

MIL-I-5482C (Wep)
 1 FEBRUARY 1960
 SUPERSEDING
 MIL-I-5482B (AER)
 1 OCTOBER 1958

MILITARY SPECIFICATION
 INDICATORS, PRESSURE, SYNCHRO, AIRCRAFT,
 165 - DEGREE SCALE

This specification has been approved by the
 Bureau of Naval Weapons, Department of the Navy.

1. SCOPE

1.1 Scope. - This specification covers fifteen 2-inch, hermetically sealed, clamp mounted, single and dual 165-degree scale, synchro type, aircraft pressure indicators.

1.2 Classification. - Indicators shall be of the following MS designations with the dial combination and with or without integral lighting as shown for the applicable MS part number specified (see 6.2).

	Without integral lighting	With integral lighting	Single or Dual	Dial Scale(s)		Indicators Without Integral Lighting Supersedes Type No.
				Left	Right	
MS 25470 ↑ ↓ MS 25470	-1		Single*	0-5		5S
	-3		Single*	0-10		10S
	-5		Single*	0-20		20S
	-7	-2	Dual	0-5	0-5	5-5D
	-9	-4	Dual	0-10	0-5	10-5D
	-11	-6	Dual	0-10	0-10	10-10D
	-13	-8	Dual	0-10	0-20	10-20D
	-15	-10	Dual	0-20	0-5	20-5D
	-17	-12	Dual	0-20	0-20	20-20D

These non-integrally lit indicators supersede the respective type numbers listed above. For these indicators to replace the respective type numbers which they supersede, an attachable mounting flange shall be supplied with the indicator in accordance with Standard MS28055.

*The single indicators are to be procured for use as replacements only, and are not to be called out for new aircraft design.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications, of the issue in effect on date of invitation for bids, form a part of this specification:

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)

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Military

- MIL-P-116 - Preservation, Method of
- MIL-E-5272 - Environmental Testing, Aeronautical and Associated Equipment, General Specification for
- MIL-T-5350 - Transmitters, Synchro, Aircraft, General Specification for
- MIL-E-5400 - Electronic Equipment, Aircraft, General Specification for
- MIL-T-5483 - Transmitters, Pressure, Synchro, Aircraft, 165 - Degree Movement
- MIL-C-5541 - Chemical Films for Aluminum and Aluminum Alloys
- MIL-I-6181 - Interference Limits, Tests and Design Requirements, Aircraft Electrical and Electronic Equipment
- MIL-S-6872 - Soldering Process, General Specification for
- MIL-L-6880 - Lubrication of Aircraft, General Specification for
- MIL-S-7742 - Screw Threads, Standard, Aeronautical
- MIL-P-7936 - Parts and Equipment, Aeronautical, Preparation for Delivery
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys
- MIL-S-20708 - Synchros, 60 and 400 Cycle, General Specification
- MIL-L-25467 - Lighting, Integral, Instrument, General Specification for
- MIL-C-26482 - Connectors, Electric, Circular, Miniature, Quick Disconnect
- MIL-D-70327 - Drawings, Engineering and Associated Lists

STANDARDS

Federal

- FED. STD. No. 1 - Standard for Laboratory Atmospheric Conditions for Testing
- FED. STD. No. 595 - Colors

Military

- MIL-STD-130 - Identification Marking of U. S. Military Property
- MS3112 - Connectors, Receptacle, Electric, Box Mounting, Miniature
- MS25470 - Indicators, Pressure, Synchro, Aircraft, 165 - Degree Scale
- MS33558 - Numerals and Letters, Aircraft Instrument Dial, Standard Form of
- MS33585 - Pointers, Dial, Standard Design of Aircraft Instrument
- MS33586 - Metals, Definition of Dissimilar
- MS33639 - Case, Instrument, Clamp Mounted, Aircraft
- MS33678 - Connector, Receptacle, Electric, Integral Mounting
- MS28055 - Bezel, Mounting, 2-Inch Size Instrument

PUBLICATION

Air Force-Navy Aeronautical Specification Bulletin

- No. 143 - Specifications and Standards, Use of

(When requesting any of the applicable documents refer to both title and number. Copies of this specification and applicable documents may be obtained upon application to the Commanding Officer, Naval Aviation Supply Depot, 5801 Tabor Avenue, Philadelphia 20, Pennsylvania, Attention Code CDS.)

3. REQUIREMENTS

3.1 Qualification. - The indicators furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the qualified products list.

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3.2 Selection of government documents. - Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with ANA Bulletin No. 143 except as provided in 3.2.1 and 3.2.2.

3.2.1 Commercial parts. - Commercial parts having suitable properties may be used where, on the date of invitation for bids, there are no suitable standard parts. In any case, commercial utility parts, like screws, bolts, nuts, cotter pins, having suitable properties, may 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 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 instrument may be subject when in storage or during normal service life.

3.3.2.1 Dissimilar metals. - Unless suitably protected against electrolytic corrosion, dissimilar metals as defined in Standard MS 33586 shall not be used in intimate contact with each other.

3.3.3 Nonmagnetic materials - Nonmagnetic materials shall be used for all parts of the instrument except where magnetic materials are essential.

3.3.4 Fungus-proof materials. - Materials which are nutrients for fungi shall not be used where it is practicable to avoid them. Where used and not hermetically sealed they shall be treated with a fungicidal agent acceptable to the procuring activity. If used in the hermetically sealed case, fungicidal treatment will not be necessary.

3.3.5 Corrosive fumes. - The materials used shall not liberate deleterious fumes.

3.4 Design and construction. - The indicators shall be designed so that either one or two indicators can be operated by one or two transmitters conforming to Specification MIL-T-5483, as applicable for single and dual indicators respectively. The single indicator shall incorporate one self-synchronous motor geared or otherwise connected to a pointer. The dual indicator shall incorporate two self-synchronous motors geared or otherwise connected to two concentric pointers and no supporting bridge over the dial shall be employed to support the pointer shaft. The instrument shall be constructed to withstand the normal strains, jars, vibrations, and such other conditions as are incident to shipping, storage, installation and service. Pivots, bearings, and gears shall neither bind nor shake and shall be as near frictionless as practicable.

3.4.1 Maintenance. - The design shall be such as to facilitate as much as possible disassembly, repair or overhaul, service maintenance, and reassembly by those tools and items of maintenance equipment which are normally available as commercial standards.

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3.4.2 Electrical circuit. - The electrical circuit of each single indicator shall conform to Figure 1. Signal rotation A.D.C. at the pins of the electrical receptacle shall produce an increasing pressure indication. The electrical circuit of each dual indicator shall conform to Figure 2. Signal rotations A.D.C. and A.G.F. at the pins of the electrical receptacle of the indicator shall produce increasing pressure indications.

3.4.3 Performance. - The indicator shall perform satisfactorily when subjected to the tests specified in Section 4.

3.4.4 Case. - The outline dimensions of the case shall conform to Standard MS33639 for the 2-inch size. The dimension indicated as "L" on MS 33639 shall not exceed 3 inches for each single indicator and shall not exceed 5 inches for each dual indicator. The body of the case shall be made of lightweight nonmagnetic metal, uniform in texture, and shall have a smooth surface. The case shall be finished with a durable, lusterless, black finish, Color No. 37038 of Standard FED STD No. 595.

3.4.4.1 Hermetic sealing. - The case shall provide a hermetically sealed enclosure for all of the mechanism. The case shall be so constructed that it may be opened, the mechanism removed and replaced and the case reclosed and resealed, at least three times. This shall be possible without the use of any special tool, jig or fixture, unless such device is specifically approved by the procuring activity. The sealing of the case shall not be dependent upon any material which will be adversely affected by any atmosphere to which the indicator may be subjected in normal use in military aircraft.

3.4.4.2 Filling medium. - The case shall be filled to an absolute pressure of 1 ± 0.1 atmosphere with an inert gas or a mixture of inert gasses. If the leakage test of 4.6.7 is to be performed with a mass spectrometer, the mixture shall contain at least eight percent helium. The gas or mixture of gasses shall be free of dust particles and shall contain not more than 0.006 milligram of water vapor per liter (dew point -65°C) at the filling pressure.

3.4.5 Window glass. - The quality of the window glass shall be in accordance with Specification DD-G-451, Type II, Quality AA.

3.5 Electronic parts. - Electronic parts and the application thereof shall be in accordance with Specification MIL-E-5400. Parts that do not appear on approved lists in accordance with Specification MIL-E-5400 shall not be used unless approved by the procuring activity.

3.5.1 Wiring. - The internal wiring shall be neat and accomplished in such a manner that individual wires may be easily traced. Wires shall be tied to the terminals prior to soldering, where practicable. The wiring shall be insulated from the indicator case.

3.5.1.1 - Indicators without integral lighting. - Each single indicator shall be color coded and connected as shown in Figure 1. Each non-integrally lit, dual indicator shall be color coded and connected as shown in Figure 2.

3.5.1.2 - Indicators with integral lighting (see 3.9). - Each integrally lit, dual indicator shall be color coded and connected as shown in Figure 2 with the exception that two additional pins "H" and "I" shall be required for the receptacle (see 3.5.4.2). The integral lighting lamps shall be connected between the pins "H" and "I". There shall not be any connection within the indicator between the integral lighting lamps and any other part of the electrical circuit of the indicator.

3.5.2 Power supply. - The indicators shall be designed to operate from a 26 volt, 400 cycle, single phase, ac. source.

3.5.3 Indicator synchro. - The indicator synchro shall consist of a salient two-pole wound rotor (primary) designed for operation on 26 volts, 400 cycles and a three winding, Y-connected stator (secondary). The stator shall be wound so that the amplitudes of the induced voltage in the three stator windings vary sinusoidally with the angular position of the rotor.

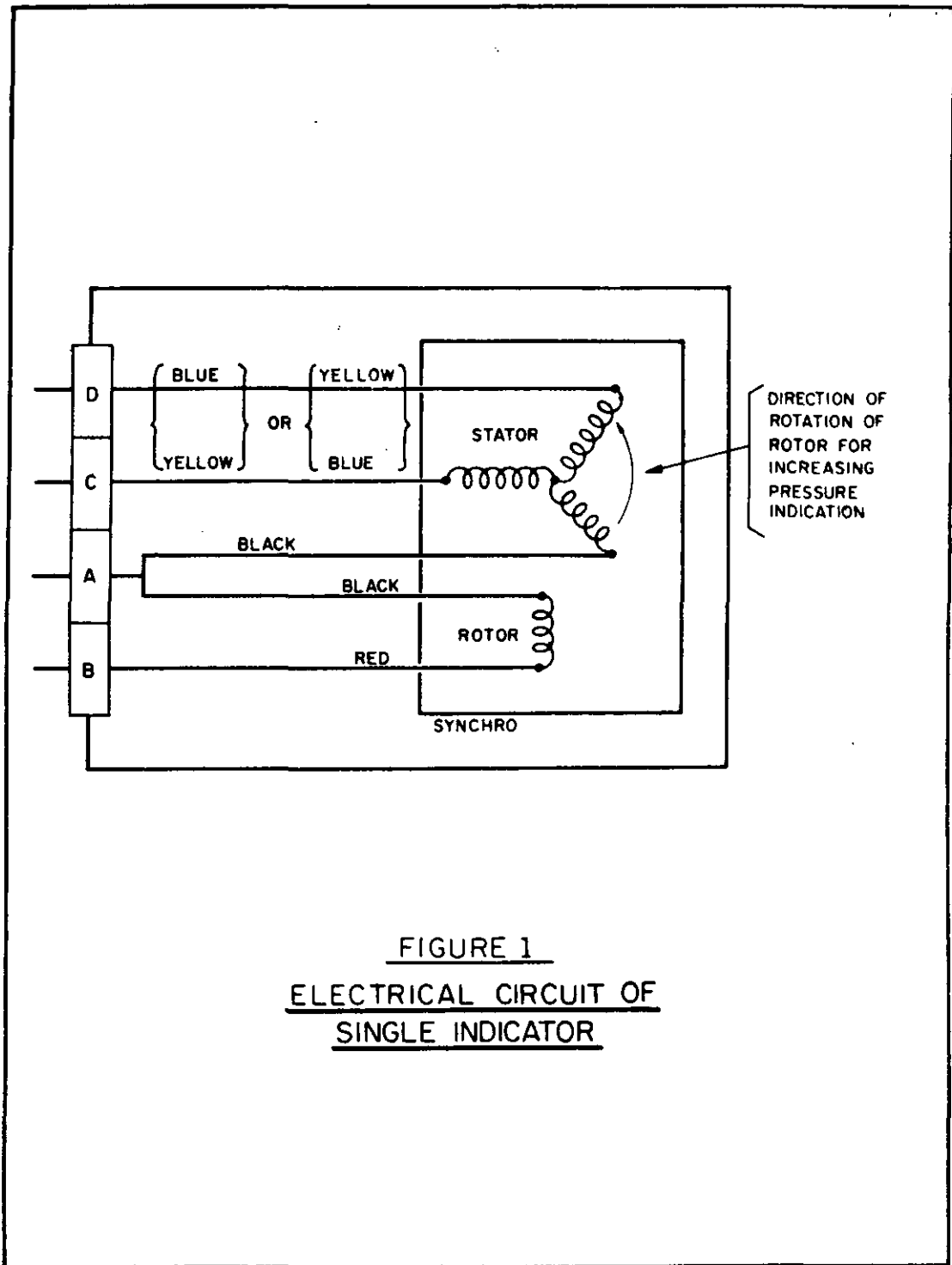


FIGURE 1
ELECTRICAL CIRCUIT OF
SINGLE INDICATOR

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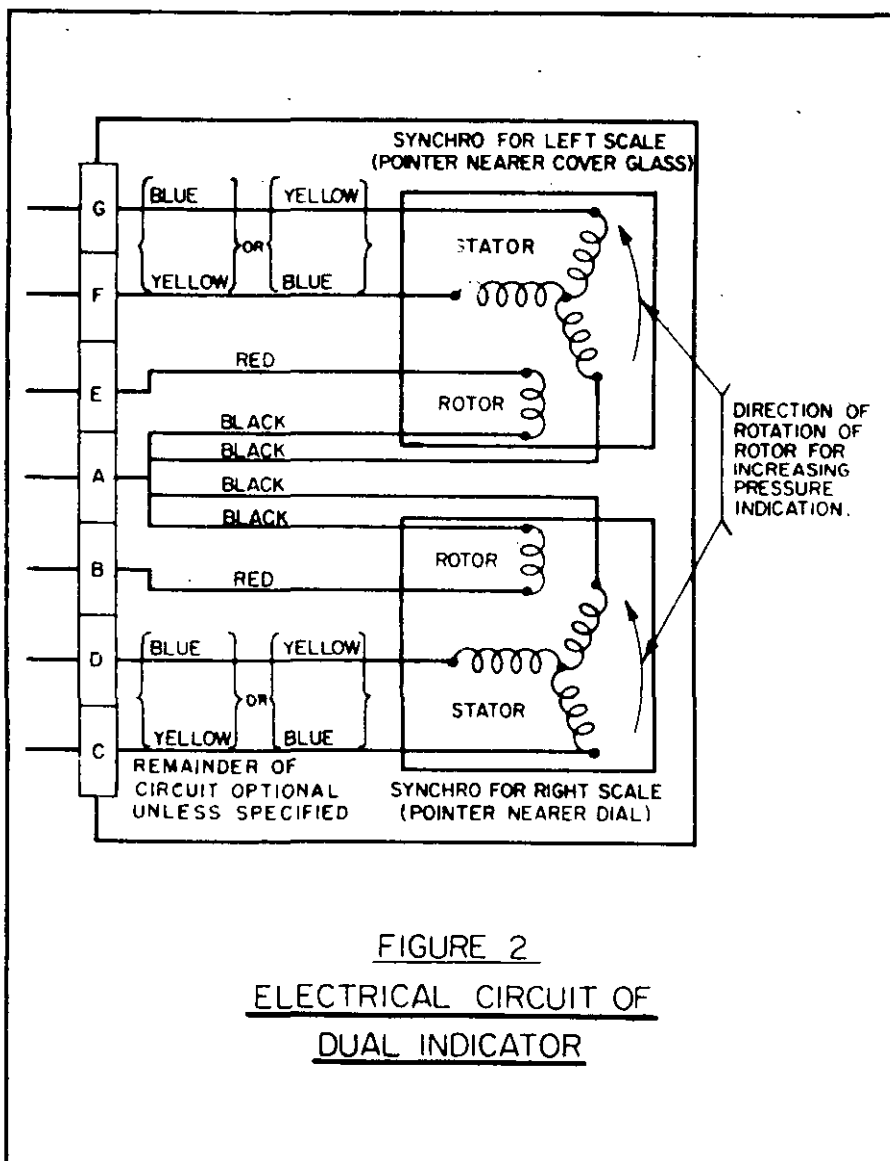


FIGURE 2
ELECTRICAL CIRCUIT OF
DUAL INDICATOR

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3.5.3.1 Electrical characteristics. - The indicator synchro shall be designed for the following electrical characteristics with normal excitation of 26 volts, 400 cycles applied to the primary (rotor).

3.5.3.1.1 Primary currents. - The current drawn by one indicator synchro shall not exceed 120 milliamperes, with secondaries (stator) open-circuited.

3.5.3.1.2 Power input. - The power consumption of each indicator synchro shall not exceed 0.60 watt.

3.5.3.1.3 Secondary voltage. - The maximum open circuit voltage measured between any two secondary leads shall be 11.8 ± 0.3 volts. The variation between the three maximum secondary voltages on any one indicator synchro shall not exceed 0.2 volt.

3.5.4 Electrical receptacle. - The electrical receptacle shall be mounted on the rear surface of the case with the axis of the receptacle within 1/16 inch of the axis of the case. The largest polarizing keyway of the electrical receptacle shall be at the top center of the shell of the electrical receptacle.

3.5.4.1 Without integral lighting. - The electrical receptacle for each single indicator shall conform to Specification MIL-C-26482 and to Standard MS3112H8-4P. The electrical receptacle for each non-integrally lit, dual indicator shall conform to Specification MIL-C-26482 and to Standard MS3112H16-8P.

3.5.4.2 With integral lighting. - The electrical receptacle for each integrally lit, dual indicator shall conform to Specification MIL-C-26482 and to Standard MS3112H12-10P.

3.6 Dial. - The dial of each indicator shall conform to Figure 3, and to Figure 4 as listed in 1.2 for the applicable MS part number. The diameter of the scale circle of each indicator shall be at least equal to the minimum diameter of the aperture of the case of the indicator required by the standard for the case minus 1/8 inch and shall not be greater than the diameter of the aperture. The background of each dial shall be finished with lusterless black paint. All marking on each dial shall be applied with lusterless white paint. Marking the scale arc on the dial is optional. All numerals and letters shall conform to Standard MS33558. The dimensions of the markings on the dial of each indicator, in inches, shall be as listed in Table I.

TABLE I

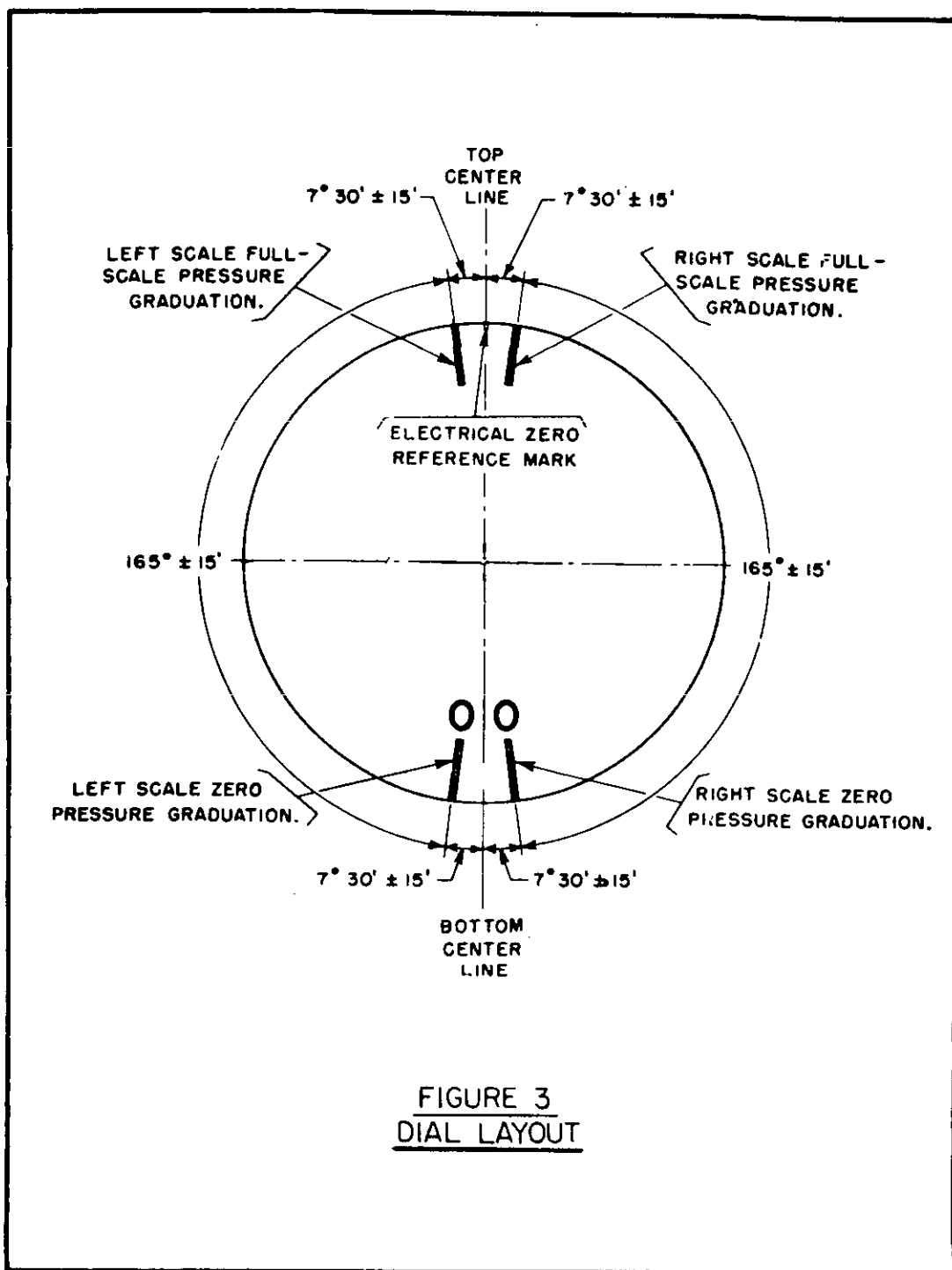
DIAL MARKING

Marking	Length or Height ± 0.010	Width of Graduation or Line ± 0.005
Scale Arc	---	0.010
Major Graduations	0.250	0.030
Minor Graduations	0.188	0.015
Numerals	0.125	0.015
"PRESS"	0.093	0.015
"LBS. SQ. IN."	0.075	0.015

3.6.1 Electrical zero mark. - An electrical zero mark shall be located at the top center of the dial in accordance with Figure 3 and shall be visible through the window glass. The electrical zero mark shall be finished in lusterless white paint and shall be approximately 1/32 inch long and 0.010 inch wide.

3.6.2 Depth of dial. - The distance from the extreme front surface of the case to the surface of the dial on which the marking is applied shall not exceed 0.250 inch for each single indicator. The distance from the extreme front surface of the case to the surface of the dial on which the marking is applied shall not exceed 0.325 inch for each dual indicator.

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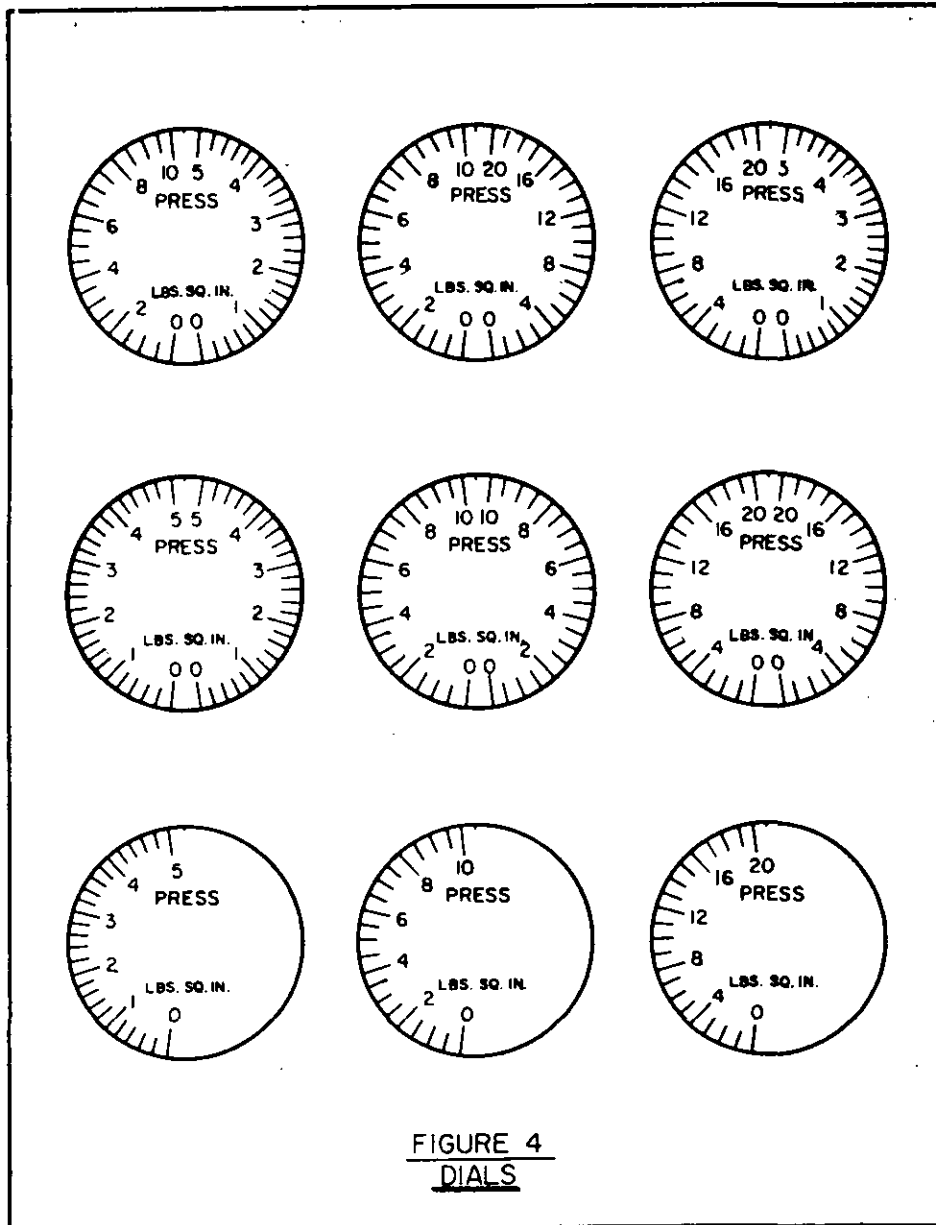


FIGURE 4
DIALS

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3.7 Pointers. - The pointer shall conform to Standard MS 33585-1 except that the pointer shall overlap each major graduation but shall not overlap any minor graduation. The nearer pointer to the cover glass of the dual indicator shall indicate on the left scale, and the nearest pointer to the dial shall indicate on the right scale. Portions of each pointer which are shown as shaded on Standard MS 33585 shall be finished with lusterless white paint. Portions of each pointer which are shown as unshaded on Standard MS 33585 shall be finished with lusterless black paint.

3.8 Visibility of pointer and dial. - The pointers, numerals, letters, at least 1/16 inch of the shortest graduation and all other specified markings on the dial with the exception of the electrical zero mark (see 3.6.1) shall be visible from any point within the frustum of a cone whose sides make an angle of 30 degrees with a perpendicular to the dial and whose small diameter is the aperture of the case.

3.9 Illumination of dial and pointers - The indicators which require integral lighting (see 1.2) shall be integrally lighted in accordance with the requirements of Specification MIL-L-25467.

3.10 Physical requirements. -

3.10.1 Weight. - The weight of each single indicator shall not exceed 0.6 pound. The weight of each dual indicator shall not exceed 0.8 pound.

3.10.2 Finish. - 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.

3.10.2.1 Aluminum Alloy Parts. - Where practicable, aluminum alloy parts shall be covered with an anodic film conforming to Specification MIL-A-8625 except that the dial, if of aluminum alloy, small holes, pipe threads and case inserts need not be anodized. Aluminum alloys which do not anodize satisfactorily shall be coated with chemical film in accordance with Specification MIL-C-5541.

3.10.2.2 Iron and Steel Parts. - Where practicable, iron and steel parts shall be cadmium, chromium or nickel plated in accordance with Specifications QQ-P-416, QQ-C-320, and QQ-N-290, respectively. Parts in a confined space in the presence of organic material shall be tin cadmium coated.

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

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

3.10.4 Lubrication. - Lubrication shall be accomplished in accordance with Specification MIL-L-6880, except that the selection of the lubricant used shall be approved by the procuring activity.

3.10.5 Color. - Lusterless black paint shall conform to Standard FED-STD-595 for color number 37038. Lusterless white paint shall conform to FED-STD-595 for color number 37875.

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

3.10.7 Cleaning. - The instrument shall be thoroughly cleaned of loose, spattered or excess solder, resin flash that may crumble, metal chips and other foreign matter.

3.11 Identification of product. - A nameplate shall be securely attached to the exterior of the case and shall be legibly and durably marked in accordance with Standard MIL-STD-130.

3.11.1 Manufacturer's part number. - The manufacturer's part number, marked in the space provided on the nameplate, shall be identical with the manufacturer's engineering production drawing number, including applicable dash numbers if the drawing is tabulated and covers more than one part.

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3.11.2 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.

3.11.3 Use of military designations. - Military designations shall not be applied to a product, except for Qualification Test Samples, nor referred to in correspondence or sales matter, until notification has been received from the activity responsible for qualification.

3.12 Installation instructions. - The contractor shall furnish with each indicator, one copy of the installation instructions, with illustrations and diagrams. The instructions shall be printed on 8-1/2 by 11 or 11 by 17 inch paper and inserted in an envelope marked:

IMPORTANT
THIS ENVELOPE
CONTAINS INSTRUCTIONS

3.13 - Workmanship. - The instrument, including all parts and accessories, shall be constructed and finished to produce an instrument free from all defects which would affect proper functioning in service. Particular attention shall be given to neatness and thoroughness of soldering, wiring, impregnation of coils, marking of parts and assemblies, welding and brazing, painting, riveting, machine-screw assemblies, and freedom of parts from burrs and sharp edges.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of tests. - The inspection and testing of the indicators shall be classified as follows:

a. Qualification tests are those tests performed on samples submitted for qualification as a satisfactory product.

b. Acceptance tests are those performed on indicators manufactured and submitted for acceptance under contract.

4.2 Qualification tests. - The qualification tests shall consist of all the tests of this specification, conducted in the following sequence:

Individual tests	Temperature shock
Sampling tests	Vibration failure
Magnetic effect	Salt spray
Effect of lead length	Radio noise interference
Torque	Endurance
Low temperature exposure	
High temperature exposure	

4.2.1 Qualification test samples. - Qualification test samples shall consist of three indicators of each manufacturer's part number which have not been previously tested, upon which qualification is desired. After obtaining authorization for submittal, the samples shall be forwarded to the testing laboratory designated in the letter of authorization. (see 6.4). The manufacturer shall submit certified tests results showing conformance with all the requirements of this specification. The test samples shall be plainly identified by securely attached durable tags marked with the following information:

Samples for qualification test
Submitted by (name, date) for qualification testing
in accordance with (reference letter authorizing tests)
MIL
MS
Indicator, Pressure, Synchro, Aircraft, 165-degree
Scale
Manufacturer's part number

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4.3 Acceptance tests. - The acceptance test of the indicators shall consist of the individual tests and the sampling tests of this specification. The contractor shall furnish all samples and shall be responsible for accomplishing the required tests. When inspection is conducted at the contractor's plant, all inspection and testing shall be under the supervision of the Government Inspector. Contractors not having laboratory facilities satisfactory to the Inspector shall engage the services of a commercial testing laboratory acceptable to the procuring agency. The contractor shall furnish test reports, in duplicate, showing quantitative results of all tests required by this specification, and signed by an authorized representative of the contractor or laboratory as applicable. 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.

4.3.1 Individual test. - The individual tests shall consist of the test listed below conducted on each indicator:

Inspection	Attitude shift
Dielectric strength	Illumination (where applicable)
Electrical zero	Leakage
Scale error and friction	

4.3.2 Sampling tests. - The sampling tests of the indicators shall consist of the following tests conducted on each sampling test sample:

Low temperature operation
High temperature operation
Vibration error

4.3.2.1 Sampling test instructions. - Samples shall consist of three indicators selected at random by the inspector from each lot of 100 or less which have passed the individual tests. A lot shall consist of identical indicators with the same manufacturer's part number, manufactured under substantially the same conditions and submitted at substantially the same time. Indicators which have been subjected to the sampling tests shall not be delivered on contract until they have been rebuilt and submitted to all individual tests.

4.4 Rejection and retest. - When any indicator fails to meet the requirements of the sampling tests, the lot represented shall be rejected and returned at the contractor's expense. Any indicator failing to meet the requirements of the individual tests shall be rejected and returned at the contractor's expense. Indicators which have been rejected may be replaced or repaired to correct the defects and resubmitted for all specified tests. Before resubmissions, 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 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 in accordance with the requirements of Federal Standard No. 1.

4.5.2 Tapping. - Except where otherwise specified, the indicators shall be vibrated before a test reading is taken. An electrical vibrator set at 3600 cps with a maximum amplitude of 0.002 inch when attached to the test item, shall be used.

4.5.3 Vibration stand. - Whenever a vibration stand is specified, it shall be a device which will vibrate at any desired frequency between 5 and 50 cycles per second and shall subject the indicators to such vibration that a point on the vibration stand shall describe, in a plane inclined 45 degrees to the horizontal plane, a circle of the diameter specified herein.

4.5.4 Level position. - Unless otherwise specified, the indicator shall be tested in their normal operating position with the dial vertical.

4.5.5 Test power. - Unless otherwise specified, the supply power shall be 26 volts, 400 cycle, single phase ac. The voltage and frequency tolerance of the ac supply shall be ± 2 percent.

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4.5.6 Electrical zero. - Whenever it is specified that electrical zero (synchro zero) be imposed upon an indicator synchro, it shall be accomplished by the method specified in Specification MIL-S-20708.

4.5.7 Test standards. - The indicators shall be tested with a transmitting standard, designed especially for the purpose. Sufficient tests shall be performed to determine that the transmitted signals provide a torque on the indicator of 2200 ± 10 percent milligram millimeters per degree, and with a maximum transmitted error not over 0.20 circular degree.

4.5.8 Test tolerances. - The test tolerances shall be as specified in Table II for each scale.

TABLE II

TOLERANCES IN PSI FOR VARIOUS TEST CONDITIONS

Range, PSI	0-5	10	20
Scale Error			
Room temperature	0.05	0.1	0.2
High temperature	0.05	0.1	0.2
Low temperature	0.10	0.2	0.4
High temperature exposure	0.10	0.2	0.4
Low temperature exposure	0.10	0.2	0.4
Friction			
Room temperature	0.05	0.1	0.2
High temperature	0.05	0.1	0.2
Low temperature	0.10	0.2	0.4
High temperature exposure	0.10	0.2	0.4
Low temperature exposure	0.10	0.2	0.4
Attitude Shift at 1/2 Scale	0.05	0.1	0.2
Vibration Pointer Oscillation	0.05	0.1	0.2

4.6 Test methods. - Where applicable, tests shall be performed on each indicator mechanism.

4.6.1 Inspection. - 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 Dielectric strength. - A potential of 200 volts (root mean square) alternating current at commercial frequency shall be applied between isolated pins, and between pins and the case for a period of 5 seconds. There shall be no breakdown of insulation or any other permanent damage to the instrument as a result of this test.

4.6.3 Electrical zero. - For the purpose of this test, a single indicator with the glass removed shall be connected to the indicator being tested and used as the transmitter unit. The standard transmitter shall not be used. With the power source disconnected, the pointer of the single indicator shall be displaced 180 degrees from the pointer position of the indicator being tested. The pointer of the single indicator shall be held in this position and power shall be applied. This procedure shall be repeated a minimum of three times, after which electrical zero shall be imposed on the indicator being tested. The tip of the pointer shall be within 0.010 inch of the electrical zero reference mark, and for dual indicators shall be within 0.010 inch of each other.

4.6.4 Scale Error and friction. - The knob of a standard transmitter shall be rotated to bring its pointer to the desired indication. Two readings shall be taken; the first before, and the second after, the indicator is tapped. The difference between the first and second readings shall not exceed the friction tolerance specified in Table II at room temperature. The second reading shall not exceed the scale error tolerance specified in Table II at room temperature.

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4.6.5 Attitude shift. - The standard transmitter shall be set at midscale and locked. The reading of the indicator taken while the indicator is in a normal up-right position shall not differ from the reading while the indicator is held in any other position, by more than the amount specified in Table II.

4.6.6 Illumination. - The indicators which require integral lighting (see 1.2) shall be tested in accordance with Specification MIL-L-25467.

4.6.7 Leakage. - Each indicator shall be tested for case leakage with a mass spectrometer or an equivalent, at least equally sensitive, quantitative leak test. The rate of leakage of the gas or mixture of gasses in the case of the indicator, adjusted to a pressure differential of one atmosphere, shall not exceed one micron-cubic foot per hour (10^{-5} cubic centimeters per second).

4.6.8 Low temperature operation (This test may be combined with the Low temperature exposure test at the discretion of the testing agency). - The indicator shall be properly connected except that no power shall be applied. The indicator shall then be subjected to an ambient temperature of -54°C (-65°F) for a period of 4 hours. During the last 5 minutes of the 4 hour period, power shall be applied to the indicator. At the end of the 4 hour period and with the temperature maintained at -54°C (-65°F) the indicator shall be subjected to the test for scale error and friction (see 4.6.4). The tolerances specified in Table II for low temperature shall not be exceeded and each indicator shall not require more than 5 seconds to come within the tolerances.

4.6.9 High temperature operation (This test may be combined with the High temperature exposure test at the discretion of the testing agency). - The indicator shall be properly connected except that no power shall be applied. The indicator shall then be subjected to an ambient temperature of 71°C (160°F) for a period of 4 hours. During the last 5 minutes of the 4 hour period, power shall be applied to the indicator. At the end of the 4 hour period and with the temperature maintained at 71°C (160°F) the indicator shall be subjected to the tests for scale error and friction (see 4.6.4). The tolerances specified in Table II for high temperature shall not be exceeded.

4.6.10 Vibration. -

4.6.10.1 Vibration error. - The indicator shall be tested in accordance with Procedure IV of Specification MIL-E-5272. The vibration errors of the pointer shall not exceed the tolerances specified in Table II for vibration pointer oscillation.

4.6.10.2 Vibration failure. - The indicator shall be tested in accordance with Procedure V of Specification MIL-E-5272. At the end of the test the indicator shall be tested for scale error and friction (see 4.6.4). The scale error and friction shall not exceed the room temperature tolerances specified in Table II.

4.6.11 Magnetic effect. - The indicator shall be properly connected and power applied. The indicator shall be revolved about a short bar magnet compass with the nearest part $5\text{-}1/2$ inches from the bar magnet, and in a vertical plane which is a perpendicular bisector of the North-South axis of the bar magnet. Starting directly under the compass, the indicator shall be held in positions 0, 45, 90, 135, 180, 225, 270 and 315 degrees from the initial position. At each of these positions the indicator shall be rotated on its horizontal axis until it is in its normal operating position. The horizontal magnetic field intensity shall be 0.17 to 0.19 oersted. The deflection of the compass at any of the specified positions shall not exceed one degree. The test shall be repeated with no power applied. For indicators with integral lighting this test shall be made with the integral lighting power applied and repeated with no integral lighting power applied.

4.6.12 Effect of Lead Length. - The indication shall not change more than 1 degree of an arc when the lead length between indicator and transmitter is changed from 5 to 500 feet of No. 20 AWG gage wire.

4.6.13 Torque. - The test shall be accomplished with the three secondary leads of one indicator synchro connected to the corresponding leads of a transmitter synchro conforming to Specification MIL-T-5350. A normal excitation of 26 volts, 400 cycles shall be supplied to the primaries of both synchros. The rotor of the transmitter synchro shall be locked in one position and the rotor of the indicator

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synchro rotated through an angle from the corresponding synchronous position. The torque tending to return the rotor of the indicator synchro to its synchronous position shall be measured. The torque is proportional to the angular displacement within displacements up to 20 degrees and shall be no less than 2,000 milligram millimeters per degree of displacement.

4.6.14 Low temperature exposure. - The indicator shall be tested in accordance with Procedure II of Specification MIL-E-5272. The indicator shall be subjected to the following tests and each test shall be conducted at the proper interval as required by Procedure II:

1. With the temperature at -62°C (-80°F), the indicator shall be checked to assure that the pointer moves over the entire scale range, and to determine that no component parts have been damaged.

2. With the temperature at -54°C (-65°F), the indicator shall be subjected to the scale error and friction tests (see 4.6.4) except that in every case the indicator shall not require more than 30 seconds to come within the tolerances specified in Table II for low temperature exposure.

3. Under standard conditions the indicator shall be subjected to the test for scale error (see 4.6.4) and the scale errors shall not exceed the tolerances specified in Table II for room temperature.

4.6.15 High temperature exposure. - The indicator shall be tested in accordance with Procedure II of Specification MIL-E-5272. The exposure time shall be 24 hours. At the conclusion of the exposure time and while still at the test temperature the indicator shall be subjected to the scale error and friction tests (see 4.6.4). The scale error and friction shall not exceed the tolerances specified in Table II for high temperature exposure. After return of the indicator temperature to standard conditions, the indicator shall be subjected to the test for scale error (see 4.6.4). The scale error shall not exceed the tolerances specified in Table II for room temperature.

4.6.16 Temperature shock. - The indicator shall be tested in accordance with Procedure I of Specification MIL-E-5272. After the testing procedure, the instrument shall be subjected to and meet the requirements of the leakage test (see 4.6.7).

4.6.17 Salt spray. - The indicator shall be tested in accordance with Procedure I of Specification MIL-E-5272. After the testing procedure, the indicator shall be subjected to and meet the requirements of the following tests:

1. Dielectric strength (see 4.6.2)
2. Leakage (see 4.6.7)

4.6.18 Radio noise interference. - The electrical system of the indicator shall be tested for conducted and radiated radio noise interference in accordance with Specification MIL-I-6181.

4.6.19 Endurance. - The indicator shall be subjected to 60,000 applications of pressure to produce an indication from 0 to 80^{+5} percent of the range of the indicator and back to zero indication at a rate of 30^{+10} cycles per minute. The indicator shall be tested not less than 1 hour after the applications, for scale errors (see 4.6.4) at room temperature and the tolerances shall not exceed those specified in Table II.

5. PREPARATION FOR DELIVERY

5.1 Packaging. -

5.1.1 Level A. - The indicator shall be packaged in accordance with Specification MIL-P-7936. The method of preservation shall be in accordance with Specification MIL-P-116, Method 1a5, omitting preservation compound, using metal reusable containers.

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5.1.2 Level C. - When this level is required packaging shall be in accordance with standard commercial practice.

5.2 Packing.

5.2.1 Levels A and B. - The indicators shall be packed in accordance with Specification MIL-P-7936. The level or levels required shall be as specified in the invitation for bid or contract.

5.2.2 Level C. - The indicators shall be packed to insure that the shipment arrives in a satisfactory condition at destination. The shipment shall conform to the applicable carriers rules and regulations in effect at the time of shipment.

5.3 Marking. - The interior and exterior containers shall be marked as specified in Specification MIL-P-7936.

5.3.1 Precautionary marking. - The following precautionary marking shall appear on two opposite sides of each interior package and shipping container whenever practicable, depending on the size of the carton:

FRAGILE
DELICATE INSTRUMENTS
HANDLE WITH CARE

6. NOTES

6.1 Intended use. - The pressure indicators covered by this specification are intended for use with pressure transmitters conforming to Specification MIL-T-5483 or other suitable synchro pressure transmitters for indicating aircraft pressures remotely. The single indicators are to be procured for use as replacements only, and are not to be specified for new aircraft.

6.2 Ordering data. - Requisitions, contracts, and orders should state the quantity and MS part number of the indicator desired and the levels of packaging (see 5.1) and packing (see 5.2) to be furnished.

6.3 Definitions. -

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

6.4 Qualification. - With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening 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 Bureau of Naval Weapons, Department of the Navy, Washington 25, D. C. and information pertaining to qualification of products may be obtained from that activity.

Notice. - When Government drawings, specification, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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 (as indicated on reverse hereof).		
SPECIFICATION		
ORGANIZATION (of submitter)		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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