MIL-G-7940C
20 August 1971
Superseding
MIL-G-007940B(USAF)
2 February 1968
MIL-G-7940A
2 December 1964

MILITARY SPECIFICATION

GAGES, LIQUID QUANTITY, CAPACITOR TYPE, INSTALLATION AND CALIBRATION OF

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

1. SCOPE

1.1 This specification covers the installation and calibration of class I (see 6.6), class II, and class III capacitor-type liquid-quantity gages conforming to MIL-G-26988.

2. APPLICABLE DOCUMENTS

2.1 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-S-571	Solder; Lead Alloy, Tin Lead Alloy, and Tin Alloy, Flux Cored Ribbon and Wire, and Solid Form

Military

MIL-C-17	Cables, Radiofrequency, Coaxial, Dual Coaxial, Twin Conductor, and Twin Lead
MIL-W-76	Wire and Cable, Hookup, Electrical, Insulated
MIL-B-5087	Bonding; Electrical (for Aircraft)
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-W-7139	Wire, Electrical, Polytetrafloroethylene-Insulated, Copper, 600 Volt
MIL-W-16878	Wire, Electrical, Insulated, High Temperature
MIL-C-26482	Connector, Electric, Circular, Miniature, Quick Disconnect, Environment Resisting
MIL-C-26500	Connector, General Purpose, Electrical, Miniature, Circular, Environment Resisting, Established Reliability, General Specification for

FSC 6680

MIL-G-26988	Gage, Liquid Quantity, Capacitor Type, Transistorized, General Specification For
MIL-C-81511	Connector, Electrical, Circular, High Density, Quick Disconnect, Environment Resisting

STANDARDS

Military

MIL-STD-143	Standardards and Specifications, Order of Precedence for the Selection of
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-889	Dissimilar Metals
MS20659	Terminal, Lug, Crimp Style, Copper, Uninsulated, Class I
MS29576	Flange, Attachment, Molded Tank Flush and Recessed, Full Molded, Circular

(Copies of documents required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General requirements. Unless otherwise specified, gages installed in accordance with this specification shall be contractor furnished and shall comply with the requirements specified herein. The aircraft contractor shall be responsible for fulfillment of these requirements.

3.2 Approval. The gage installation for each contract on each type aircraft shall be subject to the approval of the procuring activity.

3.2.1 Liquid quantity system changes. Whenever a functional change is made in the gage system which has been approved by the procuring activity, the contractor shall furnish data showing all changes to information originally submitted in accordance with 3.2.2 together with the serial numbers of the aircraft affected. These changes shall also be subject to the approval of the procuring activity.

3.2.2 Engineering report. Prior to approval of the liquid quantity gage installation, the aircraft contractor shall submit a report to the procuring activity covering all pertinent details of installation, dial calibration, and system adjustment. The report shall be submitted to the procuring activity in

triplicate, and approval of the gage installation shall be contingent upon the results outlined in this report (see 6.3 and 6.5). The report shall include the following:

a. Drawings of the following in reproducible form on 8-1/2 by 11 inch letter-size sheets:

(1) A three-dimensional perspective drawing of the aircraft showing locations of the tanks, tank units, electronic or intermediate devices, and indicators with respect to each other and to the aircraft. Each gage component shall be identified, and the total liquid capacity as well as individual tank capacity shall be indicated.

(2) A schematic diagram of the gage system, showing the external electrical connections between the components.

(3) A detailed parts list of the gage system listing each component with the gage manufacturer's part number and quantity of each used in the system. This parts list shall be in direct agreement with the identification of units as given on the three-dimensional drawing specified herein, and shall list the serial numbers of the aircraft affected.

Note: Any change in either the location of the units or the type unit employed will require the contractor to submit new drawings as listed above together with the serial numbers of the aircraft affected.

b. Drawings or photographs showing the following:

(1) Marking details of each respective indicator dial.

(2) Installation details of the tank units and compensator sensing units showing accessibility, methods of sealing, provisions for drainage, reinforcement brackets, and any other pertinent data.

(3) Details of the calibration placard, or placards, including the capacitance values that will be entered thereon, type, and form of markings.

c. Data

(1) Brief decription of the method employed in locating and selecting the number of tank units.

(2) Graph of error versus liquid quantity for a minimum of five different attitudes including normal flight attitude and any sustained pitch and roll attitudes considered applicable to the aircraft. The error shall be expressed

in percent of the added tank unit capacitance for full tanks. Points shall be computed for a minimum of seven quantities of liquid, including 0 to 100 percent of tank capacity.

(3) The amount of trapped liquid under normal flight attitude in each tank, expressed in gallons and percent of tank capacity (see 6.2.2).

(4) The amount of unmeasured liquid under normal flight attitude in each tank, expressed in gallons and percent of tank capacity (see 6.2.3). The unmeasured liquid which is above and below the sensing portions of the tank units shall be listed separately.

3.2.3 Modifications and deviations. Modifications to or deviations from this specification will be permitted only when specified requirements are included in the detail specification for the aircraft involved, or when specifically approved by the procuring activity.

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

3.4 Materials. When selecting materials for the gage installation, consideration should be given to the various climatic conditions to which the aircraft will be subjected during its service life.

3.4.1 Protective treatment. When materials are used in the gage installation that are subject to deterioration when exposed to climatic and environmental conditions likely to occur during service usage, they shall be protected against such deterioration in a manner that will in no way prevent compliance with the performance requirements of this specification. The use of any protective coating that will crack, chip, or scale with age or extremes of climatic and environmental conditions shall be avoided.

3.4.2 Fungus-proof materials. Materials that are not nutrients for fungi shall be used to the greatest extent practicable. Where materials that are nutrients for fungi must be used, such materials shall be treated with a fungicidal agent as approved by the procuring activity.

3.4.3 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.

3.5 Design and construction. Installation of the gage system shall be designed for maximum ease of inspection, maintenance, and repair. Any gage components, with the exception of internally mounted type tank and compensator sensing units, shall be replaceable within 1/2 man-hour. The removal time

specified does not include the time required for removing liquid from tanks when required prior to the removal of the externally mounted tank and compensator sensing units. Provisions shall be made for gage adjustment and checking without opening a tank and without removal of any gage component from the aircraft. Test connections shall be accessible directly or through an inspection door.

3.5.1 Installation of the gage system shall be so accomplished that no parts will work loose in service.

3.5.2 Fusing. Each electrical circuit connecting one or more tank units, an intermediate device, and an indicator shall be separately fused. Each totalizing indicator and its associated intermediate device, when used, shall also be separately fused.

3.5.3 Type of indication. The gage system installation shall be so designed and accomplished that linear indication of liquid quantity will be provided for all aircraft applications. Linear indication shall be obtained by proper location and characterization of the tank unit or units in order that a constant capacitance will be registered for each unit volume of liquid sensed in normal flight attitude (see 6.2.1). The type of indicator presentation and the number of indicators required for each specific model of aircraft shall be subject to approval by the procuring activity.

3.5.4 Gage failure indication. Each individual or totalizing gage shall be installed with a separate test switch.

3.5.5 Terminals. Terminals attached to electrical cables may be either the solder or solderless type. Solderless-type terminals shall be in accordance with MS20659. The use of terminals for connecting the cables specifically associated with the tank units shall be subject to approval by the procuring activity.

3.5.6 Terminal strips and boards. Terminal strips and boards shall be made of ceramic material or low-moisture-absorption, arc-resistant plastic material. Adequate terminal spacing or barrier shall be employed to prevent breakdown or low leakage resistance under high humidity, including condensation, or high altitude conditions.

3.5.7 Shielded and unshielded electrical cable. General-purpose unshielded connector cable shall conform to the electrical requirements specified in MIL-W-7139 or MIL-W-16878. General-purpose shielded cable shall be in accordance with MIL-C-17. Electrical cable required for use within the tank and subject to the action of the liquid shall be entirely suitable for the purpose intended. In fuel cells or applications where the temperature may exceed 90°C

in compartments of the aircraft structure through which the electrical interconnecting cables will be routed, the cables shall be subject to approval by the procuring activity. MIL-W-76 wire and cable shall not be used on new aircraft.

3.5.7.1 Cable installation. Installation of the interconnecting electrical wiring and related accessories shall be in accordance with the applicable requirements of MIL-W-5088 except that only connectors in accordance with MIL-C-26482, MIL-C-26500, or MIL-C-81511 shall be used.

3.5.8 Soldering. Soldering shall be in accordance with MIL-STD-454, requirement 5. Solder used for electrical connections shall be in accordance with QQ-S-571 and shall be of suitable composition.

3.5.8.1 Soldering flux. Only rosin, rosin and alcohol, or equivalent plastic rosin mixtures shall be used as flux in the assembly of the electrical connector cables.

3.5.9 Bonding. All components of the gage system requiring electrical grounding to the aircraft structure shall be adequately bonded. Bonding shall be in accordance with MIL-B-5087.

3.5.10 Electrical power. The installed gage shall operate from aircraft power in accordance with MIL-STD-704.

3.6 Performance

3.6.1 Pull. Connector assemblies shall withstand a longitudinal pull of 12 pounds for 1 minute.

3.6.2 Electrical leakage. The insulation resistance of the assembled electrical cables, with the fuel gage components disconnected, shall be as follows:

Type of Cable	Minimum Resistance (Megohms)
Unshielded	100
Coaxial (shielded)	500

The insulation resistance of the circuitry, fuel probes, and compensators hooked together shall be not less than the following:

Circuit	Minimum Resistance (Megohms)
Unshielded (Lo-Z) to ground	30
Coaxial center (Hi-Z) to ground	30
Hi-Z to Lo-Z	300

3.6.3 Voltage breakdown. The fuel gage circuitry shall be capable of carrying 1,000V rms at commercial frequency.

3.6.4 Accuracy. The overall installed accuracy of the fuel gages shall be as follows:

a. Class I: ±4 percent of indication, ±2 percent of full-scale indication

b. Class II: ±2 percent of indication, ±0.75 percent of full-scale indication

c. Class III: ±1 percent of indication, ±0.50 percent of full-scale indication.

3.6.5 Inductive interference. The fuel gage installation shall be such that it will not be affected by the operation of other nearby electrical circuitry.

3.7 Component mounting and location

3.7.1 Indicator. The indicator, or indicators, shall be located as specified by the procuring activity.

3.7.2 Tank units

3.7.2.1 Flanges. Where external top-mounted and bottom-mounted type tank units are authorized, the dimensions of the tank fitting for mounting the tank units shall conform to MS29576 for flange sizes 4, 5, and 6, as applicable. The means provided for mounting other types shall be entirely suitable for the purpose and shall be subject to approval by the procuring activity.

3.7.2.2 Mounting. When practicable, tank units shall be externally mounted in the top of the liquid tanks.

3.7.2.3 Drainage. If, due to the design of the aircraft, it is necessary to mount the tank units in a well or recess, provision shall be made for positive drainage of any water, oil, or liquid which may collect in such a well. The use of wells shall not result in unmeasured liquid in excess of the tolerances specified herein. Under no circumstances shall a probe be located in an area that cannot be 100 percent drained.

3.7.2.4 Sealing. Mountings of all tank units shall be sealed to prevent leakage of liquid. When gaskets are required to prevent such leakage, they shall be reuseable.

3.7.2.5 Reinforcement of units. The tank units shall be securely supported. If necessary, the tank unit mounting flange shall be reinforced by attachment to the wing or fuselage structure in such a manner that the relative position of the unit will not be disturbed by the diaphragming of the mounting surface caused by sloshing of the liquid. Additional points of support shall be provided for tank units exceeding 40 inches in length. Tank units exceeding 60 inches in length shall be provided with supports at the free end and center. The support brackets shall be subject to approval by the procuring activity.

3.7.2.6 Internally mounted units. The method of mounting and securing internally mounted tank units shall be as approved by the procuring activity.

3.7.2.7 All tank units shall be mounted in such a position that the bottom of the sensing portion of the tank unit will not extend below the lowest level of useable liquid in the normal flight attitude.

3.7.2.8 Location. The location of all tank units shall be determined by computation or experimentation so that under the complete range of loading conditions, errors owing to change in attitude about any axis wing deflection or sweep shall be within the tolerances specified herein.

3.7.2.9 Deviations to optimum locations. The requirements specified herein pertaining to the location of tank units shall be strictly adhered to unless it is structurally impractical to do so. In such cases, request for specific deviations, accompanied by drawings and data, and the reasons for such a request shall be made to the procuring activity. Optimum locations shall be defined as required to meet the tolerances specified herein.

3.7.3 Compensator sensing units

3.7.3.1 Flanges. For external top-mounted and bottom-mounted type tank units, the dimensions of the tank fitting for mounting the tank units shall conform to MS29576 for flange sizes 4, 5, and 6, as applicable. The means provided for mounting other types shall be entirely suitable for the purpose and shall be subject to approval by the procuring activity.

3.7.3.2 Mounting. The compensator sensing unit shall be so mounted that its design requirements are met under all normal operating conditions.

3.7.3.3 Mounting level. The compensator sensing unit shall be so mounted that the bottom of the sensing portion will not extend below the lowest level of useable liquid in the normal flight attitude.

3.7.3.4 Reinforcement of units. The compensator sensing units shall be securely supported and, if necessary, reinforced to prevent flexing or damage under service conditions.

3.7.4 Test switch. The test switch, or switches, shall be located as specified by the procuring activity.

3.8 Liquid measurement. The gage shall be so installed that the greatest degree of accuracy will be obtained under normal flight attitude.

3.8.1 Measured liquid. Measured liquid shall be, as nearly as practicable, equal to the total amount of liquid available to the engine or engines.

3.8.2 Unmeasured liquid. The class III tank units shall be located in such a manner that the total unmeasured liquid (see 6.2.3) in normal flight attitude, including the portions at both top and bottom of the tank, will not exceed 0.5 percent of the useable tank volume or 2.5 gallons, whichever is greater. The class I and class II tank units shall be located in such a manner that the total unmeasured liquid in normal flight attitude, including the portions at both top and bottom of the tank, will not exceed 2 percent of the useable tank volume or 10 gallons, whichever is greater. This tolerance applies to each tank, and shall not be construed as being applicable to the total amount of useable liquid carried aboard the aircraft.

3.9 Linearity. The design of the type I and type II gage installation shall be such that under normal flight attitude, each tank unit assembly (see 6.2.6) will provide a linear relationship between the electrical capacitance and the volume of liquid sensed. The type III gage installation shall be such that it will provide the appropriate calculated attitude corrections of the full gage readout.

3.10 Total errors. Installation engineering associated with the selection of the number and location of tank units for each respective aircraft application shall be accomplished by the aircraft contractor in such a manner that the total accumulated errors, plus errors due to sustained flight attitudes at other than the normal flight attitude, shall be within the accuracies specified in 3.6.4.

3.10.1 Flight attitudes. The flight attitudes, i.e., the angles in degrees from the normal flight attitude for both pitch and roll for use in the determination of number and location of tank units, shall be ascertained by the aircraft contractor with the normal tactical use of the aircraft in mind rather than the extreme momentary attitudes representing abnormal positions of the aircraft.

3.11 Indicator dial design. The indicator dials for the respective quantity gage indicators shall be graduated and marked in accordance with the applicable requirements expressed in the gage specifications. The indicator dials shall be calibrated to indicate only the liquid sensed by the respective gages.

Note: Since linear indication will be provided, it is a simple operation to lay out the indicator dial design after the total amount of useable liquid for the respective tank or group of tanks has been established. However, calibration of the type I and type II system indicators on a linear basis requires that a linear relationship exist between the capacitances of the type I and type II system probe assemblies versus the volume of liquid sensed. Likewise, proper attitude correction in the type III system depends largely upon the accurate location of the tank probes. In this connection, the importance of adequately accomplishing installation engineering of the tank unit assemblies is emphasized so that additional reworking of the tank units will not be necessary prior to final acceptance of the gage installation.

3.12 Fuel gage system adjustments

3.12.1 Adjusting tools or instruments. For making production or field adjustments, the tools or instruments used shall be of a design and accuracy suitable for the purpose and shall be subject to approval by the procuring activity.

3.12.2 System adjustment. The system adjustment procedure shall be subject to the approval of the procuring activity. All gage installations shall be adjusted for zero indication with empty tanks (see 6.2.4) and with the tanks connected to the gage systems.

3.13 Placard. A placard shall be provided in the aircraft denoting the correct capacitance values to be substituted in lieu of the capacitance of each respective tank unit assembly. This data is required to facilitate adjustment checking and trouble-shooting of the gage equipment in service. The placard shall be located in the vicinity of the gage components which house the adjustments and shall be readily visible to the service personnel. The placard shall be constructed of aluminum and shall be permanently secured to the aircraft by screws, rivets, or other suitable means.

3.13.1 Placard data. The placard shall be permanently and legibly marked, by engraving or stamping, with the following information:

a. Empty - design values corresponding to the capacitance of the tank unit assembly under empty tank conditions

b. Added - capacitance value to be added to the tank unit assembly capacitance to produce an indication corresponding to the last dial graduation (scale end)

c. Full - sum of "empty" and "added" capacitance values

d. Compensator unit - capacitance value to be substituted in lieu of the compensator unit, if applicable.

3.13.1.1 The capacitance value for the compensator is applicable to compensated gage equipment conforming to MIL-G-26988, and shall not be entered on placards associated with uncompensated gage equipment.

3.14 Workmanship. The installation, including location and mounting of the component parts of the gage system and the routing of electrical cables, shall be consistent with the best practice in installations of this kind. Particular attention shall be given to neatness and thoroughness of soldering, routing and securing of electrical connector cables, and adequate bonding of all component parts of the gage assembly that require grounding.

3.14.1 Riveting. Riveting operations shall be carefully performed to ensure that the rivets are tight and satisfactorily headed.

3.14.2 Dimensions and tolerances. All dimensions and tolerances not specified shall be as close as is consistent with the best shop practices. Dimensions and tolerances affecting interchangeability, operation, or performance of the gage system shall be limited accordingly.

3.14.3 Cleaning. After final installation, all component parts and electrical connector cables of the gage system shall be thoroughly cleaned of loose, spattered, or excess solder, soldering flux, metal chips, and other foreign material.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 Classification of tests. The inspection and testing of gage installation and calibration shall be classified as quality conformance tests.

4.2.1 Previous acceptance or approval of any part or components of the installation during fabrication or the release of any design by the procuring activity shall in no case be construed as a guaranty of acceptance of the installation.

4.3 Quality conformance tests. Quality conformance tests shall consist of:

a. Individual tests (4.3.1)

b. Sampling tests (4.3.2).

4.3.1 Individual tests. Each gage installation shall be subjected to the following tests as described under 4.5:

a. Examination of installation

b. Pull test (4.5.2)

c. Voltage breakdown (4.5.3)

d. Electrical leakage (4.5.4)

e. System adjustment (4.5.5).

4.3.2 Sampling tests. One experimental model aircraft, one of the first 5 production aircraft, the 10th, 35th, 60th, 85th, 110th, and every 100th production aircraft thereafter shall be subjected to the calibration tests (4.5.6) and interference test (4.5.7). When any production change is made that affects the tank system or gage equipment, the first production aircraft incorporating the change, the 10th, 35th, 60th, 85th, 110th, and every 100th thereafter shall also be subjected to the calibration tests (4.5.6) and the interference test (4.5.7).

4.3.3 Rejection and retest. Instructions for resubmission of rejected systems shall be as specified in the contract or order.

4.4 Test conditions

4.4.1 Electrical power. The gage shall be tested with 115V single-phase 400 Hz a-c and 28V d-c power, as required, ±10 percent.

4.4.2 Adjusting instrument. The instrument specified herein (see 3.12.1) to be used for system adjustments shall be accurate to within 0.2 percent for class III gages or 0.5 percent for class I and class II gages.

4.5 Test methods

4.5.1 Examination of installation. The gage installation shall be inspected to determine compliance with the requirements specified herein with respect to workmanship, routing of cables, soldering, marking, and any other requirements not covered by tests.

4.5.1.1 Gage inspection. Prior to installation, all components shall be inspected to establish that the gage has not been damaged during shipment and handling.

4.5.2 Pull test. The attached connector assemblies shall be subjected to a longitudinal pull of 12 pounds for 1 minute. The wire or cable shall not pull out of the connector and there shall be no physical failure.

4.5.3 Voltage breakdown. Before connection to the gage components, the cables shall be tested for electrical breakdown by applying 1,000V rms at a commercial frequency between conductors for 10 seconds. If breakdown occurs, the cable shall be replaced, retested, and shall pass this test. Extreme caution shall be used to determine that all units and other component parts are disconnected and that the test will not endanger aircraft equipment or personnel.

4.5.4 Electrical leakage. The d-c insulation resistance of electrical cables shall be measured with a reliable megohmmeter. Prior to connecting the cables to gage components, readings shall be taken between the aircraft ground and all conductors and between the connector shells and all conductors and shall be not less than the following:

Type of cable	Minimum resistance (megohms)
Unshielded	100
Coaxial (shielded)	500

Measurements shall be made of the tank unit (probe) circuit or circuits, and separately the compensator unit (probe) circuit or circuits, (if any), with all wire and cables connected. The resistance measurements shall be made with a three-wire megohmmeter at a point where a complete circuit normally is an input to an electronic device (such as an intermediate unit, or bridge circuit of the system). The electronic device shall not be connected. The respective resistance values shall be not less than:

Unshielded to ground (Lo-Z to ground), 30 megohms
Coaxial center conductor to ground (Hi-Z to ground), 30 megohms
Hi-Z to Lo-Z, 300 megohms

Note: A three-wire megohmmeter need not be used if measurement Hi-Z to Lo-Z is so high that calculation shows the other legs also meet the requirements.

4.5.5 System adjustments. The installation shall be adjusted in accordance with previously approved procedures (see 3.12.2). The instrument used for the adjustment shall conform to the accuracy requirement specified in 4.4.2.

4.5.6 Calibration tests. The aircraft specified in 4.3.2 shall be subjected to the following calibration tests to determine compliance with the requirements specified herein with respect to reproducibility of calibration accuracy. The readings obtained shall not deviate respectively from the actual quantities by more than the tolerances specified in 3.6.4.

a. Adjust the gage system in accordance with the previously approved adjustment procedure.

b. Fill aircraft tank with liquid of the specified grade for which the aircraft is designed. (Aircraft in refueling attitude.) When starting to fill the tanks, record the amount of liquid needed to start pointer movement from zero. After the gage reads full, record the amount of liquid needed to complete filling the tank. The total of these two is the unmeasured liquid to be used in subparagraph f.

c. Adjust aircraft to calibrated flight position.

d. Drain liquid out in increments that will cause the indicator to read at each major dial graduation below the initial reading.

e. Record the indicator readings and weight of liquid removed for each reading.

f. Determine the total weight of liquid removed. Subtract the cumulative total of increments removed from total weight, and compare with indicator readings obtained during test. Proper corrections shall be made for any unmeasured liquid.

4.5.7 Interference. The system shall be checked to determine if the energizing and de-energizing of other electrical circuitry which is in close proximity to the gage circuitry affects the calibration of the gage. Any noticeable change in calibration due to manipulation of other circuitry shall require corrective action to prevent such disturbance.

5. PREPARATION FOR DELIVERY

5.1 Section 5 is not applicable to this specification.

6. NOTES

6.1 Intended use. This specification is intended for use in providing accurate liquid quantity gages by adequately guiding the gage installation, dial calibration, and system adjustment.

6.1.1 The gaging of liquid quantities on aircraft has presented many varied and difficult problems, chiefly because of the irregularities in the size, shape, location, type, and allowable capacity tolerances of aircraft tanks. Difficulties are also presented by the roll and pitch flight attitudes, as well as variation in the composition and changes in the temperature of liquids used in aircraft. In order to minimize, insofar as possible, these undesirable conditions, great care must be exercised in the quantity gage design and especially the installation engineering.

6.1.2 Gages, when fabricated in accordance with applicable specifications and installed in the most efficient manner, have proved accurate and reliable. A majority of all liquid quantity irregularities and inaccuracies on different types of military aircraft has been traced to inadequacies and inefficiencies of the installation design, rather than to the gages themselves.

6.1.3 The engineering of a gage installation is considered to be of a fairly permanent nature. The modification of this type of installation usually necessitates a costly and lengthy program. Therefore, it is of the utmost importance that gage installation, calibration, and system adjustment be accomplished initially in the most permanent and efficient manner.

6.2 Definitions

6.2.1 Normal flight attitude. The normal flight attitude is the attitude specified by the manufacturer as most representative of the aircraft during a typical flight mission.

6.2.2 Trapped liquid. Trapped liquid is the quantity remaining in the tanks in normal flight attitude after all available liquid has been drained out of the tanks through the tank outlets to the engines.

6.2.3 Unmeasured liquid. Unmeasured liquid is the quantity that is available to the engines but which is above or below the uppermost and lowest sensing points of the tank units in each tank.

6.2.4 Empty tank. Empty tank is a tank from which all liquid available to the engines has been drained.

6.2.5 Full tank. Full tank is a tank filled to the volume and liquid level specified by the manufacturer as representing total capacity of the tank.

6.2.6 Tank unit assembly. Tank unit assembly is that combination of tank units associated with an individual gage.

6.3 Drawings and data. Establishment of the following information by the aircraft manufacturer is considered necessary before the installation engineering associated with the determination of the number and location of the tank units can be satisfactorily accomplished. This information should be established at the earliest practicable date so that installation engineering of the gage equipment will not be delayed and will be accomplished in an acceptable manner.

a. Size, shape, and position of each tank with respect to each other, to the normal flight attitude of the aircraft, and to the aircraft coordinate system

b. Location of all sump levels

c. Location of flight and refueling full levels

d. Location of liquid outlet from each tank

e. Location of liquid outlet from any given tank or combination of tanks to engine

f. Location of any check valves and interconnecting lines

g. Types of tanks

h. Desired number and type of indicators

i. Emptying sequence

j. Fuel level lines corresponding to known volumes for each tank in sufficient number and spacing to accurately reflect any irregularities or constrictions in the liquid tank cavities. Liquid level lines should be established for normal flight attitude and for a minimum of four different attitudes in addition to normal flight attitude, including the maximum pitch and roll attitudes considered applicable to the aircraft.

k. Useable volume of liquid for each tank

l. Any other data required to assist in computing the number and locations of the tank units.

6.3.1 Data. For the information of contractors and contracting officers, any of the data specified in the applicable documents listed in section 2 herein or referenced lower-tier documents need not be prepared for the Government unless specified in the contract or order. The data to be furnished should be listed on DD Form 1423 (Contractor Data Requirements List) which should be attached to and made a part of the contract or order. Nav Weps Form 4200/25 (Drawings, Lists, and Specifications Required) should be attached when applicable.

6.4 Pitch and roll study. To accomplish the installation engineering of the tank units to provide the performance required by this specification, a study will be made to determine the effect of pitch and roll attitudes. The study may be accomplished by either the calculated or mockup method. The calculation method is preferable and should be used wherever possible.

6.4.1 Calculation method. The calculation method will be based on the data in 6.3, as established by the aircraft manufacturer.

6.4.2 Mockup method. The study may be accomplished by using representative tanks either installed in the aircraft or arranged in such a manner as to simulate the actual installation. The relationship for normal flight attitude between the liquid level in inches and the volume in gallons will be determined. Any convenient liquid may be used provided any tank distortion caused by the liquid is compensated for. The height of the liquid level will be specified. The height of the liquid level will be specified with respect to some convenient reference datum, such as a tank unit mounting flange. Only that portion of the liquid will be considered which is available in normal flight attitude (trapped liquid excluded) (see 6.2.1). The height of the liquid level shall be accurate to within ±1/32 inch. A sufficient number of volume increments shall be used.

6.5 Method of determining capacitance values for placards

6.5.1 MIL-G-7817, MIL-G-7818, MIL-G-8798, and MIL-G-26988 require that the gages be calibrated in accordance with certain standard nominal values which are determined by the characteristics of the applicable aircraft liquids. To provide the maximum accuracy for the gage installation, it is important that the ADDED, FULL, and COMPENSATOR sensing unit capacitance values to be listed on the placard be consistent with the gage specification. These capacitances are determined as follows:

a. Under the heading "Calibration data for inspection tests," the liquid gage specification requires that the following pertinent information be furnished:

(1) Added capacitance of tank units due to complete immersion in nominal liquid (Denoted as C_1)

(2) Pounds of fuel equivalent to nominal full indication. (This is obtained by multiplying the tank volume sensed in gallons by the nominal density of the fuel in pounds per gallon being gaged. The respective nominal density values are obtainable from the respective fuel gage system specification. If JP-5 fuel is being sensed, the JP-4 octane value of MIL-G-26988 will be used.) (Denoted as M_1)

b. The required ADDED capacitance for the placard is given by the following formula:

$$C = \frac{C_1 M}{M_1}$$

Where C is the required ADDED capacitance and M is the indication corresponding to the last graduation on the indicator dial.

c. The TOTAL CAPACITANCE is the sum of the EMPTY and ADDED capacitances

d. In compensated gages, the value to be specified for the capacitances of the compensator sensing unit is the value furnished in accordance with MIL-G-7818, MIL-G-8798, and MIL-G-26988 under the heading "Total Capacitance for Complete Immersion in Nominal Fuel".

e. For gage systems in accordance with MIL-G-7818, MIL-G-8798, MIL-G-26988, or compensator probes in accordance with MIL-P-22871, the capacitance value specified for capacitor probes fully immersed in nominal fuel will be the active dry capacitance of the compensator probe multipled by the respective nominal dielectric constant specified in MIL-G-26988, table entitled "Dielectric Constant - Density," added to the dead capacitance of the probe. For JP-5 fuel, the JP-4 and octane value will be used.

6.5.2 The purpose of the empty capacitance value listed on the placard is to assist service personnel in checking the gage installation. Although the preferred method of calibrating the gage calls for draining the tanks and setting the empty adjustment with the tank units connected, it will frequently be necessary to make quick checks, using substitute capacitance values in lieu of the tank units. For this purpose, it is considered necessary to specify nominal design capacitance values rather than the values corresponding to the actual installed tank units because of the possibility of replacement tank units, in which case the actual capacitance values of the original tank units would no longer be applicable. It is recognized that a discrepancy will, in general, exist between the design capacitance values and the actual values, due to manufacturing tolerances. It will be necessary to include the required information on this matter in the operation and service instructions for the equipment.

6.6 Gages conforming to MIL-G-7817, MIL-G-7818, and MIL-G-8798 are older gages and their installation and calibration is covered by class I of MIL-G-26988.

6.7 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

Review Activities:
Army - AV
Navy - AS
Air Force - 82

User Activity:
Army - EL

Preparing activity:
Air Force - 11

Project No. 6680-0112

☆ U. S. GOVERNMENT PRINTING OFFICE: 1971-714-158/12690

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

   ☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD, FORM 1 JAN 66 1426 REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

AFLC–WPAFB–OCT 67 2M