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MILITARY SPECIFICATION

GAGES, PRESSURE, ENGINE AND UTILITY AIRCRAFT

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

1. SCOPE

1.1 Scope. This specification covers 19 flange-mounted engine and utility aircraft pressure gages.

1.2 Classification. The gages shall be furnished in the part numbers listed in column 1 of Table I, as specified (see 6.2).

TABLE I. Gage details.

1	2	3	4	5
MS Part No.	Single or Dual	Case Type (see 3.3.8)	Dial Figure	Pointer Marks
MS28061-1	Single	AT	1a	
MS28061-2	Single	RT	1b	
MS28061-3	Single	AT	1c	
MS28061-4	Single	AT	1e	
MS28061-5	Single	RT	1f	
MS28061-6	Single	RT	1d	
MS28061-7	Single	RT	1g	
MS28063-1	Single	RT	1d	
MS28063-2	Single	RT	1g	
MS28063-3	Single	RT	1b	
MS28063-4	Single	RT	1f	
MS28064-3	Dual	RT	1a	1, 2
MS28064-4	Dual	RT	1a	3, 4
MS28064-5	Dual	RT	1b	1, 2
MS28064-6	Dual	RT	1b	3, 4
MS28064-7	Dual	RT	1d	1, 2
MS28064-8	Dual	RT	1f	1, 2
MS28064-9	Dual	RT	1f	3, 4
MS28064-10	Dual	RT	1g	1, 2

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, ESSD (Code 93), Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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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.

SPECIFICATIONS

Federal

PPP-B-601	Boxes, Wood, Cleated Plywood
PPP-B-621	Box, Wood, Nailed and Lock Corner
PPP-B-636	Box, Shipping, Fiberboard

Military

MIL-P-116	Preservation-Packaging, Methods of
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-C-5541	Chemical Conversion Coatings for Aluminum and Aluminum Alloys
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series; General Specification for
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-L-25142	Luminescent Material, Fluorescent

STANDARDS

Federal

FED-STD-595	Colors
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Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-794	Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-810	Environmental Test Methods
MIL-STD-889	Dissimilar Metals
MIL-STD-1188	Commercial Packaging of Supplies and Equipment

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STANDARDS (Continued)

Military (Continued)

MS28061	Gages, Pressure, Engine and Utility, 2 Inch, Flange-Mounted, Back Ports
MS28063	Gages, Pressure, Engine and Utility, 2 Inch, Flange or Port-Mounted, Bottom Port
MS28064	Gages, Pressure, Engine and Utility, 3 Inch, Flange Mounted, Back Ports
MS28105	Window, Dial-Aircraft Instrument Cover, Glass
MS33558	Numerals and Letters, Aircraft, Instrument Dial, Standard Form of
MS33585	Pointers, Dial, Standard Design of Aircraft Instrument

(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.)

REQUIREMENTS

3.1 Qualification. The gage furnished under this specification shall be a product which has been tested and has passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable Qualified Products List.

3.2 Materials. Materials shall conform to applicable specifications and shall be as specified herein. When materials are used which are not specifically designated, they shall be entirely suitable for the purpose intended.

3.2.1 Recycled materials. Recycled materials may be used provided they meet the requirements of this specification and do not adversely affect the performance of the gages.

3.2.2 Metals. Metals shall be of corrosion-resistant types unless suitably protected to resist corrosion during storage and normal service life.

3.2.3 Dissimilar metals. Dissimilar metals, as defined by MIL-STD-889 shall not be used in intimate contact with each other unless suitably protected against electrolytic corrosion by means of protective coatings.

3.2.4 Nonmagnetic metals. Nonmagnetic metals shall be used for all parts of the gage, except where magnetic materials are essential.

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3.2.5 Fungus-proof material. Materials which are nutrients for fungi shall not be used where it is practicable to avoid them. External materials which are nutrients for fungi shall be treated with a fungicidal agent, as approved by the procuring activity.

3.2.6 Luminescent materials. Luminescent material shall conform to MIL-L-25142, type I or III, as applicable.

3.2.7 Protective treatment. When materials are used in the construction of the gages that are subject to corrosion in salt air or other atmospheric conditions likely to occur during service usage, they shall be protected against such corrosion in a manner that will in no way prevent compliance with the performance requirements of this specification. Protective coatings and finishes which will crack, chip, or scale during normal service life or due to extremes of atmospheric conditions shall not be used.

3.2.8 Materials and parts. Specifications and standards for all materials and parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with procedures established by the procuring activity except as provided herein. Standard parts (MS or AN) shall be used wherever they are suitable for the purpose, and shall be identified on the drawings by their part numbers. Commercial utility parts such as screws, bolts, nuts, cotter pins, etc., may be used, provided they possess suitable properties and are replaceable by the standard parts (MS or AN) without alteration and provided the corresponding standard part numbers are referenced in the parts list and, if practicable, on the contractor's drawings. In the event there is no suitable corresponding standard part in effect on date of invitation for bids, commercial parts may be used provided they conform to all requirements of this specification.

3.3 Design and construction.

3.3.1 Single or dual. Each gage shall be single or dual as specified in column 2 of Table I.

3.3.2 Design. The design of each gage shall be reasonably simple to permit overhaul or repair without requiring numerous special tools and fixtures. The gages shall be so constructed as to withstand the normal strains, jars, vibrations, and such other conditions as are incident to shipping, storage, installation, and service, without failure. The mechanism including the dial of each dual gage shall be mounted on a metal plate which forms the back of the instrument case and which is secured to it by at least four screws. The mechanism shall be removable from the rear of the case as a unit. Such construction is optional for single gages.

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3.3.3 Operating mechanism. The operating mechanism shall be subject to approval of the procuring activity.

3.3.4 Mechanism adjustment. Each gage shall be provided with means to adjust or correct each indication in case this becomes necessary during the service life of the instrument. The means of adjustment shall be reasonably simple but need not be external to the case. On dual gages, means shall be provided within the mechanism for accomplishing zero correction adjustments without removal of the pointers.

3.3.5 Isolation of fuel. Each gage which is identified as a fuel pressure gage shall be so designed that the fluid applied to the pressure connection of the gage cannot touch any part of the gage other than the pressure connections, the pressure sensor(s), the inside of the case of the gage, and any necessary connecting tubing, etc.

3.3.6 Independent sensors in dual fuel pressure gages. Each dual gage which is identified as a fuel pressure gage shall contain two differential pressure sensing devices operated by a total of four different pressures.

3.3.7 Pressure stops.

3.3.7.1 Overpressure stop. An overpressure stop shall be provided for each pointer, shall be so designed as to restrain the mechanism rather than the pointer, and shall allow pointer travel beyond full scale. The setting of the overpressure stop shall be as indicated in Table II.

TABLE II. Overpressure stop setting.

Range (psi unless otherwise shown)	Setting
0 to 10 inches of mercury	10.3 + 0.1
0 to 20	22 + 1
0 to 25	27 + 1
0 to 35	37 + 1
0 to 200	210 + 5
0 to 300	310 + 5
0 to 2,000	2,200 + 50
0 to 5,000	5,300 + 100

When extreme overpressure occurs, the stop shall not allow the pointer to move beyond the bottom center of the dial.

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3.3.7.2 Zero pressure stop. A pressure stop shall be provided for each pointer, designed to restrain the mechanism rather than the pointer, to protect the gage from sudden loss of pressure.

3.3.8 Case. The case of each gage shall conform to the standard for the part number of the gage. The case of each gage designated by "AT" in column 3 of Table I shall be airtight. The case of each gage designated by "RT" in column 3 of Table I shall be raintight except for a small vent hole in the bottom.

3.3.8.1 Body. The case shall be made either of nonferrous low-density metal or of synthetic material, shall be uniform in texture, and have a smooth surface. The case shall be finished with a lusterless, black material, color No. 37038 of FED-STD-595, of a durable type to withstand usage encountered in service. Synthetic material shall be of the thermosetting type, composed of a suitable filler and phenol condensation product binder.

3.3.8.2 Bosses. Flats shall be provided on the sides of the boss for a minimum distance of 1/4 inch to enable use of a wrench when tightening the mating fittings.

3.3.8.3 Inserts. Unless otherwise specified, all inserts for the tubing connections shall be straight threads conforming to MIL-S-7742.

3.3.8.4 Identification of ports. The pressure and vent ports for each differential pressure sensor shall be located and marked "P" and "V", respectively, as shown on MS28061 or MS28064, as applicable. The port(s) for the pressure sensor which operates each pointer of each dual gage shall be located and marked "To No. (1, 2, 3, or 4, as applicable) Engine" as shown on MS28064.

3.3.8.5 Cover glass. The cover glass shall be clear, flat and free from flaws which interfere with normal reading of the gage, and shall conform to MS28105.

3.3.8.6 Bezel ring. The bezel ring, if used, shall be made of aluminum alloy or a synthetic material, and shall have a durable black finish. Provision shall be made for the replacement of the cover glass by removal of the bezel ring.

3.3.8.7 Dial-to-cover-glass distance. The distance between the dial and the cover glass shall be as small as practicable and shall not exceed 0.125 inch.

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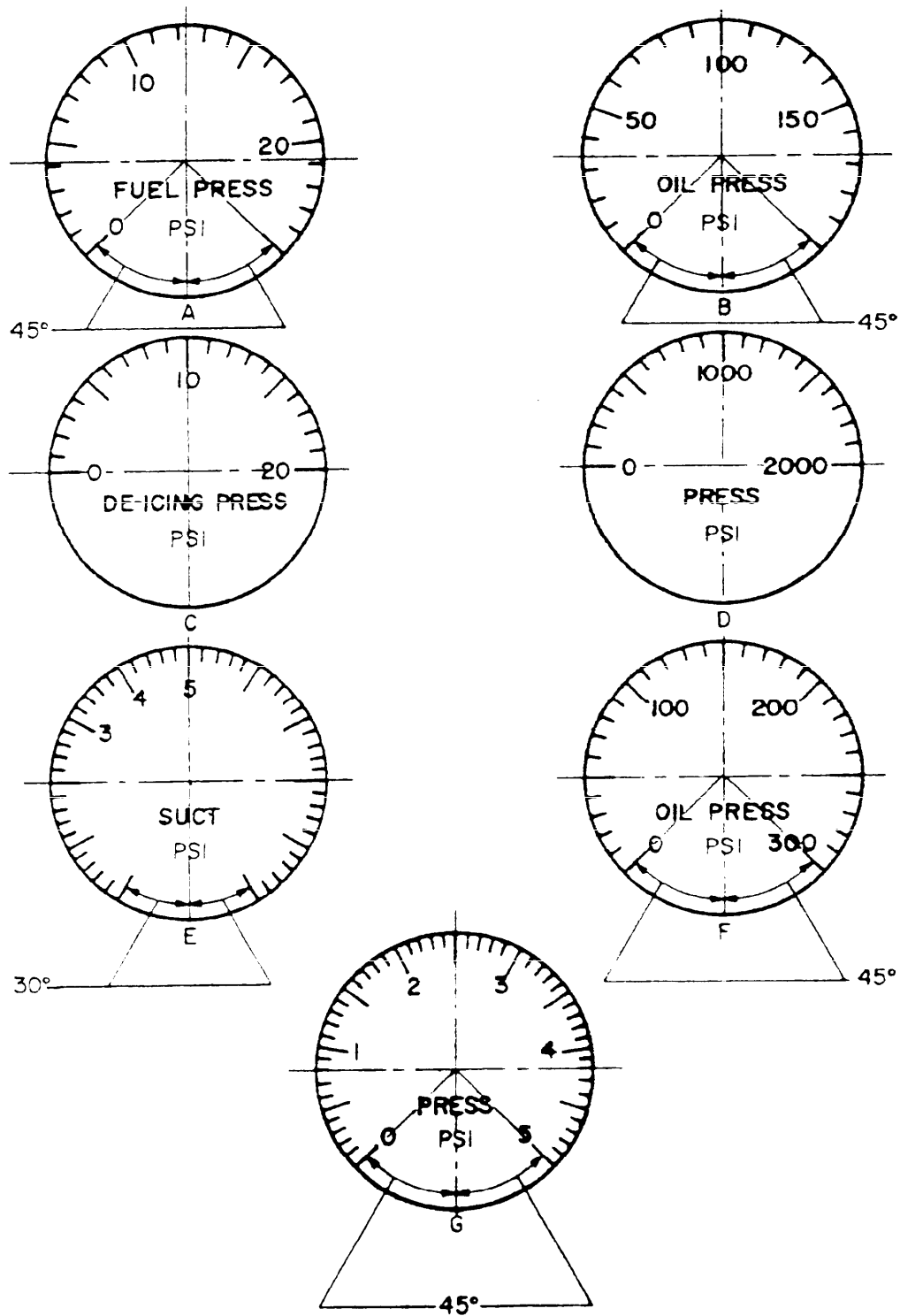
3.3.8.8 Mounting nuts. When attached insert nuts are specified, each mounting lug as indicated on the applicable drawing shall be fitted with a No. 6-32 NC-2 self-locking-type insert nut so attached as to prevent loosening under an axial load of 25 pounds and to prevent turning more than a fraction of a turn under a torque of 10 pound-inches, applied separately.

3.3.9 Dial. The dial of each gage shall conform to Figure 1 for the style under Figure 1 specified in column 4 of Table I. The form of all letters and numerals on the dial shall conform to MS33558. All markings shall be durable to withstand usage encountered in service and shall conform to Table III. Numerals shall distinctly indicate the graduation to which each applies. If practicable, each numeral shall be so placed that the center of mass of the numeral is on the radial line joining the appropriate graduation and the center of the dial.

TABLE III. Dial markings.

Numerals	Major graduations	Minor graduations	Lettering
All single gages	All gages		
All 0.240 inch high and 0.031 inch wide, except on Part Nos. MS28061-6, T6 and MS28063-1, T1 which are 0.188 inch high.	All 3/16 inch long and 0.031 \pm 0.005 inch wide.	All 1/8 inch long and 0.016 \pm 0.005 inch wide.	All 0.125 inch high and 0.020 inch wide, except "X1000", "psi", and "in. Hg", which are 0.063 inch high and 0.010 inch wide. "X1000" shall be marked in durable dull black.
All dual gages.			
All 0.140 inch high and 0.020 inch wide. On Part Nos. MS28064-3, T3 and MS28064-4, T4 only "0", "10", and "20", and on Part Nos. MS28064-5, T5 and MS28064-6, T6 only "50", "100", and "150", are marked in luminescent material.			

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TOLERANCES: ANGLES $\pm 1^\circ$

FIGURE 1. Dials.

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3.3.9.1 Diameter of scale circle. The diameter across the outer ends of the graduations of the scale of each gage shall be at least equal to the minimum diameter of the aperture required by the standard for the case of the gage 1/16 inch, and shall be not greater than the diameter of the aperture.

3.3.9.2 Dial finish. The background of the dial of each gage shall be finished with lusterless, black material, color No. 37038 of FED-STD-595. All markings on the dial shall be finished in fluorescent-luminescent material or lusterless, white material, color No. 37875 of FED-STD-595, as specified by the procuring activity. (See 6.2).

3.3.9.3 Marking. The MS part number of the gage shall be marked on the face of the dial in durable dull black letters and numbers 1/16 inch high. No other identification number shall appear on the dial.

3.4 Pointers. Each single gage shall include one pointer which shall conform to MS33585. Each dual gage shall include two pointers which shall conform to MS33585 for the types under MS33585 bearing the identifying numbers specified in column 5 of Table 1. The nearer pointer to the dial shall bear the smaller of the two numbers. The nearer pointer to the cover glass shall bear the larger of the two numbers. Pointers shall be light and sufficiently rigid to prevent oscillation under vibration. Pointers shall be firmly attached to the mechanism. All parts of each pointer which are shown as shaded in MS33585 shall be finished in fluorescent-luminescent material.

3.5 Interchangeability. All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part numbers shall be governed by the drawing requirements of MIL-D-1000, or as otherwise specified by the procuring activity.

3.6 Finish.

3.6.1 Aluminum-alloy parts. Aluminum-alloy parts shall be covered with an anodic film conforming to MIL-A-8625, except as follows.

3.6.2 Dials. Dials, small holes, and case inserts need not be anodized.

3.6.3 Aluminum alloys which do not anodize satisfactorily shall be coated with a chemical film in accordance with MIL-C-5541.

3.6.4 Where the primary purpose of the treatment is to afford a suitable paint base, chemical treatments in accordance with MIL-C-5541 may be used in lieu of anodizing.

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3.6.5 Castings containing non-aluminum-alloy integral inserts may be treated with a chemical film in accordance with MIL-C-5541 in lieu of anodizing.

3.6.6 When abrasion resistance is a factor, chemical films in accordance with MIL-C-5541 shall not be used in lieu of anodizing.

3.7 Screw threads. Screw threads shall conform to MIL-S-7742.

3.8 Weight. The weight of each gage shall not exceed 0.5 pounds for single gages and 0.8 pounds for dual gages.

3.9 Performance. The gages shall operate satisfactorily under the following conditions:

- a. Scale error at room temperature (4.6.2)
- b. Friction (4.6.3)
- c. Case leakage (4.6.4)
- d. Position error (4.6.5)
- e. Differential pressure error (4.6.6)
- f. Low-temperature scale error (4.6.7)
- g. High-temperature scale error (4.6.8)
- h. Seasoning (4.6.9)
- i. Vibration (4.6.10)
- j. Suction or overpressure (4.6.11)
- k. Examination of dials (4.6.12)
- l. High altitude - low-temperature exposure (4.6.13)
- m. High-temperature exposure (4.6.14)
- n. Endurance (4.6.15)
- o. Humidity (4.6.16)
- p. Fungus (4.6.17)
- q. Salt spray (4.6.18)
- r. Case tests (4.6.19)

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3.10 Identification of product. Equipment, assemblies, and parts shall be marked in accordance with MIL-STD-130. The nameplate shall include the following additional information:

Gage, (Insert name of specific gage)
Specification MIL-G-7734C
MS Part No. (Insert proper dash number)
Stock No.
Manufacturer's Part No.
Manufacturer's Serial No.
Contract or Order No.
Manufacturer's Name or Trademark
US

3.10.1 Use of MS designations. MS designations shall not be applied to a product, except for qualification test samples, nor referred to in correspondence, until notice of approval has been received from the activity responsible for qualification.

3.11 Installation instructions. For Navy procurement only, the contractor shall furnish with each instrument one printed copy of instructions, with illustrations and diagrams, if necessary, covering the installation of the instrument. Prior to printing, two copies shall be furnished to the Government for approval. Whenever possible, the instructions shall be arranged to require only one sheet of paper, either 8-1/2 x 11 inches or 11 x 17 inches.

3.11.1 Envelope. An envelope furnished by the contractor shall be packaged with each gage. The envelope shall contain the installation instructions. Each envelope shall be marked with the following information:

IMPORTANT
THIS ENVELOPE CONTAINS
INSTRUCTIONS

3.12 Workmanship. The gage shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of soldering, marking of parts and assemblies, plating, painting, riveting, machine screw assembly, welding, brazing, and freedom of parts from burrs, sharp edges, and rough surfaces.

3.12.1 Dimensions. Dimensions and tolerances not specified shall be as close as is consistent with best shop practices. Where dimensions and tolerances affect the interchangeability, operation, or performance of the gage, they shall be held or limited accordingly.

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

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3.12.3 Screw assemblies. Assembly screws and bolts shall be tight. The word "tight" means the screw or bolt cannot be appreciably tightened further without damage or injury to the screw or bolt threads.

3.12.4 Gears. Gear assemblies shall be properly aligned and meshed and shall operate without interference, tight spots, or other irregularities. Where required for accuracy adjustment, gear assemblies shall be free from backlash.

3.12.5 Cleaning. The gage shall be thoroughly cleaned of loose, spattered or excess solder, metal chips, or other foreign material after assembly. Burrs and sharp edges as well as resin flash which might crumble shall be removed.

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. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in 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 gages shall be classified as follows:

- a. Qualification tests (see 4.3)
- b. Acceptance tests (see 4.4)

4.3 Qualification tests.

4.3.1 Sampling instructions. The qualification test samples shall consist of four complete gages of each MS part number upon which qualification is desired. Samples shall be identified as required and forwarded to the activity responsible for qualification, designated in the letter of authorization from that activity (see 6.3).

4.3.2 Tests. The qualification tests of gages shall consist of all the tests of this specification, as described under 4.6. The tests shall be conducted in the order listed and in the following sequence:

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Group I (one group of two samples shall be subjected to the following tests):

- a. Individual tests (4.4.1)
- b. Sampling tests (4.4.2)

Group II (second group of remaining two samples shall be subjected to the following tests):

- a. High altitude - low-temperature exposure (4.6.13)
- b. High-temperature exposure (4.6.14)
- c. Endurance (4.6.15)
- d. Humidity (4.6.16)
- e. Fungus (4.6.17)
- f. Salt spray (4.6.18)
- g. Case tests (4.6.19)

4.4 Acceptance tests. The acceptance tests shall consist of individual tests and sampling tests.

4.4.1 Individual tests. Each gage shall be subjected to the following tests, as described under 4.6:

- a. Scale error at room temperature (4.6.2)
- b. Friction (4.6.3)
- c. Case leakage (airtight cases only) (4.6.4)

4.4.2 Sampling tests. One gage shall be selected from every 100 instruments or fewer of each lot which has passed the required individual tests and shall be subjected to the tests listed below, as described under 4.6 of this specification. A lot shall consist of instruments of the same part number submitted for inspection under the same contract or order.

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- a. Position error (4.6.5)
- b. Differential pressure error (4.6.6)
- c. Low-temperature scale error (4.6.7)
- d. High-temperature scale error (4.6.8)
- e. Seasoning (4.6.9)
- f. Vibration (4.6.10)
- g. Suction or overpressure (4.6.11)
- h. Pressure loss test (4.6.12)
- i. Examination of dials (4.6.12)

4.4.3 Rejection and retest. Any instrument failing to meet the requirements of individual tests shall be rejected. When any representative sample fails to meet the requirements of the sampling tests, the lot represented shall be rejected. Instruments which have been rejected may be replaced or repaired to correct the defects and resubmitted for acceptance. When this has been accomplished, all specified tests shall be repeated. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the original defects shall be furnished the inspector. Units rejected after retest shall not be resubmitted without the specific approval of the procuring activity.

4.5 Test conditions.

4.5.1 Atmospheric conditions. Unless otherwise specified, all tests required by this specification shall be made at an atmospheric pressure of approximately 29.92 inches of mercury and at a temperature of 23°C. When tests are made with atmospheric pressure and temperature substantially different from the above values, proper allowance shall be made for the difference from specified conditions.

4.5.2 Vibration stand. Whenever a vibration stand is specified, it shall consist of a device which will vibrate at any desired frequency between 300 and 3,000 cpm.

4.5.3 Tapping. Unless otherwise specified, the gage shall be tested in the normal operating position with its dial in a vertical plane and shall be tapped lightly before a test reading is taken (see 6.4).

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4.6 Test methods.

4.6.1 Examination of product. Each gage shall be carefully examined to determine conformance with the requirements of this specification not covered by tests.

4.6.2 Scale error at room temperature. The instrument shall be tested for scale error at the pressures listed in Table IV. The tests shall be made by subjecting the instrument to the pressures specified to produce these readings, first with the pressures increasing, then with the pressures decreasing. With the pressures increasing, the pressure shall be brought up to but shall not exceed the pressure specified to give the desired reading; and with the pressure decreasing, the pressure shall be brought down to but shall not fall below the pressure specified to give the desired reading. The scale errors shall not exceed the tolerances specified in Table IV.

4.6.3 Friction. The instrument shall be tested for friction at each alternate test point indicated in Table IV, beginning with the second test point. The pressure shall be so increased as to bring the pointer approximately to the desired reading, and then held constant while two readings are taken, the first before the instrument is tapped, the second after the instrument is tapped. The difference of any two such readings is the friction error and shall not exceed a tolerance of ± 2 percent of full scale reading.

4.6.4 Case leakage. This test is required only on gages with external vent connections. A suction sufficient to produce an indication of 10 psi shall be applied to each of the vent connections (except that a pressure sufficient to produce an indication of 10 inches of mercury shall be applied to the vent of the suction gage). The connecting tubing shall then be pinched off or otherwise completely sealed at a point within 2 inches of the pressure connection. During a period of 1 minute, the pointer shall not change its position more than 1 percent of full scale reading.

4.6.5 Position error. With sufficient pressure applicable to obtain a reading at approximately the midpoint of the scale, readings shall be taken while the instrument is being tapped lightly in each of several different positions. The change in pointer indication with change in instrument position from normal position (dial in a vertical plane) shall not exceed a tolerance of 1 percent of full scale reading at the given test pressure.

4.6.6 Differential pressure error. This test applies only to fuel pressure gages. The instrument shall be tested for scale errors in accordance with Table IV, with a pressure of 15 psi applied to the vent connection. The test shall be made by subjecting the instrument to the pressures specified in Table V to produce the gage readings shown. The scale errors shall not exceed ± 3 percent of full scale reading.

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TABLE IV. Test points and tolerances.

Range	Test pressure	Tolerance	
		Room temperature (4.6.2)	Seasoning (4.6.9) Vibration failure (4.6.10.2) Suction or overpressure (4.6.11) High-temperature scale error (4.6.8) Low-temperature scale error (4.6.7) Endurance (4.6.15) Humidity (4.6.16) Salt spray (4.6.18)
	psi	psi	psi
0 to 25 psi and 0 to 20 psi	0	+0.2	+0.3
	4	0.3	0.4
	8	0.4	0.5
	12	0.4	0.6
	16	0.5	0.6
	20	0.5	0.8
	25	0.5	0.8
0 to 200 psi and 0 to 300 psi	0	+3.0	+4.0
	50	3.0	6.0
	100	5.0	6.0
	150	5.0	8.0
	200	5.0	8.0
	250	6.0	10.0
	300	6.0	10.0
0 to 2,000 psi	0	+30	+40
	400	40	40
	800	50	60
	1,200	50	60
	1,600	50	80
	2,000	50	80
0 to 5,000 psi	0	+75	+100
	1,000	100	100
	2,000	125	150
	3,000	125	150
	4,000	125	200
	5,000	125	200
0 to 10 inches of mercury (in. Hg.)	Test suction		
	In. Hg.	In. Hg.	In. Hg.
	0	+0.1	+0.2
	2	0.2	0.4
	4	0.2	0.4
	6	0.2	0.4
	8	0.2	0.6
	10	0.2	0.6

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TABLE V. Differential pressure test points.

Test pressure (psi)		Gage indication
Vent connection	Pressure connection	(psi)
15	15	0
15	20	5
15	25	10
15	30	15
15	35	20
15	40	25

4.6.7 Low-temperature scale error. The instrument shall be tested for scale errors, except that the instrument shall be at a temperature of -55°C and shall have been subjected to this temperature for at least a period of 4 hours prior to testing. The gage shall then be subjected to and shall meet the requirements of the scale error at room temperature test. The scale error shall not exceed the tolerances specified in Table IV.

4.6.8 High-temperature scale error. The instrument shall be tested for scale errors, except that the instrument shall be at a temperature of 70°C and shall have been subjected to this temperature for a period of 4 hours prior to testing. The gage shall then be subjected to and shall meet the requirements of the scale error at room temperature test. The scale error shall not exceed the tolerances specified in Table IV.

4.6.9 Seasoning. The instrument shall be subjected to 10,000 applications of a differential pressure which produces an indication from 0 to 80 percent ± 5 percent of the range of the gage at a rate not to exceed 60 cpm. The application and release of pressure shall be as smooth as practicable, so as not to subject the instrument mechanism to excessive accelerations. Not less than 1 hour following this test, the instrument shall be tested for scale errors. The errors shall not exceed the tolerances specified in Table IV.

4.6.10 Vibration.

4.6.10.1 Vibration error. The instrument shall be mounted on the vibration stand in its normal operating position (gage dial in a vertical plane). The instrument shall have sufficient pressure applied to give a midscale reading, and shall then be subjected to vibration along each of 3 mutually perpendicular axes with an amplitude of 0.18 to 0.020 inch at frequencies of from 300 to 3,000 cpm. The maximum total spread of pointer oscillation shall not exceed the tolerances specified in Table VI. The mean reading during pointer oscillation shall not differ at any time, by more than the tolerances specified in Table VI, from the reading obtained when the instrument is at rest.

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TABLE VI. Vibration tolerances.

Range	Tolerance
0 20 psi 0 25 psi 0 200 psi 0 300 psi	± 1.5 percent of full scale
0 2,000 psi 0 5,000 psi 0 10 in. Hg.	± 1.0 percent of full scale

4.6.10.2 Vibration failure. The instrument shall have a sufficient pressure applied to give a midscale reading, and shall then be subjected to vibration along each of 3 mutually perpendicular axes with an amplitude of 0.18 to 0.020 inch for a 3-hour period. The frequency shall be varied uniformly from 300 to 3,000 cpm and returned once each hour during this test. After the 3-hour vibration period, the instrument shall be tested for scale errors in accordance with 4.6.2. The scale errors shall not exceed the tolerances specified in Table IV. In addition, the instrument shall be subjected to and shall meet the requirements of 4.6.3 and 4.6.4, respectively. No looseness in the mechanism nor damage to any part of the instrument shall result from the vibration.

4.6.11 Suction or overpressure. The instrument shall be subjected to the test specified in 4.6.2 and the actual readings tabulated. The instrument shall then be subjected to the pressure specified in Table VII for a period of 10 minutes. Not less than 1 hour following the application of the specified suction or overpressure, the instrument shall again be tested for scale errors in accordance with Table IV. The readings obtained following this test shall not differ from the readings obtained immediately preceding the overpressure by more than a tolerance of ± 2 percent of the full scale readings.

TABLE VII. Overpressures and suction.

Range	Overpressure	Suction
0 to 20 and 0 to 25 psi	40 psi	Not required
0 to 200 and 0 to 300 psi	600 psi	Not required
0 to 2,000 psi	3,000 psi	Not required
0 to 5,000 psi	6,000 psi	Not required
0 to 10 in. Hg.	Not required	14 in. Hg.

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4.6.12 Examination of dials. Following the sampling tests as specified in 4.4.2, the dial of each representative sample shall be observed under a standard fluorescent light. The dial markings shall be uniform and comparable in color and intensity to markings on dials which have not been subjected to the sampling tests.

4.6.13 High altitude - low-temperature exposure. The gage shall be tested for scale errors in accordance with 4.6.2 and shall meet the tolerance requirements as specified therein. The gage shall then be subjected to a temperature of $-65^{\circ} \pm 2^{\circ}\text{C}$ for a period of 48 hours. The temperature shall then be raised to $-55^{\circ} \pm 2^{\circ}\text{C}$ for a period of 24 hours. During the last hours of the 24-hour period, the pressure of the test chamber shall be lowered to 3.44 ± 0.08 inches of mercury (equivalent to 50,000 feet altitude), and the gage shall be maintained at this pressure and temperature for the 4-hour period. While at this temperature and pressure, the gage shall be subjected to and meet the requirements of the test specified in 4.6.7. After the gage has returned to room temperature for approximately 4 hours, the test specified in 4.6.2 shall be conducted. The scale errors shall not exceed the tolerance for room temperature. There shall be no damage which would adversely affect subsequent operation.

4.6.14 High-temperature exposure. The gage shall be subjected to a temperature of $70^{\circ} \pm 2^{\circ}\text{C}$ for a period of 24 hours, after which time and while at this temperature, the gage shall be subjected to and shall meet the requirements of the test specified in 4.6.8. After the gage has been returned to room temperature for approximately 4 hours, the test specified in 4.6.2 shall be conducted. The errors shall not exceed the tolerances for room temperature. There shall be no damage which would adversely affect subsequent operation.

4.6.15 Endurance. The following test method shall apply to all gages except 0-5,000 psi gages. The gage shall be subjected to 100,000 applications of a pressure which produces an indication from 0 to 80 percent ± 5 percent of the range of the gage at a rate not to exceed 60 cpm. The application and release of the pressure shall be as smooth as practicable, so as not to subject the instrument mechanism to excessive accelerations. The gage shall be tested for scale errors in accordance with the test specified in 4.6.2 not less than 1 hour after the pressure cycling. The errors shall not exceed the tolerances specified in Table IV. Any pressure gage subjected to the endurance test and the test specified in 4.6.8 shall be examined to determine if the moving parts have been worn to the extent that premature failure may occur during actual service conditions. Replacement of worn or defective parts shall be accomplished by the contractor prior to acceptance of any gage.

4.6.15.1 0-5,000 psi gages shall be tested in accordance with 4.6.15, except that the number of applications shall be 25,000 in lieu of 100,000, and the rate shall be 30 ± 5 cpm in lieu of 60 cpm.

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4.6.16 Humidity. The gage shall be subjected to the humidity tests, Procedure I, of MIL-STD-810, except that the test period shall be for 5 cycles (120 hrs). Within 1 hour after the completion of the 5 cycles, the gage shall be subjected to the test specified in 4.6.2.

4.6.17 Fungus. The gage shall be subjected to the fungus resistant tests, Procedure I of MIL-STD-810, except that the test period shall be for a minimum of 14 days. At the option of the activity responsible for qualification, tests on component parts of the gage may be accepted in lieu of or in addition to the test on the assembled gage.

4.6.18 Salt spray. The gage shall be subjected to the salt spray tests, Procedure I, of MIL-STD-810, for a period of 50 hours. External connections shall be made to the equipment to simulate installed conditions. At the end of the 50 hour period, the instrument shall be subjected to the tests specified in 4.6.2 and 4.6.3. The scale errors shall not exceed the tolerances specified in Table IV. The friction error shall not exceed a tolerance of ± 3 percent of the full scale reading.

4.6.19 Case tests.

4.6.19.1 Mounting nuts. Each attached mounting nut, if furnished, shall have an axial load of 25 pounds applied to the nut in such manner as to tend to pull the nut out of the lug toward the rear of the case. A torque of 10 pound-inches shall be applied about the axis of the threads. There shall be no loosening. The nut shall not turn more than one-eighth turn under the specified torque.

4.6.19.2 Mounting lugs. The case shall be mounted face downward on the moveable head of a suitable testing machine with the face of the case in a horizontal plane in order that the mounting lugs receive no added support. A suitable pin shall be inserted through the hole in the mounting lug and attached to a pull strap in the stationary head of the machine. A load of 175 pounds shall be applied to each lug for a period of 1 minute in a direction toward the front of the case.

4.6.20 Packaging and packing. The inspector shall ascertain that preparation for delivery conforms to the requirements of Section 5.

4.6.21 Pressure loss test. The instrument shall be subjected to the test specified in 4.6.2 and the actual readings tabulated. The instrument shall then be subjected to a pressure sufficient to produce full scale pointer deflection. The pressure shall then be suddenly released. Not less than one hour following the instantaneous release of pressure, the instrument shall again be tested for scale errors in accordance with 4.6.2. The readings obtained shall not differ from the readings obtained immediately preceding the pressure release by more than a tolerance of ± 2 percent of the full scale readings.

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5. PACKAGING

5.1 Preservation and packaging. Gages shall be preserved and packaged level A, B, or Commercial, as specified (see 6.2).

5.1.1 Level A. Gages shall be preserved and packaged in accordance with Method IA of MIL-P-116, and cushioned to prevent movement within the box. Unit containers shall conform to PPP-B-636, class weather resistant.

5.1.2 Level B. Gages shall be preserved and packaged as for level A, except that PPP-B-636, class domestic may be used.

5.1.3 Commercial. Gages shall be preserved and packaged in accordance with MIL-STD-1188.

5.2 Packing. Gages preserved and packaged in accordance with 5.1 shall be packed level A, B, or Commercial, as specified (see 6.2).

5.2.1 Level A. Gages shall be packed in snug-fitting boxes conforming to PPP-B-601 or PPP-B-621. The contents shall be blocked and braced to prevent movement within the container. Intermediate containers conforming to PPP-B-636 shall be utilized as required.

5.2.2 Level B. Gages shall be packed as for level A, except that boxes conforming to PPP-B-636, class weather resistant may be used.

5.2.3 Commercial. Gages shall be packed in accordance with MIL-STD-1188.

5.3 Marking. In addition to any special requirements of the contract or delivery order, items shall be marked in accordance with MIL-STD-129 or MIL-STD-1188, as specified (see 6.2).

6. NOTES

6.1 Intended use. The back port pressure gages covered by this specification are intended to be mounted by means of their mounting flanges in instrument panels in aircraft. The bottom port pressure gages covered by this specification are intended to be mounted either by means of their mounting flanges in instrument panels or by means of their pressure ports on the fittings to which their pressure ports are connected in aircraft.

6.1.1 MS28061-1, T1 Single fuel pressure gages are intended for use in single engine aircraft to indicate the fuel pressure.

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6.1.2 MS28064-3, T3 Dual fuel pressure gages are intended for use in two and four engine aircraft to indicate the fuel pressures of the Nos. 1 and 2 engines.

6.1.3 MS28064-4, T4 Dual fuel pressure gages are intended for use in four engine aircraft to indicate the fuel pressures of the Nos. 3 and 4 engines.

6.1.4 MS28061-2, T2 (200 psi, back port), MS28061-5, T5 (300 psi back port), MS28063-3, T3 (200 psi, bottom port), and MS28063-4, T4 (300 psi, bottom port) single oil pressure gages are intended for use in single engine aircraft to indicate the engine oil pressure and for use in single and multiengine aircraft to indicate the pressure of the automatic pilot servo system and other hydraulic system pressures.

6.1.5 MS28064-5, T5 (200 psi) and MS28064-8, T8 (300 psi) Dual oil pressure gages are intended for use in two and four engine aircraft to indicate the oil pressure of the Nos. 1 and 2 engines.

6.1.6 MS28064-6, T6 (200 psi) and MS28064-9, T9 (300 psi) Dual oil pressure gages are intended for use in four engine aircraft to indicate the oil pressures of the Nos. 3 and 4 engines.

6.1.7 MS28061-3, T3 Single de-icing pressure gages are intended for use in single and multiengine aircraft to indicate the pressure of the de-icing system.

6.1.8 MS28061-4, T4 Single suction gages are intended for use in single and multiengine aircraft to indicate the vacuum which operates vacuum-operated gyroscopic instruments.

6.1.9 MS28061-6, T6 (2,000 psi, back port), MS28061-7, T7 (5,000 psi, back port), MS28063-1, T1 (2,000 psi, bottom port), and MS28063-2, T2 (5,000 psi, bottom port) single general high pressure gages are intended for use in single and multiengine aircraft to indicate the pressure of the hydraulic system, the pressure in the landing gear hydraulic pressure lines, and the air pressure in hydraulic accumulators.

6.1.10 MS28064-7, T7 (2,000 psi) and MS28064-10, T10 (5,000 psi) Dual general high pressure gages are intended for use in single and multiengine aircraft to indicate the pressure of the Nos. 1 and 2 hydraulic systems.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.

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b. Part number of the gage desired, the quantity, whether mounting screws and mounting nuts or removable spring nuts are desired, and the type of material to be used for dial markings (see applicable MS standard).

c. Selection of applicable levels of preservation, packaging, and packing (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command, Department of the Navy, Washington, DC 20361, and information pertaining to qualification of products may be obtained from that activity.

6.4 Definition.

6.4.1 Tapped lightly. The phrase "tapped lightly" is defined as meaning the application of a light vibration sufficient to overcome that small amount of residual friction normally associated with good quality aircraft instruments.

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