[INCH-POUND]
F-F-351F
September 1, 1999
SUPERSEDING
F-F-351E
May 15, 1998

FEDERAL SPECIFICATION

FILTERS AND FILTER ELEMENTS, FLUID PRESSURE: LUBRICATING OIL, BYPASS AND FULL FLOW

The General Services Administration has authorized the use of this Federal Specification, by all federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers oil filters and oil filter elements of bypass design; and also oil filter elements of the outside-to-inside flow-path type of full-flow design for installation on internal combustion engines to remove contaminants from lubricating oil (see 6.1).

1.2 Classification. Filters and filter elements shall be of the following types, classes, and styles, as specified (see 6.2 and 6.4.9):

Type I	- Filter assembly, bypass design.
Class 1	- Light duty, regular size.
Style B	- Throw-away design.
Class 3	- Heavy duty, senior size.
Type II	- Filter elements, bypass design.
Class 1	- Light duty, regular size
Class 3	- Heavy duty, senior size.
Type IV	- Filter elements, full-flow design.
Classes 1 - 4	- See F-F-351/7 for discerning information.

2. APPLICABLE DOCUMENTS

2.1 Government publications. The following documents, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Beneficial comments, recommendations, additions, deletions, clarifications etc. and any other data which may improve this document should be sent by letter to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/BLUE, Warren, MI 48397-5000.

FSC 2940

FEDERAL SPECIFICATIONS

F-F-351/2	- Filter, Fluid Pressure: Oil, Heavy Duty, By-Pass Type, - Senior Size (Base Mounted).
F-F-351/4	- Filter Element, Fluid Pressure: For Senior Size Filter.
F-F-351/6	- Gaskets: Filter, Fluid Pressure.
F-F-351/7	- Filter Elements, Fluid Pressure-Oil, Full Flow.

FEDERAL STANDARDS

FED-STD-H28	- Screw-Thread Standards for Federal Services.

(Activities outside the Federal Government may obtain copies of federal specifications, standards and commercial item descriptions as specified in the General Information section of the Index of Federal Specifications, Standards and Commercial Item Descriptions. The Index is for sale on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service Bureau, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC 20407.)

DEPARTMENT OF DEFENSE

SPECIFICATIONS

MIL-PRF-2104	- Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service.

(Copies of military specifications and standards required by contractors in connection with specific procurement functions are obtained from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

FEDERAL REGULATIONS

Title 48	- Federal Acquisition Regulation System: Chapter I - Federal Acquisition Regulations (FAR); Part 23, Environment, Conservation, Occupational Safety, and Drug-Free Workplace; Sub-chapter D - Socioeconomic Programs; Subpart 23.4 - Use of Recovered Materials.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. When indicated, reprints of certain regulations may be obtained from the federal agency responsible for issuance thereof.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 4572 - Hydraulic Fluid Power-Filters-Multi-pass Method for Evaluating Filtration Performance.

(Application for copies should be addressed to the International Organization of Standards, 1, rue de Varembe, Case postale 56, CH-1211 Geneve 20 Switzerland.)

2.3 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D874 - Standard Test Method for Sulfated Ash From Lubricating Oils And Additives British Standard (DoD Adopted).
D893 - Standard Test Method for Insolubles In Used Lubricating Oils (DoD Adopted).
D3699 - Standard Specification for Kerosine (DoD Adopted).

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

J1260 - Standard Oil Filter Test Oil, Standard.

(Applications for copies should be addressed to Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.)

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets (see 6.5).

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.3 Materials. The offeror/contractor is encouraged to use recovered materials to the maximum extent practicable, in accordance with paragraph 23.403 of the Federal Acquisition Regulation (FAR) (see 6.4.7).

3.4 Design and construction. Filters and/or filter elements shall be the manufacturer's current standard product which meets or exceeds the requirements specified herein.

3.4.1 Type I.

3.4.1.1 Filter body. Filter bodies shall be designed to withstand all the structural loads imposed by the requirements of this specification. In addition, the filter housings and mountings shall be of such strength and rigidity as to withstand the torque loads required for making tube connections and the replacing of filter elements. Unless otherwise specified (see 6.2), exterior surfaces of body shall be given the manufacturer's standard commercial finish.

3.4.1.1.1 Class 1, Style B. Filter shall consist of a body enclosing a filter element. The body shall be equipped with necessary fastening and mounting arrangements and product markings as specified and as required for satisfactory service in the intended application (see 6.2). Exterior surfaces shall conform to 3.4.1.1.

3.4.1.1.2 Class 3. Design and general arrangement shall conform to F-F-351/2. All screw threads shall be in accordance with FED-STD-H28/2. The structural strength of the body shall be sufficient to operate safely with a tightening torque of 25 foot-pounds (ft-lb) (33.9 newton·meters (N·m)) (see 4.6.1).

3.4.1.2 Cover assemblies.

3.4.1.2.1 Class 3.

3.4.1.2.1.1 Cover. Dimensions shall conform to F-F-351/2. The cover shall be constructed of steel, 0.125 inch (in.) minimum thickness, or of material with equivalent characteristics, suitable to withstand a tightening torque of 25 ft-lb applied to cover screw. The cover shall be constructed to provide sufficient internal space for the element hold down spring and sufficient external area for the cover screw gasket. Unless otherwise specified (see 6.2), exterior surfaces of the cover shall be given the manufacturer's standard commercial finish.

3.4.1.2.1.2 Cover screw. When in place on cover, cover screw shall carry a spring, so attached that it may be removed from screw when desired. Screw threads shall be in accordance with FED-STD-H28/2.

3.4.1.2.1.3 Cover screw gasket. The cover screw gasket shall seal the joint between cover hole and cover screw gasket seat. Construction shall be of permanent type, with material optional. Dimensions shall conform to F-F-351/2.

3.4.1.2.1.4 Cover gasket. The cover gasket shall seal the joint between the cover flange and the body. For type I, class 3 filter, cover gasket shall conform to F-F-351/6.

3.4.1.2.1.5 Element hold-down spring. When in place on cover, cover screw shall carry a cylindrical or conical spring, so secured that it may be removed from the screw for servicing cover screw gasket. The spring force shall be not less than 15 nor more than 35 pounds (lb) (not less than 6.8 nor more than 16 kilograms (kg)) (see 4.6.9).

3.4.1.3 Center tube.

3.4.1.3.1 Class 3. For class 3 filters, the center tube shall be constructed of seamless steel tubing or of a material with equivalent characteristics, with adequate wall thickness to provide tensile strength sufficient to operate safely with an applied tightening torque of 25 ft-lb. The tube shall be free of burrs and shall contain a stop or collar to position and support the lower end of the filter element. The tube shall be provided with an orifice drilled through one side of the wall of the center tube to serve as an outlet passage for filtered oil. It shall conform dimensionally to F-F-351/2.

3.4.1.4 Base. For class 3, base-mounted filters, the base shall conform to F-F-351/2. Design and arrangement of inlet and outlet passages are at the manufacturer's option. A check valve, for the prevention of oil drainback, shall be provided and shall conform to the dimensional limitations as specified in F-F-351/2. Otherwise, design and method of check valve installation is optional. A drain passage shall be provided to facilitate element replacement and shall have a plug not smaller than 0.25 in. (6.4 millimeters (mm)) NPTF, dry seal.

3.4.1.5 Antidrain-back seal. Type I bypass flow filters with integral elements shall be provided with an antidrain-back seal (valve).

3.4.1.6 Installation arrangements.

3.4.1.6.1 Class 1. As specified (see 6.2), straps, brackets or other means for installation on or near the engine to be served shall be incorporated into the design of the type I, class 1, style B filter. Unless otherwise specified (see 6.2), oil lines and oil line fittings shall not be required as part of the complete filter assembly.

3.4.1.6.2 Class 3. Class 3 filters shall be arranged for base-mounted installation in accordance with F-F-351/2.

3.4.2 Type II. When specified (see 6.2), filter elements shall be furnished as separate replacement items, including applicable gasket for sealing the filter cover to the filter body.

3.4.2.1 Class 1, style B.

3.4.2.1.1 Performance requirements. Class 1, style B filter elements shall meet the applicable performance requirements of 3.5.

3.4.2.1.2 Filter element. The element for class 1, style B filter shall be supplied as part of the filter assembly and not separately.

3.4.2.1.3 Gasket. The class 1, style B filter shall be supplied with an applicable gasket for sealing filter to mounting plate as part of the filter assembly.

3.4.2.2 Class 3.

3.4.2.2.1 Design. Type II, class 3 filter element shall conform to the design and arrangement as specified in F-F-351/4.

3.4.2.2.2 Performance requirements. Type II, class 3 filter elements shall meet the applicable performance requirements of 3.5.

3.4.2.2.3 Pullout device. A pullout device shall be incorporated in the upper side (top) of each type II filter element. The pullout device shall meet the direct pull requirements of 3.5.10.1.

3.4.2.2.4 Installation. Type II, class 3 filter element shall be suitable for field installation in the type I, class 3 filter body without the use of any type of adapters.

3.4.2.2.5 Sealing members. Top and bottom seals shall be furnished for each type II, class 3 filter element. The seals shall be permanently attached (mechanically secured, not bonded with cement) to the element and shall be capable of sealing around the center tube (see F-F-351/4).

3.4.2.2.6 Spring bearing plate. Type II, class 3 filter elements shall be furnished with a spring bearing plate or equivalent, which shall be either mechanically attached to, or constructed integrally with, the element.

3.4.3 Type IV.

3.4.3.1 Design. Filter elements, according to their class, shall conform to the design and dimensions as specified on F-F-351/7. Filters shall be provided with sealing members and furnished with a gasket or gaskets appropriate for the class shown as specified in F-F-351/7.

Elements shall not contain built-in relief valves, orifices or bleeding devices. Filter elements shall have a perforated outer jacket and meet the applicable performance requirements of 3.5.

3.4.3.2 Pullout device. A pullout device is not required on type IV, class 1, 2, 3 or 4 elements. If a pullout device is required in a Type IV, class 4 element (see 6.2), it shall be a device accessible at the top and shall not interfere with the proper mating and sealing of the gasket surface when the elements are stacked vertically. The pullout device shall meet the direct pull requirements of 3.5.10.2.

3.5 Performance requirements.

3.5.1 Pressure resistance. Type I, class 1, style B filter assembly shall withstand a pressure of not less than 100 pounds per square inch (psi) (689 kilopascals (kPa)). Type I, class 3 filter housing shall withstand a pressure of 150 psi (1034 kPa) without leakage, permanent deformation, or other visible damage (see 4.6.1).

3.5.2 Media migration (see 4.6.2).

3.5.2.1 Type I and II filter elements. Media migration shall be not greater than 10 milligrams (mg).

3.5.2.2 Type IV elements. Media migration shall be not greater than shown in table I.

TABLE I. Media migration, type IV elements.

Class	Allowable media migration in milligrams
1	3
2	5
3	10
4	15

3.5.2.2.1 Filtering media design for Type IV, class 4 filter element. The filtering media shall be that of the current standard product. Pleated filtering media design shall be that of the controlled radius design to allow maximum surface area and dirt holding capacity.

3.5.3 Antidrain-back device. Device shall prevent oil leakage back through inlet ports or holes when in an inverted or partially inverted position. The leakage test of the antidrain-back valve shall be based on the total capacity for each filter unit (see 4.6.3).

3.5.4 Additive removal. Type I, class 3 filters; type II, filter elements; and type IV filter elements shall be tested for additive removal. The lubricating oil used in testing shall retain not less than 90 percent (%) of its original additive content (see 4.6.4).

3.5.5 Filtering ability (see 4.6.5).

3.5.5.1 Types I and II. Applicable filters and elements shall be tested for filtering ability as specified in 4.6.5. For type I, class 1 and 3 filters, the normal pentane insoluble content of the oil samples taken at the end of the test shall be not greater than 0.50% by weight. The cumulative filtering efficiency at the end of 22, 44, 66 and 88 hours of operation, as applicable, shall be not less than 85%.

3.5.5.2 Type IV filter elements. Elements shall be tested for filtering ability as specified in 4.6.5. Differential pressure of class 1, 2 and 4 filter elements shall not exceed 3 psi (21 kPa) initially, nor exceed 12 psi (83 kPa) before completion of the 66 hours of testing. Differential pressure of the class 3 element shall not exceed 1 psi (7 kPa) initially, nor exceed 12 psi before completion of the 66 hours of testing. The normal pentane insoluble content of the oil samples shall not be greater than as specified in table II.

TABLE II. Content in percentage by weight.

Class	22 hrs.	44 hrs.	66 hrs.
1	0.120	0.240	0.272
2	0.120	0.240	0.272
3	0.188	0.376	0.456
4	0.087	0.174	0.202

3.5.6 Shock resistance. (see 4.6.6).

3.5.6.1 Types I and II, class 3. Type I, class 3 filters and type II, class 3 filter elements shall show no evidence of mechanical or other damage after being subjected to the shock test as specified in 4.6.6.1 through 4.6.6.6. Flow rates at the end of the test shall be not less than 90% nor more than 110% of their original flow rates.

3.5.6.2 Type IV elements. Elements shall meet the filtering ability requirements of 3.5.5 after being subjected to the shock test specified in 4.6.6.7.

3.5.7 End-load strength. Type IV filter elements shall withstand end loads as specified in table III without evidence of permanent deformation or other visible damage (see 4.6.7).

TABLE III. End-load strength.

Class	End load lb (kg)
1	35 (16)
2	50 (23)
3	75 (34)
4	100 (45)

3.5.8 Differential pressure. Type IV elements shall withstand a differential pressure of 100 psi without evidence of deformation or other damage (see 4.6.8).

3.5.9 Force cover spring. When in place on cover with tightening torque of 25 ft-lb, spring force shall not be less than 15 nor more than 35 lb (66.7 nor more than 155.7 newtons (N)) (see 4.6.9).

3.5.10 Pullout device.

3.5.10.1 Type II elements. Pullout device shall withstand a direct pull of 25 lb without showing any evidence of failure or injury to the element (see 4.6.10.1).

3.5.10.2 Type IV, class 4 elements. If a pullout device is installed on type IV, class 4 elements (see 3.4.3.2), it shall withstand a direct pull of 100 lb (444.8 N) without showing any evidence of failure or injury to the element (see 4.6.10.2).

3.6 Identification and marking.

3.6.1 Type 1, class 1. For class 1, each filter shall be plainly and permanently marked. Markings shall include manufacturer's name or trademark, model or part number, and any instructions deemed necessary by the manufacturer for servicing. The words "INLET" or "OUTLET" shall be marked in the same manner near the appropriate opening on the filter. Decalcomania transfers, when used, shall be legible after the final finish or treatment has been applied (see 3.4.1.1).

3.6.2 Type 1, class 3 (base mounted). Marking, except for inlet and outlet identifications, shall be as specified in 3.6.1 and in addition, each filter shall include in its marking on the cylindrical portion of the body, manufacturer's name or trademark, model or part number, and the words "HEAVY DUTY SENIOR SIZE FILTER-USE WITH HEAVY DUTY SENIOR SIZE ELEMENT". Optional - manufacturer's element model, type number or other markings deemed necessary by the supplier.

3.6.3 Type II, class 3. Element shall be plainly marked on its upper (cover) end or on its side with the manufacturer's name or trademark, model or part number, and with the words

"HEAVY DUTY SENIOR SIZE FILTER ELEMENT." If the marking is placed on the side, the word "TOP", together with one or more arrows pointing to the top of the element shall be added.

3.6.4 Type IV. For type IV elements, the elements shall be plainly and permanently marked. Marking shall include the words "FULL FLOW OIL FILTER ELEMENT" as well as the element class, National Stock Number, manufacturer's name or trademark, and the manufacturer's part number.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of section 3 and 5. The inspection set forth in this document shall become a part of the contractor’s overall inspection system or quality control program. The absence of any inspection requirements in this document shall not relieve the contractor of the responsibility of ensuring that all products and supplies submitted to the Government for acceptance comply with the requirements of the contract. Sampling inspection, as part of manufacturing operations is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Component and material selection. Components and materials shall be inspected in accordance with all the requirements specified herein and in applicable referenced documents.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.3).
b. Conformance inspection (CI) (see 4.4).

4.3 First article inspection. When a first article is required (see 3.2, 6.2 and 6.3), the sampling method and sample number of filters and/or filter elements of each type to be manufactured, shall be as stated in the contract. The sample(s) shall be examined for the defects specified in table IV and shall be subjected to the inspections specified in table V. Failure of any filter or filter element to pass any of these inspections shall be cause for non-acceptance. If a

standard production item is submitted, the item must meet the requirements of the specification and must be representative of the design, construction, and manufacturing technique applicable to the remaining items to be furnished under the contract (see 6.2 and 6.3).

TABLE IV. Classification of defects.

Category	Defect	Methods of examination
Major:		
101	Dimensions not within specified tolerance for proper installation or operation (see figure 1 and applicable specification sheets).	SIE 1/
102	Design not as specified. Any component or part missing, damaged, deformed, or not as specified (see 3.4, 3.5, and 3.6).	Visual
103	Installation arrangements (fastening or mounting) missing, defective, or not as specified (see 3.4.1.6).	Visual
104	Pullout device, gasket, or sealing member (as applicable) missing, defective, or not as specified (see 3.4.1, 3.4.2 and 3.4.3 as applicable).	Visual
Minor:		
201	Finish missing, improper, or not as specified (see 3.4.1).	Visual
202	Identification and/or marking, missing, illegible, incomplete, incorrect, not permanent, or not as specified (see 3.6.1 through 3.6.4).	Visual

1/ = Standard Inspection Equipment

TABLE V. Verification table.

Title	Requirements	Verification	Type I		Type II		Type IV			
			Class		Class		Class			
			1	3	1	3	1	2	3	4
Pressure resistance	3.5.1	4.6.1	X	X						
Media migration	3.5.2	4.6.2	X	X	X	X	X	X	X	X
Antidrain-back device	3.5.3	4.6.3	X	X						
Additive removal	3.5.4	4.6.4		X			X	X	X	X
Filtering ability	3.5.5	4.6.5	X	X	X	X	X	X	X	X
Shock resistance	3.5.6	4.6.6		X		X	X	X	X	X
End load strength	3.5.7	4.6.7					X	X	X	X
Differential pressure	3.5.8	4.6.8					X	X	X	X
Force-cover spring	3.5.9	4.6.9		X						
Pull-out device tension	3.5.10	4.6.10			X	X				X

4.4 Conformance inspection. Conformance inspection shall consist of the examinations of 4.4.3, the tests of 4.4.4 and the packaging inspection of 5.1. Non compliance with any of the specified requirements in section 3 or 5 shall be cause for non-acceptance.

4.4.1 Sampling for examination. Sampling for conformance inspection shall be as stated in the contract (see 6.2).

4.4.2 Lot formation. Lot formation shall be as stated in the contract (see 6.2).

4.4.3 CI examinations. The samples selected in accordance with 4.4.1 shall be examined as specified in 4.4.3.1 through 4.4.3.3.

4.4.3.1 Visual and dimensional examination. Filters and/or filter elements shall be visually and dimensionally examined for completeness of manufacture, freedom from defects (other than filtering ability and pressure resistance), proper item identification, conformance to applicable drawings and specifications.

4.4.3.2 Materials and construction. Conformance to 3.3 and 3.4 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data. Recoverable materials shall conform to the same specifications (see 6.4.7).

4.4.3.3 Defects. Conformance to 3.3, 3.4 and 3.6 shall be determined by examination for the defects listed in table IV. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

4.4.4 CI tests. Each filter or filter element selected shall be subjected to the CI tests specified in table VI. Additional tests may be specified at the discretion of the procuring activity (see 6.2).

4.4.5 CI failure. Any item that fails to conform to any specified requirement shall not be accepted, any failure (one or more) of the selected sample in any category of table IV or test for the appropriate inspection lot size shall constitute a non-acceptance of the entire lot. If the contractor utilizes sampling inspection as an element of his inspection system, rejected inspected lots may be resubmitted for acceptance if the contractor performs 100% inspection on the lot for those characteristics which were defective and resulted in non-acceptance of the lot and removes all defective units or obtains procuring activity approval to resample the lot due to the insignificance of the defects. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots.

TABLE VI. Conformance test table.

Title	Requirements	Requirement verification	Type I Class 1	Type I Class 3	Type II Class 1	Type II Class 3	Type IV Class 1	Type IV Class 2	Type IV Class 3	Type IV Class 4
Pressure resistance	3.5.1	4.6.1	X	X						
Media migration	3.5.2	4.6.2								
Antidrain-back device	3.5.3	4.6.3								
Additive removal	3.5.4	4.6.4								
Filtering ability	3.5.5	4.6.5	X	X	X	X	X	X	X	X
Shock resistance	3.5.6	4.6.6								
End load strength	3.5.7	4.6.7								
Differential pressure	3.5.8	4.6.8								
Force-cover spring	3.5.9	4.6.9								
Pull-out device tension	3.5.10	4.6.10								

4.5 Test conditions.

4.5.1 Applicable methods. The tests shall be conducted as specified herein or in accordance with the applicable methods of ASTM D874.

4.5.2 Test tolerances. Unless otherwise specified (see 6.2), test tolerances for pressure, temperature and flow shall be as follows:

a. Pressure: ±1 psi for types I and II, ± 5% for type IV.
b. Temperature: ± 5 degrees Fahrenheit (°F) for types I, II, and IV.
c. Flow rate: ± 5% for type IV.

4.5.3 Ambient test conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature: 78 ± 18°F (25.6 ± 10 degrees Celsius (°C)).
b. Relative humidity: uncontrolled room ambient.
c. Atmospheric pressure: site pressure.

4.5.4 Test filters. When the use of a standard filter or a standard filter body is required in the test methods specified hereinafter, such filter or filter body shall be in accordance with the applicable provisions of section 3 and figure 1, or F-F-351/2.

4.5.5 Reference test oils. Unless otherwise specified (see 6.2), reference test oils required in the test methods specified herein shall conform to the following specifications:

a. Straight mineral oil shall conform to MIL-PRF-2104, grade 10 or equivalent commercial oil approved by the Government in the inspection test plan.
b. Additive oil is designated as Approved Filter Test Oil, RFO-3-93 conforming to SAE J1260 or equivalent SAE approved by the Government in the inspection test plan.

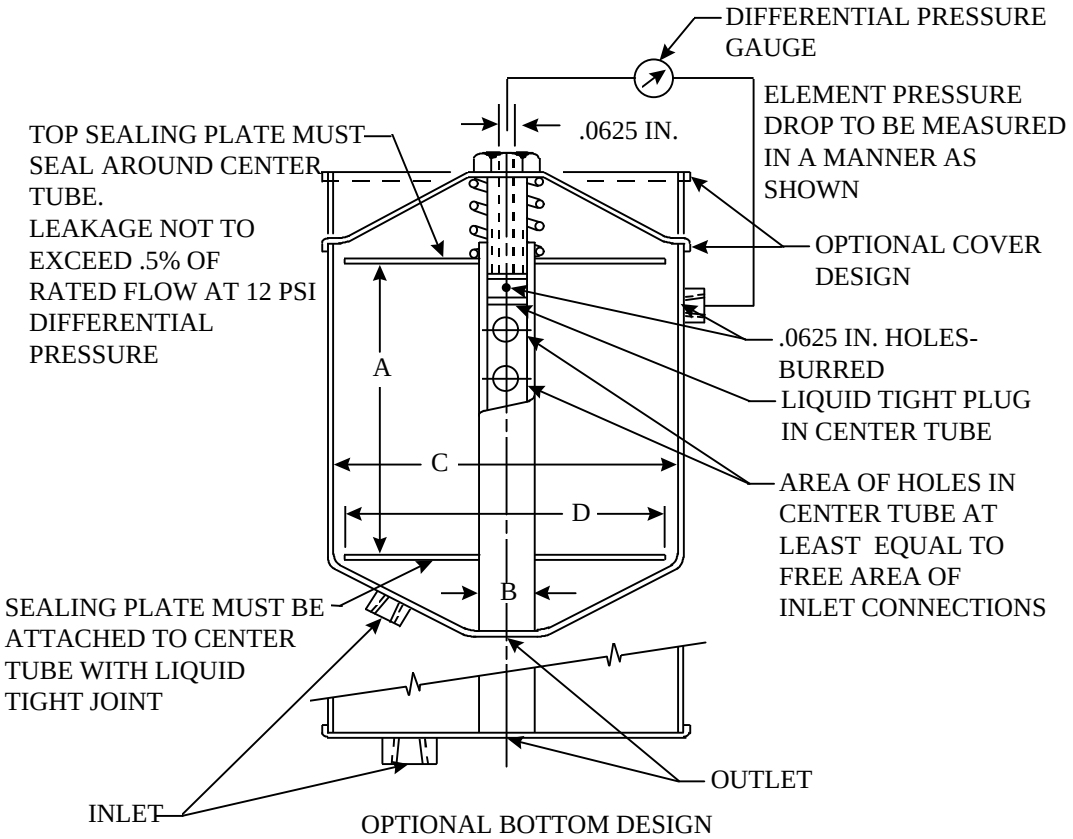
4.5.6 Constituents in standardized oil filter test contaminant (SOFTC-2A and ISO 4572). The composition of the standardization contaminant slurry required (see 6.4.1), for the test methods specified herein, shall be as follows:

a. Sixteen parts by weight of carbon black; average particle size, 85 nanometers.
b. Two parts by weight of ferric oxide; 95 percent of the particles in the range from 0 to 5 micrometers.
c. Four parts by weight of polyvinyl (PV) resin (see 6.4.4).
d. Seventy-eight parts by weight of the test oil (see 4.5.5 and 6.4.5).

4.5.6.1 Preparation of SOFTC-2A. Preparation of SOFTC-2A shall consist of the following:

a. All of the carbon black and 20 to 25% of the test oil required by the above formula shall be placed in a mechanical mixer and mixed at slow speed.
b. The mixture from (a) above shall be milled over a conventional paint roller mill. The resultant paste shall be collected directly from the mill into a container having an additional 25% of the original quantity of oil. The milled slurry and the oil shall be mixed until a homogeneous mixture is obtained.
c. A dry-mix of the remaining solid constituents, i.e., the PV resin and ferric oxide, shall be prepared. To this dry-mix, the slurry from (b) above shall be slowly added until a stiff paste is obtained. The balance of the slurry and the remainder of the lubricating oil shall be added to this paste and mixed until homogeneous.

4.6 Test methods. The contractor's testing shall adhere to the limitations of the following items as described below.



CLASS	DIMENSIONS IN INCHES(MM)					HOUSING MAX. VOLUME. CUBIC INCH. (CUBIC CENTIMETER)	SPRING PRESSURE TOTAL LOAD IN POUNDS (KILOGRAMS)
	A	B (± 1%)	C MIN.	D MIN.	MIN. PIPE SIZE		
1	3.94 (100)	0.75 (19)	3.38 (85.9)	2.00 (50.8)	0.25 (6.4)	80 (1311)	35 (16)
2	4.81 (122.2)	0.75	4.38 (111.3)	2.50 (63.5)	0.375 (9.5)	120 (1966)	50 (23)
3	9.06 (230)	1.38 (35)	5.25 (133.4)	2.25 (57.2)	0.75 (19)	290 (4752)	75 (34)
4	18.00 (457)	2.38 (60.5)	8.50 (215.9)	4.00 (101.6)	1.5 (38)	1500 (24 580)	100 (45)

NOTE: SPRING PRESSURE TOLERANCE ± 5% WHEN SEALING PLATES ARE SPACED DIMENSION A.

FIGURE 1. Test filter body for type IV filter elements.

4.6.1 Pressure resistance. To determine conformance to 3.5.1, one type I, class 3 filter body (see 3.4.1.1.2), assembled with the cover tightened to 25 ft-lb with a torque indicating wrench, shall be subjected for a period of 5 minutes to an internal pressure of 150 psi. Lacking a detachable cover, the test procedure for the type I, class 1, style B filter assembly shall consist of subjecting filter, installed on an applicable mounting plate, to an internal pressure of 100 psi for a period 5 minutes. Testing shall be made with test oil (see 4.5.5) held at a temperature of 200°F (93°C), or, if air pressure is used, filter shall be immersed in a suitable bath at 200°F. During and after the test, the sample assembly shall be examined for conformance to 3.5.1.

4.6.2 Media migration . Media migration for filter elements shall be determined as specified in 4.6.2.1 through 4.6.2.3.

4.6.2.1 Elements for type I, class 3 filters. To determine conformance to 3.5.2.1, applicable elements shall be tested for media migration in a standard filter body mounted in front of, and in series with, a 0.0015 in spacing metal edge strainer. Ten quarts of test oil (see 4.5.5) shall be circulated through filter body and through the metal edge strainer for a 4-hour period at 30 psi (206.8 kg) inlet pressure to the filter body and with the oil held at a temperature of 180°F (82°C). At the end of this 4-hour period, the strainer shall be removed and placed over a clean glass beaker to collect the oil drainings. The strainer shall be rinsed into the beaker with ASTM precipitation naptha which has been filtered through a Gooch crucible (Selas #28-080XF), or equal, fritted or sintered integral bottom) using a rubber policeman to clean all strainer surfaces. All remaining oil in the strainer body shall be drained, the strainer body shall be rinsed with filtered naptha, and both the oil and the washings shall be collected in the same beaker used for the washings from the strainer. The oil and the washing shall be diluted (to assist filtration) and filtered through a tared Gooch crucible as noted previously. The crucible shall be washed with filtered naptha, dried in an oven at 212°F (100°C), cooled in a desiccator, and weighed to the nearest 0.5 mg. This 4-hour circulation, without element shall be repeated until a run shows a removal of foreign matter from the oil not to exceed 5 mg. A sample oil filter element shall then be installed in the standard filter body and the test oil circulated through the assembly for a period 8 hours at 30 psi inlet pressure to the filter assembly and with the oil held at a temperature of 180°F. This 8-hour circulation period shall be repeated on additional test elements until a total of four have been flowed in the same manner, without a change or addition to the sump oil. Each element removed from the filter assembly shall be allowed to drain back into the filter body for a period of 5 minutes prior to starting a subsequent run. At completion of the fourth 8-hour circulation period, the strainer and the straining body shall be cleaned as prescribed for the 4-hour circulation periods without element and the amount of foreign matter determined to the nearest 0.5 mg. The total weight of foreign matter collected shall be divided by four and the value reported as media migration.

4.6.2.2 Elements for type I, class 1, style B filters. To determine conformance to 3.5.2.1, the testing shall be the same as that used in 4.6.2.1, except (a) a piece of tubing shall replace the filter body during the system cleaning process, and (b) for each 8-hour circulation of test oil,

following the system-cleaning process, new, type I, class 1, style B filter shall be used for testing the media migration.

4.6.2.3 Type IV filter elements. To determine conformance to 3.5.2.2, each element to be tested shall be installed in its applicable test filter body (see figure 1) and tested as the filters in 4.6.2.2, except that the test conditions of table VII shall be in effect.

TABLE VII. Media migration test conditions for type IV filter elements.

Element class	Flow gal/min (liters/min)	Volume of oil in system gallons (liters)	Strainer housing volume cubic inches (cubic centimeters)	Slot area of strainer square inches (square centimeters)
1	1.5 (5.7)	1 (3.8)	15.5 (254)	1.6 (10)
2	3 (11.4)	2 (7.6)	31 (508)	3.2 (21)
3	6 (22.7)	5 (18.9)	62 (1016)	6.4 (41)
4	30 (113.6)	25 (94.6)	310 (5080)	32.1 (207)

4.6.3 Antidrain-back leakage test. To determine conformance to 3.5.3, the following test has been designed to evaluate the performance of the built-in antidrain valve in new and used spin-on type filters with respect to leak back drainage during a period of engine shut down. Basically, the test consists of installing a filter on its base and applying a given static head to the system through a pipe fastened onto the base outlet and measuring any leakage passing the valve device in a specified period of time.

4.6.3.1 Test condition. The following are conditions under which antidrain-back leakage tests shall be conducted: The test oil used shall be equal to a mixture of 60% SAE 20 oil conforming to API Service Designation SA and 40% kerosene conforming to ASTM D3699. The mixture shall be a 3.6-5.8 square millimeter per second (mm^2/s) viscosity rating at 70°F (21°C), and be equivalent in flow characteristics to SAE 10 at 180°F. During test period the test oil shall be maintained at a temperature of 70° ± 5°F (21° ± 3°C).

4.6.3.2 Test apparatus and preparation. The apparatus shown in figure 2 shall be used for this test. The filter shall be base mounted by screwing proper thread sized insert into filter head base until the “O” ring is firmly seated and the filter gasket compressed to its recommended torque.

4.6.3.3 Test procedure. The following leakage test shall be performed: Purge the filter by opening valves “A” and “B” to pump test oil through the filter until it is free of air bubbles and then return the test oil collected back into the reservoir. If a used filter is being tested and the test oil was excessively contaminated, discard and replace with clean test oil. The antidrain-back valve (device) must be actuated a minimum of five times during purging cycles. After purging, close the valve “B”, then open valve “C”, and fill the pressure head column using the pump. Fill

the column slightly above the 24 in. (61 centimeters (cm)) mark and shut off pump and close the valve "A". Remove the cap on the leakage drain tube and allow the trapped test oil to drain for 2 minutes. Then adjust the pressure head to maintain a 24 in. level throughout the test period. At the end of the 2 minute period, place a graduate under the drain tube and record the leakage rate. The pressure head column should be filled from the top to maintain the necessary 24 in. level. Record the leakage rate in milliliters (mL) at 10 minute intervals for the first hour and hourly thereafter. Acceptable leakage shall not exceed 10 mL per hour, nor more than 20 mL per 12 hour period.

4.6.4 Additive removal. To determine conformance to 3.5.4, type I, class 3 filters; type II, class 3 filter elements; and type IV filter elements shall be tested for oil additive removal by use of a testing apparatus consisting of an oil reservoir, a suitable filter body, and an oil circulating system provided with oil pressure, temperature, and flow-rate indicators and controls. For type I filters and type II filter elements, five quarts of new (unused) additive test oil (see 4.5.5), plus sufficient test oil to fill the filter body, and for type IV filter elements, the volume of new (unused) additive test oil specified in table VII shall be circulated for 20 hours through the filter (without element). Inlet pressure to the filter body for type I filter and type II filter element testing shall be 30 psi. The circulation of oil for type IV element testing shall be at the rate as specified in table VII. Oil temperature shall be held at 180°F. At the end of this 20 hour period, the additive content of the oil shall be determined by the sulfated residue method (average of three determinations) conforming to ASTM D874. This 20 hour circulation through the test retention by the oil of not less than 95% of its original value. During each 20 hour circulation, 5 quarts (qt) (4.7 liters (L)) of new oil, plus sufficient oil to fill the filter body, shall be used for each run when testing type I filters and type II filter elements. The quantity of new oil used when testing the type IV filter elements shall be as specified in table VII. The second of the two consecutive readings showing an additive retention by the oil of not less than 95% of the original content shall be considered as the blank. A sample filter element shall be installed in the filter body and this complete filter assembly shall be substituted for the standard filter body in the oil circulating system. New test oil, in the applicable amount specified above, shall be added to the test apparatus and circulated through the element for 20 hours at an inlet pressure to type II filter elements of 30 psi and at the applicable rated flow for the type IV elements (see table VII), with the oil being held at a temperature of 180°F. At the end of this 20 hour period, the oil shall be examined for its additive content by the sulfated residue method (average of three determinations) conforming to ASTM D874. Correct for the blank and express as percent of original additive content of the new oil.

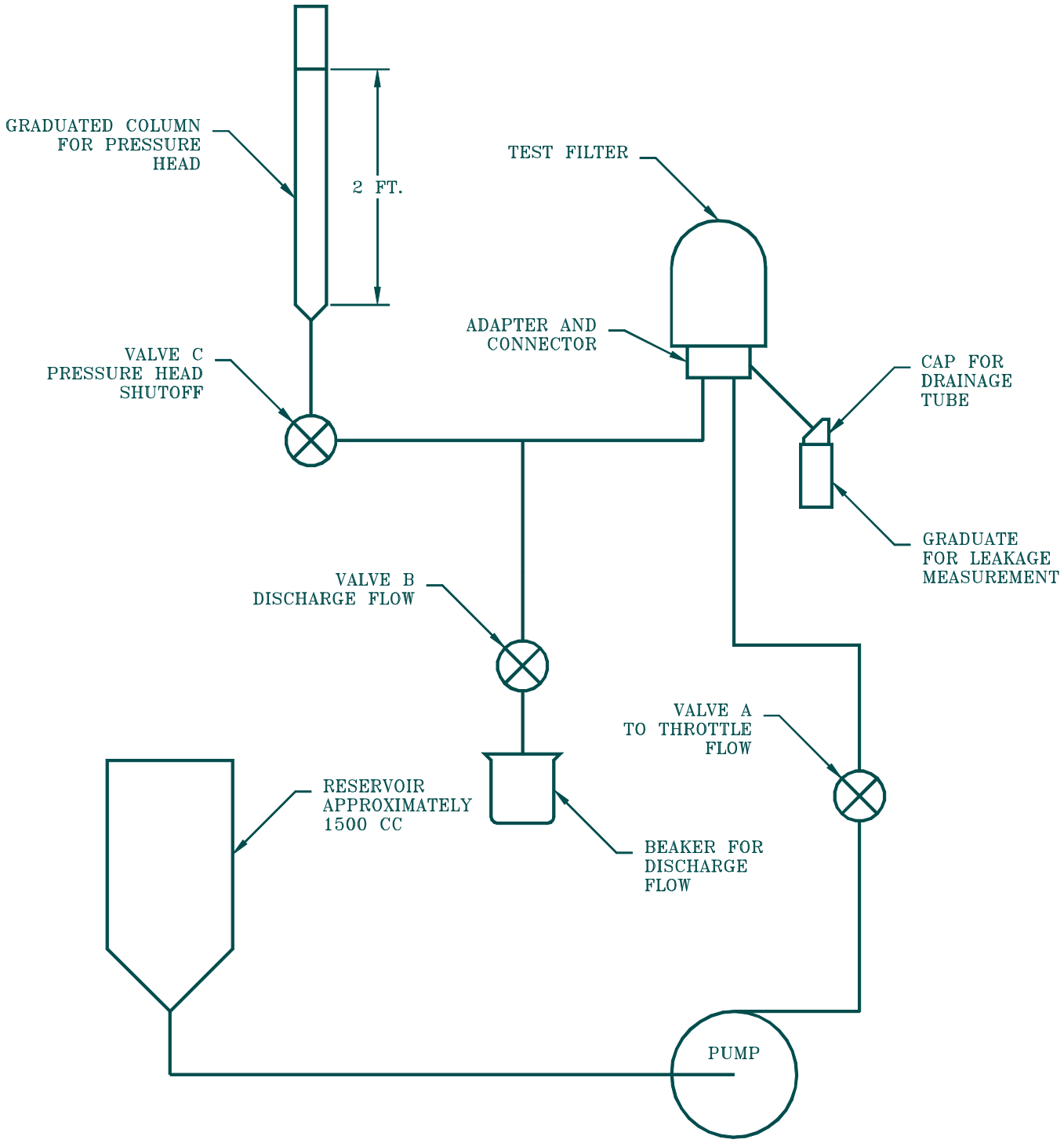


FIGURE 2. Schematic for antidrain back valve test equipment.

4.6.5 Filtering ability.

4.6.5.1 Filtering ability for type I and II filters and type IV, classes 1-3 filter elements. To determine conformance to 3.5.5, a type I or a type II filter, or a type IV, class 1-3 filter element, assembled in a filter body for which the filter element is intended, shall be tested for filtering ability by use of a testing apparatus consisting of an oil reservoir with oil level indicator, and a suitable oil circulating system provided with oil pressure and temperature indicators and controls. The capacity for the type I or type II filter of this system, exclusive of the filter under test and dependent on the filter or element type, shall be adequate for the quantities specified in tables VIII and IX, plus the contaminant added during a 22 hour period. A device shall be provided for adding contaminant to the oil in the reservoir. The addition shall be made in small, drop-sized increments at a substantially uniform rate. A weighed quantity of contaminant, appropriate for the add period employed, which has been conditioned in an agitator for at least one hour, shall be blended at 30 psi pressure for 30 minutes with oil taken from the filter test system in preparation for charging the quadrant. The blending process is started 30 minutes before the quadrant is ready for its charge. Quadrant add periods of 4 or 5 hours are recommended for test periods. Longer add periods may be used, provided continuous mixing system is employed to keep the contaminant mixed. Additional test conditions and procedure shall be as specified in tables VIII and IX. Curves of pressure drop and normal pentane insolubles shall be plotted versus hours of operation. Smooth curves shall be faired through the plotted data points. The contractor's Government approved inspection plan shall include a procedure for filtering ability that uses the restrictions and methods of determination shown in tables VIII and IX for the filter types indicated.

TABLE VIII. Filtering ability test conditions and procedure for type I filters and type II filter elements.

	Oil at filter inlet		Test oil		Contaminant				
Class	Temp °F (°C)	Pressure psi (kPa)	Type	Quantity Quarts (Liters)	Designation	Rate of solids addition grams/ hour	Total hours of filter operation 1/	Oil sample to be analyzed 2/	Filter Effic. (% min.) 4/
1	180 ± 5 (82 ± 3)	30 ± 1 (206 ± 11)	Mineral	5 (4.7) plus	SOFTC-2A	2.2	88	Normal	85
3	180 ± 5	30 ± 1	Additive	Sufficient oil to fill assembly	SOFTC-2A	4.4	88	Pentane insolubles 3/	85

1/ To be accumulated in successive units of 22 hour periods of continuous filter operation and contaminant addition, separated by 2 hour shutdown periods during which the oil bypasses the filter completely and no contaminant is added.

2/ Immediately after each 22 hour period, oil shall be withdrawn from the system to reestablish the initial oil level in the reservoir. The portion of oil so withdrawn shall constitute the sample for analysis.

TABLE VIII. Filtering ability test conditions and procedure for type I filters and type II filter elements - Continued.

3/ Normal pentane insolubles shall be determined by ASTM method D893, except that a 10 000 relative centrifugal force (rcf) centrifuge shall be used.

4/ Minimum cumulative filtering efficiency (expressed in percent):

$$\frac{\text{Total weight of contaminant solids added} - \text{Weight of contaminant solids in total test oil}^{*}}{\text{Total weight of contaminant solids added}} \times 100$$

*Weight of total test oil x % normal pentane insolubles.

4.6.5.2 Filtering ability for type IV, class 4, filter element. To determine conformance to 3.5.5, a type IV class 4 filter element, assembled in a filter housing for which the element is intended, shall be set up and tested for filtering ability in accordance with table IX. A mean efficiency of 10 microns (beta ratio $\beta(10) = 2$)) and an absolute efficiency of 25 microns (beta ratio $\beta(25) = 75$) shall be specified as the target filtration performance of the filter elements. A copy of the qualified element's test data shall be submitted by the offeror/contractor to the procuring agency for review.

TABLE IX. Filtering ability test conditions and procedure for type IV filter elements.

	Oil	Test oil*		Contaminant		
Class	Temperature at filter inlet °F	Oil in system gallons	Flow rate galllons/min liters/min	Designation	Rate of addition of solids (grams per hour)	Total hours of filter operation 1/
1	180 ± 5	1	2/7.6	SOFTC-2A	0.4	66
2**	180 ± 5	2	6/22.7	SOFTC-2A	0.8	66
3	180 ± 5	5	12/45.4	SOFTC-2A	2.6	66
4	In accordance with ISO 4572					

1/ To be accumulated in successive units of 22 hour periods of continuous filter operation and contaminant addition, separated by 2 hour shutdown periods during which the oil bypasses the filter completely and no contaminant is added. Immediately after each 22 hour period, oil shall be withdrawn from the system to reestablish the initial oil level in the reservoir. The portion of oil so withdrawn shall constitute the sample for analysis. Normal pentane insolubles shall be determined by ASTM method D893, except that a 10 000 rcf centrifuge shall be used.

* Additive oil shall be used.

** Type IV, class 2 filtering ability test conditions shall also apply to type III filters.

4.6.6 Shock resistance.

4.6.6.1 Type I, class 3 filters, and type II, class 3 filter elements. Filter body shall be modified for use in the shock test so that the flow area of any oil passage in the filter body shall be not less than the cross sectional area of the inlet or outlet connection pipe size, whichever is the smaller. This may be accomplished by drilling out the restricting orifice in the inlet or outlet connection, or the center tube, or both.

4.6.6.2 Filter body calibration. A flow rate calibration of the modified filter assembly (without element) shall be determined when circulating new, straight mineral oil at 145°F (63°C) (see 4.5.5)

4.6.6.3 Flow rate test procedure. Install a filter element in the modified filter body and circulate new, straight mineral oil at 145°F throughout the filter assembly at a flow rate of 10 gallons per minute (gal/min) (37.8 L/min), or a pressure drop of 30 psi, whichever is attained first. Record pressure drop of 10 gal/min flow, or flow in gal/min at 30 psi pressure drop. (NOTE: The pressure drop across the element is equal to the pressure drop across the filter body and element, minus the pressure drop across the body (see 4.6.6.2) at the same flow rate.) This data will be required to evaluate the test in 4.6.6.6.

4.6.6.4 Element mounting. The same sample type II, class 3 element, for which the flow rate has been determined (see 4.6.6.3) shall be installed over a 0.563 in. (14 mm) diameter center tube and secured in place by a lower stop and upper spring similar in construction to that specified for the cover and center tube (see 3.4.1.2.1.1 and 3.4.1.3).

4.6.6.5 Shock test procedure. The center tube, with filter element assembled thereon, shall be rigidly mounted at each end to a support. The contractor's Government approved inspection test plan will include the shock test configuration and procedures to establish meeting these requirements. Sufficient shock is established to equal striking the center tube support, with filter element assembled thereon, an equivalent of 20 blows at 10 second intervals, alternating the blows on the front and back of the element support. Each blow shall have an acceleration value of 20 gravity units (g), or approximately 300 ft-lb (406.8 N·m.).

4.6.6.6 After-shock flow rate. After completing shock test procedure, to determine conformance to 3.5.6, the elements shall be examined for any evidence of surface failure or other injury, then reassembled in the modified filter body (see 4.6.6.1) and the flow rate through the element determined at the pressure drop obtained in 4.6.6.3. The flow rate, after shock, shall be reported as percent of the original flow rate.

4.6.6.7 Type IV filter elements. Each filter element for the shock test shall be one used in the media migration test, or one that has been subjected to 180°F clean oil flow for not less than eight hours and allowed to drain for not less than one hour. The contractor's Government approved inspection test plan will include the shock test configuration and procedures to establish meeting these requirements. The element shall be installed over a center tube of appropriate diameter and length and secured in place by a lower stop and upper spring and spring bearing plate to simulate installation in a test filter body. The center tube shall then be rigidly mounted in a vertical position and subjected to shock testing. Sufficient shock is established to equal striking the center tube support, with filter element assembled thereon, an equivalent of 20 blows at 10 second intervals, alternating the blows on the front and back of the element support. Each blow shall have an acceleration value of 20 g, or approximately 300 ft-lb. After completing shock

procedure, the element shall be visually examined for evidence of damage or failure. If the element appears satisfactory, it shall be installed in a test case and a filtering ability test made in accordance with 4.6.5. After completion of the filtering ability test, element shall be dissembled and examined for evidence of damage to determine conformance to 3.5.6.

4.6.7 End load strength. To determine conformance to 3.5.7, type IV filter elements shall be tested for resistance to static end loading by installing the element over a center tube of appropriate diameter, supporting one end of the element on a plain concentric surface of at least the maximum diameter listed in table X. Pressure shall be applied to the opposite end of the element by means of a flat surfaced annular ring, 0.06 in. (1.5 mm) in width, within the element-sealing surface diameters per class as listed in table X. Constant pressure shall be applied for a period of 30 minutes, after which the element shall be examined for evidence of damage.

TABLE X. Element sealing surface diameters.

Class	Max.diameter1/ inches (mm)	Min. diameter 1/ inches (mm)
1	2.00 (51)	1.00 (25.4)
2	2.50 (63.5)	1.00
3	3.50 (76)	1.63 (41.4)
4	4.00 (102)	3.00 (76.2)

1/ Pressure ring to apply force between limits.

4.6.8 Differential pressure. To determine conformance to 3.5.8, all type IV filter elements assembled in a filter body (see figure 1) shall be tested for resistance to differential pressure by means of a test apparatus similar to that employed for the filtering ability test. The same filter element tested for filtering ability may be used in this test. Otherwise, a new, unused element which has been subjected to 180°F clean oil at rated flow for a period of 66 hours shall be selected for test. With the element installed in the appropriate filter body, a viscous oil (see 6.4.6) shall be circulated through the system at room temperature. The system shall be started with the pump bypass valve in the open position. The bypass valve shall then be slowly and uniformly closed, causing the element differential pressure to rise gradually until element failure occurs, or until 100 psi is observed. The psi differential pressure shall be held for 30 seconds. The bypass valve shall then be opened, the element shall be removed from the filter body, and a disassembly inspection shall be made for evidence of damage or failure.

4.6.9 Cover-spring force. To determine conformance to 3.5.9, each hold-down spring of the four sample type I, class 3 filters shall be tested to determine the force required to compress each spring to its assembled height.

4.6.10 Pullout device tension.

4.6.10.1 Type II element. To determine conformance to 3.5.10.1, with the media container of a sample type II element held stationary, the pullout device shall be subjected to a straight tension pull gradually increased to a minimum of 25 lb (11.3 kg). During this test, the element, the device, and its attaching means shall be observed for any evidence of failure.

4.6.10.2 Type IV, class 4 elements. To determine conformance to 3.5.10.2, type IV, class 4 filter elements shall be tested as in 4.6.10.1 except that the straight tension pull shall be gradually increased to a minimum of 100 lb. During and after this test, the device and its attaching means shall be observed for any evidence of failure.

5. PACKAGING

5.1 Packaging requirements. The preservation, packaging, packing and marking shall be as specified in the contract or order (see 6.2).

6. NOTES

INFORMATION FOR GUIDANCE ONLY. This section contains information of a general or explanatory nature which is helpful, but is not mandatory.

6.1 Intended use. Bypass type filters and filter elements, and full-flow type filter elements covered by this specification are intended primarily for application to the crankcase lubrication system of engines installed in passenger cars, trucks and similar commercially built ground vehicles as well as on military combat and transport vehicles.

6.1.1 Other applications. Appropriate provisions of this specification may be used in the procurement of filters and filter elements required for installation on industrial or marine engines.

6.2 Acquisition requirements. Purchasers should select the preferred options permitted herein and include the following information in acquisition documents:

a. Title, number, and date of this specification.
b. Issue of the DoDISS to be cited in the solicitation.
c. Class and style (if applicable), of filter, type, and class of filter element (see 1.2, 3.4.1.1 and 3.4.1.1.1)
d. If first article is required (see 3.2, 4.3 and 6.3).
e. Intended application (when available), including make, type, and year of vehicle or similar data for engine or filter (see 3.4.1 through 3.4.3).

f. Color of exterior finish, if different from standard commercial finish (see 3.4.1.1 and 3.4.1.2.1.1).
g. Type of mounting, i.e., straps, brackets, or other suitable means (see 3.4.1.6.1).
h. When oil lines and fittings are required (see 3.4.1.6.1).
i. When type II filter elements are for replacement usage (see 3.4.2).
j. If a pullout device is required in a Type IV, class 4 element (see 3.4.3.2)
k. If a standard production item is to be submitted (see 4.3).
l. How sampling for conformance inspection should be determined (see 4.4.1).
m. How lot formation should be determined (see 4.4.2).
n. Any additional CI tests required (see 4.4.4)
o. When test tolerances and ambient test conditions are to be other than specified (see 4.5.2 and 4.5.3).
p. Whether reference test oil to be used should be other than as specified (see 4.5.5).
q. Levels of preservation, packaging and packing required (see 5.1).
r. Any additional marking requirements (see 5.1).

6.3 Inspection for first article. When first article inspection is required, the contract should provide specific guidance to contractors as to the method for selecting samples for the inspection. The contract should also provide specific guidance as to whether the item(s) should be a first article sample, a first production item, or a standard production item from the contractor's current inventory. The contract should include specific instructions in acquisition documents regarding arrangements for examinations, approval of the first article test results, and disposition of the first articles. Invitations for bids should provide that the Government reserves the right to waive the requirements for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions.

6.4.1 Standardization contaminant. For use in blending the standardized contaminant (see 4.5.6), the materials described in 6.4.2 through 6.4.5 have been found satisfactory.

6.4.2 Carbon black. One brand of this material is designated as "Raven 450-powder", advertised particle size 85 nanometers, offered by Colombian Chemicals Company, 1600 Parkwood Circle, Atlanta, GA 30339.

6.4.3 Ferric oxide. A brand of this material is designated "Chemically Pure Ferric Oxide" and is offered by Microfab Inc., P.O. Box 1092, Park Ridge, IL 60068. It has been found that 95 percent of the particles are in the range from 0 to 5 microns.

6.4.4 Chloroform soluble PV resin. One brand of this material is designated as "Geon 218" and is offered in particle size as follows:

a. 100 percent to pass through a 30-mesh sieve;
b. 90 percent to pass through an 80-mesh sieve; and
c. 60 percent to pass through a 200-mesh sieve.

This material is offered by the Geon Company, 1 Geon Center, Avon Lake, OH 44012.

6.4.5 Additive test oil (RFO-3-93). Further information on this oil (see 4.5.5) may be obtained from Society of Automotive Engineers, Oil Filter Test Method Subcommittee, 400 Commonwealth Drive, Warrendale, PA 15096.

6.4.6 Viscous oil. Any type of viscous oil or lubricant may be used for the differential pressure test described in 4.6.8. A SAE 140 transmission lubricant and No. 6 boiler fuel have been found satisfactory.

6.4.7 Recycled materials. The use of recycled materials which meet the requirements of the applicable material specifications without jeopardizing the intended use of the item should be encouraged (see 3.3).

6.4.8 PIN. The PIN used in the specification slash sheets consist of the basic number of this specification, the slash number from the appropriate sheet plus applicable dash number corresponding to the number of parts per slash sheet.

6.4.9 Light duty, heavy duty, and senior size. These descriptions are leftover from F-F-351D, and are differentiated according to size, flow capacity, and stringency of performance requirements.

6.5 Cross reference of classifications. The following specification sheets form a part of F-F-351F/GEN. These documents were formerly military standards associated with F-F-351D (see 3.1).

a. F-F-351/2 was derived from MS35342-1 and F-F-351D, figure 3.
b. F-F-351/4 was derived from MS35345.
c. F-F-351/6 was derived from MS35347.
d. F-F-351/7 was derived from MS35802.

6.6 Subject term (key word) listing.

Additive removal
Antidrain-back leakage test
Cover-spring force
Differential pressure
End load strength
Filtering ability
Media migration
Pressure resistance
Pullout device tension
Shock resistance

6.7 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

MILITARY INTERESTS:

Custodians:
Army - AT
Navy – SH
Air Force – 99

Review Activities:
Army - CR4
Navy – MC
Air Force - 82
DLA – CC

CIVIL AGENCY COORDINATING ACTIVITY:
GSA – FSS

Preparing Activity:
Army – AT

(Project 2940-0184)