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MILITARY SPECIFICATION

FUEL SYSTEM COMPONENTS: GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for aircraft fuel, vent, and propulsion system functional components.

1.2 Classification. Components shall be identified by class based upon a temperature environment in accordance with table I.

TABLE 1. Temperature classification.

Class	High Temperature °C			Low Temperature Fuel and Air °C
	T	T_t	T_a	
A	60°C ±3	75°C ±5	75°C ±5	-57°C ±4
B	95°C ±5	115°C ±5	175°C ±5	-57°C ±4
C	150°C ±5	180°C ±7	315°C ±10	-57°C ±4

T - High operational fuel temperature

T_t - High fuel test temperature

T_a - High ambient temperature

1.2.1 Non-standard environment. Wherever the temperature environment exceeds the classes of 1.2, or where unusual circumstances exist, the lowest and highest fluid, vapor, and ambient temperatures shall be identified. A component may still belong to one of the above classes if the exposure to a higher ambient temperature (T_a) is transitory and does not result in heating the component more than 30°C above the test temperature (T_t) for more than 15 minutes total during 10 hours of operation.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

QQ-C-320	Chromium Plating
QQ-P-416	Plating, Cadmium (Electrodeposited)
TT-S-735	Standard Test Fluids, Hydrocarbon
VV-G-109	Gasoline, Unleaded

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MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-S-4040	Solenoid, Electrical, General Specification for
MI -B-5087	Bonding, Electrical and Lightning Protection, Aerospace Syst ems
MIL-W-5088	Wiring, Aircraft, Selection and Installation of
MIL-P-5315	Packing, Preformed, Hydrocarbon Fuel Resistant
MIL-G-5572	Gasoline, Aviation, Grades 80/87, 100/130, 115/145
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-C-6021	Castings, Classification and Inspection of
MIL-E-6051	Electromagnetic Compatibility Requirements, Systems
MIL-R-6855	Rubber, Synthetic, Sheets, Strips, Molded for Extruded Shapes
MIL-C-7024	Calibrating, Fluids, for Aircraft Fuel System Components
MIL-E-7080	Electric Equipment, Aircraft, Selection and Installation of
MIL-F-7190	Forging, Steel, for Aircraft and Special Ordnance Applications
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series, General Specification for
MIL-M-7969	Motor, Alternating Current, 400 Cycle, 115/200-Volt System Aircraft General Specification for
MIL-M-8609	Motor, DC, 28 Volt System, Aircraft, General Specification for
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter; General Specification for
MIL-A-21180	Aluminum Alloy Castings, High Strength
MIL-E-2S499	Electrical System, Aircraft, Design and Installation of, General Specification for
MIL-R-25988	Rubber, Fluorosilicone Llastomer, Oil- and Fuel-Rcsistant, Sheets, Strips, Molded Parts and Extruded Parts

MIL-F-27351	Fluid, Calibrating, High Flash Point Aircraft Fuel Systems Components
MIL-C-38999	Connector, Electrical, Circular, Miniature, High Density Quick Disconnect, Environment Resistant Removable Crimp Contacts
MIL-R-83248	Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compressor Set Resistant

STANDARDS

FEDERAL

FED-STD-151	Metals, Test Methods

MILITARY

MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking for US Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-461	Electromagnetic Interference Requirements
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-471	Maintainability Demonstration
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-781	Reliability Tests, Exponential Distribution
MIL-STD-794	Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-810	Environmental Test Methods
MIL-STD-831	Test Reports, Preparation of
MIL-STD-882	System Safety Program Requirements
MIL-STD-889	Dissimilar Metals
MIL-STD-1523	Age Controls of Elastomeric Items
MS16142	Boss, Gasket Seal, Straight Thread Tube Fitting
MS33649	Bosses, Fluid Connection - Internal Straight Thread
MS33656	fitting End, Standard Dimensions for Flared Tube Connection, and Gasket Seal
MS33657	Fitting End, Standard Dimensions for Bulkhead Flared Tube Connections

(Copies of specifications, standards, bulletins 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 documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Society of Automotive Engineers

ARP 868 Pressure Drop Test for Fuel System Components

(Copies of the above publication may be obtained from the Society of Automotive Engineers, Two Pennsylvania Plaza, New York, New York 10001.)

American Society for Testing and Materials

ASTM-D1655 Aviation Turbine Fuels
ASTM-E380-74 Metric Practice Guide

(Copies of the above documents may be obtained from the American Societ for Testing and Materials, 1916 Race Street, Philadelphia, PA 19106.)

3. REQUIREMENTS

3.1 First article. Unless otherwise specified, the assemblies furnished. under this specification shall have been inspected and passed the first artic inspection specified herein.

3.2 Item specification. A specification providing all design and performance details shall be submitted by the contractor to the procuring agency for approval. The item specification shall reiterate all applicable requirements of this specification inserting the necessary specific and special requirements. The item specification shall include a specification control drawing.

3.2.1 Drawings. The installation and outline drawings shall be in accordance with MIL-D-1000. At the time and place of first article approval, the data shall include the detailed assembly drawing(s) with the parts list showing the material, coating, temper, special finishes for all parts and applicable processes and assembly procedures, as applicable.

3.2.2 Weight. The allowable wet and dry weights of the component shall be stated in the item specification.

3.3 Selection of standards and specifications. Standards and specificat ions for commodities and services not specified herein, shall be selected in accordance with MIL-STD-143.

3.4 Materials. Materials and processes shall conform to applicable Government specifications. Materials conforming to contractor's specifications may be used after approval by the procuring activity. All materials shall be resistant to the fuels, fuel vapors, humidity, salt fog, and other environmental factors encountered in service.

3.4.1 Fungus proof. Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where used and not hermetically sealed, they shall be treated with fungicidal agent acceptable to the procuring activity; however, if used in a hermetically sealed enclosure, fungicidal treatment will not be necessary.

3.4.2 Metals. Metals shall be of the corrosion-resistant type or suitably treated to resist corrosion due to contact with materials or exposure to environments likely to be met in storage or normal service. Metals shall be inspected in accordance with FED-STD-151.

3.4.2.1 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.4.2.2 Magnesium and copper. Magnesium and copper or alloys thereof shall not be used in contact with fuel.

3.4.2.3 Castings and forgings. Castings shall be in accordance with MIL-C-6021, or MIL-A-21180. The minimum acceptable elongation shall be 3 percent. Steel forgings shall satisfy the applicable requirements of MIL-F-7190.

3.4.3 Rubber. Rubber materials shall conform to MIL-P-5315, MIL-R-6855, Class I, MIL-R-25988 or MIL-R-83248. All other elastomeric materials are required to have specific approval from the procuring activity for the particular application.

3.4.4 Finishes and coatings. All finishes and protective treatments shall be in accordance with applicable Government specifications. The use of any protective coating that will crack, chip, peel, or scale because of age or the aircraft operational environment is prohibited. Paint shall not be used on surfaces normally in contact with fuel.

3.4.4.1 Cadmium plating. Cadmium plating shall conform to QQ-P-416, Class 2, Type II. Cadmium plating shall not be used on surfaces which would normally be in contact with fuel, unless specifically approved by the procuring activity.

3.4.4.2 Chromium plating. Chromium plating shall conform to QQ-C-320, Class 2.

3.5 Fluids. The item specification shall state the principal fluid and other fluids expected to be encountered in use. Fuel system components shall normally be compatible with MIL-G-5572, MIL-T-5624, MIL-C-7024, MIL-F-27351, TT-S-735, VV-G-109, ASTM D-1655, Types A, A-1, and B and other comparable fuels. In normal aircraft operation, these fuels may contain various quantities of dissolved and free water, salts, gases, some solid contaminants, such as sand, dirt and metal chips.

3.6 Design and construction

3.6.1 Pressure. Fuel system components shall be compatible with the pressure schedules of table II, or higher pressures in accordance with the item specification.

TABLE II (Metric)

FLUID SYSTEM	PRESSURE kPa (gage)		
	OPERATING	PROOF	ULTIMATE
TRANSFER	420	830	1240
REFUELING	620	1240	1860
VENT	DESIGN	DOUBLE	TRIPLE

ALTERNATE TABLE II (Customary Units)

FLUID SYSTEM	PRESSURE psig		
	OPERATING	PROOF	ULTIMATE
TRANSFER	60	120	180
REFUELING	90	180	270
VENT	DESIGN	DOUBLE	TRIPLE

3.6.2 Leakage

3.6.2.1 External. The item specification shall state the permissible external leakage from less than atmospheric pressure up to the ultimate pressure.

3.6.2.2 Internal. The item specification shall state the permissible internal leakage for all operating conditions.

3.6.2.3 Plug-in units. When applicable, the item specification shall state the maximum allowable fuel loss when plug-in units are removed and reinstalled.

3.6.3 Strength. The specific requirements of each of the following parameters shall be stated in the item specification as applicable.

3.6.3.1 Mechanical load. The component shall be capable of withstanding normal operating maintenance loads without distortion or failure. The minimum design value of torque for installation and removal of fittings, fasteners, etc., shall be at least 125 percent of the normal maximum.

3.6.3.2 Shock resistance. The component mounting shall assure safe retention in place and not be a cause for leakage of fuel in the event of a shock load within the envelope of the applicable structural design criteria.

3.6.3.3 Fatigue resistance. The component shall be capable of withstanding the vibrations and acoustical noise of its installed environment as well as any other external force input that causes repeated stress in any portion of the component. The vibration and acoustical noise environment shall be specified in accordance with MIL-STD-810.

3.6.4 Bonding. Bonding for electrical requirements and lightning protection shall be in accordance with MIL-B-5087.

3.6.5 Electrical. Electrical devices shall be compatible with the aircraft electrical system as well as power in accordance with MIL-STD-704 and shall satisfy the applicable requirements of MIL-E-7080 and MIL-E-25499.

3.6.5.1 Electrical connector. Electrical connectors shall be in accordance with MIL-C-38999, or in accordance with the applicable aircraft specification.

3.6.5.2 Wiring. Electrical wiring shall be in accordance with MIL-W-5088.

3.6.5.3 Solenoids. Solenoids in fuel system components shall be continuous duty in accordance with MIL-S-4040.

3.6.5.4 Motors. Electrical motors shall satisfy the applicable requirements of MIL-M-7969 and MIL-M-8609.

3.6.5.5 Electrical fault containment. The assembly housing shall be completely capable of containing any internal fault without failure of the housing. In no case shall an electrical short or internal explosion propagate to the outside of the housing or generate an unsafe condition.

3.6.5.6 Electrical insulation requirements. The electrical components shall withstand, without damage, breakdown, or excessive leakage current, applications of test voltages in accordance with the test procedure of Section 4. The AC dielectric current shall not exceed 2 milliamperes. Insulation resistance shall not be less than 100 megohms for motors, or 200 megohms for other electrical components.

3.6.5.7 Electromagnetic interference. The electrical components shall meet the applicable requirements of MIL-STD-461 and shall be capable of satisfying the requirements of MIL-E-6051 when installed in the aircraft.

3.6.6 Thermal protection. If normal operation of the equipment or if an electrical fault can generate high temperatures, thermal protection shall be incorporated to assure that the assembly is maintained within safe temperature limits under all operating or nonoperating conditions. The peak temperature, from any heat source, of any portion of the assembly in contact with fuel or fuel vapors, shall not exceed 200°C or a lower temperature in accordance with the item specification.

3.6.7 Shaft seals, drains, and vents. Motor operated fuel system components shall provide shaft seals and a suitable drain chamber between the motor and the component unless the rotating element of the motor is immersed in fuel. A vent connected to an electrical motor chamber shall not be connected to the seal drain chamber and shall incorporate a flame arrestor.

3.6.8 Traps and voids. Fuel system components shall not contain traps, pockets, or voids in which moisture may freeze or contaminants may collect that affects performance or reliability.

3.6.9 Threaded connections. Threaded connections shall comply with MIL-S-7742, MIL-S-8879, MS16142, MS33649, MS33656, or MS33657, as applicable.

3.6.9.1 Pipe threads. Pipe threads shall not be used except for permanent closures.

3.6.9.2 Threaded safety. All threaded parts shall be positively locked or safetied in accordance with applicable military standards or other accepted practice. Wherever loosening of a self-locking nut could possibly result in the nut or other parts entering the fuel system plumbing, approval of the installation shall be obtained from the procuring activity. The use of cotter pins on studs, or the use of lockwashers or staking is prohibited.

3.6.10 Lubrication. Fuel system components shall function satisfactorily without the need for lubrication other than the fuel in which it operates during its useful service life. Wherever a lubricant is required (such as a gear assembly) it shall be a sealed unit and shall not require relubrication between overhaul periods.

3.6.11 Overspeed. Components containing rotating members which can overspeed for any reason shall have a self-contained speed regulator and shall also be designed to prevent propagation of any failure outside of the housing.

3.7 Performance. All necessary specific performance requirements must be provided by the item specification. The following paragraphs shall be used as guides in preparing the item specification requirements, but they do not necessarily contain all the required performance parameters.

3.7.1 Calibration. All critical calibration points shall be specified, such as, flow rates, pressure schedules, pressure drop (or rise), fluid level, response adjustments, or power requirements.

3.7.2 Altitude. Fuel system components shall deliver full required performance at all altitude levels, and during changes in altitude. If performance is required to be insensitive to altitude, the specification shall so state.

3.7.3 Acceleration. The required performance during changes in speed or changes in direction shall be specified.

3.7.4 Gravity force. The component performance during periods of inverted flight or changes in the effective gravity force, shall be in accordance with system requirements as stated in the detail specification.

3.7.5 Endurance. In general, components whose operational life is time dependent shall have a minimum endurance of 1,200 hours between overhaul periods. For components whose operation is intermittent, and are operated 10 times or more per flight or a component whose failure can impose a hazard shall have a minimum endurance of 100,000 cycles. For components that operate less frequently, and are not safety critical, the required endurance shall be 10,000 cycles. The endurance test shall encompass all operational conditions from sea level to maximum altitude, including high and low temperature exposure as well as dry operation (without fuel).

3.7.6 Water and ice. Water (or ice) shall not be a cause of a fuel system component failure. The water may come from any available source, such as free or dissolved water in the fuel, vapor in a bleed air system, clouds, rain, etc. Any fuel system component whose failure, due to water (or ice) could prevent transfer of fuel, or could cause a buildup of pressure, either positive or negative, in excess of design allowances, shall demonstrate its capability to satisfy aircraft system requirements in the presence of water, either in the fuel or in the surrounding atmosphere.

3.7.6.1 Above freezing. The component shall demonstrate its ability to perform in the presence of water when the temperature is above freezing.

3.7.6.2 Icing conditions. The minimum endurance and required performance under icing conditions shall be specified.

3.7.7 Speed. Where applicable, the duration of time for a valve opening and closing shall be specified. Whenever a component contains a speed control device, or whenever a variation in the amount of fluid in a component will allow a speed change, the minimum performance requirements shall be specified.

3.7.8 Dust (fine sand). Components installed in exposed locations shall be capable of withstanding the damaging effects of sand and dust in the atmosphere without excessive deterioration in performance.

3.7.9 Pressure surge. Fuel system components shall not cause pressure surges in the fuel tubing greater than the proof pressure of table II. If this requirement cannot be satisfied, a specific approval of the deviation must be obtained, and the proof and burst pressure test requirements shall be increased accordingly. Surge pressures are transient pressure peaks above the normal system pressure, caused by component actuation.

3.7.10 Thermal shock. The component shall be capable of withstanding the thermal cycling effects of its environment and fluid temperature changes without deterioration in either performance or endurance, and without any other failure. Where applicable, thermal shock performance requirements shall be specified.

3.8 Safety analysis. Where applicable, all possible failure modes and their impacts shall be examined in accordance with the applicable paragraphs of MIL-STD-882, and in accordance with the system safety requirements of the air vehicle.

3.8.1 Proof-of-safety tests. Tests shall be conducted to verify the safety analysis. The requirements of MIL-STD-882 shall be applied to the verification tests.

3.9 Reliability. The reliability of the component to perform shall be stated in the item specification, as needed to satisfy system requirements. A test plan shall be prepared for demonstrating the required reliability in accordance with MIL-STD-781.

3.10 Maintainability. The maintainability plan shall provide an estimate of maintenance manhours, total clock-hours, and special tools needed for intermediate shop and overhaul maintenance of the component, in accordance with MIL-STD-471.

3.10.1 Accessibility. Fuel system components which require routine service checking, adjustment, or parts replacement, shall provide accessibility for this routine maintenance without requiring teardown, or disassembly of the housing from the airframe, fluid lines or electrical components.

3.10.2 Seal replacement. Wherever seals are partially exposed and subject to possible damage, the seal unit shall be readily replaceable and preferably without removal of the main housing from its mounted position.

3.10.3 Error-free maintenance. The following general requirements will reduce the possibility of human errors during assembly and maintenance of system components, if applicable:

a. Stacked assemblies shall use arrangements which prevent improper assembly, such as the use of indicator markings which are exposed if parts are omitted.

b. Similar components shall either be identical and interchangeable, or shall have some design feature to prevent their interchange. The use of right and left hand parts shall be avoided.

c. When bolts of different sizes are used near the same location, widely differing sizes shall be specified. Two bolts identical except for length shall not be used in the same location. Design shall protect against damage to parts caused by accidental use of screws or bolts which are too long.

d. Where reversed or rotated mounting of a part cannot be tolerated, non-symmetrical mounting arrangements (including key ways or pins) shall be used, Parts that are capable of proper operation when mounted in any orientation are more desirable.

e. Identical cable receptacles shall not be used side-by-side unless internal functions are identical and interchangeable.

3.11 Interchangeability. All component part.; shall be governed by the part numbering system of MIL-STD-100.

3.12 Identification. All assemblies and parts shall be marked in accordance with MIL-STD-130. The information may be etched, engraved, embossed, or stamped in a suitable location on the assembly or on a corrosion resistant-nameplate securely attached to the component. The information shall be located where it can be read with the component mounted in place, insofar as practical.

3.12.1 Color identification. The component shall be color coded to indicate fuel use by means of a red color. The color shall be permanent and shall not deteriorate, loosen or fade due to contact with fuel or the operational environment. The marking may consist of a red band 1/4 inch or wider around the component body or a stripe at least 1 inch long on opposite sides of the component or by coloring the entire outer surface of the principal body, or by use of an embossed nameplate with a red background color.

3.13 AGE Control. The assembly date marking shall be in accordance with MIL-STD-1523.

3.14 Workmanship. Workmanship shall be in accordance with all applicable specifications, drawings, and quality control plans.

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 as specified herein. The contractor may use his own or other suitable facilities unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspection and testing of the componen shall be classified as follows:

a. First article inspection

b. Quality conformance inspection.

4.3 First article inspection. The first article inspection shall consist of all applicable inspections and tests herein, and any additional tests shall be in accordance with the item specification. The number of test articles and the order of tests shall be in accordance with table 111.

4.3.1 Test report. The test report, covering all details of the first article inspection shall be prepared in accordance with MIL-STD-831. The report shall include the assembly and cross-section drawings of the component, copies of test log sheets and other applicable sketches and photographs. The description of the test apparatus may be abbreviated by including sketches and photographs to provide a clear understanding of each test set-up.

TABLE III. First article inspection program.

INSPECTION	REQUIREMENT	TEST	TEST ARTICLE		
			1	2	3
0 Examination	3.2, 3.14	4.5.2	x	x	x
1 Break-in Run	3.2	4.5.3	x	x	x
2 Calibration	3.7.1	4.5.5	x	x	x
3 Speed	3.7.7	4.5.7	x	x	x
4 Leakage	3.6.2	4.5.4	x	x	x
5 Electrical Insulation	3.6.5.6	4.5.16.2	x	x	x
6 Fuel Resistance	3.4	4.5.11		x	
7 Corrosion Resistance	3.4	4.5.14	x		
8 Endurance	3.7.5	4.5.7	x		
9 Contaminated Fuel	3.5	4.5.13	x		
10 Altitude	3.7.2	4.5.6		x	
11 Gravity	3.7.4	4.5.9		x or x	
12 Acceleration	3.7.3	4.5.8		x or x	
13 Vibration	3.6.3.3	4.5.18.4		x or x	
14 Water	3.7.6	4.5.17	x or x		
15 Icing	3.7.6	4.5.17.3	x or x		
16 Dust	3.7.8	4.5.18.3	x or x		
17 Pressure Surge	3.7.9	4.5.10	x or x		
18 Mechanical Shock	3.6.3.2	4.5.15.1			x
19 Mechanical Load	3.6.3.1	4.5.15.2	x	x	
20 Overspeed	3.6.11	4.5.15.3			x
21 Electrical Actuators	3.6.5.3, 3.6.5.4	4.5.16.1			x
22 Explosion Proof	3.6.5.5	4.5.16.3			x
23 Electrical Compatibility	3.6.5.7	4.5.16.4	x or x		
24 Thermal Protectors	3.6.6	4.5.16.5			x
25 Humidity	3.4, 3.7.6	4.5.18.1	x		
26 Fungus Resistance	3.4.1	4.5.18.2	x		
27 Acoustical Noise	3.6.3.3	4.5.18.5		x or x	
28 Thermal Shock	3.7.10	4.5.18.6		x or x	
29 Bonding and Lightning	3.6.4	4.5.19		x or x	
30 Disassembly	3.1	4.5.20	x	x	x

NOTES: A. Inspections 2, 3, 4, and 5 shall be repeated at the end of the tests for each test article, prior to disassembly.

B. Inspections 7, 8 and 9 shall be conducted in the order listed.

C. Inspection 6 shall be conducted prior to any other lower number in the list.

D. A simple mechanical device without electrical equipment may only require two test articles. A 4th test article is optional for sharing the inspections of test article 3.

4.3.2 Disposition of test articles. All items subjected to test shall be available for the first article inspection and thereafter shall be retained or delivered to the procuring agency in accordance with the contract requirements.

4.4 Quality conformance inspections. The quality conformance inspections shall consist of individual tests.

4.4.1 Individual tests. Each assembly shall be subjected to individual tests prior to delivery in accordance with the detail specification. This will normally consist of at least the following.

a. Examination

b. Break-in-run

c. Leakage

d. Calibration

e. Electrical insulation tests.

4.4.2 Sampling inspections. The sampling inspections, whether based upon a production lot quantity or upon calendar intervals shall be conducted in accordance with the item specification. These will consist of at least the following:

a. Calibration (4.5.5)

b. Strength (4.5.15).

4.5 Inspection methods. Unless otherwise specified, the atmospheric pressure and temperature shall be the local ambient.

4.5.1 Test fluid. Unless otherwise specified, the test fluid shall be the principal fluid the component shall experience in use. For quality conformance inspections, the test fluid shall be in accordance with the item specification.

4.5.2 Examination of product. All component assemblies shall be inspected and certified to be in accordance with the applicable drawings and specifications, including all requirements of Section 3 for which tests are not appropriate. The units shall be of satisfactory workmanship, within the weight allowance, clean and free of contaminants, oil, grease, preservatives or any other material not specified on the assembly drawings.

4.5.3 Break-in run. Where applicable, a break-in run (either dry or wet) shall be conducted in accordance with the item specification.

4.5.4 Leakage. All leak tests shall be performed at a variety of pressure levels from the minimum up to the maximum pressure. Wherever slight leaks are critical, the pressure at each level shall be held for a sufficient length of time (5 *to* 30 minutes or more) to provide an accurate assessment. Leak detection by pressure gage drop is not permitted for first article or sampling inspections. Leak checks for individual tests may be conducted at fewer pressure levels and for a shorter duration of time.

4.5.4.1 Internal. Internal leakage tests are normally conducted from minimum up to proof pressure or maximum operating pressure, and back down again to minimum. The pressure levels and allowable leakage rate shall be specified.

4.5.4.2 External. There shall be no visible external leakage except as permitted by the item specification from minimum pressure up to ultimate pressure.

4.5.4.3 Plug-in units. The quantity of fuel loss resulting from engagement and disengagement of plug-in units shall satisfy specification requirements.

4.5.5 Calibration. Calibration tests shall be conducted to demonstrate compliance with 3.7.1. For first article and sampling inspections, sufficient data points shall be taken to thoroughly demonstrate the complete performance characteristics of the component. For individual tests, the number of data points may be limited to only one or two critical points, as specified.

4.5.6 Altitude. Altitude tests shall be conducted to demonstrate as specified in 3.7.2. These tests may be conducted concurrently with the endurance requirements as specified in 3.7.5.

4.5.7 Speed. Tests shall be conducted to demonstrate as specified in 3.7.7.

4.5.8 Acceleration. Tests shall be conducted in accordance with MIL-STD-810, Method 513.2 to demonstrate as specified in 3.7.3.

4.5.9 Gravity. Tests shall be conducted to demonstrate as specified in 3*7.4.

4.5.10 Pressure surge. Tests shall be conducted to demonstrate as specified in 3.7.9 as applicable.

4.5.11 Fuel resistance. This test is applicable to all components having any parts whose physical properties are affected by contact with fuel. The test shall be conducted in a continuous manner in accordance with the schedule of table IV. Each period shall follow the preceding one in the order noted with a minimum of delay. The soak periods shall be conducted with a body of fluid in continuous contact with all affected parts. For the dry periods, the component shall be drained, without disassembly, and blown dry with the ports open and placed in a test chamber having air continuously circulating around the component at the test temperature.

4.5.11.1 Test fluids. The test fluids for the fuel resistance test shall be in accordance with TT-S-735, Types I and III and MIL-T-5624, JP-4 and JP-5. For the high temperature soak periods, it is advisable to perform the soak in a closed container with a pressure not to exceed 15 psi to prevent boiling. For Class B components, MIL-T-S624 fuel may be used in lieu of Type III if permitted by the item specification.

TABLE IV

Test Period	Phase I		Phase II		Phase III
	Soak	Dry	Soak	Dry	Soak
Ambient and fluid test temperature (Table I)	T_t	T_a	T_t	T_a	-57° ±4°C
Test Fluid During Soak					
Class A	Type III		Type III		Type I
Class B	Type III		Type III		Type I
Class C	JP-5		JP-5		Type I
Period Duration	96 hours minimum	24 hours	18 hours minimum	30 hours	18 hours minimum
Test fluids to be used for tests immediately after period	Type III	Type I	Type III	Type I	Type I

4.5.11.2 Fuctional operation during tests. At least once each day during the soak periods, components with moving parts shall be actuated. Intermittent duty components shall be actuated through a minimum of 4 cycles. Continuous duty or motor operated components shall be operated for 1 hour or a minimum of 25 cycles. During dry periods, actuation shall be accomplished if the component may be operated in the dry condition when installed. The item specification shall provide the specific actuation requirements.

4.5.11.3 Tests after each period. At the conclusion of each soak or dry period, the component shall be actuated through 4 cycles or operated for 5 to 10 minutes and subjected to a leakage test. Following the Phase I and II periods, the tests shall be conducted at room temperature. The fluid to be used following the soak periods shall be Type III and following the dry periods, Type I. Following the Phase III period the test shall be conducted at -57° ±4°C (-70″ ±5°F) using Type I fluid, and repeated at room temperature. The component actuation and leakage shall satisfy the specification, except that following the dry periods, some increased leakage may be permitted for no more than 15 minutes.

4.5.12 Endurance. The endurance test is applicable to nearly all fuel system components in order to demonstrate as specified in 3.7.5. The test shall be a simulation of the operating conditions of the component for its design operational life between overhauls. It shall be accomplished without disassembly, lubricative adjustment, or other maintenance, except as provialed by the specification. Calibration and leakage tests shall be accomplished following each phase to verify performance. For power operated components, which are subjected to variations in power input, the test should be conducted with these variations. The test set-up shall not provide for surge pressure relief and should simulate the aircraft installation insofar as practical. If operation of the unit causes pressure surges, the instrumentation shall automatically record the rate of pressure change and the pressure peaks and valleys.

4.5.12.1 Altitude. When applicable, this test shall be conducted at the various critical operating conditions occurring at altitude. If operation at altitude produces some special effect, such as slow start-up, overspeed, or heating, the test should include a reasonable number of these cycles or duration of time for the special effect. This test shall comprise at least 20 percent of the total endurance test.

4.5.12.2 High temperature. The high temperature endurance test is applicable to all components and shall consist of 20 percent of the total required endurance test. The fluid and ambient temperature shall be in accordance with the appropriate class.

4.5.12.3 Low temperature. The low temperature endurance test is applicable to all components and shall consist of at least 10 percent of the total required endurance test.

4.5.12.4 Dry. The dry-endurance test is applicable to all components which may be operated dry when installed in aircraft. The test is applicable, whether the operation occurs by design or is inadvertent. If the unit contains an automatic dry shut-off feature, the dry endurance test shall demonstrate the operation of this feature. The dry endurance shall consist of at least 5 percent of the total endurance test. The test shall consist of at least four periods of dry operation between periods of wet operation. The test chamber temperature shall be the high ambient temperature of the component class.

4.5.12.5 Room temperature. The room temperature endurance test shall consist of the remaining portion of the unassigned endurance hours or cycles after the other phases have been assigned their share. The room temperature endurance test may normally be conducted first.

4.5.12.6 Combining of tests. Half of the high temperature and low temperature endurance runs may be combined with the altitude test; especially when the combinations simulate a realistic operating environment.

4.5.13 Contaminated fuel test. This test is applicable to all components required to perform the endurance test as specified in 4.5.12.

4.5.13.1 Contaminated test fluid. The test fluid shall contain the types and concentration of the contaminant mixture as specified in.table V. The fluid circuit shall insure that the contaminants remain in suspension in the fluid and enter the component under test. The contaminant shall normally not be recirculated.

4.5.13.2 Test method. The component shall be subjected to rated flow and pressure for 2-1/2 hours or 500 cycles and to 10 to 25 percent rated flow for 2-1/2 hours or 500 cycles. The operation of the component during this time shall be in accordance with the specification. For components with no moving parts, the above test shall be sufficient. For components with operating parts, the above test shall be repeated once. If fuel flows in both directions when installed in a system, then the test shall be conducted with flow in both directions.

4.5.13.3 Tests following contaminated fuel endurance. Following the above tests, the component may be flushed with fuel to loosen contaminant, but it may not be disassembled for cleaning. The component shall satisfy a functional and leakage test in accordance with the item specification.

TABLE V. Contaminant mixture.

CONTAMINANT	PARTICLE SIZE (Microns)	QUANTITY (gms per 1000 liters)
Iron Oxide	0 - 5 5 - 10	19 1.0
Sharp Silica Sand	150 - 300 300 - 420	0.7 0.7
Prepared dirt conforming to AC Spark Plug Co. Part Nr. 1543637 (Coarse Arizona road dust)	Mixture as follows: 0 - 5 (12%) 5 - 10 (12%) 10 - 20 (14%) 20 - 40 (23%) 40 - 80 (30%) 80 - 200 (9%)	5.3
Cotton linters	Staple Below 7 U.S. Dept of Agriculture Grading Standards	0.07
Iron Chips	150 - 500	10
Aluminum Chips	150 - 500	10

4.5.14 Corrosion resistance. The corrosion resistance tests shall consist of both accelerated corrosion and salt fog, unless otherwise specified. There shall be no evidence of corrosion beyond superficial. These tests may be abbreviated or deleted when it can be demonstrated that all materials individually and in contact in the assembly, are not subject to any manner of corrosive deterioration, whether chemical, electrolytic or stress accelerated. Following each test, leakage and calibration tests shall be conducted. There shall not be any excessive leakage or deterioration nor any malfunction due to the tests.

4.5.14.1 Accelerated corrosion. The component (except for open electrical connectors) with all fuel ports open, shall be submerged and, if practical, operated manually or otherwise for 3 cycles in a saturated salt solution. The unit shall then be drained for 30 seconds and operated as necessary to remove trapped salt solution. The component shall be placed immediately in a test chamber maintained at a temperature of 30° ±2°C with a relative humidity of 100 percent for a period of 20 minutes. Upon completion of the humidity exposure period, the unit shall be placed in an air oven maintained at a temperature of 55° to 60°C for a period of 20 minutes. The component shall not be operated again until a total of 50 immersions, high humidity, and drying cycles have been completed. Immediately after completion, the component shall be washed with warm water, dried, wetted with fuel, and actuated as in normal service.

4.5.14.2 Salt fog. The component shall be subjected to salt fog in accordance with MIL-STD-810, Method 509.1. At the end of the test period, the component shall be washed with warm water to remove the deposits, dried, wetted with fuel, and actuated as in normal service.

4.5.15 Strength. The following strength tests shall be conducted for first article and sampling inspections in accordance with the item specification. Following each test, leakage and calibration tests shall be conducted.

4.5.15.1 Mechanical shock. The component shall be subjected to a crash safety test in accordance with the requirements of the shock tests of MIL-STD-810, Method 516.2. The mounting shall simulate the aircraft installation with tubing and electrical wiring. Fluid cavities may be filled with water, and pressure may be applied, if required. The component shall demonstrate as specified in 3.6.3.2 and the item specification.

4.5.15.2 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 to demonstrate as specified in 3.6.3.1 and with the item specification. There shall be no evidence of failure, permanent distortion, excessive leakage or deterioration in performance.

4.5.15.3 Overspeed. Overspeed tests shall be conducted to demonstrate as specified in item specification requirements and 3.6.17.

4.5.16 Electrical. The following tests are applicable *to* components incorporating electrical equipment.

4.5.16.1 Electrical actuators. Tests shall be conducted to demonstrate in accordance with MIL-S-4040 and MIL-M-7969 as applicable.

4.5.16.2 Electrical insulation tests

4.5.16.2.1 Dielectric withstanding voltage. A test shall be conducted in accordance with MIL-STD-202, Method 301, and table VI. There shall be no disruptive discharge, flashover, or breakdown. Leakage current shall not exceed the requirements as specified in 3.6.5.6.

TABLE VI. Dielectric test voltages (AC).

System Voltage	Initial Test		Altitude*	Repeat Tests
	1 Minute	10 Seconds	1 Minute	10 Seconds
28 VDC	1050	1250	500	500
115 VAC	1250	1500	500	600
115/200 VAC	1500	1800	700	700

* If not specified, use 20 mm Hg pressure.

4.5.16.2.2 Insulation resistance. The insulation resistance test shall be conducted in accordance with MIL-STD-202. For equipment operating at less than 250 volts rms, the test potential shall be 500 volts. For equipment operating at voltages between 250 and 500 volts rms, the test potential shall be 1,000 volts. The insulation resistance shall not be less than *as* specified in 3.6.5.6.

4.5.16.3 Explosion proof. The test shall be conducted in accordance with MIL-STD-810, Method 511.1, Procedure II or IV, as applicable, and with the following modifications:

a. The fuel to be used shall be the principal fuel to be used in service. If a different fuel is used, additional tests shall be conducted to demonstrate that the explosive vapor possesses the same rate of pressure rise and peak pressure as the fuel to be used in service.

b. The chamber temperature shall be the high vapor temperature (T_a) of table I unless it can be shown that a lower temperature provides equivalent results.

c. The electrical equipment shall be operated for sufficient time for the temperature of the equipment to stabilize and demonstrate that no external hot spot exists to cause a fire or explosion.

4.5.16.4 Electromagnetic compatibility. The electrical equipment shall be tested in accordance with MIL-STD-462 for Class A1 equipment. The minimum test shall be in accordance with method CE03. Additional tests shall be in accordance with the item specification.

4.5.16.5 Thermal protectors. Tests shall be conducted to demonstrate that the thermal protectors are capable of repeated cycles of heating and cooling without causing deterioration in their capability to operate in accordance with specification requirements.

4.5.17 Water. Tests shall be accomplished to demonstrate as specified in 3.7.6 through 3.7.6.2 and tests as specified in 4.5. 17.1 through 4.5.17.3, as applicable, in accordance with the item specification. The test requirements for components using bleed air or subject to externally applied water shall be in accordance with the item specification.

4.5.17.1 Fuel-water mixture. The fuel for this test shall be without anti-icing additives and may contain up to 30 percent aromatics. While maintaining the fuel at 30° to 40°C temperature, pump a fine spray of water into the fuel (approximately 0.26 ml water per liter of fuel) while continuously agitating the mixture. The atmosphere above the fuel shall be above 60 percent relative humidity at the same temperature as the fuel in order to minimize loss of water by evaporation. The entire quantity of the mixture should be circulated through an agitating pumping system at least four times for 2 hours. Three samples from different locations in the bulk of the mixture shall be analyzed and shall indicate an average of at least 90 ppm up to supersaturated level.

4.5.17.2 Above freezing test. The unit shall be functionally operated using the above fuel mixture. The duration in time shall be 2 hours or 100 cycles of operation. There shall be no indication of incorrect operation, disruptive electric discharge or other failure. If the item specification does not require an icing test, this test may be accomplished using plain water.

4.5.17.3 Icing test. While agitating or circulating the above fuel-water mixture, begin atomizing water above the surface of the fuel at a rate of approximately 100 ml per minute per square meter of fuel mixture surface. Continue atomizing to insure at least 0.25 ml of water per liter of fuel. During this time, circulate the fuel-water mixture through the component while cooling the mixture to the test temperature. To avoid complete freeze-up of the heat exchanger, the difference in the temperatures of the refrigerant and the fuel-water mixture should not exceed 6°C at the test temperature. Immediately upon reaching the test temperature, begin the test run. The component shall be functionally operated for a length of time and number of cycles in accordance with the item specification. The test temperatures

shall be -2°C, -10"C, and -20°C (+1°C, -4°C). Upon completion of each run, the fuel-water mixture shall contain not less than 0.12 ml of water per liter of fuel above the quantity required to saturate the fuel.

4.5.18 Environmental. The following environmental inspections and tests, as applicable, shall be conducted in accordance with the item specification. There shall be no degradation in performance except as permitted in the specification.

4.5.18.1 Humidity. This test applies to all components containing electrical equipment and shall be conducted in accordance with MIL-STD-810, Method 507.1, Procedure II or III. Component operation during the test shall be in accordance with the item specification. Within 2 hours of the completion of the last cycle, a calibration shall be conducted in fuel at -S7° ±4°C.

4.5.18.2 Fungus resistance. This test applies to all components containing any material that can be a nutrient or be damaged by fungi. The test shall be performed in accordance with MIL-STD-810, Method 508.1, except that substitution of a specified fungus may be made, if authorized by the procuring agency.

4.5.18.3 Dust. This test applies to all components installed in vent systems or external to fuel tanks. The test shall be performed in accordance with MIL-STD-810, Method 510.1.

4.5.18.4 Vibration. This test is applicable to all fuel system components and shall be accomplished in accordance with MIL-STD-810, Method 514.2 and the item specification. Components containing electrical switches shall be monitored for contact bounce and contact resistance variations.

4.5.18.5 Acoustical noise. The acoustical noise test is applicable to all components located near a jet engine exhaust and other high noise level areas. It shall be conducted in accordance with MIL-STD-810, Method 515.2.

4.5.18.6 Thermal shock. The thermal shock test shall be performed in accordance with MIL-STD-810, Method 516.2.

4.5.19 Bonding and lightning protection. Tests shall be conducted to demonstrate as specified in 3.6.4.

4.5.20 Disassembly and inspection. Following completion of all tests, including repetition of inspections 2, 3, 4, and 5 of table III, each component submitted to test shall be disassembled for inspection. There shall be no evidence of any problem that will affect safety, performance, or cause premature wearout. Photographs shall be taken of all parts and of any critical area discussed in the test report, as needed.

4.6 Safety analysis report. The safety analysis and proof-of-safety test report shall be prepared as required by the specification, and the procurement documents.

4.7 Reliability and maintainability. The reliability and maintainability demonstration plans shall be delivered as required by the procurement document.

5. PACKAGING

5.1 Preservation and packaging. Unless otherwise specified in the item specification, preservation, packaging, and packing shall be in accordance with MIL-STD-794 (see 6.2).

5.2 Marking for shipment. In addition to any special marking required by the contract or order, marking of individual packages and shipping containers shall be in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Components covered by this specification are intended for use in fuel and fuel vapor systems.

6.2 Ordering data. Procurement documents should specify:

a. Title, number and date of item specification, and of specification control drawing (3.1).

b. instructions concerning delivery of test reports and the test articles to the procuring agency or the responsible engineering office (4.3).

c. Preparation for delivery instructions (5.1 and 5.2).

d. Instructions concerning delivery of sampling test data (4.4.2).

e. Instructions concerning delivery of reliability and maintainability demonstration plans (4.7).

6.3 International standardization agreement. Certain provisions of this specification regarding fuel pressures (3.6.1) and fuel compatibility (3.5) are the subject of international standardization agreement ASCCAS 11/3B and STANAG 3105. When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international] agreement , concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization offices, if required.

6.4 Metric units. The metric units are in accordance with the ASTM Metric Practice Guide E-380-74.

6.5 Identification of changes. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Reviewer activity:
Army - AV
Navy - AS
Air Force - 11, 82

User activity.
Air Force - 79

Preparing activity:
Air Force - 11

Project No. 2915-0082

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5. PROBLEM AREAS

a. Paragraph Number and Wording.

b. Recommended Wording

c. Reason/Rationale for Recommendation

6. REMARKS

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