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MILITARY SPECIFICATION

INSTRUMENT SYSTEMS; PITOT-STATIC TUBE OPERATED, INSTALLATION OF

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 This specification covers the general requirements for the installation of all types of pitot-static, tube-operated instrument systems.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

WW-T-787 —Tubing, Aluminum Alloy 52S, Round, Seamless, Drawn

MILITARY

JAN-A-669 —Anti-Seize Compound, White Lead Base, General Purpose (for Threaded Fittings)

MIL-P-8585 —Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity

MIL-A-8625 —Anodic Coatings, for Aluminum and Aluminum Alloys

STANDARDS

MILITARY

MS33586 —Metals, Definition of Dissimilar

AIR FORCE-NAVY AERONAUTICAL

AN5810 —Tube; Pitot-Static, Unheated, Monoplane Type

AN5814 —Tube, Pitot-Static, "L" Shaped, Electrically Heated

AN5816 —Tube-Pitot Static, Straight, Electrically Heated

AN5831 —Valve—Static Pressure Selector

AN6270 —Hose Assembly—Detachable Swivel Fitting, Low Pressure

AND10375 —Colors—Fluid Line Identification

AND10410 —Pitot-Static and Pitot Tube—Wiring Diagram for

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

FSC 6610

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 shall apply.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Report 919 —Accuracy of Airspeed Measurements and Flight Calibration Procedures

(Copies of NASA Report 919 may be obtained from the Library of Congress, Photostatic Division Service, Washington 25, D. C.)

BUREAU OF AERONAUTICS

Report No. NAES-INSTR. 16–44 —Dual Sighting Stand and Other Methods of Calibrating Altimeter and Airspeed Installations

(A copy of this report (on a loan basis only) may be obtained by writing to the Bureau of Naval Weapons, DLI-3, Navy Department, Washington 25, D. C.)

3. REQUIREMENTS

3.1 *Materials.* Materials used in the installation of pitot-static, tube-operated instrument systems in military aircraft shall be of high quality, suitable for the purpose, and shall conform to applicable Government specifications. Materials conforming to contractor's specifications may be used, provided they are released by the Government and contain provisions for adequate tests. The use of contractor's specifications will not constitute waiver of Government inspection.

3.1.1 *Metals.* All metals used in the construction of pitot-static, tube-operated instrument systems in military aircraft shall be suitably protected to resist corrosion during normal service life. Where practicable dissimilar metals, such as defined by Standard MS33586, shall not be used in intimate contact with each other. Where such contacts are unavoidable, as the connection between the pitot-static tube and the mount or mast, both contact surfaces shall be painted with zinc-chromate primer conforming to Specification MIL–P–8585. The installation shall be made with cadmium-plated mounting screws while the primer is still wet, care being exercised to keep primer off the electrical connections.

3.2 *Selection of specifications and standards.* Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with procedures established by the procuring activity, except as provided in 3.2.1.

3.2.1 *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 number. 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.

3.2.1.1 AN or MS straight threaded fittings only shall be used and shall be connected in accordance with the applicable AND and MS standards listed in section 2.

3.3 *Design.*

3.3.1 *Pitot-static tubes.* Each airplane shall be equipped with a pitot-static tube or tubes conforming to Standard AN5810, AN5814, or AN5816, as specified in the detail specification for the airplane.

3.3.2 *Multiple pitot-static tube installations.* Airplanes in which the services of both a pilot and copilot are required at all times for operation of the aircraft shall have a dual pitot-static system and each system shall be operated from an individual pitot-static tube. One tube shall furnish pressure for the pilot's instruments and the other shall furnish pressure for the copilot's in-

struments. In no case shall lines carrying pressure from two separate pitot-static tubes be connected together.

3.3.3 *Number of instruments.* Pitot-static pressure for additional instruments (including navigator's, engineer's, and bombardier's) may be furnished by either tube; or if more convenient, some of the additional instruments may be connected to one tube and some to the other. Not more than six instruments consisting of a combination of altimeters, airspeed indicators, rate-of-climb indicators, and the equivalent in other pitot-static pressure-operated equipment shall be connected to any one pitot-static tube. If there are more than 6 but not more than 12 such instruments installed, they shall be equally divided between the two pitot-static tubes with one less on the pilot's tube in case of an odd number. Other pitot-static, pressure-operated equipment, such as airspeed switches, Mach number limit switches, or armament controls shall be supplied by the copilot's pitot-static tube if a copilot's pitot-static tube is used. The number of such instruments which may be connected to a tube shall be on the basis of internal volume as compared to a standard instrument such as an airspeed indicator or altimeter.

3.3.4 *Location.* The pitot-static tubes shall be installed to project forward in such a location that impact pressure is obtained without interference. They shall be located so as to be clear of the slip stream and, insofar as possible, in a position free from aerodynamic interference, spray, and dirt. The tube shall be so located as not to interfere with the necessary movements of the operating personnel in placing or removing the chocks from the wheels or entering or leaving the airplane. The tubes shall be installed so that satisfactory water drainage will be accomplished for all attitudes of the airplane while in flight and on the ground, and so that no rain or melted snow or ice will flow into the lines.

3.3.4.1 *Wing.* Pitot-static tubes installed on the leading edge of the wing shall be of the straight type and shall be located as far out as possible to avoid the slip stream and blanketing in a 15-degree yaw. The tubes shall be sufficiently far forward of the leading edge to avoid errors caused by high local angle of attack which may be encountered at low speeds. A position at least one-half of the chord length forward of the wing on the extension of the chord line is usually necessary. The lateral distance in from the wing tip may be as little as one-half of the same chord length.

3.3.4.2 *Fuselage.* Pitot-static tubes installed on the nose of the fuselage may be either the straight or curved type, and the same precautions as listed for the installation of the wing shall be observed against blanketing in yaw. Whenever possible, the mounting of a pitot-static tube under the fuselage shall be avoided, as this type of installation has the disadvantages of a static pressure ground effect and an undesirable obstruction to emergency belly landings.

3.3.5 *Mounting.* The method of mounting shall be such that the tube shall not vibrate with an amplitude greater than that of the point on the wing or the fuselage to which the mount is attached under all conditions of engine operation on the ground and in flight. The pitot-static tubes shall be mounted and located in such a position that no oscillation of the instrument pointers will be produced by the firing of guns, rockets, etc.

3.3.6 *Connecting lines.* The pitot and static lines connecting the pitot and static tubes to the instruments shall conform to Specification WW–T–787, anodized in accordance with Specification MIL–A–8625, and shall be ¼-inch outside diameter and 0.032-inch wall thickness. Bends in the tubing shall be uniform, free from kinks, and the minimum bend radius shall be not less than twice the outside diameter of the tubing.

3.3.6.1 *Location and support.* All tubing and related equipment shall be inside the fuselage and wing construction to prevent damage. There shall normally be no unsupported lengths greater than 18 inches for ¼-inch tubing, except where flexible con-

nections are used. Supports shall not interfere with expansion or other movements of the tubing in flight or on the ground.

3.3.6.2 *Identification.* All pitot and static tubing shall be marked with identifying colors in accordance with Standard AND10-375. The color coding shall specify distinctly which line is pitot pressure and which line is static pressure. The markings shall be within 3 inches of the terminal fittings.

3.3.7 *Connecting fittings.* Connecting fittings used throughout the installation of pitot-static instrument systems shall conform to Air Force-Navy aeronautical standards.

3.3.8 *Flexible connections.* Flexible hose assemblies in accordance with Standard AN-6270 shall be used to connect the instruments to the pitot and static lines in order to completely insulate the instrument panel from the vibration of the airplane structure. Flexible connections in accordance with Standard AN6270 shall be used in other places where flexible connections are required.

3.3.9 *Anti-seize compound.* Anti-seize compound in accordance with Specification JAN–A–669 shall be applied to all threaded parts on all the connection fittings.

3.3.10 *Drain traps.* A drain trap with a removable drain plug which shall be easily accessible for inspection shall be located at the lowest point in each pressure line and at any other low point at which water may collect. The capacity of the traps shall not cause any appreciable increase in error from pressure lag in the pitot or static lines.

3.3.11 *Accessibility of joints.* Each joint in the pitot-static pressure lines shall be readily accessible for inspection and maintenance. Inspection doors may be provided if necessary.

3.3.12 *Removal of tube.* A union shall be installed in the pitot and static lines at the point of attachment of the mounting strut to the wing or fuselage to permit the removal and replacement of the pitot-static tube.

3.3.12.1 *Modification.* The pitot-static tube shall not be modified in form or color by the attachment of any rings, sleeves, or other additions of paint or finish.

3.3.13 *Clearing of lines.* The pitot and static lines shall be blown clear with dry, high-pressure air immediately before the pitot-static tube or tubes are connected and the instruments are installed in the system or systems. All drain plugs shall be removed and all instrument connections shall be vented to the atmosphere while the air is being blown through the lines.

3.3.14 *Electrical circuit.* The electrical circuit for the pitot-static tubes provided with heater elements shall be in accordance with Standard AND10410. Circuit breakers shall be located where they can be conveniently reset in flight.

3.3.15 *Alternate sources of static pressure.* When specified, an alternate source of static pressure for each pitot-static tube shall be provided by installing a static pressure selector valve conforming to Standard AN5831, with the valve connections as shown in figure 1 and the "Alternate source" port of the selector valve open to the cockpit except in supercharged cabin installations. The selector valves for the pilot's and copilot's instruments should be mounted on the instrument panel or immediately adjacent thereto.

3.3.15.1 *Alternate source of static pressure for supercharged cabin airplane.* The "Alternate source" connection of the selector valve in supercharged cabin airplanes shall be connected to an alternate source of static pressure within the wing structure and as near to the wing tip as practicable. This alternate source shall consist of a compartment of the wing structure which is in free communication with the entire wing (except for the flotation compartments) and with the outside air through the openings made for control rods or drain holes. This same alternate source may be used for all selector valves but each valve shall be independently connected thereto.

3.4 *Performance.* The installation of pitot-static, tube-operated instrument systems shall satisfy the performance requirements

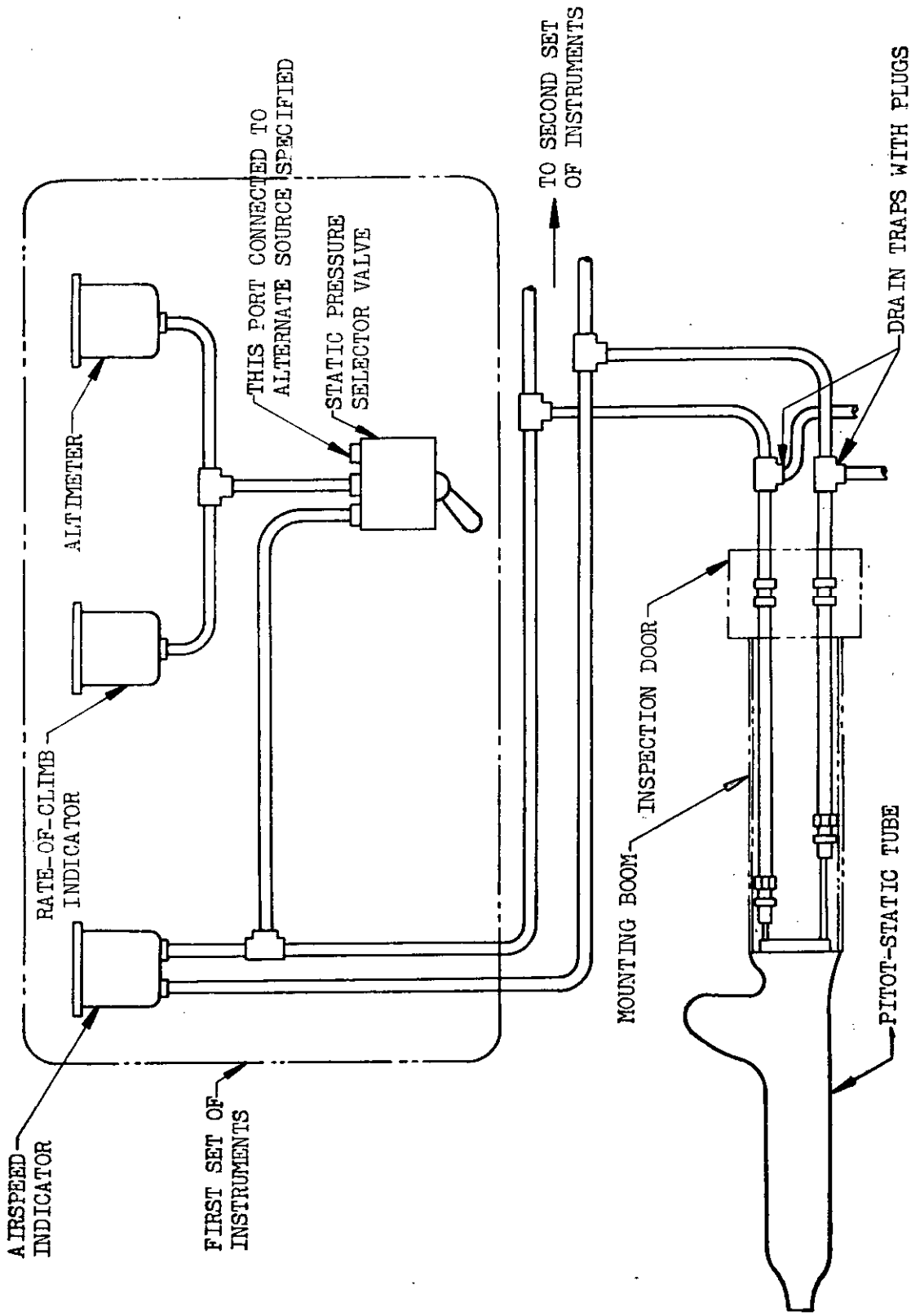

FIGURE 1. Pitot-static tube installation

of section 4 when subjected to the tests described under 4.3.2, 4.3.3, 4.3.4, 4.3.5, and 4.3.6.

3.5 *Workmanship.* Details of workmanship shall be in accordance with high-grade practice for installations of this type and of sufficient quality to insure safety, operation, and service life.

4. QUALITY ASSURANCE PROVISIONS

4.1 *Inspection responsibility.* The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. 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.* All the tests required herein for the testing of the system installation are classified as acceptance tests, for which necessary sampling techniques and methods of testing are specified in this section.

4.2.1 *Individual tests.* Each installation shall be subjected to the tests described in 4.3.1, 4.3.2, 4.3.3, and 4.3.4. In addition, all installations shall be subjected to any of the other tests specified herein which the inspector considers necessary to determine conformance with the requirements of this specification.

4.2.2 *Sampling tests.* The first pitot-static tube installation on an airplane model of any design and the first installation embodying a change in design of the pitot-static tube installation or a change in the airplane model design submitted for acceptance under contract shall be subjected to all the tests described under 4.3. This shall be done prior to the fabrication of the installation for the remaining airplanes on the order, to determine suitability of design and compliance with performance requirements of this specification.

4.3 *Test methods.*

4.3.1 *Visual examination.* All pitot-static tube system installations shall be visually examined to determine conformance to the requirements of this specification not covered by tests.

4.3.2 *Electrical wiring.* The electric circuit shall be properly connected to a combined generator and battery source of 14.25 volts for a 12- to 14-volt tube or a 28.5 volts for a 24-volt tube. The voltage when measured across the terminals of the tubes shall be 12 to 14 volts or 24 to 28 volts, respectively.

4.3.3 *Compass deviation.* With the airplane pointed to each of the four cardinal headings, the compass reading of all compasses in the airplane shall be noted with the electrical circuit "OFF" and with the electrical circuit "ON." The difference in readings on any heading with the electrical circuit "OFF" and with the electrical circuit "ON" shall not be more than 1 degree.

4.3.4 *Leakage.*

4.3.4.1 *Pitot pressure line.* The pitot pressure chamber drain holes of the pitot-static tube shall be sealed for this test. With the instruments properly connected to the pitot pressure line, the pitot pressure opening of the pitot-static tube shall be suitably connected to a source of pressure. A pressure sufficient to produce approximately three-fourths of full scale deflection on the lowest range airspeed indicator connected to the pitot line shall be applied and the pressure cut off. After 1 minute, the indicated airspeed shall not have decreased more than 5 knots. NOTE: DO NOT APPLY VACUUM TO PITOT LINES.

4.3.4.2 *Static pressure line.* The static pressure selector valve shall be set to "Static tube." With the instruments properly connected to the static pressure line and any

additional sources of static pressure in the system sealed off, the static pressure openings of the pitot-static tube shall be suitably connected to a source of vacuum. A vacuum shall be drawn on the system (at a rate within the range of rate-of-climb indicator) sufficient to cause the standard altimeter to indicate 10,000 feet and the source of vacuum cut off. After 1 minute the indicated altitude on the altimeter shall not fall below 7,000 feet. NOTE: DO NOT APPLY PRESSURE TO STATIC PRESSURE LINES.

4.3.5 *Determination of pitot-static tube system installation error.*

4.3.5.1 The installation errors shall be determined by any one of the following methods. They are described more completely in the NASA Report 919, and Bureau of Aeronautics Report No. NAES-INSTR. 16–44.

(a) The speed course method in which the time to cover a given distance is measured.

(b) The suspended head or trailing tube method in which the readings of the system under calibration are referred to those of a suspended pitot-static head which is either free from error or has known errors.

(c) The altimeter method, which provides a calibration of the static system only, in which the error is determined by comparing the altimeter reading (corrected for scale error) with the known flight level pressure altitude.

(d) Pacer airplane method in which the airplane with the installations to be calibrated is flown in formation with one which has an airspeed installation already calibrated by methods (a), (b), or (c).

4.3.5.2 An outline of the method and instrumentation to be used shall be submitted to the procuring activity and approval obtained prior to the actual beginning of the tests.

4.3.5.3 *Airspeed and altitude indication errors.* The airspeed and altitude indication errors resulting from the location of the pitot-static tube, corrected to standard sea level conditions, shall not exceed the limits specified in table I when tested in flight.

TABLE I

Tolerances on airspeed indicator and altimeter readings
(Corrected to standard sea level conditions—15° C, 29.92 inches Hg)

Configuration	Speed range	Gross weight	Tolerances	
			Airspeed indicator	Altimeter
Approach [1]	Stalling to 50 knots (58 mph) above stalling	Landing	±4 knots ±4.5 mph	25 ft per 100 knots IAS
Approach [1]	Stalling to 50 knots (58 mph) above stalling	Normal	±4 knots ±4.5 mph	25 ft per 100 knots IAS
Clean	Speed for maximum range to speed at normal rated power	Normal	±½ percent of indicated airspeed	25 ft per 100 knots IAS
Clean	Stalling to maximum	Normal	±4 knots ±4.5 mph	25 ft per 100 knots IAS
Clean	Stalling to maximum	Overload	±4 knots ±4.5 mph	25 ft per 100 knots IAS
Dive	Maximum speed with dive brakes full open	Normal	±6 knots ±7 mph	50 ft per 100 knots IAS

[1] The "Approach" configuration shall include (in addition to wing flaps and landing gear down) such conditions as "canopy open," "tail hook down," etc. which may vary with or be peculiar to certain model airplanes.

4.3.6 *Effect of maneuvers.*

4.3.6.1 *Pull-up.* A rate-of-climb indicator shall be connected to the static pressure system of each pitot-static tube. (The pilot's and copilot's instruments may be used.) The variation of static pressure during "pull-ups" from straight and level flight shall be determined at a safe altitude above the ground and at least three widely separated indicated airspeeds. During an abrupt "pull-up" from level flight, the rate of climb indicator shall indicate "Up" without excessive hesitation and shall not indicate "Down" before it indicates "Up."

4.3.6.2 *Push-over.* A rate-of-climb indicator shall be connected to the static pressure system of each pitot-static tube. (The pilot's and copilot's instruments may be used.) The variation of static pressure during "push-over" from straight and level flight shall be determined at a safe altitude above the ground and at least three widely separated indicated airspeeds. During an abrupt "push-over" from level flight the rate-of-climb indicator shall indicate "Down" without excessive hesitation and shall not indicate "Up" before it indicates "Down."

4.3.6.3 *Yawing.* Sufficient maneuvering shall be done in flight to determine that the installation of the pitot-static tube shall provide accurate static pressure to the flight instruments during yawing maneuvers of the airplane.

4.3.6.4 *Rough air.* Sufficient maneuvering shall be done in flight to determine that the installation of the pitot-static tube shall produce no objectionable instrument pointer oscillation in rough air. Pointer oscillation of the airspeed indicator shall not exceed 3 knots (4 mph).

4.4 *Rejection and retest.* The individual installations failing to meet their respective tests shall be rejected. Installations which have been rejected may be reworked or replaced to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejections shall be furnished the inspector.

5. PREPARATION FOR DELIVERY

5.1 Not applicable to this specification.

6 NOTES

6.1 *Intended use.* The pitot-static tube installation covered by this specification is intended for use on aircraft to provide a source of the dynamic and static pressures.

Custodians:
Army—TC
Navy—Wep

Preparing activity:
Navy—Wep

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