

MIL-I-18804B

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 SUPERSEDING
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MILITARY SPECIFICATION*** INDICATOR, VERTICAL SPEED, 0-6000 FPM, 2-INCH**

* *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 Scope. This specification covers design and all performance requirements for the 2-inch nominal size vertical speed indicator with a range of 0-6000 feet per minute ascent and descent.

* 1.2 Classification. The indicators shall be of the following types:

MS28075-1 unlighted
 MS28075-2 lighted

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS**FEDERAL**

DD-G-451 —Glass, Flat and Corrugated, for Glazing, Mirrors and other uses
 QQ-C-320 —Chromium Plating (Electrodeposited)
 QQ-N-290 —Nickel Plating (Electrodeposited)
 QQ-P-416 —Plating, Cadmium (Electrodeposited)
 QQ-Z-325 —Zinc Coating, Electrodeposited, Requirements for

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

MILITARY

MIL-P-116 —Preservation, Methods of
 MIL-M-3171 —Magnesium Alloy, Process for Corrosion Protection of
 MIL-N-3336 —Nut, Self-Locking, Instrument Mounting
 MIL-E-5272 —Environmental Testing, Aeronautical and Associated Equipment, General Specification for
 MIL-E-5400 —Electronic Equipment, Aircraft, General Specification for
 MIL-C-5541 —Chemical Films for Aluminum and Aluminum Alloys
 MIL-S-6872 —Soldering Process, General Specification for
 MIL-S-7742 —Screw Threads, Standard, Optimum Selected Series, General Specification for
 MIL-P-7936 —Parts and Equipment, Aeronautical, Preparation for Delivery

* FSC 6610

MIL-I-18804B

- MIL-A-8625 —Anodic Coatings, for Aluminum and Aluminum Alloys
- MIL-P-23408 —Planting: Tin-Cadium (Electrodeposited)
- MIL-L-25467 —Lighting, Integral, Aircraft Instrument, General Specification for
- MIL-C-26482 —Connectors, Electric Circular, Miniature, Quick Disconnect
- MIL-D-70927 —Drawings, Engineering and Associated Lists

STANDARDS**FEDERAL**

FED-STD-595—Colors

MILITARY

MIL-STD-129 —Marking for Shipment and Storage

MIL-STD-130 —Identification Marking of U. S. Military Property

MIL-STD-143 —Specifications and Standards, Order of Precedence for the Selection of

MS24367 —Lamp, Incandescent—Miniature Integral Lighting

MS24515 —Lamp—Sub Miniature

MS28075 —Indicator, Vertical Speed, 0-6000 FPM

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

MS33586 —Metals, Definition of Dissimilar

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

* 2.2 Other publications. The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

CONSOLIDATED FREIGHT CLASSIFICATION COMMITTEE PUBLICATIONS

Consolidated Freight Classification Ratings, Rules, and Regulations

(Copies of Consolidated Freight Classification Ratings, Rules, and Regulations may be obtained from the Consolidated Freight Classification Committee, 202 Chicago Union Station, Chicago 6, Illinois.)

AMERICAN TRUCKING ASSOCIATION

National Motor Freight Classification Rules and Container Regulations

(Copies of National Motor Freight Classification Rules and Container Regulations may be obtained from the National Classification Board, 1424 Sixteenth Street, N.W., Washington 6, D. C.)

3. REQUIREMENTS

* 3.1 Qualification. The indicator 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 Selection of Government documents. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143 except as provided in 3.2.1 and 3.2.2.

* 3.2.1 *Commercial parts.* Commercial parts having suitable properties shall be used, where on the date of invitations for bids, there are no suitable standard parts. In any case, commercial parts, such as screws, bolts, nuts, cotter pins, having suitable properties shall be used provided:

(a) They can be replaced by the standard parts (MS or AN) without alteration.

(b) The corresponding standard part numbers are referenced in the parts list and if practicable, on the contractor's drawings.

* **3.2.2 Standard parts.** With the exception of 3.2.1, MS and AN standard parts shall be used where they suit the purpose. They shall be identified on the drawings by their part numbers.

* **3.3 Materials.** Materials shall conform to applicable specifications and shall be as specified herein. Materials for which there are no applicable specifications, or which are not specifically described herein, shall be of the best quality, of the lightest practicable weight and suitable for the purpose intended.

* **3.3.1 Critical materials.** Noncritical materials shall be used where practicable. Where the use of a critical material is essential to meet specification requirements, the material used shall be the least critical of those which are adequate for the purpose.

3.3.2 Nonmagnetic materials. Nonmagnetic materials shall be used for all parts of the indicator except where magnetic materials are essential.

* **3.3.3 Metals.** Metals shall be of the corrosion resistant type, or shall be suitably protected as specified herein to resist corrosion due to fuels, salt spray or atmospheric conditions to which the vertical speed indicator may be subjected when in storage or during normal service life.

* **3.3.3.1 Dissimilar metals.** Dissimilar metals as defined in MS33586 shall not be used in intimate contact with each other, unless suitably protected against electrolytic corrosion by means of protective coatings.

* **3.3.3.2 Magnesium alloy parts.** Magnesium alloy parts shall be treated in accordance with Specification MIL-M-3171. When abrasion resistance is a factor, an anodic treatment approved by the procuring activity shall be used.

* **3.3.3.3 Aluminum alloy parts.** Where practicable, aluminum alloy parts shall be covered with an anodic film conforming to Specification MIL-A-8625. Small holes, pipe threads and case inserts need not be anodized. Aluminum alloys which do not anodize sat-

isfactorily shall be coated with a chemical film in accordance with Specification MIL-C-5541.

* **3.3.3.4 Iron and steel parts.** Iron and steel parts which are in hermetically sealed cases shall be cadmium plated in accordance with Specification QQ-P-416. Parts which are not in sealed cases shall be chromium, nickel, or zinc plated in accordance with Specification QQ-C-320, QQ-N-290, or QQ-Z-325 respectively. Parts in a confined space in the presence of organic material shall be tin-cadmium plated in accordance with specification MIL-P-23408.

* **3.3.4 Protective treatment.** When materials are used in the construction of the indicator that are subject to atmospheric or environmental conditions likely to cause corrosion in normal service life, they shall be protected against corrosion in a manner that will in no way prevent compliance with the performance requirements of this specification. Finishes and protective coatings which will crack, chip or scale during normal service life or are affected by extremes of atmospheric or environmental conditions, shall not be used.

* **3.3.5 Fungus-proof materials.** Materials which are nutrients for fungi shall not be used where it is practicable to avoid them. Where used, they shall be treated with a fungicidal agent acceptable to the procuring activity.

* **3.3.6 Fumes and vapors.** Materials used in the construction of the indicator shall not produce corrosive, deleterious, or toxic fumes or vapors under the conditions specified herein.

* **3.4 Design and construction.** The indicator shall conform to MS28075. The indicator shall be so designed to operate from atmospheric pressure changes to give a visual indication of rates of ascent or descent from 0 to 6000 feet per minute (fpm). The indicator shall be constructed to withstand the normal shocks, vibrations and such other conditions as are incident to service without failure, shipping, storage, and installation.

MIL-I-18804B

* **3.4.1 Operating mechanism.** The operating mechanism shall be of the leak type and shall be sufficiently rugged to prevent small distortion of the case from affecting the accuracy of the indicator.

* **3.4.2 Zero-setting mechanism.** A Zero-setting system controlled by a slotted setting shaft or screw shall be located as shown on MS28075 and shall permit the instrument pointer to be set to indicate zero. The use of the zero-setting system shall not change the calibration of the indicator.

* **3.4.3 Stops.** Suitable stops shall be incorporated within the mechanism to limit pointer movement. The pointer shall rotate to the 6000 foot graduation plus $\frac{1}{16}$ inch on both ascent and descent scales.

* **3.4.4 Maintenance.** The design of the indicator shall be reasonably simple to facilitate as much as possible disassembly, repair or overhaul, service maintenance, and reassembly using those tools and items of maintenance equipment which are normally available as commercial standards.

* **3.4.5 Case.** The indicator case shall conform to MS28075. The case and mounting flange shall be made of non-ferrous, low density metal, uniform in texture, having a smooth surface. The case shall be finished with a lusterless black material, Color No. 37038 of FED-STD-595. The finishing material shall be of a durable type to withstand usage encountered in service.

* **3.4.6 Weight.** The indicator shall be so designed that when completely assembled the weight shall not exceed 1.5 pounds.

* **3.4.7 Screw threads.** Screw threads 0.060 inch in diameter or larger shall be in accordance with Specification MIL-S-7742.

* **3.5 Electrical requirements (integral lighted indicator)**

* **3.5.1 Internal wiring.** Internal wiring and the application thereof shall be in accordance with Specification MIL-E-5400.

* **3.5.2 Integral lighting.** The lighted indicators shall be provided with integral lighting in accordance with Specification MIL-L-25467.

* **3.5.3 Lamps.** The lamps for the lighted indicator shall be located within the indicator case. Lamps conforming to MS24367-680, -715 or MS24515-1 may be used in lieu of, or in addition to, the lamps specified in Specification MIL-L-25467. When using MS-24367-715 lamps a minimum of (3) three lamps shall be used.

* **3.5.4 Electric connectors.** The electric connectors used shall conform to Specification MIL-C-26482 and MS28075.

* **3.5.5 Wiring.** Pins A and C shall be used for lighting.

3.6 Dial and pointer

* **3.6.1 Dial.** The dial shall be securely mounted in such a manner that it will not loosen or slip when the indicator is vibrated. If screws are used they shall be so located that they will not interfere with the proper location of any dial marking.

* **3.6.2 Visibility of dial.** The pointer, numerals, at least $\frac{1}{3}$ of the shortest graduations and all other specified markings on the dial shall be visible from any point within the frustum of a cone whose side makes an angle of 30° with a perpendicular to the dial and whose small diameter is the aperture of the indicator case.

* **3.6.3 Dial marking.** The dial shall be marked as shown in Figure 1. Unless otherwise specified, all visible portions of the dial shall be lusterless black Color No. 37038 of FED-STD-595 and all markings on the dial shall be lusterless white Color No. 37875 of FED-STD-595. All markings shall be durable to withstand usage encountered in service. The form of the numerals and letters shall be in accordance with MS33558. Numerals shall distinctly indicate the graduation to which each applies. If practiceable, each numeral shall be placed so that the center of area of the numeral(s) is on the radial line joining the appropriate graduation and the center of the dial. Any confusion resulting in doubt as to the graduation to which the numeral applies shall be cause for rejection. When several numerals are used in one

group, the space between the numerals shall be not less than $\frac{1}{64}$ th inch.

* **3.6.4 Pointer.** The pointer of the indicator shall be as light weight as practicable, sufficiently rigid to prevent flexing under vibration and shall be firmly attached to the mechanism but also shall be readily adjustable to zero position. The shaded portion of the pointer shall be finished lusterless white, Color No. 37875 of FED-STD-595. The unshaded portion shall be finished lusterless black, Color No. 37038 of FED-STD-595. The pointer shall be suitable for integral lighting and shall conform to MS33585-1, except that the length of the pointer shall be such that the tip will overlap from $\frac{1}{8}$ to $\frac{3}{8}$ of the length of the shortest graduation.

* **3.7 Cover glass.** The quality of the cover glass shall be in accordance with Specification DD-G-451, Type II, Quality AA. Any flaws permitted by Specification DD-G-451 shall not interfere with reading of the dial. The dimensions of the cover glass shall be in accordance with MS28105.

* **3.7.1 Cover glass mounting.** The distance from the inner surface of the cover glass to the surface of the dial on which the marking is applied shall not exceed 0.188 inch.

* **3.8 Performance.** The indicator shall perform satisfactorily when subjected to the tests specified in Section 4 of this specification.

* **3.9 Identification of product**

* **3.9.1 Nameplate.** A nameplate shall be securely attached to the exterior of the case and shall be marked in accordance with the requirements of MIL-STD-130.

* **3.9.2 Manufacturer's part number.** The manufacturer's part number on the nameplate shall be identical with the manufacturer's engineering production drawing number including applicable dash numbers if drawing is tabulated and covers more than one part.

* **3.10 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 number shall be governed by the drawing number requirements of Specification MIL-D-70327.

* **3.11 Installation**

* **3.11.1 Installation instructions.** The contractor shall furnish with each indicator one copy of installation instructions with illustrations and diagrams if necessary. Prior to printing, two copies shall be furnished to the procuring activity for approval. The instructions shall be printed on paper either $8\frac{1}{2}$ by 11 or 11 by 17 inches.

* **3.11.2 Mounting hardware.** The contractor shall furnish mounting screws and self locking nuts conforming to Specification MIL-N-3336, in sufficient quantity to install the indicator. The screws shall be No. 6-32NC-2, round head brass machine screws having a durable, lusterless black, oxidized or nickel finish. The length shall be sufficient to mount the instrument on panels up to $\frac{3}{8}$ inch thick.

* **3.11.3 Envelope.** An envelope furnished by the contractor shall be packaged with each indicator and shall be marked as follows:

IMPORTANT

THIS ENVELOPE CONTAINS
INSTALLATION INSTRUCTIONS,
MOUNTING SCREWS AND NUTS.

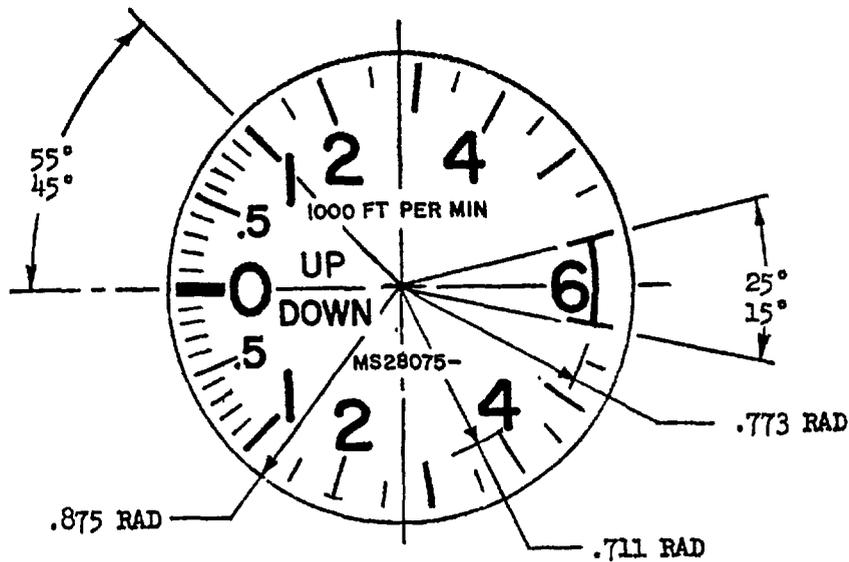
* **3.12 Workmanship.** The indicator, including all parts and accessories, shall be constructed and finished in a thoroughly workmanlike manner conforming to Specification MIL-E-5400.

* **3.12.1 Soldering.** Soldering shall be performed in accordance with Specification MIL-S-6872.

4. QUALITY ASSURANCE PROVISIONS

* **4.1** Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Ex-

MIL-I-18804B



NUMERALS SHALL DISTINCTLY INDICATE THE GRADUATION TO WHICH EACH APPLIES

MARKING	HEIGHT OR LENGTH ±.010	WIDTH OF LINE ±.002	FINISH
ZERO GRADUATION	----	.093	LUSTERLESS WHITE FED-STD-595 Color No. 37875
100-FT AND 500-FT GRADUATIONS	----	.030	
100-FT GRADUATIONS	----	.015	
ARC CONNECTING 6000-FT MARKS	----	.030	
NUMERALS .5	.125	----	
NUMERALS 0, 1, 2, 4, 6	.188	----	
LETTERING "UP", "DOWN"	.094	----	
LETTERING "1000 FT PER MIN"	.047	----	
BACKGROUND OF DIAL	----	----	LUSTERLESS BLACK FED-STD-595 Color No. 37038
MS28075- (add proper dash number)	.047	----	

FIGURE 1. Dial and Pointer Markings

cept as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 the indicator shall be classified as follows.

- * (a) *Qualification tests:* Qualification tests are those tests performed on sample indicators submitted for qualification as a satisfactory product.
- * (b) *Quality conformance tests:* Quality conformance tests are those tests

performed on indicators manufactured and submitted for acceptance under contract.

* **4.3 Qualification tests.** The qualification tests of the indicator shall consist of all of the tests of this specification specified under the paragraph headed Test methods.

* **4.3.1 Qualification test sample instructions.** Qualification test samples shall consist of three indicators manufactured in accordance with this specification. The indicators submitted for qualification testing shall not have been previously tested except for the Individual tests. The samples shall be forwarded to the testing laboratory designated in the Letter of Authorization.

* **4.3.1.1 Qualification test sample identification.** The test samples shall be plainly identified by securely attached, durable tags marked with the following information:

Sample for Qualification Testing
INDICATOR, VERTICAL SPEED,
0-6000 FPM, 2-INCH

Submitted by (Manufacturer's name,
date) for Qualification Testing in accordance with Specification MIL-I-18804B under authorization (reference letter authorizing tests).

MS28075 (Add proper dash number.)
Manufacturer's Part Number

* **4.4 Quality conformance tests.** The quality conformance tests shall consist of the Individual tests and the Sampling plan tests of this specification. The contractor shall furnish all samples and shall be responsible for accomplishing the required Individual, Sampling plan A, and Sampling plan B tests. The Sampling plan B tests shall be conducted at a Government Laboratory designated by the procuring activity. Quality conformance tests, except for Sampling plan B tests, shall be under the supervision of the Government Inspector. Acceptance or approval of material during the course of manufacture shall in no case be construed as a guarantee of the acceptance of the finished product.

* **4.4.1 Individual tests.** Each indicator submitted for acceptance under a contract shall

have passed the following individual tests, conducted in the order listed:

Examination of product
Zero-setting
Case leakage
Room temperature scale error
Position error
Integral lighting (lighted indicators only)

* **4.4.2 Sampling plan tests.** The Sampling plan tests shall consist of Sampling plan A and Sampling plan B tests. The test samples selected for sampling tests shall first have passed the Individual tests. The test samples which have been subjected to Sampling plan A tests shall not be delivered on contract until they have been refurbished, and resubjected and passed all the Individual tests. Test samples which have been subjected to the Sampling plan B tests shall not be delivered on contract.

* **4.4.2.1 Sampling plan A sample selection.** Sampling plan A samples shall be selected at random in accordance with the following schedule:

Quantity of Indicators Offered for Acceptance	Quantity to be Selected for Testing
First 15	1 (see**Note)
Next 50	1
Next 75	1
Next 100	1
Each additional 200 or fraction thereof	1

* **4.4.2.1.1** When a defect occurs, no items from those still on hand or later produced shall be accepted until the extent and cause of failure have been determined and appropriately corrected. In addition, when a failure occurs, shift to one sample out of the first fifteen (when sampling plan B is omitted) and proceed as indicated.

* **4.4.2.1.2 Sampling plan A tests.** Each indicator selected for Sampling plan A testing shall be subjected to the following tests, conducted in the order listed:

Pointer lag	Low temperature
Friction	zero error
High temperature	Temperature change
scale error	scale error

**NOTE: When Sampling plan B is invoked the quantity shall be zero. When Sampling plan B is to be omitted the quantity shall be one.

MIL-I-18804B

Low temperature
scale error
Temperature change
zero error
Overpressure

Lighting contrast
(lighted indicators
only)
Magnetic effect
Vibration resonance

Pressure —Normal atmospheric
(approximately 29.92
inches Hg.)

Humidity —Room ambient 40% to
90% relative humid-
ity

* 4.4.2.2 *Sampling plan B instructions.*

Two indicators shall be selected at random from the first 15 produced on contract and submitted within 10 days after manufacture. These samples shall be forwarded to a Government Laboratory designated by the procuring activity. Each sample shall be plainly identified by a securely attached, durable tag marked with the following information:

INDICATOR, VERTICAL SPEED,
0-6000 FPM, 2-INCH

Submitted by (Manufacturer's name,
date) for Production acceptance Sam-
pling plan B testing, in accordance
with Specification MIL-I-18804 under
Contract/Order No. _____.

Manufacturer's part number _____

* 4.4.2.2.1 *Sampling plan B tests.* Each indicator selected for Sampling plan B testing shall be subjected to the following tests, conducted in the order listed:

Sampling plan A
Vibration cycling
High temperature exposure
High altitude—low temperature
Acceleration
Temperature shock
Humidity
Fungus resistance
Salt spray
Sand and dust
Life test
Lamp life (lighted indicators only)
Mounting lugs
Internal examination

4.5 Test conditions

* 4.5.1 *Standard conditions.* Unless otherwise specified, all tests required by this specification shall be made under the following conditions:

Temperature —Room ambient 25° C
±5° C

* 4.5.2 *Test readings.* Unless otherwise specified, before a test reading is taken the indicator shall be tapped at 30 cps, 60 cps, or 120 cps with a maximum amplitude of 0.002 inch for a one second time period.

* 4.5.3 *Attitude.* Unless otherwise specified, the indicator shall be tested in its level position in which the upper mounting holes are on a horizontal line and the face is vertical.

* 4.5.4 *Integral lighting.* The lighted indicator lighting system shall be energized and shall operate satisfactorily during all tests except Humidity, Fungus resistance, Salt spray and as otherwise specified herein. The lighting shall operate satisfactorily after completion of each test unless otherwise specified herein.

4.6 Test methods

4.6.1 *Examination of product.* Each indicator shall be examined externally to determine conformance with the applicable drawings and with all the requirements of this specification not covered by tests.

* 4.6.2 *Zero-setting.* The adjusting screw shall be moved throughout its range in both up and down directions. The adjustable range of pointer movement shall be not less than 400 fpm up to not less than 400 fpm down.

* 4.6.3 *Case leakage.* The static pressure connection of the indicator shall be suitably connected to a mercury manometer and a vacuum source of 15 inches of mercury shall be applied at a rate not exceeding 20,000 fpm. With the source closed off, the difference between the mercury levels in the manometer during a period of 1 minute shall not exceed 0.05 inch of mercury. The same procedure shall then be repeated with a pressure source of 10 inches of mercury and the same values.

* **4.6.4 Room temperature scale error.** The indicator, with the pointer carefully set to zero, shall be placed in an altitude chamber. A mercury barometer shall be connected to the chamber. The pressure shall be reduced at a rate such that the pointer indicates 500 fpm. While the pointer indicates 500 fpm, the time required for the mercury barometer to change from a pressure corresponding to 2000 feet altitude to that of an altitude of 3000 feet shall be determined by a stop watch. The pressure shall then be increased at such a rate that the pointer will indicate a descent of 500 fpm and the time required for the barometer to change from 3000 feet altitude to 2000 feet altitude determined. This procedure shall be continued for the test rates and altitudes shown in Table I. The scale error shall not exceed the tolerance listed in Table I.

4.6.4.1 When testing several indicators in one chamber at the same time, one indicator may be selected to indicate the "test rate". This "test rate" shall be maintained at a constant value while the "test readings" of all indicators are observed and noted, and while the time and altitude interval on the barometer are noted. The "computed rate" shall be obtained. The scale errors shall be determined.

* **4.6.5 Position error.** The pointer shall be set to zero and atmospheric pressure applied. The indicator shall be held in the normal operating position, vibrated in accordance with 4.5.2 and a reading taken. This procedure shall be repeated at 45° increments as the indicator is rotated through 360° about each horizontal axis. The maximum deviation of the latter readings from the original reading shall not exceed 50 fpm.

* **4.6.6 Integral lighting.** Each indicator shall be subjected to and meet the requirements of the following tests specified in Specification MIL-L-25467:

- (1) Operation
- (2) Dial visibility
- (3) Dielectric strength

TABLE I. Scale error at room temperature

Standard Altitude interval ft.	Test rate ft. per min.	Tolerances scale error ft. per min.	
		Up	Down
2,000 to 3,000	500	100	100
2,000 to 3,000	1,000	200	200
2,000 to 4,000	2,000	300	300
2,000 to 5,000	3,000	300	300
2,000 to 6,000	4,000	300	300
2,000 to 7,000	5,000	300	300
16,000 to 18,000	2,000	300	300
16,000 to 20,000	4,000	400	400
28,000 to 30,000	2,000	300	300
26,000 to 30,000	4,000	400	400

* **4.6.7 Pointer lag.** The static pressure connection of the indicator shall be suitably connected to a water manometer and alternate sources of vacuum or pressure. A vacuum shall be carefully applied to cause the pointer to indicate a rate of ascent of approximately 2500 fpm. The vacuum shall then be instantaneously released by opening the static pressure to the atmosphere, causing the pointer to indicate a rate of descent greater than 2000 fpm. As the pointer moves back toward zero, a stop watch shall be started at the instant the pointer passes the 2000 fpm dive graduation and shall be stopped when the pointer passes the 200 fpm dive graduation. The elapsed time shall be recorded. This procedure shall be repeated, except that a pressure shall be carefully applied to the static pressure connection and the time determined for the indication to change from 2000 fpm climb to 200 fpm climb. The lag of the pointer shall be not less than 4 seconds nor more than 7 seconds for each procedure.

4.6.7.1 Friction. In conducting a repeat Pointer lag test, the following observations should be noted. In the time intervals at which the lag times were measured, the pointer shall move towards zero with reasonable smoothness. Note the positions at which the pointer stops. The pointer shall return to zero within 150 feet in both directions. No tapping vibration shall be applied for this repeated lag test.

MIL-I-18804B

* **4.6.8 High temperature scale error.** (This test may be combined with the High temperature exposure test at the discretion of the testing agency.) The indicator shall be subjected to an ambient temperature of $71^{\circ} \pm 2^{\circ} \text{C}$ for a period of 4 hours. At the end of the 4-hour period and with the temperature maintained at $71^{\circ} \pm 2^{\circ} \text{C}$ the indicator shall be subjected to and shall meet the requirements of the Room temperature scale error test except that the intervals and rates listed in Table II shall be used. The Case leakage test (vacuum only) shall also be repeated and may be performed coincident with the Scale error test.

* **4.6.9 Low temperature zero error.** Before starting this test, the pointer shall be carefully set to zero at room temperature. The indicator shall then be placed in test chamber, and cooled to approximately $-54^{\circ} \pm 2^{\circ} \text{C}$ and allowed to remain at the temperature for a period of not less than 4 hours. With the test chamber at atmospheric pressure, the low temperature zero error during the cooling period and during the 4-hour period at $-54^{\circ} \pm 2^{\circ} \text{C}$, shall not exceed 200 fpm.

* **4.6.10 Temperature change scale error.** At intervals of 1 hour during the cooling period and during the 4-hour period at $-54^{\circ} \pm 2^{\circ} \text{C}$, the indicated rates of the indicator corresponding to the test rates of 2000 fpm ascent and descent, in the standard altitude interval between 2000 and 4000 feet, shall be obtained. Their indicated rates, corrected for the corresponding zero errors shall not exceed the values listed in Table II.

* **4.6.11 Low temperature scale error.** After a temperature of $-54^{\circ} \pm 2^{\circ} \text{C}$ has been maintained within the chamber for 4 hours, the indicator while still at the low temperature shall be subjected to and meet the requirements of the Room temperature scale error test except that the intervals and rates listed in Table II shall be used. The indicated rates, corrected for the low temperature zero error test at the end of the 4-hour period at $-54^{\circ} \pm 2^{\circ} \text{C}$ shall not exceed the value listed in Table II. The Case leakage test (vacuum only) shall also be repeated and may be performed coincident with the Scale error test.

TABLE II. Scale errors during temperature tests

Standard Altitude interval ft.	Test rate ft. per min.	Tolerances scale error ft. per min.	
		Up	Down
2,000 to 4,000	2,000	300	300
2,000 to 6,000	4,000	400	400
16,000 to 18,000	2,000	300	300
16,000 to 20,000	4,000	400	400
28,000 to 30,000	2,000	300	300
26,000 to 30,000	4,000	400	400

* **4.6.12 Temperature change zero error.** After the Low temperature scale error test has been conducted, the indicator shall be allowed to return to room temperature at atmospheric pressure by removal from the temperature chamber. While the temperature of the indicator is increasing, the indication shall be observed for a period of $\frac{1}{2}$ hour at 1-minute intervals for the first 5 minutes and at 5-minute intervals thereafter. During the first 5-minute interval, the maximum reading shall not exceed 300 fpm; thereafter, the maximum reading shall not exceed 200 fpm.

* **4.6.13 Overpressure.** With the indicator in an altitude test chamber after the pointer has been carefully set to zero, the pressure shall be decreased at a rate of 120,000 fpm from sea level until a pressure corresponding to 50,000 feet of altitude is reached. The pressure shall then be increased at a rate of 120,000 fpm until sea level pressure is reached. The pressure rates above shall be established within two seconds after initial application. Within twenty seconds after sea level is reached the pointer shall return to within 100 feet of zero setting. The Room temperature scale error tests of paragraph 4.6.4 shall then be repeated.

* **4.6.14 Lighting contrast.** The indicator shall be subjected to and meet the requirements of the Contrast test specified in Specification MIL-L-25467.

* **4.6.15 Magnetic effect.** The indicator shall be properly connected and, for lighted indicators, lighting power applied. The indi-

cator shall be revolved about a short bar magnet compass with the nearest part of the indicator $5\frac{1}{2}$ inches from the bar magnet. The compass shall have its compensating magnets removed and shall be set up in a uniform magnetic field whose horizontal intensity is between 0.17 and 0.19 oersted. The indicator shall be revolved in a horizontal plane which is perpendicular to the axis of the bar magnet. The indicator shall be held in position 0, 45, 90, 135, 180, 225, 270 and 315 degrees. At each of these positions the indicator shall be rotated 360 degrees about its horizontal axis. The deflection of the compass at any of the specified positions shall not exceed one degree. For lighted indicators this test shall be repeated with no lighting power applied.

* 4.6.16 *Vibration resonance.* The indicator shall be tested in accordance with Procedure XIII of Specification MIL-E-5272. The pointer shall be set to zero. Maximum range of pointer oscillation during this test shall not exceed 100 fpm. Pointer vibration from the zero position shall not exceed 100 fpm.

* 4.6.17 *Vibration cycling.* The indicator shall be tested in accordance with Procedure XIII of Specification MIL-E-5272. The pointer shall be set to zero for this test. Following the 3-hour vibration period, the pointer reading shall be noted. The difference in reading at the beginning and at the end of the vibration period shall not exceed 100 fpm.

* 4.6.18 *High temperature exposure.* The indicator shall be tested in accordance with Procedure II of Specification MIL-E-5272 except that the exposure period at $+71^{\circ}\pm 2^{\circ}$ C shall be 24 hours. After the indicator has returned to room temperature, it shall be subjected to and meet the requirements specified in the Room temperature scale error test.

* 4.6.19 *High altitude—low temperature.* The indicator shall be placed in an altitude chamber maintained at a temperature of $-54^{\circ}\pm 2^{\circ}$ C and the pressure reduced to simulate an altitude condition of 50,000 feet (3.425 inches of mercury absolute pressure) for a period of 4 hours. The indicator shall

then be maintained at a temperature of $-54^{\circ}\pm 2^{\circ}$ C, normal atmospheric pressure, for an additional period of 44 hours. After returning to room temperature, the indicator shall be carefully examined for any evidence of damage. No damage to any part of the indicator shall result from this test.

4.6.20 *Acceleration.* The indicator shall be tested in accordance with Procedure III of Specification MIL-E-5272. After completion of the testing procedure, the indicator shall be subjected to and meet the requirements specified in the Individual tests.

* 4.6.21 *Temperature shock.* The indicator shall be tested in accordance with Procedure I of Specification MIL-E-5272 except that the exposure period at each high and each low temperature shall be 2 hours. After completion of the testing procedure, the indicator shall be subjected to and meet the requirements specified in the Individual tests.

* 4.6.22 *Humidity.* The indicator with the static connection down shall be tested in accordance with Procedure I of Specification MIL-E-5272. After completion of the testing procedure, the indicator shall be subjected to and meet the requirements specified in the Room temperature scale error test.

* 4.6.23 *Fungus resistance.* The indicator shall be tested in accordance with Procedure I of Specification MIL-E-5272 except that the exposure period shall be 14 days. After the testing procedure has been completed, any evidence of the growth of fungi found upon inspection shall be cause for rejection of the indicator or of any lot represented by the tested indicator.

* 4.6.24 *Salt spray.* The indicator with the static connection down shall be tested in accordance with Procedure I of Specification MIL-E-5272 except the exposure period shall be 48 hours. After the completion of the testing procedure, the indicator shall be subjected to and meet the requirements specified in the Individual tests.

* 4.6.25 *Sand and dust.* The indicator shall be tested in accordance with Procedure I of Specification MIL-E-5272. After the com-

MIL-I-18804B

pletion of the testing procedure, the indicator shall be subjected to and meet the requirements specified in the Individual tests.

* **4.6.26 Life test.** The indicator, in addition to meeting the performance requirements of this specification, shall have a high degree of trouble-free and adjustment-free operation during the service life. As an assurance that the life and reliability of the indicator shall have a mean-time-between-failure of at least 1000 hours, 3 production indicators shall be subjected to cyclic operation by providing rate inputs of 4000 fpm up followed by 4000 fpm down rate of climb at a rate of one complete cycle every 3 minutes or less in the following sequence for a total of 1000 hours:

Room ambient $25 \pm 2^\circ \text{C}$	40 hours
Room ambient with vibration at .018 to .020 inch double amplitude at 30cps	8 hours
Low temperature $-55 \pm 2^\circ \text{C}$	24 hours
High temperature $+70 \pm 2^\circ \text{C}$	24 hours

The reliability shall be considered satisfactory if no more than one failure occurs during the 1000 hours of operation on each of the 3 indicators. A failure shall be defined as the inability of the indicator to satisfactorily display the repeated rate inputs provided. The indicators shall have only the parts which fail replaced after each failure. If subsequent analysis reveals that several parts have deteriorated, each should be counted a failure, unless one part caused the other parts to fail. Tests shall then continue. Failures and subsequent corrective actions shall be noted in the Test Report.

* **4.6.27 Lamp life.** The indicator shall be subjected to the Life test specified in Specification MIL-L-25467.

* **4.6.28 Mounting lugs.** The case of the indicator shall be mounted face downward on the moveable head of a suitable testing machine with the face of the case in a horizontal plane so 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 for one minute to

each lug in a direction toward the front of the case. The lugs shall withstand the applied load without fracture and there shall be no damage to any part of the indicator.

* **4.6.29 Internal examination.** The case of the indicator shall be opened and the mechanism of the indicator shall be examined. The lamp circuit of the lighted indicator also shall be checked as specified in Specification MIL-L-25467. Any deterioration or damage which could in any manner prevent the indicator from meeting functional operation or maintenance requirements during service life shall be cause for rejection.

5. PREPARATION FOR DELIVERY

* **5.1 Packaging.** The indicator shall be packaged in accordance with Specification MIL-P-7936, level A or level C, as specified in contract or order (see 6.2).

* **5.1.1 Level A.** Indicators shall be individually packaged in accordance with method 1A-5 of Specification MIL-P-116, without preservative compound, using metal reusable containers.

* **5.1.2 Level C.** Indicators shall be packaged to prevent deterioration or damage during shipment from the supply source to the first receiving activity.

* **5.2 Packing.** The indicator shall be packed in accordance with Specification MIL-P-7936, level A, level B, or level C, as specified in contract or order (see 6.2).

* **5.2.1 Level A.** Indicators packaged in accordance with 5.1 shall be packed in close fitting wood-cleated plywood boxes conforming to overseas type of Specification PPP-B-601; in nailed wood boxes conforming to class 2, overseas type of Specification PPP-B-621; or in fiberboard boxes conforming to class 2 of Specification PPP-B-636. Items shall be cushioned as necessary to prevent movement within shipping containers. Containers shall be closed and strapped in accordance with the applicable container specification or appendix thereto. Gross weight of the pack shall not exceed approximately 200 pounds, except

that when fiberboard boxes are used, the weight limitation of the container specification shall apply.

* 5.2.2 *Level B.* Unless otherwise specified, indicators shall be packed as for level A (see 5.2.1), except that containers shall be of domestic type or class as applicable.

** 5.2.3 *Level C.* Indicators shall be packed to insure carrier acceptance and safe delivery to destination at lowest rates, in compliance with the Consolidated Freight Classification Ratings, Rules, and Regulations and National Motor Freight Classification Rules and Container Regulations as applicable, or with other carrier regulations applicable to the mode of transportation.

* 5.3 *Marking.* Interior and exterior containers shall be marked in accordance with MIL-P-7936.

* 5.3.1 *Precautionary marking.* The following precautionary markings shall appear on two opposite sides of each interior package and shipping container wherever practicable:

FRAGILE
DELICATE INSTRUMENT(S)
HANDLE WITH CARE.

6. NOTES

* 6.1 *Intended use.* The indicator covered by this specification is intended for use on high performance aircraft to indicate the vertical component of the aircraft's speed based on rates of change of atmospheric pressure.

* 6.2 *Ordering data.* Procurement documents should specify the following:

- (a) Title, Number and Date of this specification.
- (b) The quantity and MS part number of the instrument desired.
- (c) If mounting screws and nuts shall be furnished with each indicator.
- (d) Levels of packaging (see 5.1) and packing (see 5.2) desired.
- (e) Whether Sampling plan B is to be omitted.

(f) *Manufacturer's qualified part number.*

* 6.3 *Drawing requirements.* The attention of contractors is invited to the fact that Government contracts for equipment, whether procured directly by the Government or through another contractor, require that all drawings submitted must be in accordance with the requirements of Specification MIL-D-70327.

* 6.4 Definitions

- (a) *Test reading:* The indication of the instrument during the test.
- (b) *Test rate:* The rate specified in column 2 of Table I and column 2 of Table II at which the instrument is to best tested.
- (c) *Computed rate:* The computed rate is the rate computed by dividing the altitude interval (2,000 feet as measured by a manometer) by the time in seconds (required for the change in altitude) and multiplying by 60.

$$\text{Computed rate} = \frac{\text{Altitude interval} \times 60}{\text{Time in seconds}}$$

* 6.4.1 *Amplitude.* Whenever the word amplitude is specified, it shall mean the extent of motion as measured from one extreme to the opposite extreme.

* 6.5 *Qualification.* With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for the 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 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 Bureau of Naval Weapons; Department of the Navy, Washington 25, D. C., and information pertaining

MIL-I-18804B

to qualification of products may be obtained from that activity.

6.6 International agreements. Certain provisions of 3.4, 3.4.5, 3.6, and figure 1 of this specification are the subject of international standardization agreements ABC 10/8 and STANAG 3320. When amendment, revision, or cancellation of this specification is proposed, the department custodians will inform their respective Departmental Standardization Offices so that appropriate action may be taken respecting the international agreement concerned.

Custodians:

Army—MO
Navy—Wep
Air Force—ASD

Review Interest:

Navy—Wep
Army—MO

* 6.7 The left margins of this specification have been marked with an asterisk (*) to indicate where changes (deletion, additions, etc.) have been made from the previous issue. This has been done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written irrespective of the marginal notations and relationship to the last previous issue.

Preparing activity:
Navy—Wep

**Notice.* Review/user information is current as of date of this document. For future coordination of changes to this document, draft circulation should be based on the information in the current DODISS.

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
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.		
SPECIFICATION		
ORGANIZATION		CITY AND STATE
CONTRACT NO	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> 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? <input type="checkbox"/> YES <input type="checkbox"/> 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)		DATE

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