m (16 to 18 lbf.Ft)
3. Check Oil Level and Fill if Required
4. Run Engine and Check for Oil Leaks
5. Re-Check Oil Level and Fill if Required
6. Safety Wire

4.6.4.4 Category III: Converter Kit: Converter kits in this category shall have included in the packaging an instruction sheet describing the marking and procedure for installing the converter kit.

4.6.5 Installation Torque: Filter assemblies furnished under this document shall have the required installation torque clearly marked on the product. The maximum torque required to effect a seal between the filter assembly and the filter mounting base shall not exceed 40.7 N·m (30 lbf-ft).

4.6.6 Engine Application Reference: Filter assemblies furnished under this document shall make reference (by marking on the filter assembly or by inclusion in the installation instructions) to applicable catalogs and service bulletins of filter manufacturers or engine manufacturers to determine approved filter models and engine applications.

Example:

ATTENTION:

CONSULT CURRENT APPROPRIATE CATALOGS, CHARTS, SALES AND SERVICE BULLETINS OF FILTER, OR ENGINE MANUFACTURER, FOR APPROVED FILTER MODEL.

4.6.7 Date Stamp: Filter assemblies and replacement filter elements furnished under this document shall be marked with the day, month, and year of manufacture on the product or package. This requirement may be accomplished by the date coding method normally employed by the individual product manufacturer.

4.6.8 Conformance to SAE Specification: Filter assemblies and replacement filter elements furnished under this document shall be clearly marked to show conformance to this document.

Example:

Meets the requirements of ARP1400 Category IIA

4.7 Workmanship:

Workmanship of filter assemblies, replacement filter elements, and accessories furnished under this document shall be of a quality and grade necessary to ensure proper installation, functional operation, and flight safety.

4.8 Bubble Point:

The bubble point as tested per 5.4.6 shall be no less than 96 mm (3.8 in) of water column.

4.9 Wrench Hex:

There shall be no evidence of damage or permanent deformation when tested per 5.4.10 with a minimum torque at 110 N·m (80 lb-ft).

5. QUALITY ASSURANCE PROVISIONS:

5.1 Place of Tests and Test Data:

All testing shall be conducted at the filter manufacturer's test laboratory or other certified laboratories. All test data shall be recorded and placed in the Quality Assurance Department files at the filter manufacturer's facility for the retention period specified in 5.7.

5.2 Test Conditions:

Unless otherwise specified herein, all tests shall be conducted under the following conditions:

a. Test Fluid: (SAE 50) Engine Lubricating Oil, Ashless Dispersant or equivalent (NOTE: The viscosity of the test fluid shall be determined and recorded at the beginning of each test).

b. Test Fluid Temperature: 82 °C (180 °F), unless otherwise specified.

c. Measurements: All measurements shall be made with calibrated and certified instruments traceable to the National Institute of Standards and Technology.

d. Temperature: Unless otherwise specified, all tests shall be conducted at room temperature.

5.3 Classification of Tests:

The following categories of tests shall apply to this document:

a. Qualification Test
b. Production Acceptance Test
c. Production Sampling Test

5.4 Qualification Test:

5.4.1 Tests to be Performed: The following tests shall be required for Category I and Category II filter assemblies. Where differences in test procedures between Category I and Category II filter assemblies exist, the differences are noted. Qualification of Category III converter kit shall be included as part of the qualification tests. (For changes or revisions, only those qualification tests relevant to the change need be retested.)

TABLE 3

Ref. Para. No. Herein	Tests
5.4.2	Examination of Product
5.4.3	Dry Weight
5.4.4	Proof Pressure
5.4.5	Pressure Drop
5.4.6	Bubble Point[1]
5.4.7	Contaminant Holding Capacity
5.4.8	Oil Soak
5.4.9	Integral Stud Torque Test (Category II Filters)
5.4.10	Wrench Hex Torque Test
5.4.11	Burst Pressure
5.4.12	Pressure Impulse
5.4.13	Vibration
5.4.14	Collapse Pressure[1]
5.4.15	Filtration Efficiency
5.4.16	Anti-drainback Leakage Test
5.4.17	Element Bond Test[1]
5.4.18	Cold Start Test

1 On Category II, Filter Assemblies, disassembly of the spin-on housing and removal of the filter element may be required for this test. The housing should be opened at the base (slightly above the lockseam) using a can opener type tool.

5.4.1 (Continued):

Qualification test shall consist of the tests specified above conducted on the applicable specimens, as given in the following tables:

TABLE 4 - Filter Element No. 1

Test	Ref. Paragraph
Examination of Product	5.4.2 Category II only
Dry Weight	5.4.3 Category II only
Integral Stud Torque Test	5.4.9 Category IIB only
Wrench Hex Torque Test	5.4.10 Category II only
Bubble Point[1]	5.4.6 Category II only

1 On Category II, Filter Assemblies, disassembly of the spin-on housing and removal of the filter element may be required for this test. The housing should be opened at the base (slightly above the lockseam) using a can opener type tool.

TABLE 5 - Filter Element No. 2

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Bubble Point	5.4.6 Category I only
Proof Pressure	5.4.4
Pressure Drop	5.4.5
Cold Start	5.4.18

TABLE 6 - Filter Element No. 3

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Hot Oil Soak	5.4.8
Bonding Pull Test[1]	5.4.17

1 On Category II, Filter Assemblies, disassembly of the spin-on housing and removal of the filter element may be required for this test. The housing should be opened at the base (slightly above the lockseam) using a can opener type tool.

TABLE 7 - Filter Element No. 4

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Burst Pressure	5.4.11

TABLE 8 - Filter Element No. 5

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Pressure Impulse	5.4.12

TABLE 9 - Filter Element No. 6

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Vibration	5.4.13

TABLE 10 - Filter Element No. 7

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3

TABLE 11 - Filter Element No. 8

Test	Ref. Paragraph
Examination of Product	5.4.2
Dry Weight	5.4.3
Bubble Point	5.4.6 Category I only
Contaminant Holding Capacity	5.4.7
Filtration Efficiency	5.4.15
Collapse Pressure	5.4.14

5.4.2 Examination of Product: The test unit shall be thoroughly examined and shall meet the requirements of the manufacturer's top assembly drawings and specifications with respect to dimensions, identification and marking, general workmanship, material and finishes. For Category II Spin-on filter assemblies, this examination shall include a check of thread squareness as follows:

The threads in the filter assembly base plate or the threads of the stud (whichever is applicable) shall be perpendicular to the filter assembly gasket sealing surface within the limits shown in Figures 9 and 10.

5.4.3 Dry Weight of Units: The dry weight of the test units shall be recorded.

5.4.4 Proof Pressure: The test unit shall be installed in a test system as shown in Figure 14 and completely filled with test fluid at room temperature. The outlet port of the fixture shall be capped. A static pressure per 4.5.3.2 shall be applied at the fixture inlet port and maintained for 2 min. This test shall be performed two times.

5.4.5 Pressure Drop:

NOTE: This test is based upon the procedures of SAE HS 806 with more specific definition. The procedures of this test are applicable to Category IA and IB (Shell and Bolt) and Category II (Spin-on) Filters.

5.4.5.1 Test System: The test unit shall be installed in a test system as shown in Figure 15.

5.4.5.2 Test Conditions: The following test conditions shall apply during this test:

1. Test Fluid: Engine Lubricating Oil, per 5.2a
2. Test Fluid Temperature: 82 °C ± 3 °C (180 °F ± 5 °F)
3. Flow Rate: 0.50 L/s (8 gpm) (Short)
   0.50 L/s (8 gpm) (Long)

5.4.5.3 Test Procedure:

NOTE: The test fluid viscosity, at the test temperature, shall be recorded at the beginning of the Pressure Drop test.

The net differential pressure across the test filter element shall be determined as follows:

a. Test fluid shall be flowed through the test unit at a minimum of 5 different flow rates; with flow rates above, below and at rated flow. Flow rates, fluid temperature, and differential pressure across the test unit shall be recorded at each flow rate. These results shall be plotted on a graph as Flow Rate versus Pressure Drop and considered as the "Gross" pressure drop results.

b. A similar pressure drop test, as described in (a), shall be performed on the test fixture and the system connecting tubing with the test fixture element, removed from the test fixture.

   These results shall be plotted on a graph and considered as the "Tare" pressure drop results.

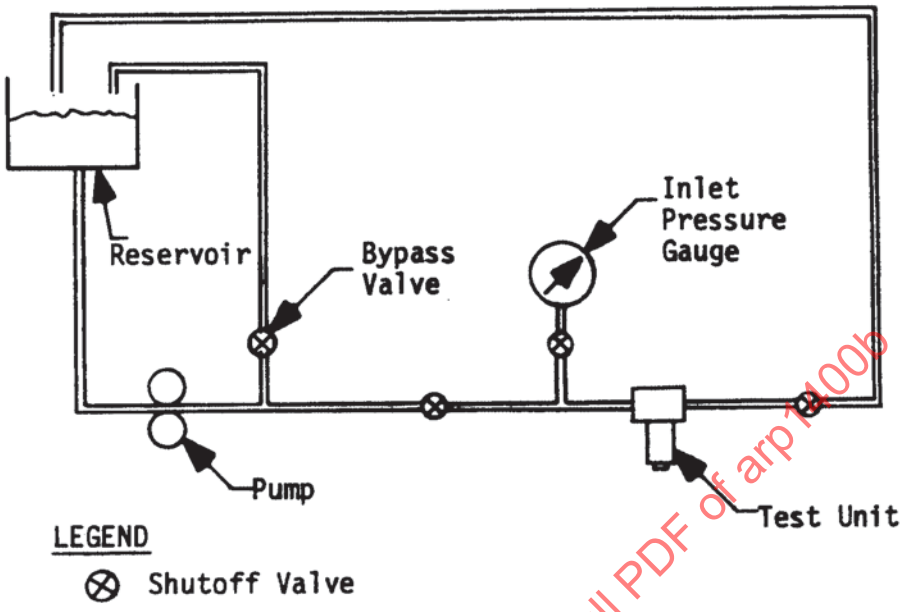


FIGURE 14 - Typical Schematic - Proof Pressure Test Setup

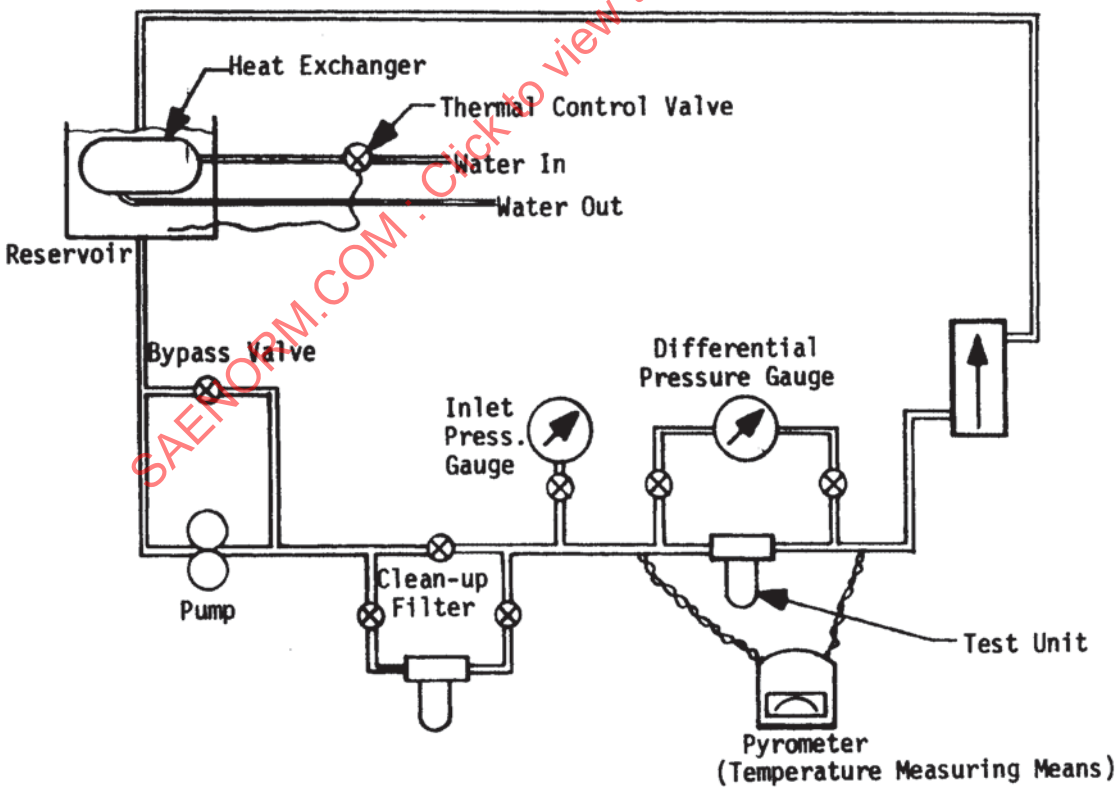


FIGURE 15 - Typical Schematic - Pressure Drop Test Setup

5.4.5.3 (Continued):

c. The "Tare" pressure drop results obtained in (b) shall be subtracted from the "Gross" pressure drop results obtained in (a). These results shall be considered the test filter assembly "net" pressure drop results and plotted on a graph as "Flow Rate versus Filter Element Net Pressure Drop."

d. The net pressure drop may be no greater than that specified in 4.5.2.

5.4.6 Bubble Point (with element removed from filter housing): Procedure - (Reference ARP901): The test filter element shall be installed in a test setup as schematically shown in Figure 16 herein. Fluid level shall be maintained at 12.7 mm ± 1.5 mm (0.500 in ± 0.060 in) above the top of the element.

The test apparatus shall be installed on a solid, vibration-free base. The filter element bubble point shall be determined as follows

1. The test element shall be completely immersed in the test fluid (Isopropanol, or other suitable test fluid), maintained at 24 °C ± 3 °C (75 °F ± 5 °F) and rotated until all air pockets have eliminated.

2. The manometer shall be adjusted to zero; the test element shall then be connected to the air inlet line and rotated several times to ensure that no air pockets remain.

3. The air pressure shall be slowly increased while rotating the test element 360° axially. The manometer readings shall be recorded when the first bubble is emitted from the test element media. Care shall be taken to ensure that the initial bubble is from the media and not from defective end cap sealing or from seams.

4. Steps 1 through 3 shall be repeated for a total of three times and the average of the three runs shall be considered as the initial bubble point, and shall meet the requirement of 4.8.

5.4.7 Contaminant Capacity: The filter element shall be installed in a housing and test system as shown in Figure 17. The filter element contaminant holding capacity shall be determined using the multipass method for evaluating filtration performance per SAE J1858 (NOTE: This test is run with MIL-H-5606 hydraulic oil at 100 °F). The test shall be run to the terminal pressure drop at the flow rate and contaminant add rate as specified in 4.5.6 and must meet or exceed the minimum contaminant holding capacity specified therein.

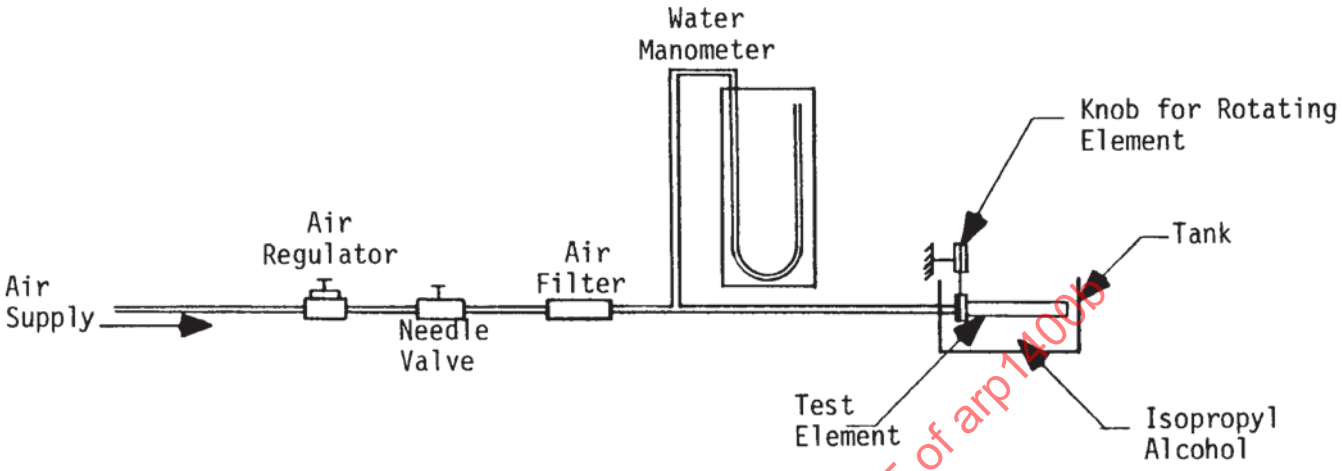


FIGURE 16 - Schematic - Bubble Point Test Setup

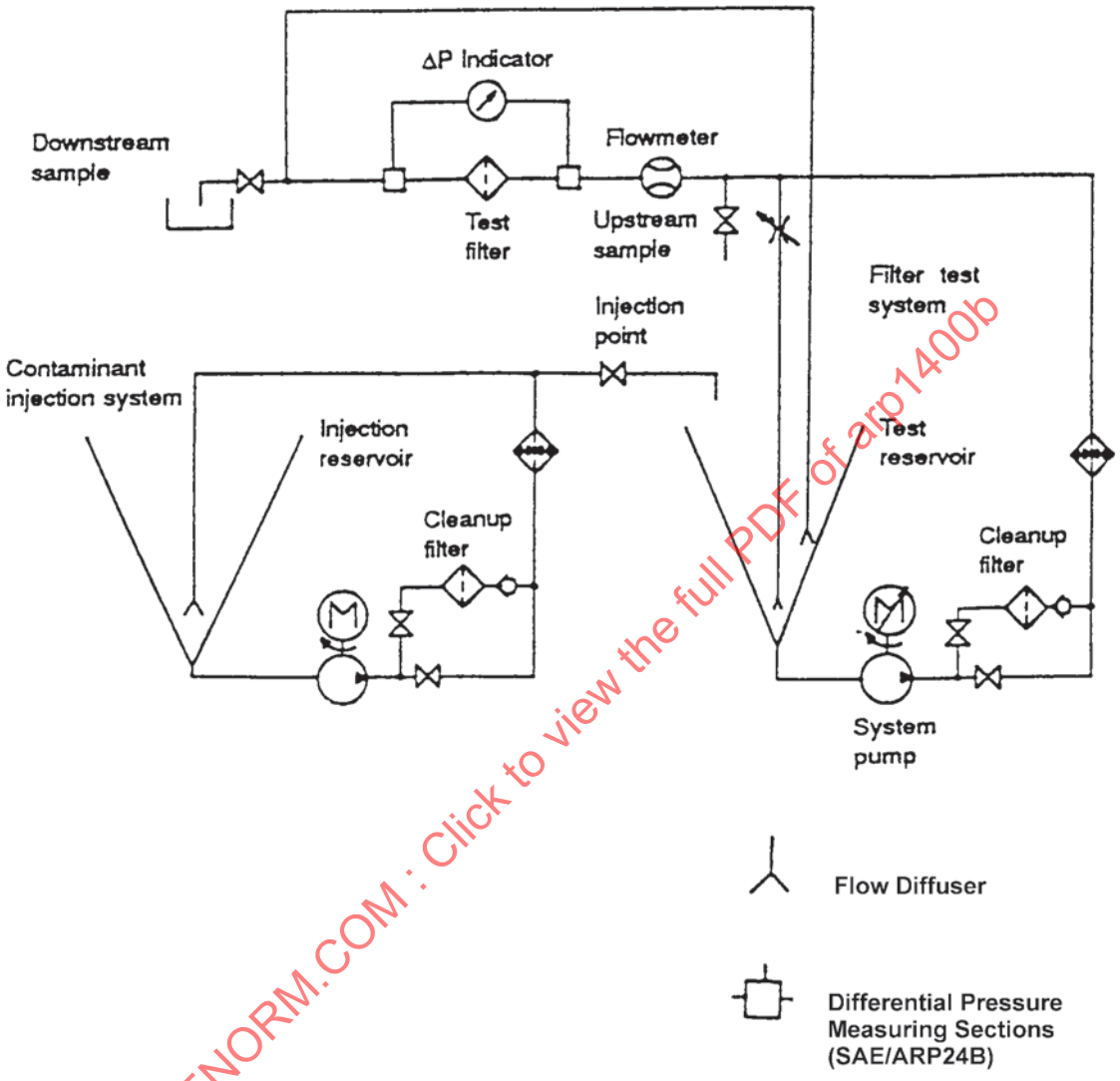


FIGURE 17 - Schematic - Contaminant Capacity, Filtration Efficiency, and Collapse Pressure Test System (Typical Setup)