MILITARY SPECIFICATION

FUEL SYSTEM COMPONENTS;
GENERAL SPECIFICATION FOR

This specification has been approved by the Department of the Air Force and by the Navy Bureau of Aeronautics.

1. SCOPE

1.1 This specification covers the requirements for aircraft fuel system components such as pumps, valves, filters, strainers, filler units, filler caps, fuel CG control units, fuel tank transfer pressure regulators, fuel tank vent pressure control units, and similar functional components. (See Section 6.)

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS

2.1 The following specifications, standards, drawings, and publications, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

P-S-661	Solvent; Dry-Cleaning
QQ-M-151	Metals; General Specification for Inspection of
QQ-P-416	Plating, Cadmium (Electrodeposited)

Military

MIL-C-5015	Connectors; Electrical
MIL-D-5028	Drawings and Data Lists; Preparation of (For Engines, Accessories and Other Auxiliary Equipment)
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment, General Specification for
MIL-E-5557	Enamel; Heat-Resisting, Glyceryl-Phthalate, Black
MIL-F-5161	Fuel; Referee, Aircraft Turbine and Jet Engine
MIL-F-5572	Fuel; Aircraft Reciprocating Engine
MIL-F-5616	Fuel; Aircraft Engine, Grade JP-1
MIL-F-5624	Fuel; Aircraft Turbine and Jet Engine, Grade JP-3 and JP-4

ENCLOSURE (1)

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MIL-F-8616	Fuel System Components; Model Specification for
MIL-H-3136	Hydrocarbon-Fluid, Standard Test
MIL-I-6181	Interference Limits, Tests and Design Requirements, Aircraft Electrical and Electronic Equipment
MIL-P-5315	Packing, "O" Ring, Hydrocarbon Fuel Resistant
MIL-P-6064	Packing of Lightweight Aircraft Accessories
MIL-P-6871	Plating, Chromium
MIL-P-6889	Primer; Zinc-Chromate for Aircraft Use
MIL-P-6906	Plates, Information and Identification
MIL-P-7105	Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT
MIL-S-7742	Screw Threads, Standard, Aeronautical
MIL-W-5086	Wire, Electrical, 600-Volt, Copper, Aircraft
JAN-M-745	Moisture-Resistance-Test, for Material Items Used in Electronic, Communication, and Electrical Equipment

Air Force-Navy Aeronautical

AN-QQ-A-696	Anodic-Films; Corrosion-Protective (for) Aluminum Alloys
AN-N-10	Nuts, Self-Locking, 550°F

STANDARDS

MIL-STD-129	Marking of Shipments
MS29513	Packing "O" Ring Hydrocarbon Fuel Resistant

DRAWINGS

Air Force-Navy Aeronautical Standard Drawings

AN995	Wire - Lock
AND10049	Bosses - Straight Internal Thread Engine
AND10050	Bosses - Standard Dimensions for Gasket Seal Straight Thread
AND10056	Fitting End - Standard Dimensions for Flared Tube Connection and Gasket Seal
AND10066	Connectors - Electrical Receptacle, Integral Mounting
AND10068	Nuts and Plate Nuts - Self Locking, Functional Limitations of
AND10086	Fitting Installation - Flared Tube and Hose, Swivel
AND10398	Metals - Definition of Dissimilar

PUBLICATIONS

Air Force-Navy Aeronautical Bulletin

No. 143	Specifications and Standards; Use of
No. 410	Age-Controls Fuel System Synthetic Rubber Part

(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications.- The following publications, of the issue in effect on date of invitation for bids, unless otherwise stated, forms a part of this specification to the extent specified herein:

National Advisory Committee for Aeronautics

Report No. 218 Standard Atmosphere Tables and Data

(Copies of this publication may be obtained from the Research Information Division, NACA, 1724 F Street, N. W., Washington, D. C.)

3. REQUIREMENTS

3.1 Model specification.- A fuel system component model specification conforming to Specification MIL-F-8616, shall be submitted by the component manufacturer for approval.

3.2 Materials.- Materials and processes used by the manufacturer of fuel system components shall be of high quality, suitable for the purpose, and shall conform to applicable Government specifications. Materials conforming to contractors' specifications may be used provided the specifications are released by the Services and contain provision for adequate tests. The use of contractor's specifications shall not constitute waiver of Government inspection. All materials used in the component shall be sufficiently resistant to fluids conforming to Specifications MIL-F-5161, MIL-F-5616, MIL-F-5624, MIL-F-5572, and MIL-H-3136, of aromatic content from 0 to 30 percent, to assure satisfactory operation as herein defined.

3.2.1 Metals.- All metals used in the construction of fuel system components that are not of a corrosion-resisting type, shall be suitably protected to resist corrosion during the normal service life of the component. The use of dissimilar metals, especially brass, copper, or steel, in contact with aluminum or aluminum alloy, shall be avoided where practicable. Dissimilar metals are defined by Drawing AND10398. Magnesium shall not be used in fuel system components.

3.2.2 Selection of materials.- Specifications and standards for all materials, parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with ANA Bulletin No. 143, except as provided in the following paragraph.

3.2.2.1 Standard parts.- Standard parts (MS, AN, or JAN) shall be used wherever they are suitable for the purpose, and shall be identified on the drawing by their part numbers. Commercial utility parts such as screws, bolts, nuts, cotter pins, etc, may be used, provided they possess suitable properties and are replaceable by the standard parts (MS, AN, or JAN) without alteration, and provided the corresponding standard part numbers are referenced in the parts list and, if practicable, on the contractor's drawings. In the event there is no suitable corresponding standard part in effect on date of invitation for bids, commercial parts may be used provided they conform to all requirements of this specification.

3.3 Design and construction.-

3.3.1 Design.- Fuel system components shall be designed in accordance with standard aircraft practices. The weight and size of the unit shall be kept to a minimum, and safety shall be of paramount consideration.

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3.3.1.1 Special tools.- The design shall be such that disassembly and replacement of parts of the fuel system component shall be accomplished without the use of special tools.

3.3.2 Detailed design requirements.- The detailed design requirements shall be specified by the model specification and shall include the following data, if applicable:

(a) Installation characteristics:

(1) Mounting detail (include normal mounting position if critical)
(2) Over-all dimensions
(3) Location, size and type of plumbing and electrical connections
(4) Servicing clearance
(5) Direction of flow

(b) Material of construction:

(1) Material
(2) Treatment
(3) Finish

(c) Physical characteristics:

(1) Weight
(2) Strength
(3) Schematic wiring diagram

(d) Performance characteristics:

(1) Rated pressure
(2) Rated flow
(3) Pressure drop at rated flow
(4) Maximum power consumption
(5) Control limits

3.3.3 Construction.- The fuel system component shall be constructed to withstand the strains, jars, vibrations, and other conditions incident to shipping, storage, installation, and service use.

3.3.3.1 "O" ring packing.- All "O" rings shall conform to the requirements of Specification MIL-P-5315 and the dimensional requirements of Standard MS29513.

3.3.3.2 Electrical devices.- Fuel system components incorporating electrical devices shall conform to the following requirements whenever applicable.

3.3.3.3 D-c operating voltage.- Equipment intended for use in 28-volt d-c electrical systems shall operate satisfactorily over a range of voltage from 18 to 30 volts.

3.3.3.4 A-c operating voltage and frequency.- Equipment intended for use in 115/200-volt 400-cycle electrical systems shall operate satisfactorily at any applied frequency between 380 and 420 cps and at any applied line-to-line terminal voltage between 190 and 220 volts.

3.3.3.5 Wire.- Internal wire other than windings shall be in accordance with the requirements of Specification MIL-W-5086.

3.3.3.6 Electrical connectors.- On fuel system components incorporating electrical devices, the electrical connectors shall be in accordance with Specification MIL-C-5015. The size and type of connectors shall be as specified on the manufacturer's drawing.

3.3.3.7 Grounding.- Each electrical connector used in a fuel system component shall incorporate a ground return terminal.

3.3.3.8 Lubrication.- Fuel system components shall not require added lubrication during their normal life. Parts in contact with the fuel shall not be lubricated.

3.4 Interchangeability.- All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part numbers shall be governed by the drawing number requirements of Specification MIL-D-5028.

3.5 Color identification.- Each fuel system component shall be marked by a red color in conformance with Army-Navy Aircraft Color Standard Code No. 509. The color shall be permanent, and when applied to parts that may come in contact with fuel the color shall not soften, chip, crack, or cause the fuel to be affected in any way. The marking shall consist of a band 1/4 inch wide, by 1 inch long on each side or around the component, a 45-degree arc 1/4 inch wide on both sides of this component, or the entire component may be colored.

3.6 Finish.-

3.6.1 Anodizing.- All aluminum-alloy parts shall be anodized in accordance with Specification AN-QQ-A-696, or adequately treated in some other acceptable manner for corrosion prevention.

3.6.2 Protective treatment.- Steel parts, other than corrosion-resisting steel, not in moving contact, shall be cadmium plated in accordance with Specification QQ-P-416, type II. Wearing surfaces shall be chromium plated in accordance with Specification MIL-P-6871, or adequately treated in some other acceptable manner for corrosion prevention, where galling of cadmium plating would cause malfunctioning. Brass, bronze, and copper-alloy parts shall be cadmium plated, or adequately treated in some other acceptable manner for corrosion prevention. Stainless-steel parts shall be passivated.

3.6.3 Paint.- Any parts painted shall be finished with one coat of primer conforming to Specification MIL-P-6889, type I, and one coat of enamel conforming to Specification MIL-E-5557, type IV.

3.7 Synthetic-rubber parts.-

3.7.1 Marking.- All synthetic-rubber parts such as diaphragms, but excepting "O" rings and parts with no suitable surface, shall have printed, stamped with ink, or otherwise noted on the part, the year and month of the curing date of the part.

3.7.2 Serviceability.- All synthetic-rubber parts shall be readily replaceable with a minimum replacement of attaching parts.

3.7.3 Uniformity.- For components which include parts fabricated on synthetic material in contact with fuel, manufacturers shall control subsequent batches to provide for uniformity.

3.7.4 Age controls.- Age controls for synthetic-rubber parts shall comply with the requirements of ANA Bulletin No. 410.

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3.8 Parts list.- A manufacturer's parts list, submitted in compliance with paragraph 4.2.1, shall list the unit nomenclature, manufacturer's type number, and the manufacturer's outline drawing number for each unit of the fuel system component. A manufacturer's parts list number shall be assigned to each parts list.

3.9 Threaded connections.-

3.9.1 Pipe threads.- Pipe threads shall not be used on fuel system components, except for permanent closures in which case the pipe threads shall conform to Specification MIL-P-7105.

3.9.2 Screw threads.- Machine screw threads shall conform to Specification MIL-S-7742.

3.9.3 Locking of parts.- All threaded parts shall be positively locked by safety wiring, self-locking nuts in conformance with Specification AN-N-10, cotter pins, or other approved methods. Safety wire shall have a minimum diameter of 0.032 inch and shall conform to Drawing AN995. Self-locking nuts shall be used in accordance with Drawing AND10068. Staking and the use of lockwashers is not permitted.

3.9.4 Plumbing connections.- Threaded plumbing connections shall conform to Drawing AND10056 or AND10050, except that bosses provided for installation of drain valves incorporating machine screw threads shall conform to Drawing AND10049. Swivel-fitting connections shall conform to Drawing AND10086.

3.10 Performance.- Fuel system components shall satisfy the performance requirements when subjected to the tests described in Section 4.

3.11 Markings.- All marking shall be durable to prevent obliteration resulting from service.

3.11.1 Part number.- Each part and assembly shall be marked with a part number which shall be the same as the manufacturer's drawing number, except under the following conditions:

(a) Parts or assemblies which do not have a suitable or sufficient surface for a part number.

(b) Assemblies which are permanently assembled by welding, brazing, soldering, or riveting. These shall carry their assembly part number.

3.12 Identification of product.-

3.12.1 Nameplate.- A nameplate conforming to Specification MIL-P-6906 and containing the following information properly and legibly filled in, shall be securely attached to the component, or the same information may be etched, engraved, embossed, or stamped in a suitable location on the component.

(FUEL SYSTEM COMPONENT NOMENCLATURE)
Specification MIL-F-8615
Manufacturer's Part No.
Serial Number (may be deleted if the component is not normally identified by a serial number)
Contract or Order No.
Manufacturer's name or trade-mark
US

3.12.2 Use of AN or MIL designations.- AN or MIL designations shall not be applied to a product, except for Qualification test samples, nor referred to in correspondence, until notice of approval has been received from the activity responsible for qualification, or from the Aeronautical Standards Group.

3.13 Report of Qualification test.- The reports submitted in compliance with paragraph 4.2.1 shall include the following:

(a) Report of all tests, graphically presented when possible, together with a detailed statement indicating compliance or extent of noncompliance with all requirements of this specification, referring specifically to paragraph numbers. Wherever a requirement is considered to be not applicable, the report should so state this.

(b) Summary of Endurance test.

(c) Diagrams of all test setups.

(d) Reproducible outline and description of tests and test conditions. Where tests specified in this specification are not considered applicable, the reason, and the substituted test shall be clearly described.

(e) Copies of test log sheets.

(f) Photographs when available.

3.14 Drawings.- Manufacturer's assembly and detail drawings shall conform to the requirements of Specification MIL-D-5028.

3.15 Workmanship.- Workmanship and finish on all parts shall be in accordance with high-grade manufacturing practice covering this class of aircraft accessories.

3.15.1 Cleaning.- All parts shall be clean and free from dirt, sand, metal chips, and other foreign matter during and after assembly.

4. SAMPLING, INSPECTION AND TEST PROCEDURES

4.1 Classification of tests.- The inspection and testing of fuel system components shall be classified as follows:

(a) Qualification tests: Qualification tests are those tests accomplished on samples submitted for qualification as a satisfactory product.

(b) Inspection tests: Inspection tests are those tests accomplished on fuel system components manufactured and submitted for acceptance under contract.

4.2 Qualification tests.-

4.2.1 Sampling instructions.- Unless otherwise specified, each Qualification test sample shall consist of two sets of components of each manufacturer's part number upon which qualification is desired. The number of components in each set shall be that necessary to perform the applicable tests as indicated herein. One set of components shall have been tested by the manufacturer in accordance with this specification prior

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to being forwarded to the testing activity (each component shall be qualified separately). The components shall be accompanied by one complete set of manufacturer's drawings, the manufacturer's model specification, a parts list, and a complete test report showing the results of the manufacturer's tests. Samples shall be identified as required and forwarded to the testing activity designated in the letter of authorization from the activity responsible for qualification. (See paragraph 6.3.)

4.2.2 Tests.- The Qualification tests of any fuel system component shall consist of the tests, as applicable, in the order indicated and any additional tests, including actual or simulated service, considered necessary to determine that the particular component conforms to the requirements of this specification.

4.2.2.1 Components employing no moving parts.- When the component has no moving parts, the following tests, as described under "Test methods," shall be conducted in the order listed, on a single sample:

(a) Leakage
(b) Calibration
(c) Fuel resistance and extreme temperature
(d) Vibration
(e) Contaminated fuel
(f) Accelerated corrosion
(g) Strength
(h) Disassembly and inspection

4.2.2.2 Components including moving parts but no electrical equipment.- When the component has moving parts but does not include electrical equipment, the following tests, as described under "Test methods," shall be conducted in the order listed:

Sample No. 1

(a) Leakage
(b) Calibration
(c) Fuel resistance and extreme temperature
(d) Contaminated fuel endurance
(e) Disassembly and inspection

Sample No. 2

(a) Leakage
(b) Calibration
(c) Endurance
(d) Vibration
(e) Corrosion resistance
(f) Strength
(g) Disassembly and inspection

4.2.2.3 Components including electrical equipment.- When components include electrical equipment, the following tests, as described under "Test methods," shall be conducted in the order listed:

Sample No. 1

(a) Dielectric strength
(b) Leakage
(c) Calibration
(d) Fuel resistance and extreme temperature
(e) High ambient air temperature
(f) Low ambient air temperature
(g) Humidity
(h) Contaminated fuel endurance
(i) Disassembly and inspection

Sample No. 2

(a) Dielectric strength
(b) Leakage
(c) Calibration
(d) Endurance
(e) Corrosion resistance
(f) Strength
(g) Disassembly and inspection

Sample No. 3	Sample No. 4
(a) Dielectric strength	(a) Explosion-proof 1/
(b) Leakage	(b) Dielectric strength
(c) Calibration	(c) Leakage
(d) Vibration	(d) Calibration
(e) Sand and dust	(e) Radio interference
(f) Fungus resistance	(f) Humidity
(g) Disassembly and inspection	(g) Disassembly and inspection

1/ Additional sample shall be furnished where drilling required for the Explosion-proof test may make the No. 4 sample unsatisfactory for additional tests.

4.2.2.4 Rejection and retest of qualification samples.- If, during the Qualification tests, a major part fails, the test shall be terminated. The replacement unit assembly shall have a redesigned part or one of different material corresponding to the failed part, except that if the failure was caused by faulty material or workmanship, the procuring activity may authorize the installation of a part of the original design and material with the defect overcome. The Qualification tests shall be considered completed when every major part has concurrently completed the Qualification tests. Minor parts may be replaced and penalty runs conducted at the option of the procuring activity.

4.3 Inspection tests.- The Inspection tests shall consist of Individual tests and Sampling tests.

4.3.1 Individual tests.- Each fuel system component shall be subjected to an Examination of product and the following tests, as described under "Test methods":

(a) Dielectric strength
(b) Functional - at rated conditions only
(c) Internal leakage (-14 psi and +60 psi only)
(d) Proof pressure
(e) Power requirements - at rated conditions only

4.3.2 Sampling tests.- One fuel system component shall be selected by the Inspector from each lot of 200 or fraction thereof on the order, and manufactured and submitted for acceptance at the same time.

4.3.3 Tests.- The Inspection tests of fuel system components shall consist of Individual tests, and the following tests, as described under "Test methods":

(a) Examination of product
(b) Leakage
(c) Calibration
(d) Strength

In addition, the Inspector may require that the component be subjected to any other applicable test, as deemed necessary to determine conformance with the requirements specified herein.

4.3.4 Rejection and retest.- Failure of any representative sample shall be cause for the rejection of the lot represented. Fuel system components which have been rejected, may be reworked to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the Inspector. Fuel system components rejected after retest shall not be resubmitted without the specific approval of the procuring activity.

4.4 Test conditions.- Unless otherwise specified, the following test conditions shall apply during the tests performed in accordance with this specification.

4.4.1 Cleaning.- Prior to testing any fuel system component, all lubricants and preservative compounds, except permanent protective coatings such as paint, shall be removed from the external parts of the unit and from all internal parts which are normally wetted with fuel.

4.4.2 Test fluid.- Unless otherwise specified herein, the fluid used for testing shall be fuel conforming to Specification MIL-F-5572, or test fluid conforming to Specification MIL-H-3136, type I. Other fluids such as fluids conforming to Specification P-S-661 may be used only with the specific approval of the procuring activity.

4.4.3 Room temperature and pressure.- Unless otherwise specified herein, all tests shall be conducted at a temperature of 60° to 90°F and at atmospheric pressure.

4.4.4 Altitude.- Altitude pressures shall be determined from NACA Report No. 218, Tables and Data on Standard Atmosphere.

4.4.5 Attitude.- Unless otherwise specified, all tests shall be conducted with the component installed in the normal mounting attitude.

4.5 Test methods.- The model specification shall list and describe the detailed test procedures of the applicable tests. The required performance of the component during or after each test shall be included. This information shall be presented by curves when applicable.

4.5.1 Examination of product.- Each fuel system component submitted for acceptance shall be carefully examined to determine conformance with the requirements of this specification (including the contractor's approved drawings and specifications) not covered by tests.

4.5.2 Leakage.- Test shall be conducted to determine both internal and external leakage.

4.5.2.1 Internal.- This test shall be applicable to all components whose function in the fuel system includes that of shutting off the flow of fuel in any manner. The Internal leakage test shall be conducted on the component in the "shut-off" position by applying pressures to each port from -6 psi to +60 psi, or 125 percent of the maximum operating pressure, whichever is greater, unless the function of the unit in the fuel system is such that it is not required to withstand such pressures without excessive leakage even though these pressures might exist in the fuel system. The leakage permitted during this test shall be as specified in the model specification or drawing and shall be consistent with the application. Generally, leakage rates greater than 10 drops per minute are considered excessive.

4.5.2.2 External.- The External leakage test shall be applicable to all fuel system components and shall be conducted over a pressure range from -6 psi to +60 psi or to 125 percent of the maximum operating pressure, whichever is greater. Unless otherwise specified, no external leakage shall be permitted.

4.5.3 Calibration.- The Calibration test specified in the model specification shall include the following tests, when applicable. The data recorded during these tests shall be sufficient to permit the plotting of curves demonstrating each major performance characteristic of the unit under test. The performance shall be as specified in the model specification or drawing.

4.5.3.1 Functional.- This test shall demonstrate the ability of the unit to perform its intended function in the airplane over a range of flows and pressures consistent with the application, and, in the case of electrically operated equipment, over a range of input voltages and frequencies as specified in paragraph 3.3.3.3 or 3.3.3.4.

4.5.3.2 Pressure drop.- This test shall be applicable to all components whose function in the fuel system is such as to affect the total pressure drop of the fuel system. The Pressure drop test shall be conducted over a range of flows that completely covers the design capacity of the unit, and sufficient data shall be recorded to permit the plotting of curves. The pressure-drop graph shall show the pressure drop of the component using the test fluid ΔP obs., and the pressure drop of the component corrected to fuel in accordance with Specification MIL-F-5572, grade 115/145 (reference viscosity 0.462 centipoises, reference specific gravity 0.696), using the following formula:

$$\Delta P_{corrected} = \left(\frac{0.462}{\mu}\right)^{.25} \times \left(\frac{0.696}{\rho}\right)^{.75} \times \Delta P_{obs.} + 7.72 \times 10^{-4} \times G^2 \times \left(\frac{1}{Di^4} - \frac{1}{Do^4}\right)$$

Where: μ = absolute viscosity in centipoises of test fluid
ρ = specific gravity of test fluid
G = rate of flow in gallons per minute
D_i = inside diameter of inlet tube, inches
D_o = inside diameter of outlet tube, inches
$\Delta P_{obs.}$ = observed pressure drop, psi

The allowable pressure loss shall conform to the requirements of the model specification.

4.5.3.3 Pressure control.- This test shall be applicable to all components where the actuation of the component is dependent upon fuel system pressure. This test shall be conducted using a simulated installation and actuating fuel pressures shall be varied over a range that completely covers the design capacity of the component.

4.5.3.4 Flow control.- This test shall be applicable to all components where the actuation of the component is dependent upon fluid flow in the fuel system. This test shall be conducted using a simulated installation and with fluid flows that completely cover the design capacity of the component.

4.5.3.5 Level control.- This test shall be applicable to all components where the actuation of the component is dependent upon fuel level in a component of the fuel system. This test shall be conducted using a simulated installation and with actuating fuel levels that completely cover the design capacity of the component.

4.5.3.6 Altitude.- This test is applicable to all fuel system components in which the performance may be affected by reduced atmospheric pressure. The test conditions shall simulate those occurring in the aircraft with a fuel temperature of 110° to 115°F and with a rate of climb and terminal altitude as specified in the model specifications.

4.5.3.7 Extreme attitude.- This test is applicable to all components in which the performance may be affected by attitudes other than normal. The test conditions shall simulate those occurring in the aircraft.

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4.5.3.8 Power requirements.- The Power requirements test shall be applicable to all components requiring an external source of power for their operation whether this source be electrical, mechanical, manual, pneumatic, hydraulic, or other. This test shall be conducted over the complete range of operating flows and pressures.

4.5.4 Fuel resistance and extreme temperature.- The Fuel resistance and extreme temperature tests are applicable to all components containing nonmetallic parts which may come in contact with fuel and shall be conducted in accordance with the appropriate table:

Table I - Applicable to fuel system components employing no moving parts.

Table II - Applicable to fuel system components employing moving parts but no electrical equipment.

Table III - Applicable to fuel system components incorporating electrical equipment.

4.5.5 Endurance.- The Endurance test shall be applicable to all fuel system components incorporating moving parts and shall be conducted in accordance with table IV. The unit shall be operated at its maximum operating load condition for a number of cycles or period of time consistent with 1,200 hours of airplane operation or as specified below, whichever is the more severe:

(a) All fuel system components having a definite operating cycle and which normally operate more than 10 times per flight shall be subjected to a minimum of 100,000 complete cycles; all others shall be subjected to a minimum of 10,000 complete cycles. The Endurance test shall consist of the following:

(1) Wet (60 percent of total)
(2) Dry (15 percent of total)
(3) Altitude (15 percent of total)
(4) Low temperature (5 percent of total)
(5) High temperature (5 percent of total)

Wherever the Dry or Altitude endurance test are not applicable, the Wet endurance test is to be proportionally increased to cover the minimum number of complete cycles as outlined above.

(b) All pumps of the intermittent duty type with respect to airplane operation shall be subjected to a minimum of 500 hours of operation.

4.5.5.1 Wet.- The Wet endurance test shall be conducted using any suitable fluid acceptable to the procuring activity, preferably that fluid normally used with the component in service.

4.5.5.2 Dry.- The Dry endurance test shall be applicable to all components which may be subjected to dry operation during service in an aircraft.

4.5.5.3 Altitude.- The Altitude endurance test shall be applicable to fuel pumps and to all fuel system components incorporating electrical devices which may be adversely affected by operation at reduced atmospheric pressure, e.g., d-c motors, units containing electrical contacts, etc. The test shall be conducted at the maximum rated load condition of the component and at a simulated altitude of 60,000 feet, except that the ambient temperature shall be room temperature, and, except that in the case of pumps, the pump inlet pressure shall be the least at which the pump will be required to operate normally in the aircraft. Fuel conforming to Specification MIL-P-5572 shall be used during tests requiring a test fluid.

TABLE I

Fuel resistance and extreme temperature test schedule
components employing no moving parts

Test	Fuel resistance					Extreme temp	
Period 1/	Initial drying	Phase I soak	Phase I dry	Phase II soak	Phase II dry	Low temp	High temp
Component configuration	Drained, inlet and outlet ports open.	2/	Drained, inlet and outlet ports open.	2/	Drained, inlet and outlet ports open.	2/	2/
Test fluid	None	MIL-H-3136 type III	None	MIL-H-3136 type I	None	MIL-H-3136 type I	MIL-H-3136 type III
Period duration	168 hours (7 days)	168 hours (7 days)	4 hours	504 hours (21 days)	4 hours	72 hours (3 days)	72 hours (3 days)
Ambient and test fluid temperature	158° ±2°F	Room	158° ±2°F	Room	158° ±2°F	-67° ±2°F	130° ±5°F
Tests during period	None	None	None	None	None	None	None
Tests immediately after period	Conduct Leakage test using MIL-H-3136, type I fluid. 3/	Conduct Leakage test using MIL-H-3136, type III fluid.	Conduct Leakage test using MIL-H-3136, type I fluid.	Conduct Leakage test using MIL-H-3136, type I fluid.	Conduct Leakage test using MIL-H-3136, type I fluid.	With an ambient temp and test fluid at not higher than -65°F, conduct Leakage test using MIL-H-3136, type I fluid.	With an ambient temp and test fluid at not lower than 125°F, conduct Leakage test using MIL-H-3136, type III fluid.

1/ Each period shall follow immediately after the preceding one in the order noted.

2/ During periods of soaking in the test fluid, the component shall be maintained in such a manner as to insure complete contact of all nonmetallic parts with the fluid as would be expected under service conditions.

3/ No leakage is allowed at any time during the test, except for the first 15 minutes of the Leakage tests conducted after the three dry periods.

TABLE II

Fuel resistance and extreme temperature test schedule
for components incorporating moving parts but no electrical equipment

Test	Fuel resistance					Extreme temperature	
Period 1/	Initial drying	Phase I soak	Phase I dry	Phase II soak	Phase II dry	Low temperature	High temperature
Component configuration	Drained, normal condition as would be expected under service storage conditions, ports open.	2/	Drained, normal condition as would be expected under service conditions, ports open.	2/	Drained normal condition as would be expected under service conditions, ports open.	Mounted as would be expected under normal service conditions. 2/	Mounted as would be expected under normal service conditions. 2/
Test fluid	None	MIL-H-3136 type III	None	MIL-H-3136 type I	None	MIL-H-3136 type I	MIL-H-3136 type III
Period duration	168 hours (7 days)	168 hours (7 days)	4 hours	504 hours (21 days)	4 hours	72 hours (3 days)	72 hours (3 days)
Ambient and test fluid temp	158° ±2°F	Room	158° ±2°F	Room	158° ±2°F	-67° ±2°F	130° ±5°F
Operation or tests during period	None	Actuate component at least twice per day in a normal manner.	None	Actuate component at least twice per day in a normal manner.	None	None	None
Operation or test immediately after period	(a) Actuate component for 5 cycles. (b) Conduct Functional and Leakage tests using MIL-H-3136, type I fluid. 3/	Conduct Leakage test using MIL-H-3136, type III fluid.	(a) Actuate components for 5 cycles. (b) Conduct Functional and Leakage tests using MIL-H-3136, type I fluid.	Conduct Leakage test using MIL-H-3136, type I fluid.	(a) Actuate component for 5 cycles. (b) Conduct Functional and Leakage tests using MIL-H-3136, type I fluid.	With temp not higher than -65°F, conduct Functional and Leakage tests using MIL-H-3136, type I fluid.	With temp not lower than 125°F, conduct Functional and Leakage tests using MIL-H-3136, type III fluid.

1/ Each period shall follow immediately after the preceding one in the order noted.
2/ During periods of soaking in the test fluid, the component shall be maintained in such a manner as to insure complete contact of all nonmetallic parts with the fluid as would be expected under normal service conditions.
3/ Leakage shall be kept within the allowable limits of this specification and the model specification or drawing, except for the first 15 minutes of the Leakage tests conducted after the three dry periods.

TABLE III

Fuel resistance and extreme temperature test schedule
for fuel system components incorporating electrical equipment

Test	Fuel resistance					Extreme temperatures	
Period 1/	Initial drying	Phase I soak	Phase I dry	Phase II soak	Phase II dry	Low temperature	High temperature
Component configuration	Drained, normal condition as would be expected under service storage conditions, ports open.	2/	Drained, normal condition as would be expected under service conditions, ports open.	2/	Drained, normal condition as would be expected under service conditions, ports open.	Mounted as would be expected under normal service condition. 2/	Mounted as would be expected under normal service condition. 2/
Test fluid	None	MIL-H-3136 type III	None	MIL-H-3136 type I	None	MIL-H-3136 type I	MIL-H-3136 type III
Period duration	168 hours (7 days)	168 hours (7 days)	4 hours	504 hours (21 days)	4 hours	72 hours (3 days)	72 hours (3 days)
Ambient and test fluid temp	158° ±2°F	Room	158° ±2°F	Room	158° ±2°F	-67° ±2°F	130° ±5°F
Operation or test during period	None	For intermittent duty components, actuate component 2 cycles/day. For continuous duty components and all pumps, run for 30 min/day.	None	For intermittent duty components, actuate component 2 cycles/day. For continuous duty components and all pumps, run for 30 min/day.	None	None	None

TABLE III (continued)

Fuel resistance and extreme temperature test schedule
for fuel system components incorporating electrical equipment

Test	Fuel resistance					Extreme temperatures	
Period 1/	Initial drying	Phase I soak	Phase I dry	Phase II soak	Phase II dry	Low temperature	High temperature
Operation or test immediately after period	(a) Conduct functional test. (b) Actuate for five times or for 1 min, as applicable. (c) Conduct Leakage test using MIL-H-3136, type I fluid. 3/	Conduct Leakage test using MIL-H-3136, type III fluid.	(a) Conduct Functional test. (b) Actuate for five times or for 1 min, as applicable. (c) Conduct Leakage test using MIL-H-3136, type I fluid.	Conduct Leakage test using MIL-H-3136, type I fluid.	(a) Conduct Functional test. (b) Actuate for five times or for 1 min, as applicable. (c) Conduct Leakage test using MIL-H-3136, type I fluid.	With temp not higher than -65°F, conduct Functional and Leakage tests using MIL-H-3136, type I fluid.	With temp not lower than 125°1, conduct Functional and Leakage tests using MIL-H-3136, type III fluid.

1/ Each period shall follow immediately after the preceding one in the order noted.

2/ During periods of soaking in the test fluid, the component shall be maintained in such a manner as to insure complete contact of all nonmetallic parts with the fluid as would be expected under normal service conditions.

3/ Leakage shall be kept within the allowable limits of this specification and the model specification or drawing, except for the first 15 minutes of the Leakage tests conducted after the three dry periods.

TABLE IV

Endurance test schedule

			Wet endurance		
Test period	Dry endurance 1/	Altitude endurance 2/	Room temperature	Low temperature	High temperature
Test setup or component configuration.	Suitable test setup	Suitable test setup, 60,000 feet pressure altitude.	Suitable test setup, atmospheric pressure.	Suitable test setup, atmospheric pressure	Suitable test setup, atmospheric pressure.
Test procedure during period	(a) Dry component at 158° ±2°F for 4 hours. (b) For intermittent duty components, cycle components for 3.75 percent of the total cycles dry at atmospheric pressure. (c) For continuous duty components, the component shall be run for 5 hours. (d) Wet component with test fluid.	Conduct test at rated flow and pressure. For power driven components, the test shall be conducted with inlet conditions specified in the model specification.	Conduct test at rated flow and pressure. For power driven components, the test shall be conducted with inlet conditions specified in the model specification.	Conduct test the same as the Room temperature test, except flow need not be rated for intermittent duty components.	Conduct test the same as the Room temperature test, except flow need not be rated for intermittent duty components.
Ambient and test fluid temperature	Room (except for 4 hour drying)	Room	Room	-67° ±2°F	130° ±5°F
Number of periods	To be specified in the model specification.	To be specified in the model specification.	To be specified in the model specification.	To be specified in the model specification.	To be specified in the model specification.
Tests after completion of period	Calibration and Leakage tests.	Calibration and Leakage tests.	Calibration and Leakage tests.	Calibration and Leakage tests.	Calibration and Leakage tests.

1/ Dry Endurance test is applicable only to components that may operate dry in the fuel system.

2/ Altitude endurance may be conducted simultaneously with dry endurance for intermittent duty components.

4.5.5.4 Low temperature.- The Low temperature endurance test shall be conducted using type I fluid, conforming to Specification MIL-H-3136, or a fluid acceptable to the procuring activity.

4.5.5.5 High temperature.- The High temperature endurance test shall be conducted using type III fluid, conforming to Specification MIL-H-3136, or a fluid acceptable to the procuring activity.

4.5.6 Corrosion resistance.- Unless otherwise specified herein, corrosion resistance shall include both accelerated corrosion and salt spray.

4.5.6.1 Accelerated corrosion.- This test shall be applicable to all fuel system components, except positive displacement pumps. The component, (except for unsealed electrical units) with all fuel ports open shall be immersed in a solution consisting of 2-1/2 percent sodium chloride in distilled water. After immersion, the component shall be drained and heated to a temperature of 130° ±5°F for a period of 1 hour. This immersion and heating cycle shall be repeated 50 times. The component shall not be actuated at any time during the above test. Immediately after completing the immersion and heat cycles, the component shall be washed with warm water to remove all salt accumulations, after which the component shall be dried, wetted with fuel, and actuated as in normal service. The torque, force, or current (in the case of electrically actuated components) shall not exceed the maximum requirements specified in the contractor's model specification or drawing. There shall be no evidence of deterioration that might adversely affect subsequent operation.

4.5.6.2 Salt spray.- The component shall be subjected to a salt spray in accordance with Specification QQ-M-151 for a period of 50 hours. At the end of the test period, the salt deposits shall be removed with warm water. The component shall be dried, wetted with fuel, and actuated as in normal service. The torque, force, or current (in the case of electrically actuated components) shall not exceed the maximum requirements specified in the contractor's model specification or drawing. Any evidence of corrosion that might adversely affect the operation of the component shall be cause for rejection.

4.5.7 Contaminated fuel endurance.-

4.5.7.1 Solid particle.- This test shall be applicable to all components, except positive displacement pumps. Test fluid, containing a type of contaminant and at the concentration specified in table V, shall be circulated through all fuel ports of the component. Ten thousand gallons of the contaminated test fluid shall be circulated through components with no moving parts, with the first 2,500 gallons at rated flow, the second 2,500 gallons at 10-percent rated flow, the third 2,500 gallons at rated flow, and the fourth 2,500 gallons at 10-percent rated flow. Components with moving parts shall be tested as follows:

(a) With rated flow, manually operated components shall be cycled at a speed not in excess of 10 cpm for 500 cycles, power driven components shall be operated under normal conditions for a period of 2-1/2 hours.

(b) With 10-percent rated flow, manually operated components shall be cycled at a speed not in excess of 10 cpm for 500 cycles, power-driven components shall be operated under normal conditions for a period of 2-1/2 hours.

The procedures described in (a) and (b) shall be repeated. If the component (either manual or power driven) is so designed that the sequence of events constituting a complete cycle may be reversed in normal operation, then 50 percent of the actuations shall be performed in the reverse direction. After this test, the component shall be flushed out with clear fuel and drained, and the Functional and Leakage tests shall be conducted. The component shall perform satisfactorily during the Contaminated fuel endurance, Functional and Leakage tests.

TABLE V

Contaminated fuel endurance test dust

Contaminant description	Particle size	Quantity per 20 gal of test fluid
Sharp silica sand	smaller than 30 mesh larger than 50 mesh	0.2 gram
Sharp silica sand	smaller than 50 mesh larger than 100 mesh	0.2 gram
Prepared dust AC Spark Plug Co. Part No. 1543637 or equal.	0-5 microns 12 ±2 percent 5-10 microns 12 ±3 percent 10-20 microns 14 ±3 percent 20-40 microns 23 ±3 percent 40-80 microns 30 ±3 percent 80-200 microns 9 ±3 percent	1.6 grams

4.5.7.2 Gum.- The test setup, procedure, and requirements, of this test shall be specified in the contractor's model specification.

4.5.8 Strength.-

4.5.8.1 Proof pressure.- A test fluid pressure of 120 psi shall be applied to the component in the same manner as for the Internal and External leakage tests. There shall be no evidence of failure, malfunction, distortion, or unsatisfactory leakage.

4.5.8.2 Burst pressure.- A test fluid pressure of 180 psi shall be applied to the component in the same manner as for the Internal and External leakage tests. There shall be no evidence of failure or distortion and when the pressure has been reduced to 60 psi, the component shall satisfy the requirements of the Leakage tests.

4.5.8.3 Surge pressure.- The test setup, procedure, and requirements, of this test shall be specified in the contractor's model specification.

4.5.8.4 Mechanical load.- With the component mounted in the normal manner, it shall be subjected to the most severe tension, compression bending, or torsional loads, that would be expected to occur in service. There shall be no evidence of failure, malfunction, distortion, or unsatisfactory leakage, as a result of this test.

4.5.8.5 Overspeed.- This test is applicable to components which may be damaged as result of overspeed. During this test, the component shall be operated at a speed 25 percent above the rated maximum speed for a period of 5 minutes. Any governors, speed limiters, or equivalent devices shall be rendered inoperative during this test. Components incorporating electric motors shall be tested while the motor is hot as a result of testing. Intermittent duty motors may be operated several cycles to accomplish the 5

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minutes of operation if excessive temperature is encountered during continuous operation. The component shall demonstrate its ability to operate at overspeed conditions for 5 minutes without mechanical failure, damage to any part, or effect on subsequent performance.

4.5.9 Electrical.-

4.5.9.1 Explosion-proof.- The Explosion-proof test shall be conducted in a test chamber having a transparent window on one side and the opposite side closed by thin non-porous paper to permit instant pressure relief during explosion. The chamber shall be equipped with a suitable means for vaporizing fuel and maintaining a predetermined gasoline vapor-air mixture throughout the test chamber. Three drilled holes in the electrical unit housing shall be tapped for insertion of a spark plug, a vapor line, and a vent line. A pressure gage shall be connected in the vapor line to indicate when explosions occur in the unit housing. The unit and surrounding chamber shall be filled with the explosive mixture and the valves in the vapor and vent lines shall be closed. The temperature of the explosive mixture shall not exceed 135°F. The unit shall be operated at approximately rated load for a period of 15 minutes. During this period, the explosive mixture in the unit shall be exploded (either by arcing within the unit or by means of the spark plug) and replaced for three explosions. At the end of the 15-minute period, the mixture in the chamber shall be exploded to determine that an explosive mixture existed in the chamber. A total of four tests as described above shall be conducted at each of the following airfuel ratios (by weight): 12.6:1, 13.5:1, 14.5:1 and 15.5:1. The unit shall confine all sparks and flame within the electrical enclosure of the unit. Any explosion within the unit shall not ignite the surrounding explosive mixture or cause any damage to the unit.

4.5.9.2 High ambient air temperature.- This test shall be conducted on all components which incorporate any electrical subcomponents and which are rated as "continuous duty" with the exception of pumps. This will include items which are solenoid operated. The test shall be conducted as follows:

> The entire unit, dry, shall be placed into a chamber with the ambient air controlled within the limits of 160° and 170°F. It shall then be energized with the maximum allowable voltage, e.g., 30 volts dc, etc, applied to the power unit terminals, for a period of 3 hours. At approximate 10-minute intervals the current flow, terminal voltage, ambient temperature, and power unit housing temperatures shall be recorded. The unit shall then be removed from the chamber and the Functional test shall be conducted at room temperature with the minimum allowable voltage, e.g., 18 volts dc, etc, applied to the power unit terminals. The unit shall satisfactorily operate for 30 cycles. Using data taken during this test, a curve shall be plotted showing the variation of coil temperature with time as determined by the resistance method.

4.5.9.3 Low ambient air temperature.- This test shall follow the High ambient air temperature test. The procedure shall be similar to the High ambient air temperature test, except that ambient air shall be controlled to a value of -67° ±2°F in lieu of 160°F.

4.5.9.4 Dielectric strength.- This test shall be applicable to all fuel system components which include any electrical circuits. The applicable test voltage as specified in table VI shall be applied between circuits and between each circuit and the metal frame of the component. Current flow in excess of 2 milliamperes or breakdown of insulation shall constitute failure.

TABLE VI

Test voltage

Nominal voltage	Component	Test voltage	Time
28V dc	Motor	600V or 500V	1 sec 1 min
28V dc	Other than motors	1,000V	1 min 1/
115/200V 400 cy ac	All	1,500V	1 min 1/

1/ For Individual tests this time may be reduced to 1 sec.

4.5.9.5 Radio interference.- All fuel system components employing any electrical circuits shall conform to the requirements of Specification MIL-I-6181. The detail test procedure for each particular component shall be described in the model specification.

4.5.10 Environmental.-

4.5.10.1 Humidity.- This test applies only to fuel system components which include electrical equipment. The component shall be tested in accordance with the requirements of Specification JAN-M-745. Examination, testing, and operation after test, shall be in accordance with the model specification.

4.5.10.2 Fungus resistance.- This test shall be conducted in accordance with the requirements of Specification MIL-E-5272, except that substitution for the specified fungi may be made with the approval of the activity responsible for qualification.

4.5.10.3 Sand and dust.- The Sand and dust test shall be conducted in conformance with the Sand and dust tests, Procedure II of Specification MIL-E-5272.

4.5.11 Vibration.- The Vibration test shall be conducted in accordance with the Vibration tests, Procedure I or II of Specification MIL-E-5272.

4.5.12 Disassembly and inspection.- The unit shall be disassembled and inspected. There shall be no evidence of deterioration or undue wear.

5. PREPARATION FOR DELIVERY

5.1 Application.- The requirements specified herein apply only to direct purchases by or direct shipments to the Government.

5.2 Preservation, packaging, and packing.- The preservation, packaging, and packing of fuel system components shall conform to the requirements of Specification MIL-P-6064, of the group number specified by the contract or order.

5.3 Marking of shipments.- All marking and labeling shall be in accordance with the applicable requirements of Standard MIL-STD-129. The nomenclature shall be as follows: Fuel System Components; General Specification for, Specification MIL-F-8615, Federal Stock No. * (if no FSN available, leave space therefor).

* Information to be entered by the manufacturer.

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6. NOTES

6.1 Intended use.- Components covered by this specification are intended for use in aircraft fuel systems. It is not intended to cover tanks, piping, simple fittings, and quantity gaging equipment. It is also not intended to cover engine components nor components for which detailed Government specifications exist.

6.2 Ordering data.- Requisitions, contracts, and orders should state the number of this specification and the applicable contractors' approved specification, the quantity, and if overseas packing is desired.

6.3 Provisions for Qualification tests.- In the procurement of products requiring qualification, the right is reserved to reject bids on products that have not been subjected to the required tests and found satisfactory for inclusion on the Military Qualified Products List. The attention of suppliers is called to this requirement, and manufacturers are urged to communicate with the Commanding General, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, or with the Bureau of Aeronautics, Navy Department, Washington 25, D. C., the activities responsible for qualification, with a copy to the other Service, and arrange to have the products that they propose to offer to the Navy or the Air Force, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the above designated activities responsible for qualification.

> NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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