

INCH-POUND

MIL-I-27193C(USAF)
16 November 1989
SUPERSEDING
MIL-I-27193B(USAF)
8 MARCH 1963

MILITARY SPECIFICATION
INDICATOR, ATTITUDE ARU-2B/A

This specification is approved for use by the Department of the Air Force and is available for use by all Department and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one type of remote attitude director indicator, designated ARU-2B/A.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement hereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Oklahoma City Air Logistics Center/MMEOR, Tinker AFB OK 73145-5990 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 6610

DISTRIBUTION STATEMENT X. Distribution authorized to U.S. Government agencies and private individuals or enterprises eligible to obtain export-controlled technical data in accordance with regulations implementing 10 U.S.C. 140c 11 April 1988. Controlling DoD Office is OC-ALC/MMEOR, Tinker AFB Ok 73145-5990.

WARNING - This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U.S.C., Sec. 2751 et seq) or Executive Order 12470. Violations of these export laws are subject to severe criminal penalties.

DESTRUCTION NOTICE For classified documents, follow the procedures in DoD 5200.22-M, Industrial Security Manual, Section II-19 or DoD 5200.1-R, Information Security Program Regulation, Chapter IX. For unclassified, limited documents, destroy by any method that will prevent disclosure of the contents or reconstruction of the document.

SPECIFICATIONSFederal

MMM-A-134	Adhesive, Epoxy Resin, Metal To Metal
PPP-B-601	Boxes, Wood, Cleated Plywood
PPP-B-636	Box, Shipping, Fiberboard

Military

MIL-P-116	Preservation, Method Of
MIL-C-675	Coating Of Glass Optical Elements (Antireflection)
DOD-D-1000	Drawings, Engineering And Associated List
MIL-E-5400	Electronic Equipment, Aircraft, General Specification For
MIL-C-5541	Chemical Films 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-S-8802	Sealing Compound, Temperature-Resistant, Integral Fuel Tanks And Fuel Cell
MIL-A-9067	Adhesive Bonding, Process And Inspection Requirements For
MIL-L-25467	Lighting, Integral, Instrument, General Specification For
MIL-L-27160	Lighting, Instrument, Integral, White, General Specification For
MIL-C-83488	Coating, Aluminum, ION Vapor Deposited

STANDARDSFederal

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-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission And Susceptibility Requirement For The Control Of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement Of
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization
MIL-STD-810C	Environmental Test Methods For Aerospace And Ground Equipment
MIL-STD-838	Lubrication Of Military Equipment
MIL-STD-889	Dissimilar Metals
MIL-STD-970	Standards and Specifications, Order Of Preference For The Selections Of
DOD-STD-1866	Soldering Process General
MIL-STD-2073-1	DOD Material Procedures For Development And Application Of Packaging Requirements.
MS24367	Lamp - Incandescent, Miniature, Integral Lighting
MS24515	Lamp, Sub Miniature
MS25237	Lamp, Incandescent, T-1-3/4 Bulb Midget Flange Base
MS33545	Case - Instrument 5 x 5-1/5 Standard Dimensions For
MS33558	Numerals and Letters , Aircraft Instrument Dial, Standard Form Of

(Unless otherwise indicated copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (Attn: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

(Copies of MIL-STD-810C are available from the Director, Naval Publications and Printing Service, 700 Robbins Ave, Bldg 4 Section D, Philadelphia PA 19111.)

2.2 Non-Government Publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issue of the documents cited the solicitation (see 6.2).

American Society for Testing And Materials (ASTM)

ASTM D3951 Packaging, Commercial

(Application for copies should be addressed to: ASTM, 1916 Race St, Philadelphia PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), the text of this document take precedence. Nothing in this document however, shall supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The indicators furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.4 and 6.4).

3.2 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-970.

3.3 MATERIALS

3.3.1 Fungus-Proof Materials. Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where used and not hermetically sealed, they shall be treated with a fungicidal agent acceptable to the contracting activity. However, if they will be used in a hermetically sealed inclosure, fungicidal treatment will not be necessary.

3.3.2 Nonmagnetic Materials. Nonmagnetic materials shall be used for all parts except where magnetic materials are essential.

3.3.3 Metals. Metals shall be of the corrosion-resistant type or suitably treated to resist corrosion due to fuels, salt fog or atmospheric conditions likely to be encountered in storage or norman service.

3.3.4 Dissimilar Metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.3.5 Corrosive Fumes. The materials, as installed in the indicator and under the service conditions specified herein, shall not liberate deleterious fumes.

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

3.4 Design And Construction. The indicator shall be designed to display pitch and roll attitude information with full freedom about each axis, flight director information controlled by a remote computer, and turn and slip information.

a. The indicator shall be so designed that a second servo can be installed within the sphere for the purpose of driving sphere caps for heading indication without redesign of the main castings. Space provisions shall be made within the indicator for slip rings for this additional servo. The indicator shall be in accordance with class 2 requirements of MIL-E-5400.

b. The indicator shall be so designed and constructed that adjustments and repairs can be easily made by the personnel of operating units and overhaul bases. The complete mechanism, consisting of all components except the pitch trim knob assembly, shall be removable from the case as a unit. The indicator shall be built to withstand the strain, jars, vibrations, and other conditions incident to shipping, storage, installation, and service.

3.5 Performance. The indicator shall be capable of satisfactory operation when subjected to the following conditions:

- a. Temperatures ranging from -62° to -71° C
- b. Pressures ranging from 30 inches Hg down to 0.81 inch Hg (sea level to 80,000 ft)
- c. Relative humidity up to 100 percent
- d. Fungus growth as encountered in tropical climates
- e. Simulated rainfall as encountered in any locals
- f. Exposure to simulated salt sea atmosphere
- g. Dust (fine sand) particles as will be encountered in desert areas
- h. Acceleration forces up to 10g
- i. Vibration with a double amplitude 0.020 to 0.100 inch
- j. Primary power consumption not to exceed 26 va; power consumption for white or red integral lighting not to exceed 10 va

k. Voltages and frequencies varying from 103 to 127V and 320 to 480 respectively

1. Operation under actual service for a period of 1.000 hours

3.5.1 Radio Noise. Radio noise interference shall be in accordance with MIL-STD-461 and MIL-STD-462.

3.5.2 Mean Time Between Failures (MTBF). From results of tests of section 4, a MTBF shall be calculated. The MTBF shall be not less than 1,000 hours. If six test samples are used, a MTBF shall be calculated for group I and III tests. The same MTBF shall apply. If this test is not passed, three production units shall be picked at random and subjected to the life test only. The calculated MTBF shall be not less than 1,150 hours for the repeated life test. If this second test is not passed, no deliveries shall be made until corrective action is taken and incorporated into all units. The MTBF shall be equal to the number of samples times life hours divided by the total number of failures occurred throughout the life test.

a. Where a performance accuracy tolerance-type requirement is specified, a failure shall be considered as any electrical or mechanical condition which exceeds the specified tolerance by 100 percent. This does not apply to the lighting requirements.

b. Where a maximum-type requirement is specified, a failure shall be considered as any electrical or mechanical condition which results in a 4 percent increase of the specified maximum.

c. Where a minimum-type requirement is specified, a failure shall be considered as any electrical or mechanical condition which results in a 4 percent decrease of the specified minimum.

d. Where a condition is specified as a requirement, a failure shall be considered as any electrical mechanical malfunction which results in any condition other than that specified.

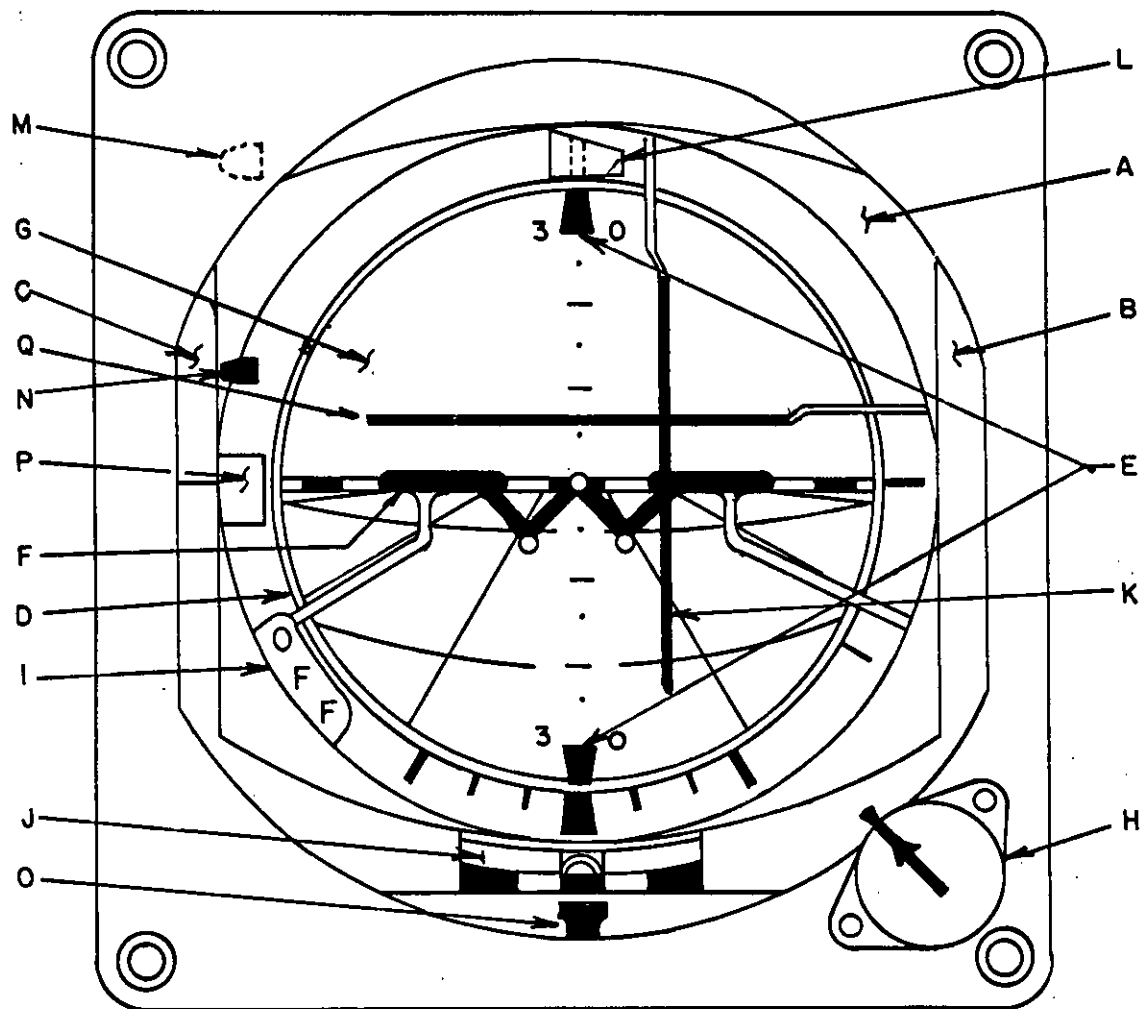
e. The interpretation provided under a, b, c, and d applies to 4.6.37.

3.6 Part Numbering Of Interchangeable Parts. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of DOD-D-1000 shall govern the manufacturer's part numbers and changes thereto.

3.7 Component Parts. The indicator shall consist of the parts and mechanisms necessary to provide and operate an attitude display, an inclinometer, a flight director display, and rate of turn display as specified herein and illustrated on figures 1, 2, and 3. All colors referenced shall be in accordance with FED-STD-595.

3.7.1 Attitude Display. The attitude display shall basically consist of a bank scale, bank indexes, a miniature aircraft, and an attitude sphere background which is supported and rotated about two servo-driven gimbal axes.

3.7.1.1 Banks Scale Dimensions and Markings. The bank scale dimensions and markings shall be in accordance with figures 1, 2, and 3. The front of the inner edge of the dial shall not exceed 0.750 inch from the inner surface of the cover glass.



- A. Bank scale.
- B. Dial mask and vertical pointer shield.
- C. Displacement pointer scale or glide slope deviation scale.
- D. Mechanism mask.
- E. Bank angle indexes.
- F. Miniature aircraft.
- G. Attitude sphere.
- H. Pitch trim knob.
- I. Power failure indicator.
- J. Inclinometer.

- K. Vertical pointer or bank steering bar.
- L. Vertical pointer alarm flag or course warning flag.
- M. Displacement pointer out of view.
- N. Displacement pointer or glide slope indicator.
- O. Rate of turn.
- P. Displacement pointer alarm flag or glide slope warning flag.
- Q. Horizontal pointer or pitch,

FIGURE 1. Indicator display.

The portion of the dial within $\pm 45^\circ$ of the zero-bank index shall be a portion of a cone with the visible portion of the dial at approximately a 75° angle to the roll axis of the indication. The front edge of the outer periphery of the dial within $\pm 45^\circ$ of the zero bank index shall not exceed 0.687 inch from the inner surface of the cover glass. The outer radius of the dial shall be 1.906.

3.7.1.1.1 Dial Masks A mask shall be attached to each side of the bank scale dial in accordance with figures 1, 2, and 3. The mask on the left shall also be the scale for the displacement pointer specified in 3.7.6.5. The surface of the scale shall follow the arc of the displacement pointer movement. The mean depth of the scale shall be approximately 0.250 inch from the cover glass and shall appear symmetrical with the one on the right. The surface of the mask on the right shall be approximately 0.250 inch from the cover glass. This mask shall be the shield behind which the vertical pointer is driven as specified in 3.7.6.1.1. The inner vertical edges of the masks shall each be 1.906 inches from the center of the display. The mask shall be so designed that the displacement pointer can be driven out of view to the top as shown on figure 1.

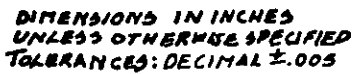
3.7.1.2 Mechanism Mask. A mask shall be incorporated which is attached to the roll gimbal and extends essentially from the bank scale to the attitude sphere. The visible surface of this mask shall be shaped as the surface of a frustrum of a cone. The large diameter shall be forward and shall be approximately 3.281 inches. The edge of the mask shall be hidden by the inner diameter of the bank scale. The small diameter shall be toward the rear and shall be approximately 3.156 inches. There shall be approximately 0.062 inch between this edge of the mask and the sphere.

3.7.1.3 Bank Indexes. Bank indexes shall be affixed to and shall rotate with the roll gimbal. They shall be in accordance with figures 1 and 2. At zero roll indication, one shall be adjacent to and aligned with the zero roll marking on the bank scale. The other index shall be at the 180° roll position.

3.7.1.4 Miniature Aircraft. The miniature aircraft shall be in accordance with figure 2. The indicator shall be so designed that the miniature aircraft will be located between the attitude sphere and the horizontal pointer at the zero pitch position. The front surface of the center dot shall not be more than 0.060 inch maximum from the sphere surface. The center of this dot shall be 2.500 ± 0.031 inch from the top edge of the mounting flange. The wings of the miniature aircraft shall be curved so that they follow the swing radius of the vertical pointer.

3.7.1.5 Attitude Sphere. The attitude sphere that forms the background of the display shall be mounted in the roll gimbal of the indicator. It shall rotate with the gimbal about the roll axis for roll indications and shall rotate in relation to the roll gimbal about the pitch axis for pitch indications. The roll axis shall be perpendicular to the face of the indicator and the pitch axis. The pitch axis shall be horizontal when the indicator is level and is indicating a zero-roll attitude. The sphere and sphere markings shall be in accordance with figure 4. The sphere shall be driven in pitch so that the horizon line goes above the miniature aircraft or dive maneuvers and below for climb maneuvers. The distance between the cover glass and the sphere shall be held to a minimum and shall not exceed 0.390 inch.

3.7.1.5.1 Pitch Trim. Means shall be incorporated for adjusting the position of the sphere by means of a pitch trim knob mounted on the lower right-hand side of the face of the indicator and marked in accordance with figures 1 and 5. The knob shall have approximately one-half turn of freedom in the clockwise direction and one-fourth turn of freedom in the counter clockwise direction from the zero pitch trim position. The freedom in each direction shall be limited by a positive stop. When the knob is rotated to the stop in the clockwise direction, the sphere shall



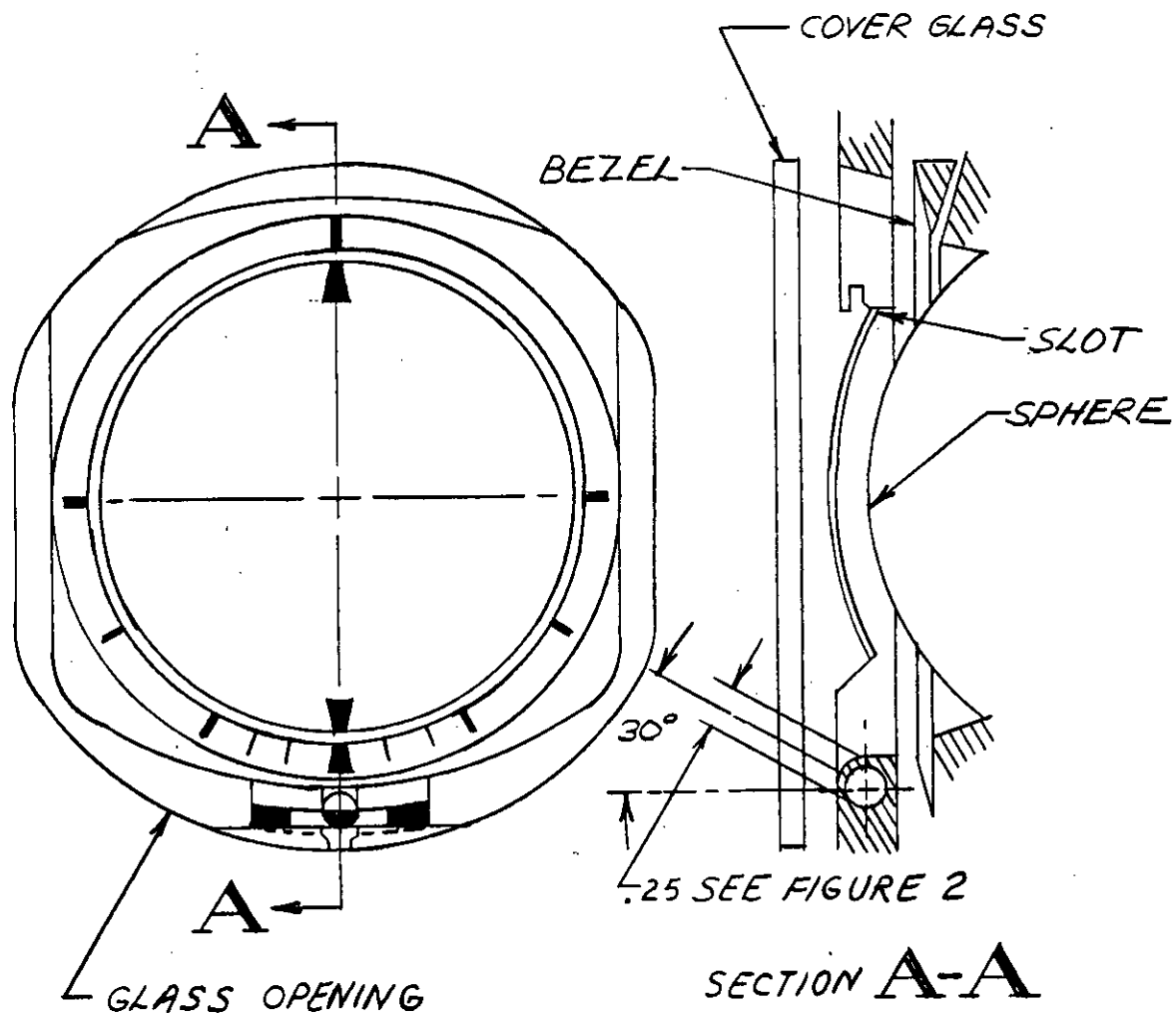


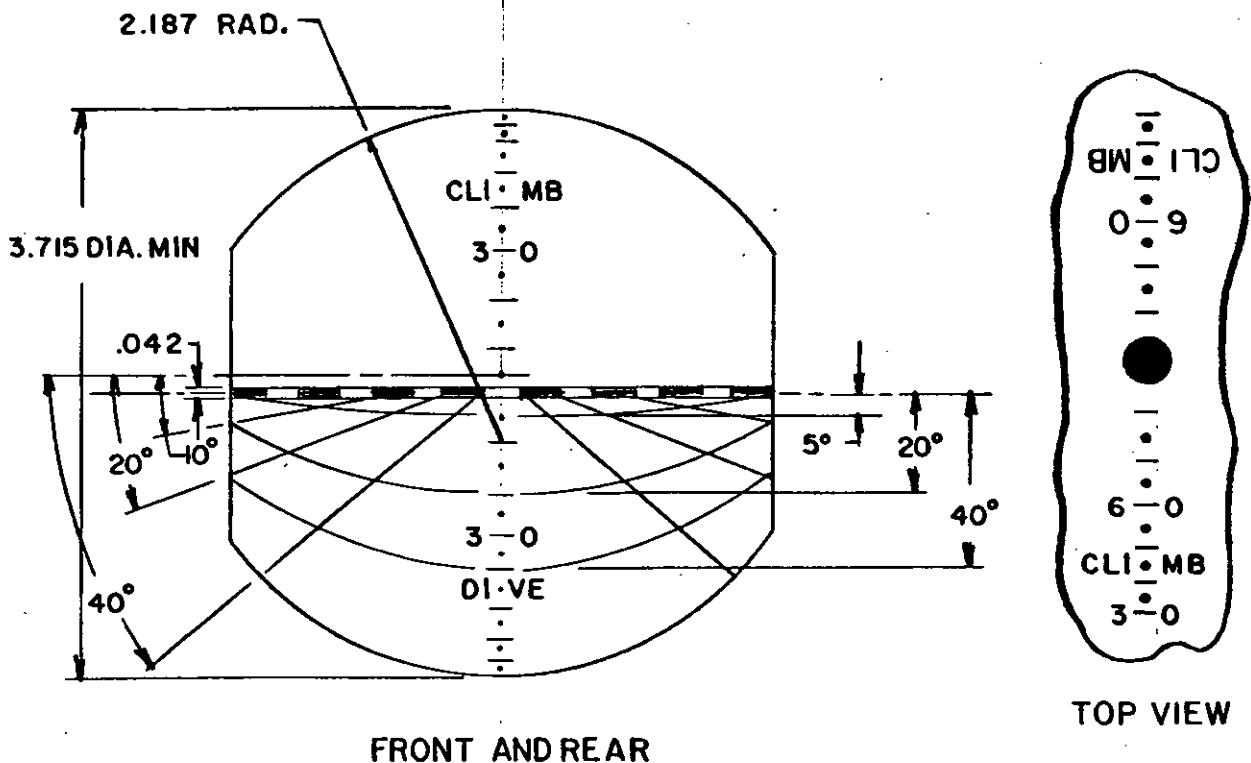
FIGURE 3. Glass cover and opening.

rotate to deflect the horizon line upward to indicate between 10° and 20° dive. When the knob is rotated to the stop in the counter clockwise direction, the sphere shall rotate to deflect the horizon line downward to indicate a climb of between 5° and 10° . The servo system shall operate properly for any pitch trim adjustment. A minimum of 1 ounce-inch and a maximum of 8 ounce-inches shall be required to rotate the pitch trim knob through the full range of settable indications in both the clockwise and counter clockwise directions. The torque required shall not exceed the above range in any of the environments or life tests in which the indicator is specified to operate properly. The internal design of the indicator shall be such that any pitch trim input will automatically fade out as the sphere is driven to the extreme pitch indications and the sensing of the trim signal will be reversed to correspond to the side of the sphere showing when the sphere is driven through the 90° pitch positions. The fade out shall occur as the sphere is driven from the 20° to 75° pitch indications and the fade-in shall occur as the indicated pitch angle changes from 75° to 20° . It shall occur on both sides of the sphere for both climb and dive indications.

- a. The design shall be such that when two indicators are hooked in parallel, the change in pitch trim adjustment of one indicator shall not affect the indication on the second instrument. The design shall be such that no degradation of performance shall result at any pitch trim or roll zero setting. The pitch trim knob, item H, figure 1, shall be medium gray, color No. 36231. The arrow provided on the knob shall be black, color No. 37038, and the reference mark against which the arrow on the knob is set shall be white, color No. 37875.

3.7.2 Indicator Synchro Control Transformer The synchro control devices on the indicator axes shall be high impedance Eclipse-Pioneer type AF500-5 synchros, or equal. The servo circuit shall be so designed that when one to four indicators per axis are connected to a single test transmitter synchro, no noticeable change in performance can be noted. All synchro control device stator leads shall be electrically isolated from each other, from other circuitry in the case, and from the case.

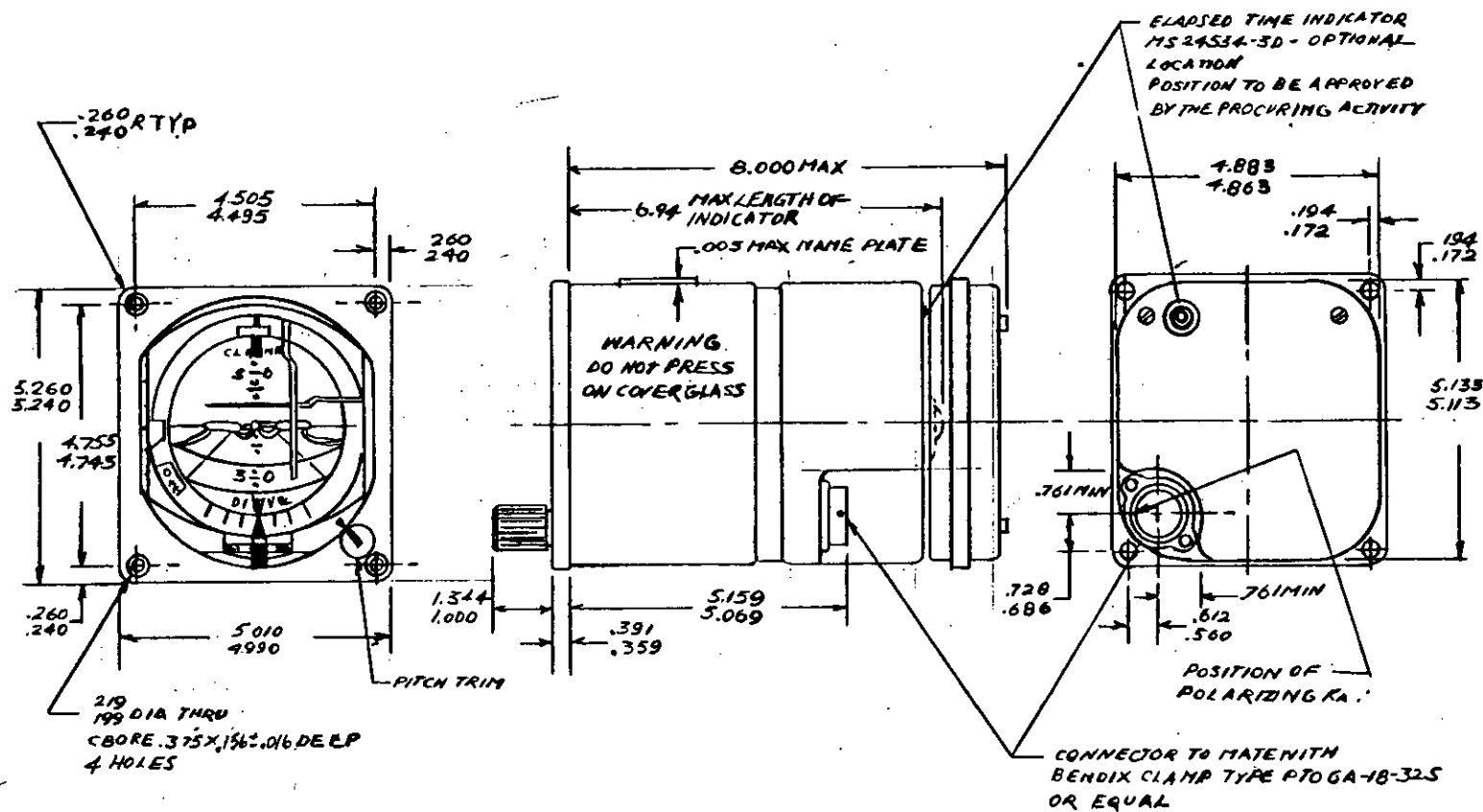
- a. The standard test transmitter synchro shall be an Eclipse-Pioneer type AY201-1, or equal, with minimum and known errors. These errors shall be subtracted from those of the indicator under test.
- b. The transmitter shall be equipped with an accurate dial having a $\pm 1^{\circ}$. It shall be graduated through 360° and shall be capable of continuous rotation.
- c. The transmitter shall be calibrated and the rotor and stator leads identified as follows:
 1. The rotor leads designated as H and C with C grounded.
 2. One stator lead designated as Z and connected to C.
 3. 26V 400 Hz applied across H and C and the voltage measured across the two remaining stator leads and across H and one of the stator leads.
 4. The rotor turned until the voltage across H and the one stator lead is approximately maximum (about 35V) and the voltage across the two stator leads is exactly minimum. The dial locked to the rotor with the dial exactly on zero.



Notes:

1. Perspective lines shall be 0.008 inch wide and shall extend between opposite cardinal points on the sphere. The lines shall be white color No. 37875.
2. The pitch marking shall be 0.025 X 0.1874 and shall be white color No. 37875 on the color No. 370038 dull black portion of the sphere and dull black on the upper color No. 36373 gray area.
3. All numerals and letters shall be 0.1875 high. Dots will be placed at the 5° intervals.
4. The large dots shown on the top and bottom view shall have a diameter equal to a 10° pitch angle.
5. The horizon line to be alternating black color No. 37038 and white color No. 37875 areas. Center area to be black.

FIGURE 4. Sphere layout.



DIMENSIONS IN INCHES

FIGURE 5 Indicator altitude director.

5. The dial turned through increasing numbers and the voltage measured across the two undesignated stator leads and Z. The voltage across XZ will increase before decreasing and the voltage across YZ will decrease before increasing.

3.7.2.1 Test Transmitter Excitation. The test transmitter rotors shall be excited from the same power supply voltage that operates the indicator. It shall be so applied that the voltage from rotor lead (C) to rotor lead (H) will be in phase with the voltage from pin A to pin B of the indicator with lead (C) and Pin A (see table I) common.

3.7.2.2 Indication Zeroing and Sensing When the pitch and roll servo control devices of the indicator are connected to standard test transmitters in accordance with table I with the respective transmitters set at the 180° dial reading, the indications shall come to rest at zero. Increasing dial readings of the respective test transmitter shall produce right roll and pitchup indications, Decreasing dial readings shall produce opposite indications.

3.7.2.3 Attitude Actuation The sphere shall be rotated about the pitch and roll gimbal axes by means of geared servo motors until a null is attained between the synchro control devices on the indicator axes and the transmitter synchros in the pitch and roll displacement reference. The freedom of sphere rotation about either axis shall not be limited.

3.7.2.4 Followup Rate The rate at which the motors drive the gimbals shall be no less than 300° per second in roll nor 90° per second in pitch.

3.7.2.5 Accuracy The pitch and roll indications shall agree with the input signals from their respective test transmitter synchros to within $\pm 0.500^{\circ}$ for all positions through 360° .

3.7.2.6 Followup Operation The electrical and mechanical design of the indicator shall be such that in the process of followup, the indications of pitch or bank shall move smoothly without hunting, oscillating, or jumping more than 0.125° total amplitude in pitch or bank when connected to a standard transmitter. There shall be no sustained electrical or mechanical oscillations in either axis at any attitude, nor overshoot greater than 3° with a step input equal to the maximum followup lag.

3.7.2.7 Amplifiers. The amplifiers provided as a part of the indicator shall be 3-stage transistorized amplifiers with redundant transistor stages. The amplifiers shall be designed with redundant circuits so that the indicator will continue to operate, though with reduced performance, should partial failure of the amplifier occur. The amplifiers shall be housed in a separate package from the indicator proper, so that it can be physically attached to the rear of the indicator proper or mounted remotely. The amplifier shall be so designed that it will meet the requirements of this specification when mounted directly to an airframe without shock mounts as well as when mounted on the indicator. The amplifier shall be so designed that each channel is a separate module within the amplifier case, and so that the channels are interchangeable. The external configuration of the amplifiers shall conform to figure 6.

3.7.2.8 Zeroing Adjustments. Means shall be incorporated to externally adjust the position of the sphere $\pm 3^{\circ}$ minimum in pitch and roll. The initial setting of the pitch and roll indication at the time of delivery of the indicator shall indicate zero pitch and roll within 0.500° when the indicator is connected to a test

transmitter set to the 180° dial reading. The pitch adjustment shall be combined with the pitch trim circuit by means of a settable knob. The roll adjustment shall be mounted and adequately marked so that adjustment can be accomplished either with the amplifier mounted to the indicator or remotely. The trim adjustment shall be equipped with stops so positioned that an erroneous indication of attitude cannot result from the positioning of this adjustment. The trim adjustment shall incorporate a locknut or similar device to secure the adjustment setting.

3.7.3 Power Failure Indicator. A power failure warning indicator shall be incorporated in the lower left of the face of the indicator as shown on figures 1 and 2. The word OFF shall be black on a red background. A lead shall be brought out through the electrical connector as shown in table I. When the ground connection or the power is removed, or both, the warning shall appear. When power is applied but internal failure of the B+ amplifier voltage occurs, the warning shall appear. Under night lighting the flag shall be front lighted.

3.7.4 Electrical Power Requirements. The power supplied to the indicator shall be 115V, 1 phase, 400 Hz in accordance with MIL-STD-704.

3.7.4.1 Electrical Power Variation. The indicator shall operate properly for any a-c voltage between 103 and 127V, for any frequency between 320 and 480 Hz or for any combination thereof.

3.7.4.2 Case Isolation. The case shall be isolated from all electrical circuits within it.

3.7.5 Inclinator. The inclinometer shall be incorporated into the display in accordance with figures 1, 2, and 3.

3.7.5.1 Tube. The glass of the inclinometer tube shall be made of clear annealed glass tubing free from any flaws that will seriously affect the readability of the inclinometer. The inside of the tube shall be smooth and uniform so that the ball may roll freely except for the damping of the liquid. The arc length of the visible portion of the tube shall be approximately 1.250 inches. The radius of curvature of the tube shall be 3.500 inches.

3.7.5.2 Ball. The ball shall be a highly polished, accurate, 0.203 inch white sphere. A minimum of two-thirds of the ball shall remain in view at either extreme of the tube, when viewed from 12 inches in front of the zero mark of the slip indicator at an angle of 30° with the horizontal plane prescribed by the base of the indicator.

3.7.5.3 Damping Liquid. The damping liquid used shall be sufficiently colorless to preclude interference with the visibility of the ball under daylight and night lighting conditions and under normal and temperature extremes.

3.7.6 Flight Director Display. The flight director display shall consist of vertical pointer, a horizontal pointer, a pointer to show displacement from commanded flight path, and two signal level flag alarms. These pointers and flags shall be driven by meter movements and shall be in accordance with figures 1 and 2. The design of these pointer meter movements shall be such that when not energized these pointers will be maintained as near as practicable to their adjusted zero positions while under all flight conditions, including rough air. All meter movements leads shall be electrically isolated from each other, from other circuitry in the case, and from the case. Unless otherwise specified, all meter movements shall operate as specified herein when operated singularly, when connected in

TABLE I

Connector Pins	Function
A	Neutral (external power ground)
B	115V 400 Hz
D	Spares
E	Internal lighting power input for white lighting (0-5V).
j	Power warning flag. Connect to pin A to complete circuit.
g)	Neutral for internal lighting.
h)	Internal lighting power input for red lighting (0-5V).
d (X)	Roll servo control transformer stator leads
e (Y)	
f (Z)	
a (X)	Pitch servo control transformer stator leads.
b (Y)	
c (Z)	
Y (+)	Vertical pointer (deflects to right).
Z (-)	
W (+)	Horizontal pointer (deflects downward).
X (-)	
U (+)	Vertical pointer warning flag (out of view).
V (-)	
S (+)	Displacement pointer (deflects pointer downward).
T (-)	
P (+)	Rate of turn indicator (deflects to right).
R (-)	
L	Spares.
M	
N	
J (+)	Displacement pointer flag (out of view).
K (-)	
F (X)	Reserved for heading control transformer stator leads in three axes indicators.
G (Y)	
H (Z)	

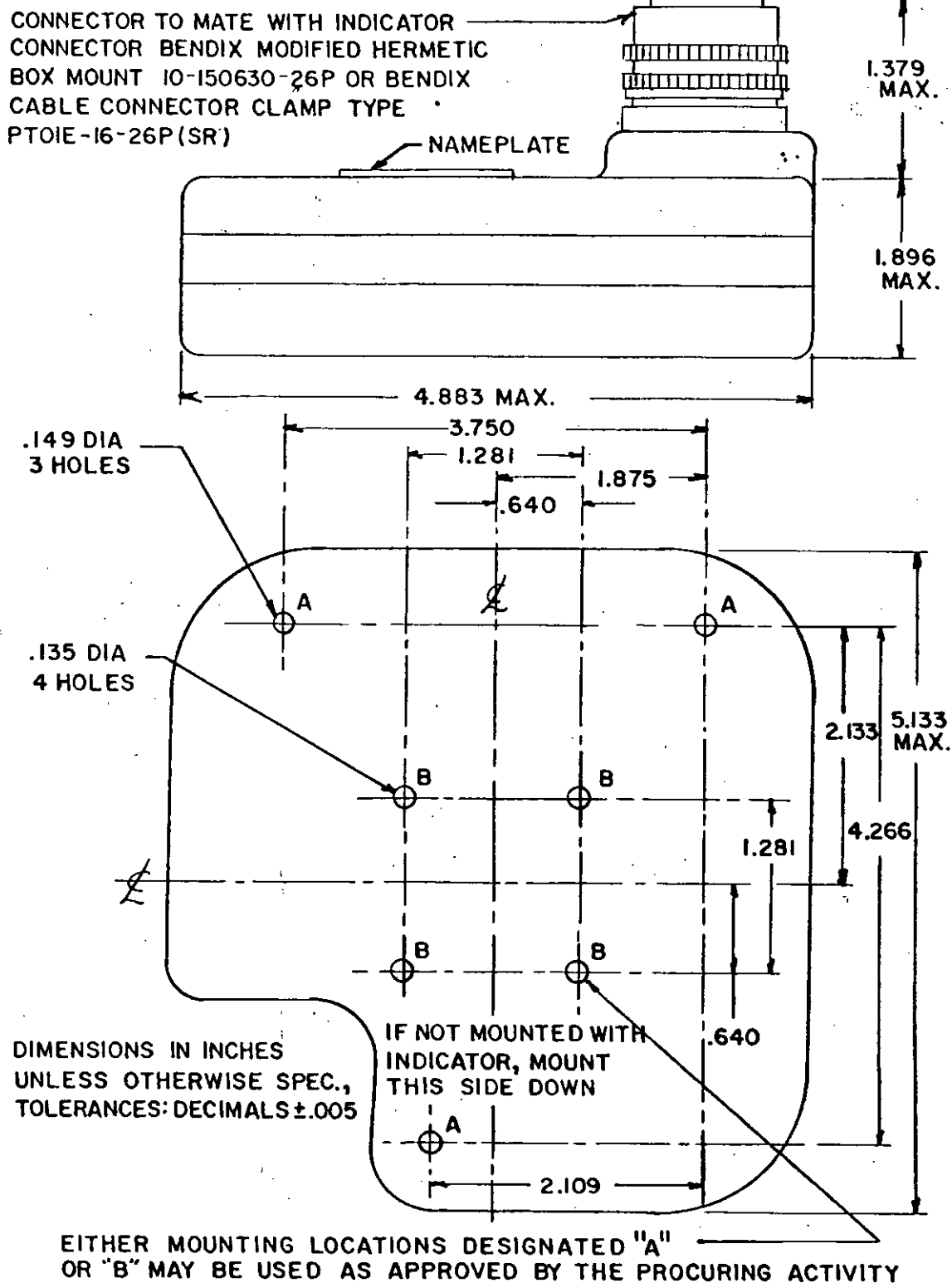


FIGURE 6. Amplifier envelope.

parallel with a like meter movement, or when connected in parallel with a 1,000-ohm load to a signal source which has an impedance between 350 and 1,000 ohms. The yellow area of the horizontal and vertical steering pointers shall be centered over the dot of the miniature aircraft.

3.7.6.1 Vertical Pointer. The vertical pointer shall be positioned directly behind the wedge provided for integral lighting purposes. With the indicator in normal operating position, the vertical pointer shall be mounted on a meter movement that is pivoted at a point approximately 4.500 inches behind the pointer in such a manner that the pointer will remain vertical at zero center or at any point of deflection to the right or left of center, and will deflect right or left in agreement with the polarity of direct current received from the flight director computer. An external mechanical zero adjustment shall be provided. The portion of the vertical pointer dimensioned in figure 2 shall be yellow, color No. 33695.

3.7.6.1.1 Deflection (Vertical Pointer). The design shall be such that the deflection of the pointer to the left of the center position is limited to 1 inch by a physical stop and the maximum deflection to the right will carry the pointer behind the mask on the right side of the display. The direction of deflection for given input signal shall be as specified in table I.

3.7.6.1.2 Response (Vertical Pointer). The vertical pointer response shall be linear in degrees with respect to current within 7.5 percent of the proportionate full scale value. A deflection of 0.875 inch measured from the center of the dial to the pointer along the horizontal line shall require 2.2 ma ± 7.5 percent and 2.5 ma shall not deflect the pointer by more than 1.062 inches. An application of 10 ma of the proper polarity shall drive the pointer from view behind shield to the right. The 10 to 13.5 ma shall be applied as a step input without damaging the meter movement.

3.7.6.1.3 Resistance (Vertical Pointer). The resistance across the vertical pointer input terminals shall be 1,000 ohms ± 3 percent at 25° C.

3.7.6.1.4 Damping (Vertical Pointer). The pointer mechanism shall be damped so that there is no more than 1.5 percent overshoot.

3.7.6.1.5 Response Time (Vertical Pointer). Response time of the vertical pointer shall be a maximum of 0.333 second. Response time is defined as the time required for the pointer to reach 90 percent of its final indication, and time is counted from the instant of application of the current. The pointer shall be considered as having come to apparent rest when it has reached within ± 1 percent of the scale length of the actual rest point.

a. Flight computer. The flight director computer referred to herein shall be designed so that its current to the pointer movements is limited to 2.5 ma maximum when in a mode where the pointers are being used and it will provide 10 to 17 ma of the proper polarity to either or both pointer movements when these pointers are to disappear.

3.7.6.2 Vertical Pointer (Flag Alarm). The vertical pointer flag alarm shall be operated by a suppressed zero type of mechanism which shall hold the flag against a stop in the position shown on figure 1 in the absence of current, or when the current application is below a predetermined value as specified below.

3.7.6.2.1 Deflection (Flag Alarm). The vertical flag alarm shall be designed to deflect out of view with the input signal polarity of table I connected to a voltage which is polarized plus and minus, respectively.

3.7.6.2.2 Response (Flag Alarm). The flag alarm shall leave its visible-position stop with a current application of 180 ua or more. The flag alarm shall disappear with a current application of 245 ua. Response of the flag alarm mechanism shall be approximately linear in degrees with respect to current. The application of 380 us as a step input shall not damage the meter movement.

3.7.6.2.3 Resistance (Flag Alarm). The resistance across the vertical pointer flag alarm input shall be 1,000 ohms ± 3 percent at 25°C.

3.7.6.3 Horizontal Pointer. The horizontal pointer shall be positioned directly behind and as near as practicable to the vertical pointer. The horizontal pointer shall be mounted on a meter movement which shall be pivoted at a point approximately 4.500 inches behind the pointer. With the indicator in normal operating position, the pointer shall move in such a manner that it will remain horizontal at zero center or at any point of deflection up or down from center, and shall deflect up or down in agreement with the polarity of direct current received from the flight director computer. An external mechanical zero adjustment shall be provided. The dimensioned portion of the horizontal pointer shown on figure 2 shall be yellow, color No. 33695.

3.7.6.3.1 Deflection (Horizontal Pointer). The maximum deflection upward shall be physically limited to 1.062 inches. The design shall be such that the pointer can be deflected downward (1.937 inches minimum) until it disappears from view behind a mask which shall not be closer than 1.906 inches to the roll axis of the indicator. The direction of deflection for a given input signal shall be as specified in table I.

3.7.6.3.2 Response (Horizontal Pointer). The horizontal pointer response shall be linear in degrees with respect to current to within 7.5 percent of the proportionate full scale value. A deflection of 0.875 inch measured from the center of the dial to the pointer along a vertical line shall require 2.2 ma ± 7.5 percent, and 2.5 ma shall not deflect the pointer by more than 1.062 inch. An application of 10 ma of the proper polarity shall drive the pointer from view behind its mask at the bottom of the display. The application of 13.5 ma as a step input to drive the pointer from view shall not damage the meter movement.

3.7.6.3.3 Resistance (Horizontal Pointer). The resistance across the horizontal point input terminals shall be 1,000 ohms, ± 3 percent at 25°C.

3.7.6.3.4 Damping (Horizontal Pointer). The bar mechanism shall be damped so that there is no more than 1.5 percent overshoot.

3.7.6.3.5 Response Time (Horizontal Pointer). Response time (see 3.7.6.1.5) of the horizontal pointer shall be a maximum of 0.333 second.

3.7.6.4 Displacement Pointer. The displacement pointer and scale shall be in accordance with figure 2. The pointer shall be mounted on a meter movement which shall be pivoted at a point approximately 4.500 inches behind the pointer. With the indicator in normal operating position, the pointer shall move in such a manner that it will remain horizontal at zero center or at any point of deflection up or down from center, and shall deflect up or down in agreement with the polarity of direct current received from the flight director computer. An external mechanical zero adjustment shall be provided. The pointer shall run adjacent to the displacement scale as shown on figure 1. The design of the displacement pointer shall be such that an application of 500 ua of the proper polarity applied as a step input will drive the displacement pointer up out of view to the position shown on figure 1.

The application of 1,000 ua to drive the pointer out of view shall not damage the meter movement. This pointer shall perform as specified herein when connected to a 350-ohm signal source impedance and when connected in parallel with two additional like meter movements or two 1,000-ohm dummy loads.

3.7.6.4.1 Deflection (Displacement Pointer). The direction of deflection for a given input shall be as specified in table I.

3.7.6.4.2 Response (Displacement Pointer). The displacement pointer response shall be linear in degrees with respect to current to within 7.5 percent of the proportionate full scale value. A deflection of 0.875 inch measured from the zero position of the scale to the center line of the pointer shall require 150 ua ± 5 percent.

3.7.6.4.3 Resistance (Displacement Pointer). The resistance across the displacement pointer input terminals shall be 1,000 ohms ± 3 percent at 25° C.

3.7.6.4.4 Damping (Displacement Pointer). The pointer mechanism shall be overdamped (no overswing).

3.7.6.4.5 Response Time (Displacement Pointer). Response time (see 3.7.6.1.5) of the indicating pointer shall be a minimum of 1.15 seconds and a maximum of 2 seconds.

3.7.6.5 Displacement Pointer Flag. The displacement pointer flag shall be in accordance with figures 1 and 2. Its characteristics shall be the same as those specified for the vertical pointer flag alarm. The displacement pointer flag terminal and polarization shall be as shown in table I.

3.7.7 Rate Of Turn. The rate of turn display shall be in accordance with figures 1, 2, and 3. The moving index shall be mounted as a meter movement that is pivoted at a point approximately 4.500 inches behind the pointer. The design shall be such that the pointer is as stable as practicable under rough air conditions. Within normal operating position, the index shall move left or right in agreement with the polarity of the direct current received from the remote rate of turn sensor. An external mechanical zero adjustment shall be provided. The scale shall be made to conform to the path of the index so that there is a minimum of parallax. The front surface of the scale and index shall be within 0.250 inch of the cover glass at zero displacement. The index deflection to either side of the center zero position shall be limited to 0.625 inch. At each of fully deflected positions, a minimum of one-half of the index shall be in view when viewed at a horizontal distance of 2 feet from the center dot of the display.

3.7.7.1 Deflection (Rate Of Turn Index). The direction of deflection for a given input shall be as specified in table I.

3.7.7.2 Response (Rate of Turn Index). The index response shall be linear in degrees with respect to current to within 7.5 percent of the proportions to full scale value. A deflection of one index width from the zero position shall require 0.5 ma ± 7.5 percent. a deflection of two index widths so that the index aligns with the appropriate outer scale mark shall require 1.0 ma ± 7.5 percent.

3.7.7.3 Resistance (Rate Of Turn Index). The resistance across the rate of turn input terminals shall be 1,000 ohms, ± 3 percent at 25° C.

3.7.7.4 Damping (Rate of Turn Index). The pointer mechanism shall be damped so that there is no more than 1.5 percent overshoot.

3.7.7.5 Response Time (Rate of Turn Index). Response time (see 3.7.6.1.5) of the rate of turn index shall be a maximum of 0.333 second.

3.7.8 Elapsed Time Indicator. An elapsed time indicator shall be incorporated to record the running time of the indicator proper. The elapsed time indicator shall be provided in such a manner that it is not necessary to unseal the indicator proper to read the elapsed time recorded.

3.8 Markings. Unless otherwise specified, the dimensions of all markings on the indicator shall be in accordance with figures 1, 2, 3, and 4. Unless otherwise specified, all visible portions of the indicator shall be color No. 37038 in accordance with FED-STD-595.

3.8.1 Numerals and Letters. Unless otherwise specified, all numerals and letters on the indicator, other than the nameplate, shall be in accordance with MS33558.

3.9 Electrical Connectors. A Scintilla Division, Bendix Aviation Corporation part No. 10-150631-32P connector, or equal, shall be provided on the indicator in the manner shown on figure 5. The connections shall be in accordance with table I. This connector shall mate with a Scintilla Division part No. 10-150606-32S, or equal, connector. As shown on figure 5, a second connector shall be provided on the indicator to interconnect the indicator proper with the amplifier. The connector on the indicator shall be a Scintilla Division part No. 150630-26P, or equal, connector which shall mate with a Scintilla Division part No. 10-179145-26S, or equal, connector to be supplied as part of the amplifier. The physical position of each electrical connector and location of the polarizing key on the connector with respect to the indicator case shall be as shown on figure 5.

3.10 Cover Glass. The cover glass shall be flat and free from discolorations, scratches, and striae that interfere with reading of the indicator. It shall be mounted in the flange by inserting it from within the case. It shall be a minimum of 0.187 inch thick. Tempered glass shall be utilized.

3.10.1 Antireflection Coatings. A magnesium flouride coating in accordance with MIL-C-675 shall be applied to each surface of the cover glass and the lighting wedge. Coated surfaces shall not chip, scale, peel, flake, dissolve, discolor, or otherwise be adversely affected by the environmental tests specified herein or in normal service use. The coating on the outer surface of the cover glass shall withstand abrasion incident to normal service usage.

3.11 Indicator Case The indicator case shall be in accordance with MS33545, with the exceptions stated herein. Dimension A of MS33545 shall be in accordance with figure 1. Dimension L of MS33545 shall be the length of the envelope when the amplifier is physically attached to the indicator proper and shall not exceed 8 inches, required for electrical connectors, as shown on figure 5. The pitch trim knob shall be approximately 0.750 inch in diameter and 1 inch long. The case of the indicator proper shall be hermetically sealed. The amplifier unit need not be hermetically sealed but shall be sealed in such a manner that it will withstand all environmental tests specified herein.

3.11.1 Filling Medium When a hermetically sealed case is used, the filling medium shall be of at least 98 percent purity, free of dust particles, and contain not more than 0.006 milligram of water vapor per liter (dew point -65° C) at the filling

pressure. The filling medium shall be 100 percent helium, a mixture of 88 to 92 percent nitrogen and the remainder helium, or 95 percent helium and 5 percent carbon dioxide. The absolute pressure of the filling medium in the case shall be approximately 1 atmosphere. Where practicable, the 100 percent helium filling medium shall be utilized.

3.11.2 Leak Rate. The indicators shall be so sealed that the maximum leak rate will not permit more than 10 percent contamination of the filling medium after 1,000 hours at a pressure differential of approximately 1 atmosphere.

3.12 Lighting. Internal lighting shall be designed into the indicator. The design of the indicator shall be such that the internal lighting may be either white or red lighting, depending upon the pins shown in table I to which the power for lighting is applied. With the exceptions specified herein, the red lighting shall be in accordance with MIL-L-25467 and the white lighting in accordance with MIL-L-27160. The ratio of the brightness of the gray portion of the sphere to the brightness of the aircraft shall never exceed 0.6. The internal lighting of the prime standard and all qualification indicators shall be subjected to the approval of the contracting activity. All production units shall be visually compared to the prime standard for approval.

3.12.1 Lamps. MS25237-328, MS24515-718-AS15, or MS24367-715-AS15 lamps shall be used as the light source.

3.12.2 Prime Standard. The internal lighting shall be comparable and shall balance in brightness with a prime standard indicator. The prime standard shall be either an attitude-director conforming to the requirements of this specification, or a lighted model. The prime standard shall be equipped with both red and white lighting and shall be used as the reference for acceptance of all production indicators.

a. A minimum of 12 average areas covering all representative areas of the face of the prime standard indicator shall be measured for brightness in foot lamberts. The prime standard instrument shall be measured periodically (at least every 50 hours of operation) to determine and brightness change. Any variation greater than ± 20 percent in two or more of these areas will require the return of the prime standard to the contracting activity for investigation, reapproval or corrective action, or both.

3.12.2.1 Visual Comparison. The general overall lighting level of the indicator shall fall within the limits of the prime standard when energized at the voltage levels specified (see 4.6.21.1).

3.12.3 Stray Light. The lighting system shall be so housed as to prevent the leakage of stray light and shield all lamp filaments from direct view. Stray light measurements shall be made as follows: A flat white reflecting surface of 85 \pm 5 percent reflectance shall be placed perpendicular to the front cover glass and parallel to the top edge of the mounting flange. Brightness readings shall be made looking down (perpendicular) on this reflecting surface and 1.0 inch in front of the cover glass. When this reflecting surface is positioned in the lower half of the display, the readings shall not exceed 1.5 foot lamberts and when positioned in the upper half, shall not exceed 0.2 foot lamberts. Measurements shall be repeated looking up on the reflecting surface. In no case shall the readings exceed 0.2 foot lamberts.

3.13 Soldering. Soldering shall be accomplished in accordance with MIL-STD-1866.

3.14 Screw Threads. Unless otherwise specified, the threads of all machine screws 0.060 inch or larger in diameter shall conform to MIL-S-7742.

3.15 Lubrication. The indicator shall be lubricated in accordance with MIL-STD-838.

3.16 Weight. The weight of the indicator with amplifier attached shall not exceed 8.5 pounds.

3.17 FINISHES AND PROTECTIVE COATINGS

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

- a. Dials, small holes, and case inserts need not be anodized.
- b. Aluminum alloys which do not anodize satisfactorily shall be coated with a chemical film in accordance with MIL-C-5541.
- c. 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.
- d. Castings containing nonaluminum alloy integral inserts may be treated with a chemical film in accordance with MIL-C-5541 in lieu of anodizing.
- e. When abrasion resistance is a factor, chemical films in accordance with MIL-C-5541 shall not be used in lieu of anodizing.
- f. Parts in a hermetically sealed container need not be anodized.
- g. When the part is plated with tin over a copper flash, the part need not be anodized.

3.17.2 Steel Parts. Steel parts shall be coated with ion vapor deposited aluminum, where practicable, in accordance with MIL-C-83488, type I or II as applicable and of a class that is adequate to achieve the degree of protection required. Other protective coating in lieu of MIL-C-83488, may be used if demonstrated to be satisfactory and approved by the preparing activity. Cadmium plating must be avoided when satisfactory alternative processes can be used.

3.18 Identification of Product. Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130.

3.19 Workmanship. The indicator, including all parts and accessories, shall be fabricated and finished in a thoroughly workmanlike manner in accordance with MIL-STD-454, requirement 9. Particular attention shall be given to freedom from blemishes, defects, burrs, and marking of parts and assemblies, thoroughness of soldering, welding, brazing, painting, wiring, and riveting, alignment of parts, and tightness of assembly screws and bolts.

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

3.19.2 Cleaning. The indicator shall be thoroughly cleaned, and loose, spattered, or excess solder, metal chips, and other foreign material removed during and after

final assembly.

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

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

3.19.5 Markings. All markings shall be clear and sharp. Dimensions shall be as specified and on any given mark the width shall not vary noticeably throughout the length of the mark. All markings which, for some given indication, become adjacent and are specified to have the same basic dimension at the adjacent point shall not be noticeably different at that point.

3.20 Recycled and Reclaimed Materials. Recycled and reclaimed materials shall be encouraged to the maximum extent possible without jeopardizing the intended end use of the item.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicted or actual, nor does it commit the Government to accept defective material.

4.2 Classification of Inspection. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Quality conformance inspection (see 4.5).

4.3 Inspection Conditions. Unless otherwise specified all inspections shall be performed in accordance with the test condition specified in 4.3.1 of this specification.

4.3.1 Standard Atmospheric Conditions. Unless otherwise specified, tests shall be

conducted at atmospheric pressure (approximately 29.92 inches Hg) and at room temperature (approximately 25° C).

4.3.2 Voltage Input. Unless otherwise specified, the indicator shall be tested with 115V 400 Hz (nominal) single-phase power.

4.3.3 Proper Connection. When the indicator is referred to as being properly connected, it shall mean that it is connected to a test fixture providing a lighting circuit voltage variable from 5V ac or dc to approximately 0V, synchro signals in accordance with 3.7.2 through 3.7.2.2, variable-current d-c signals 1,000-ohm source and with reversible polarity to the meter movements, a-c power as required, and that the pin j is jumped to pin A through a closed switch.

4.3.4 Visual Observation. Unless otherwise specified, all visual observations of indicator performance shall be made at a distance of 2 feet.

4.3.5 Definition of Indicator. Unless otherwise specified in a particular test, the word "indicator" as used herein shall be construed to mean the indicator proper together with the amplifier unit.

4.3.6 Recordings. Upon application of power, the indication of the elapsed time indicator shall be recorded. Readings shall be recorded after completion of the tests specified in 4.6.28, 4.6.30, 4.6.31, 4.6.35.1, 4.6.35.2, and 4.6.36 and after completion of all tests specified under 4.6.

4.4 QUALIFICATION INSPECTION

4.4.1 Test Samples. The test samples shall consist of 3 indicators representative of the production equipment. The samples shall be identified with the manufacturer's part number and such other information as required by the contractors activity.

4.4.2 Qualification Inspection. The qualification inspections shall consist of all tests described under TEST METHODS.

4.5 Quality conformance inspection. Acceptance tests shall consist of:

- a. Individual tests (see 4.5.1)
- b. Sampling plans and tests. (see 4.5.2)

4.5.1 Individual Tests. Each indicator shall be subjected to the following tests as described under 4.6 TEST METHODS:

- a. Examination of product (see 4.6.1)
- b. Starting (see 4.6.2)
- c. Pitch and bank zero (see 4.6.3)
- d. Sensitivity (see 4.6.4)
- e. Followup rate (see 4.6.5)
- f. Followup accuracy (see 4.6.6)
- g. Followup operation (see 4.6.7)

- h. Indication lag (see 4.6.7.1)
- i. Hunting and jumping (see 4.6.7.2)
- j. Overshooting (see 4.6.7.3)
- k. Gimbal freedom (see 4.6.8)
- l. Pitch trim (see 4.6.9)
- m. Zeroing adjustments (see 4.6.10)
- n. Sealing (see 4.6.11)
- o. Power warning indicator (see 4.6.12)
- p. Early failure detection (see 4.6.33)
- q. Inclinator sensitivity (see 4.6.13)
- r. Inclinator zero position (see 4.6.14)
- s. Inclinator friction (see 4.6.15)
- t. Inclinator visibility (see 4.6.16)
- u. Inclinator filling (see 4.6.17)
- v. Response (see 4.6.18)
- w. Pointer balance (see 4.6.19)
- x. Pointer flag alarms (see 4.6.20)
- y. Lighting (see 4.6.21)
- z. Fogging (see 4.6.22)

4.5.2 SAMPLING PLANS AND TESTS

4.5.2.1 Sampling Plan A One indicator shall be selected at random from each 100 or less produced on the contract or order and subjected to the following tests as described under 4.6 TEST METHODS:

- a. Individual tests (with the exception of early failure detection test)
(see 4.5.1)
- b. Power consumption (see 4.6.23)
- c. Low voltage (see 4.6.24)
- d. Magnetic property (see 4.6.25)
- e. Acceleration (see 4.6.26)
- f. Dielectric (see 4.6.27)
- g. Vibration error (see 4.6.28)

- h. Horizon line and bank index null position shaft (see 4.6.29)
- i. Low temperature operation (see 4.6.30)
- j. High temperature operation (see 4.6.31)
- k. Slip indicator leak (see 4.6.31.1)
- l. Inclinator damping, room temperature (see 4.6.32)
- m. Response time (see 4.6.18)

4.5.2.2 Sampling Plan B Unless otherwise specified, 3 indicators selected at random from the first 15 items of the contract or order shall be subjected to the following tests in the order specified and as described under 4.6 TEST METHODS.

- a. Sampling plan A (see 4.5.2.1)
- b. Radio noise interference (see 4.6.34)
- c. High temperature exposure (see 4.6.35.1)
- d. Temperature-altitude (cycling) (see 4.6.35.2)
- e. Temperature shock (see 4.6.35.3)
- f. Humidity (see 4.6.35.4)
- g. Fungus (see 4.6.35.5)
- h. Rain (see 4.6.35.6)
- i. Salt fog (see 4.6.35.7)
- j. Dust (fine sand) (see 4.6.35.8)
- k. Vibration failure (see 4.6.35.9)
- l. Acceleration (see 4.6.36)
- m. Life and MTBF (see 4.6.37)
- n. Sealing thermal shock (see 4.6.38)
- o. Structural (see 4.6.39)
- p. Pitch trim torque (see 4.6.40)
- q. Pitch trim effect (see 4.6.41)
- r. Pressurization (see 4.6.42)

4.5.2.2.1 Indicator Requirements. At the option of the contracting activity, the sampling plan B tests may be divided into 3 groups as follows, to be conducted on 3 sets of 3 instruments each if a need exists to expedite tests. Each indicator shall meet the requirements of all the individual tests after completing the group of

specific tests to which submitted. At the option of the contracting activity, group II may be conducted on empty cases which have all external parts installed or attached as on a completed indicator.

<u>Group I</u>	<u>Group II</u>	<u>Group III</u>
Radio noise interference	Humidity	Vibration failure
High temperature exposure	Fungus	Acceleration
Temperature-altitude cycling	Rain	Life and MTBF
Temperature shock	Salt fog	Structural
Pitch trim effect	Dust (fine sand)	Pitch trim torque
	Sealing thermal shock	Pressurization

4.5.2.3 Rejection and retest. When one item selected from a production run fails to meet the specification, no items still on hand or later produced shall be accepted until the extent and cause of failure are determined. After corrections have been made, all necessary tests shall be repeated.

4.5.2.3.1 Individual Tests May Continue. For operational and production reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of indicators on hand or later produced shall not be made until it is determined that the indicators meet all the requirements of the specification.

4.5.3 Defects In Items Already Accepted. The investigation of a test failure could indicate that defects may exist in indicators already accepted. If so, the contractor shall fully advise the contracting activity of all defects likely to be found and methods of correcting them.

4.6 TEST METHODS

4.6.1 Examination of Product. Each indicator shall be inspected to determine compliance with the requirements specified herein with respect to materials, workmanship, and marking. Each indicator shall be placed in the face-down position, shaken by hand, and inspected in this position to determine that no loose hardware or foreign material is present. Evidence of any such material shall be cause for rejection.

4.6.2 Starting. The indicator shall be properly connected. When power is applied, the warning flag shall disappear and the indicator shall be ready for immediate operation.

4.6.3 Pitch and Bank Zero. The standard test transmitters in the pitch and roll axis shall be set to the 180° dial reading. Power shall be applied and the indicator shall follow up to the zero indications in pitch and bank within $\pm 0.500^\circ$ from any random indication in either axis. This test shall be repeated for any initial indication at the discretion of the contracting activity. The pitch and roll indications shall be adjusted to zero by means of the zeroing adjustments specified in 3.7.2.8.

4.6.4 Sensitivity. The test transmitter for the roll axis shall be moved 0.250° in right bank and returned to the original position and then 0.250° in left roll and returned to the original position. This test shall be repeated in climb and dive with the pitch trim adjusted to its extreme positions except that the pitch test transmitter shall be moved 0.500° in each direction. The test transmitter for the

pitch axis shall be moved 0.250° in dive and returned to the original position and then 0.250° in climb and returned to the original position. There shall be a smooth, perceptible movement of the indicator bank index and horizon line for each movement of the appropriate test transmitter.

4.6.5 Followup Rate. The indicator shall be properly connected to a remote signal source or standard test transmitter. The followup rates in pitch and roll shall be determined. The rate in the roll axis shall not be less than 300° per second. The rate in the pitch axis shall not be less than 90° per second with the pitch trim at zero and when adjusted to each of its extreme positions.

4.6.6 Followup Accuracy The standard test transmitter in the roll axis shall be displaced to at least 10 random positions other than the 180° dial reading. The indicator shall position itself with the rotor of the standard test transmitter within $\pm 0.500^\circ$ for each position within $\pm 30^\circ$ indication and within 1° at all other indications. The standard test transmitter in the pitch axis shall be displaced to at least 10 random positions other than the 180° dial reading. The indicator shall position itself with the standard test transmitter within $\pm 0.500^\circ$ for each position within $\pm 30^\circ$ indication and within $\pm 1^\circ$ for all other indications.

4.6.7 Followup Operation. Suitable test equipment shall be connected to the appropriate test pins of the indicator to observe and record any hunting, jumping, lag, or overshooting of the indication when the indicator is made to follow the standard transmitter at various constant rates in both the pitch and roll axes. This shall be possible with the indicator sealed. The recorded data shall meet the following requirements: The data shall be recorded during the initial individual tests preceding all other tests and during the final individual tests following the completion of all other tests. While performing the individual tests at other times, the indicator may be checked visually for noticeable hunting, jumping, lag, or overshooting.

4.6.7.1 Indication Lag. The indication shall not lag behind the shaft of the remote input transmitting synchro by more than the amount shown in the curve of figure 7. The indicator shall be tested at three different rates (including the maximum rate specified in 4.6.5) for each servo. The servos may be checked at any rate within the maximum rate, at the discretion of the contracting activity. A 25 percent increase in indication lag shall be permitted during temperature extremes and low voltage tests.

4.6.7.2 Hunting and Jumping. There shall be no noticeable hunting or jumping when the standard transmitter shaft is not rotating. The manufacturer shall conduct a survey on the indicator of his design operated over the full range of operating speeds. The testing rates chosen for hunting and jumping shall include at least one rate within each of the following ranges; 0° to 20° per second, 20° to 90° per second, and 90° to 300° per second. The peak-to-peak amplitude of the hunting and jumping shall not exceed 0.125 for shaft speed up to 90° per second in the pitch axis, or 300° per second in the roll axis. The maximum shaft speed at which the test is conducted in the pitch axis shall be 90° per second and the maximum shaft speed at which the test is conducted in the roll axis shall be 300° per second.

4.6.7.3 Overshooting. Upon the completion of pitch or roll maneuvers, overshooting shall be held to a practical minimum and shall not exceed one overswing with a maximum amplitude of 3° with a step input equal to the maximum allowable followup lag.

4.6.8 Gimbal Freedom. The indicator shall be properly connected and the remote signal source or standard test transmitter moved 360° in roll and pitch. The indicator shall follow smoothly without sticking and overshooting or hunting greater in magnitude than that specified in 4.6.7. There shall be no disturbance of any of the meter movements as a result of this test.

4.6.9 Pitch Trim. The pitch trim knob shall be adjusted to its limits and the deflection of the horizon line observed. The deflection shall be from 5° to 10° down and from 10° to 20° up from the level flight indications.

4.6.10 Zeroing Adjustments. The indicator shall be properly connected to the standard test transmitters with each set to electrical zero. The roll zeroing adjustment shall be moved to its extremes and the deflection of the bank index shall not be less than $+3^{\circ}$ from the zero positions. The pitch test transmitter shall be rotated 3° in climb and then 3° in dive. In each case, the pitch trim knob shall be loosened on its shaft and the shaft rotated until the indication is zeroed. The pitch trim knob shall be tightened again to the shaft at the zero position. In each case, the requirements of 4.6.9 shall be met. This test shall be performed only during the initial individual tests and during the final individual tests conducted as part of the life tests.

4.6.11 Sealing. The case of the indicator proper shall be tested for leaks by means of a mass spectrometer type of helium leak detector. The maximum leak rate shall not permit more than 10 percent contamination of the filling medium after 1,000 hours at a pressure differential of approximately 1 atmosphere.

4.6.12 Power Warning Indicator. The indicator shall be properly connected but no power shall be applied. Power shall then be applied and the flag shall disappear. The power shall be disconnected and the flag shall immediately appear. Power shall be reapplied and the jumper from pin J to A shall be disconnected. The flag shall appear.

4.6.13 Inclinometer Sensitivity. With the dial vertical, the indicator shall be rotated about the roll axis to the right until the ball is just short of its limit. The angle of rotation shall be $10^{\circ} \pm 2^{\circ}$. The test shall be repeated rotating the instrument to the left. The same tolerance shall apply. The ball shall not stick at the high end of the tube.

4.6.14 Inclinometer Zero Position. The indicator shall be positioned with the upper edge of the mounting bezel horizontal, and the indicator shall be gently tapped. The ball shall rest at the zero mark of the slip indicator within ± 0.031 inch.

4.6.15 Inclinometer Friction. The indicator shall be slowly tipped to either side in the vertical plane of the dial. The ball shall roll smoothly when the indicator is gently tapped.

4.6.16 Inclinometer Visibility. The indicator shall be so tipped that the ball is at rest at either end of the tube. Not less than two-thirds of the ball shall be visible when the ball is viewed from the position specified in 3.7.4.2.

4.6.17 Inclinometer Filling. The indicator shall be so tipped that all the air in the tube is trapped in the expansion chamber end of the tube. The face of the indicator shall be in a vertical plane with the line joining the centers of the two lower mounting holes in a horizontal plan. No part of the air bubbles shall be visible when the indicator is viewed from the position specified in 3.7.5.2.

4.6.18 Response. The response of the vertical, horizontal, displacement, and rate of turn pointers shall be measured and shall be in accordance with 3.7.6.1.2, 3.7.6.3.2, 3.7.6.4.2, and 3.7.7.2, respectively.

4.6.18.1 Response Time. The response time of the indicating pointers shall be measured and shall be in accordance with 3.7.6.1.5, 3.7.6.3.5, 3.7.6.4.5, and 3.7.7.5, respectively. For this test, the instrument shall be shunted externally with a resistance of 350 ohms to allow for the shunting effect of another indicator in parallel with the usual source. The voltage source shall be steady and shall be applied to the above circuit through at least 50,000 ohms. At least 5 seconds shall be allowed in order to establish the calibration of the 100 percent mark.

4.6.19 Pointer Balance. With the indicator in a normal upright position and the pointer mechanism de-energized, the vertical and horizontal pointer shall each be adjusted by means of the zero correctors to bisect the center of the indication. The vertical, horizontal, and rate of turn pointers shall not deflect more than 0.015 inch and the displacement pointer shall not deflect more than 0.031 inch as the indicator is rotated 360° in roll and pitch.

a. The indicator shall be accelerated along its normal vertical axis with a force of 10g. The pointers shall not vary by more than 0.078 inch from the zero position. This test shall be repeated with the acceleration applied along each of the two axes that are perpendicular to the vertical axis and to each other. The positions shall not vary more than 0.078 inch from the zero position.

4.6.20 Pointer Flag Alarms. The response of the pointer flag alarms shall be measured and shall be in accordance with 3.7.6.2.2.

4.6.21 Lighting. The lighting circuits of the indicator shall be properly connected and the indicator tested in accordance with MIL-L-25467 or MIL-L-27160, as applicable. Upon completion of the life test and other environmental tests as specified, slight degradation in the brightness and color readings shall not be considered as failures unless so determined by the procuring activity. Lighting data (brightness and color) shall be taken at the start of the life test and at least every 500 hours thereafter. In addition, the indicator shall meet the requirements specified in 3.12.

4.6.21.1 Visual Comparison. The prime standard and the indicator under the test shall be placed side by side at eye level. The two indicators shall be viewed at a distance of approximately 2 feet in a sighting cone 30° from normal to the surface of the cover glass. The overall lighting of the two units shall be compared with 3.00± 0.01V applied to the lighting terminals of the indicator under test. General overall lighting level comparison shall then be made between the production indicator being tested and the prime standard with the prime standard voltage at 2.85V and then at 3.15V. All production units failing the visual comparison tests shall have the questionable areas measured with a photometer as specified in the applicable lighting specifications MIL-L-25467 or MIL-L-27160. If they also fail this test, the production indicators shall be rejected. Visual comparison by prime standard shall not be used for testing of preproduction or qualification units. If the general overall lighting level of the indicator does not fall within the brightness limits of the prime standard when energized at the specified voltage levels, the indicator shall be rejected.

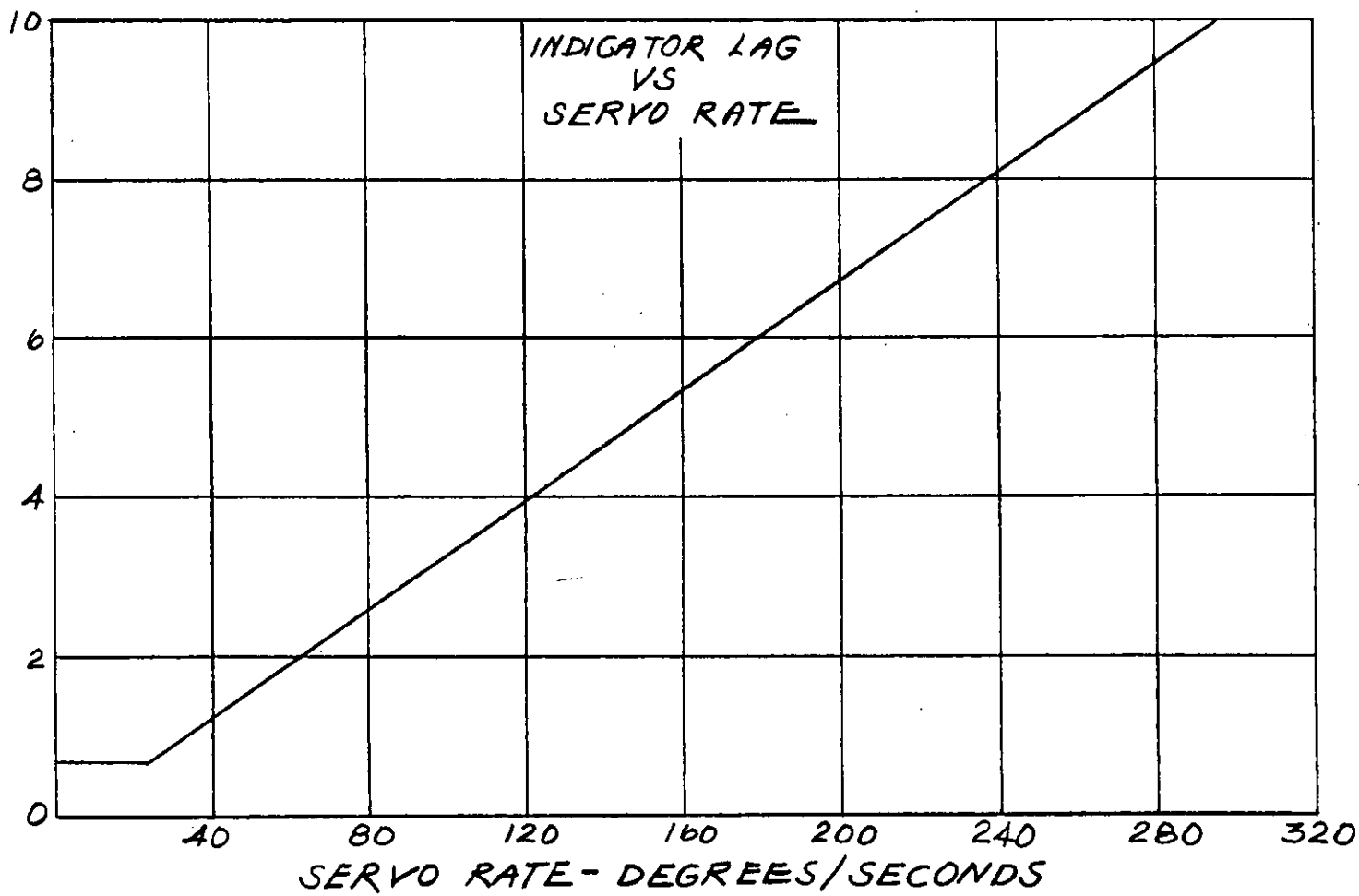


FIGURE 7. Indicator lag degrees

4.6.21.2 Sub-Areas Comparison. The requirements of 3.12 shall be measured. The airplane may be divided into subareas; such as each wing, center dot, and white areas in between. The average brightness of these individual areas shall be compared with the maximum brightness on any portion of the grey sphere. The maximum brightness of the grey sphere shall not exceed 0.60 times the minimum brightness of the individual sections of the airplane mentioned above.

4.6.22 Fogging. The indicator shall be energized for a minimum period of 1 hour in a $71^{\circ} \pm 2^{\circ}$ C controlled ambient. After this period and while at this temperature, an ice cube shall be rubbed on the indicator glass face for a period of from 1 to 2 minutes. The glass shall be wiped dry (do not use compressed air) and the indicator inspected for evidence of water or oil fog. Evidence of fogging shall be caused for rejection.

4.6.23 Power Consumption. The power consumption of the indicator shall be measured with suitable meters. The a-c consumption shall not exceed 26 va. The power factor shall be maintained between 0.85 and 1.00. The power consumption and power factor shall be measured with the pitch servo operating at 90° per second and the roll servo operating at 300° per second.

4.6.24 Low Voltage. The indicator shall be properly connected. The a-c voltage shall be reduced to 103V and 320 HZ. The indicator shall meet all individual tests, except 4.6.11, 4.6.13, 4.6.14, 4.6.15, 4.6.16, 4.6.17, 4.6.18, 4.6.19, 4.6.20 and 4.6.21.

4.6.25 Magnetic Property. This test shall be made first with no power applied to the indicator and then repeated with the indicator operating on rated power. The indicator shall be held in various positions magnetically east or west of and not more than 12 inches from the center of a free magnet approximately 1.500 inches long in a magnetic field with a horizontal of 0.18 ± 0.01 oersted. The maximum deflection of the magnet shall not exceed 5° . An aircraft compass with the compensating magnets removed may be used as the free magnet for the test.

4.6.26 Acceleration Tests. The indicator shall be properly connected and power applied to the attitude circuit. The indicator shall be accelerated along its normal vertical axis with a force of 10g. The attitude display shall not vary by more than 1° in pitch or roll from the initial indication and the pointers shall not vary by more than 0.078 inch from the zero position. This test shall be conducted with the altitude set at zero pitch and roll and with each axis displaced 90° .

4.6.27 Dielectric. With the indicator properly connected to the amplifier unit, a potential of 500V dc shall be applied between isolated pins of Scintilla connector PT 10-150631-32P and between pins of this connector and the indicator case for a period of 10 seconds. There shall be no breakdown of insulation.

4.6.28 Vibration Error. The indicator, with amplifier attached, shall be mounted as specified in MIL-STD-810C, method 514.2, equipment category 6.2, properly connected, and shall be subjected to vibration and shall meet the following requirements.

4.6.28.1 Roll, Pitch, and Director Pointers. The maximum total amplitude of roll, pitch, horizontal pointer, vertical pointer and displacement pointer (hereinafter referred to as "the pointers") oscillation, throughout the frequency range shall be noted and shall not exceed 0.5000 in roll and pitch or one-half of the width of the respective pointer.

4.6.28.2 Roll, Pitch, and Pointer variation. Throughout the frequency range, the maximum variation during vibration roll, pitch, or the pointers, from the original indication before vibration, shall be noted and shall not exceed 0.500° in roll and in pitch, or one-half of the width of the respective pointer.

4.6.28.3 Oscillation and Variation. Oscillation and variation tests may be conducted at any indication at the discretion of the inspector.

4.6.28.4 Inclinometer accuracy. The slip indicator reading shall not differ at any time by more than 0.062 inch from the reading obtained when the indicator is at rest.

4.6.29 Horizon Line and Bank Index Null Position Shift. The indicator shall be properly connected to standard test transmitters in the pitch and roll axes. The transmitters shall be set to drive the indicators in both axes to the zero position. The input voltage and frequency shall be varied within the following limits and combination:

Frequency	320 to 480Hz
A-C voltage	130 to 127V

The horizon line shall not shift more than $+0.062$ inch from normal position. The bank index shall not shift more than 0.250° from normal null position.

4.6.30 Low Temperature Operation. With no power applied, the indicator shall be properly connected and placed in a chamber at a temperature of $-54^{\circ} \pm 2^{\circ}$ C for a 4-hour period. At the end of this period and with the indicator at the reduced temperature, power shall be applied for a period of 10 minutes after which the indicator shall meet the individual tests and the test specified in 4.6.32 except as follows:

- a. The time of roll shall be 4 seconds maximum.
- b. The meter movements shall be checked only for operation without evidence of sticking or binding, and to ascertain that they have not shifted by more than ± 0.015 inch from their null settings at room-temperature conditions.
- c. The tests specified in 4.6.11, 4.6.18, 4.6.19.1, and 4.6.21 need not be conducted until the indicator has returned to room temperature.

4.6.31 High Temperature Operation. The indicator shall be properly connected and placed in a chamber at a temperature $71^{\circ} \pm 2^{\circ}$ C and operated with power applied for a 4-hour period. At the end of this period and while at the high temperature, the indicator shall be subjected to and shall meet the individual tests except as follows:

- a. The meter movements shall be checked only for operation without sticking or binding, and to ascertain that they have not shifted by more than ± 0.015 inch from their null settings under room-temperature conditions.
- b. The tests specified in 4.6.11, 4.6.18, 4.6.19.1, and 4.6.21 need not be conducted until the indicator has returned to room temperature.

4.6.31.1 Slip Indicator Leakage. Prior to the high-temperature test, the size of the air bubble in the tube shall be determined with the indicator at room temperature.

Following the high-temperature test, the size of the air bubble shall again be determined with the indicator at room temperature. There shall be no appreciable change in the size of the air bubble.

4.6.32 Inclinometer Damping, Room Temperature. The plane of the face of the indicator shall be placed in a vertical position with the upper flange inclined to the horizontal at an angle of 12° . The indicator shall be tipped suddenly through a vertical angle of 24° so that the ball will roll to the opposite of the tube. The time of roll of the ball from the zero mark of the indicator to the end of the tube shall be between 0.15 and 0.50 second.

4.6.33 Early Failure Detection. The following listed tests shall be conducted once on every indicator furnished under this specification. These tests shall be conducted after calibration of the indicator and prior to the individual tests conducted in accordance with 4.5.1. During these tests, no adjustments shall be made. Failure to pass any of these tests is reason for rejection. The tests of 4.6.33.1, 4.6.33.2, 4.6.33.3, 4.6.33.4, and 4.6.33.5 may be conducted separately or concurrently.

4.6.33.1 Horizontal Pointer. A current of 13.5 ma dc shall be applied to pins W (+) and X (-) as a step input. This current shall be applied for a total of 10 cycles. Each following cycle shall not start until the horizontal pointer has returned to the zero position. Failure of the pointer to disappear or return to the zero position after each cycle shall constitute reason for rejection of the unit. The above shall then be repeated but with the polarity reversed on pins W and X except that the step input shall be 5.0 ma. After completion of 10 cycles each direction, the response of the horizontal pointer shall be tested for requirements specified in 3.7.6.3.1, 3.7.6.3.2, and 3.7.6.3.4. Failure to meet these requirements shall be cause for rejection.

4.6.33.2 Vertical Pointer. A current of 13.5 ma dc shall be applied to pins Y (+) and Z (-) as a step input. This current shall be applied for a total of 10 cycles. Each following cycle shall not start until the vertical pointer has returned to the zero position. Failure of the pointer to disappear or return to the zero position after each cycle shall constitute reason for rejection of the unit. The above shall then be repeated but with the polarity reversed on pins Y and Z except that the step input shall be 5.0 ma. After completion of 10 cycles in each direction, the response of the vertical pointer shall be tested for requirements specified in 3.7.6.1.1, 3.7.6.1.2, and 3.7.6.1.4. Failure to meet these requirements shall be cause for rejection.

4.6.33.3 Vertical Alarm Flag. A current of 380 ua dc shall be applied to pins U (+) and V (-) as a step input. This current shall be applied for a total of 10 cycles. During each cycle the flag shall disappear and reappear. Upon completion of the cycles, the vertical alarm flag shall meet the requirements of 3.7.6.2.2.

4.6.33.4 Displacement Pointer. A current of 1,000 ua dc shall be applied as a step input to pins S (-) and T (+). This current shall be repeated for a total of 10 cycles. The following cycle shall not start until the displacement pointer has centered. Failure of the displacement pointer to center shall be cause for rejection. After completion of the above the test shall be repeated with the polarity reversed on pins S and T except that the step input shall be 500 ua. Upon completion of 10 cycles in each direction, the unit shall be tested for and shall meet the requirements specified in 3.7.6.4, 3.7.6.4.1, 3.7.6.4.2, and 3.7.6.4.4.

4.6.33.5 Servo Loops. The pitch and roll servo loops shall be excited and

subjected to an input which shall oscillate both axes through a manimum of $\pm 30^\circ$ from 5 to 7 times per minute. This test shall be conducted for 20 hours continuously. Any failure during or as a result of this test shall be cause for rejection.

4.6.34 Radio Noise Interference. The radio noise interference tests shall be conducted in accordance with MIL-STD 461 and MIL-STD-462.

4.6.35 Environmental Tests. The indicator shall be subjected to the following tests, conducted in accordance with the specified procedures fo MIL-STD-810C and as specified.

4.6.35.1 High Temperature Exposure. The indicator shall be properly connected and subjected to the high temperature exposure test in accordance with 501.1, Procedure I, for a 48-hour period with no power applied. At the end of this period and while still at the high temperature, the indicator shall meet the test specified in 4.6.8. All meter movements shall operate without binding or sticking and shall be checked to ascertain that they have not shifted more than ± 0.016 inch from their null settings under room conditions. At the conclusion of this test with the indicator at room temperature, the indicator shall be checked for satisfactory operation. Satisfactory operation is defined as proper operation of all servos and meters without sticking or binding at any indication.

4.6.35.2 Temperature-Altitude (cycling). The indicator shall be properly connected and tested in accordance with method 504, except that step 7 shall be conducted at 71°C and step 10 shall not be conducted. Satisfactory operation is defined as proper operation of all servos and meters without sticking or binding at any indication. At the conclusion of this test and after the indicator has returned to room temperature, it shall be subjected to and shall meet the individual tests with the exception of the early failure detection.

4.6.35.3 Temperatue Shock. The indicator shall be subjected to a temperatue shock test in accordance with method 503 after which it shall be subjected to and shall meet the individual tests with the exception of early detection.

4.6.35.4 Humidity. The humidity test shall be conducted in accordance with method 507. At the conclusion of this test, the indicator shall be subjected to and shall meet the tests specified in 4.6.7 and 4.6.18. There shall be no evidence of corrosion or rust of the internal or external parts as a result of this test.

4.6.35.5 Fungus. The indicator shall be subjected be conducted in acordance with method 508 after which the indicator shall be subjected to and shall meet the tests specified in 4.6.7 and 4.6.19. There shall be no evidence of deterioration that adversely affects subsequent operation nor shall fungus be supported.

4.6.35.6 Rain. The indicator shall be subjected to a rain test in accordance with method 506 except that the indicator shall be mounted in a rain test chamber for 0.50 hour with the dial in a vertical plane and for 0.50 hour with the dial in a horizontal plane (dial face upward). Upon removal from the chamber, the indicator shall be subjected to and shall meet the tests specified in 4.6.7 and 4.6.18.

4.6.35.7 Salt Fog. The salt fog test shall be conducted in accordance with method 509 for a period of 50 hours. At the end of this period, the indicator shall meet the tests specified in 4.6.7 and 4.6.18. There shall be no damage as a result of this test and the tolerance specified under individual tests shall apply.

4.6.35.8 Dust (fine sand). The sand and dust test shall be conducted in accordance

with method 510. At the end of this test, the indicator shall be removed from the test chamber and allowed to cool at room temperature. The indicator shall then be subjected to and shall meet the tests specified in 4.6.7 and 4.6.18.

4.6.35.9 Vibration Failure. The indicator shall be subjected to a vibration test in accordance with method 514.2, equipment category 6.2 except that the frequency sweep shall be made between 5 and 50 cps. The amplifier unit shall be tested in accordance with method 514.2 equipment category 6.1 at room temperature only. At the conclusion of these tests the indicator shall be properly connected and shall pass the tests specified in 4.6.3 and 4.6.4. No looseness in the mechanism nor damage to any part of the indicator shall result from this test.

4.6.36 Acceleration. The indicator (not operating) shall be mounted in its normal operating position and accelerated first along its vertical axis and then along each of two axes that are perpendicular to the vertical axis and to each other. The indicator shall be subjected to an acceleration of 20g in each of the above axes for a period of 1 minute. At the end of this acceleration, the indicator shall meet the individual tests. No damage to the indicator shall result from this test.

4.6.37 Life and Mtbf In conducting the life test, a cycle shall consist of a 4-hour period of operation followed by a period of 5 minutes during which no power is applied to the indicator. During the operating period, the following conditions shall exist.

- a. Both axes of the attitude display shall be oscillated through a minimum of $\pm 30^\circ$ 5 to 7 times per minute.
- b. The lighting circuits (either red or white) shall be energized with 5V ac or dc.
- c. The power warning flag shall show that proper power is being supplied to the indicator.
- d. The vertical, horizontal, displacement, and the rate of turn pointers shall be driven through their complete operating ranges (none of the pointers driven out of view) at the rate of 5 to 7 times per minute.
- e. Displacement and vertical pointer alarm flags shall be energized.

4.6.37.1 Light and Flag Circuits. During the 5-minute resting or cooling-off period, all power shall be removed from the instrument under test, including power to the pointer, lighting circuits, and flag circuits. During this resting or cooling-off period, the standard test transmitter shall remain excited and its rotor shall continue to be displaced through a minimum of $\pm 30^\circ$ at a rate of 5 to 7 times per minute. The cycles defined herein shall be repeated a sufficient number of times to extend the operating time of the indicator to a total of 2,000 hours. During each 5-minute period, the pitch trim knob shall be rotated on its extremes in both directions 10 times. No loosening shall result at the end of 2,000 hours. During each 4-hour period each meter movement shall be subjected to a step input equivalent to that necessary to drive the meter out of view. No damage or stickiness shall result. There shall be no failures if the indicator or amplifier except as allowed by the MTBF requirements of 3.5.2 during the life test and at the end of the 2,000 hours, the indicator shall be subjected to and shall pass the sampling plan A tests. While conducting the life test, the indicator may be checked for compliance with the individual tests after any period of cycling. Accumulated

hours from tests prior to life and sampling plan A, after life, may be considered as part of the total 2,000 hours except for group II tests.

4.6.38 Sealing Thermal Shock. The indicator shall be immersed alternately in tap water maintained at $85^{\circ} \pm 5^{\circ}$ C and $5^{\circ} \pm 4^{\circ}$ C for a total of 8 cycles. The length of time for each bath immersion shall be 30 minutes. Not more than 5 seconds shall elapse between bath immersions. No damage to the hermetic seal shall result due to this test. Following the immersions, the indicator proper shall be tested for leaks by means of a mass-spectrometer-type of helium leak detector. The initial maximum detected leak rate at a differential pressure of 1 atmosphere shall not permit more than 10 percent loss of the total filling medium after 1,000 hours.

4.6.39 Structural. A test shall be conducted to ascertain that neither the indicator electrical connector nor the indicator case is damaged or deformed in any way when a total force up to 60 pounds is applied to the connector along the longitudinal axis of the instrument while inserting the indicator into a stationary mount upon installing the indicator in the aircraft. The testing apparatus and procedure to be utilized shall be approved by the procuring activity prior to conducting this test.

4.6.40 Pitch Trim Torque. The torque required to rotate the pitch trim knob shall be measured throughout the range of settable indications in both the cw and ccw directions and shall be from 1 to 8 ounce-inches. A minimum of 4 readings shall be taken.

4.6.41 Pitch Trim Effect. Two indicators shall be connected in parallel to the same power source with both pitch synchro control transformers connected to the same standard test transmitter. The standard test transmitter shall be an Eclipse-Pioneer type AY200-1, or equal, and shall be connected as specified in 3.7.2.1 and 3.7.2.2 except that a calibration dial need not be provided. The pitch transmitter stator leads shall also be connected to a third synchro control transformer, Eclipse-Pioneer type AY500-5, or equal, having a 10,000-ohm resistive load connected across the rotor leads. The following test procedure shall apply:

- a. With pitch trim knob of each indicator set to a visual indication of zero pitch trim, the test transmitter rotor shall be positioned to produce a zero degree ($\pm 5^{\circ}$) pitch indication on the two indicators.
- b. The rotor of the third synchro transformer shall then be positioned to produce null voltage across the control transformer rotor winding of 100 millivolts or less, as measured by a vacuum tube voltmeter.
- c. Rotation of the pitch trim knob of either indicator from the zero trim position to the extreme position in either direction shall not produce a change in the null voltage across the third control transformer rotor of more than ± 20 millivolts from the initial null voltage reading. The pitch trim knob of the other indicator shall be maintained in the zero position during this test.
- d. This test shall be repeated with the test transmitter rotated $180^{\circ} \pm 5^{\circ}$ from the original position.
- e. All the tests of 4.6.41 shall be conducted as outlined using an Eclipse-Pioneer type AY200-3, or equivalent, as the test transmitter.
- f. All the tests of 4.6.41 shall be conducted as outlined using a

Kearfott CM01012-107, or equivalent, as the test transmitter.

4.6.42 Pressurization. The indicator shall be placed in a chamber with absolute pressure of 28 pounds per square inch and temperature of 25° C for a period of 4 hours. During this period, no deformation or other damage to the indicator shall occur. At the conclusion of this test, the indicator shall operate satisfactorily. Evidence of deformation, damage, or any unsatisfactory operation shall be cause for rejection. After this test, the indicator shall be subjected to and shall pass the specified leak rate test.

4.7 Inspection of packaging. The inspection of the preservation-packaging and interior package marking shall be in accordance with group A and B quality conformance inspection requirements, section 4 of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of applicable container specification and the marking requirements of MIL-STD-129."

4.7.1 Qualification. When the unit container is capable of serving as the shipping container, Qualification Inspection and rough handling test as outline in section 4 of MIL-P-116, shall be accomplished followed by a functional test of the unit to insure freedom from operational malfunction."

5. Packaging

5.1 Preservation. Preservation shall be level A, C, or Industrial, IAW MIL-STD-2073-1, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Indicator shall be cleaned in accordance with process C-1 or MIL-P-116.

5.1.1.2 Drying. Indicator shall be dried in accordance with process D-4 of MIL-P-116.

5.1.1.3 Preservation application. Preservative shall not be used.

5.1.1.4 Unit packaging. Unless otherwise specified by the contracting activity, each indicator shall be packaged in quantity unit packs of one each in accordance with Method IC-1 of MIL-P-116. Each indicator shall be placed in a PPP-B-636 Fiberboard container weather resistant, with sufficient cushioning material between bag and unit container of a type, density, and thickness to insure shock transmission does not exceed peak values in G's established for the indicator when completed packs are subjected to the rough handling drop tests of MIL-P-116.

5.1.2 Level C. Each indicator shall be clean, dry, and individually packaged in a manner that will afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity.

5.1.3 Industrial. The Industrial preservation of indicator shall be in accordance with ASTM D3951.

5.2 Packing. Packing shall be level A, B, C, or Industrial as specified (see 6.2).

5.2.1 Level A. Indicator packaged as specified in 5.1.1 shall be packed in shipping containers conforming to PPP-B-601, Styles A or B, Class overseas, unless otherwise specified by the contracting activity. Insofar as practical, exterior shipping container shall be of uniform shape, size, minimum tare and cube consistent with the protection required.

5.2.2 Level B. Indicator packaged as specified in 5.1.1 shall be packed in shipping containers to PPP-B-636, class weather-resistant, unless otherwise specified by the contracting activity. Other requirements as specified in 5.2.1 apply.

5.2.3 Level C. Packing shall be applied which affords adequate protection during domestic shipment from the supply source to the first receiving activity for immediate use. This level shall conform to applicable carrier rules and regulations.

5.2.4 Industrial. The packaged indicator shall be packed in accordance with ASTM D3951.

5.3 Marking. In addition to any other markings required by the contract or order (see 6.2), interior and exterior containers shall be marked in accordance with MIL-STD-129."

6. NOTES

6.1 Intended Use. The remote attitude director indicator covered by this specification is intended for use in high performance aircraft as part of integrated panel. The indicator will be controlled by a vertical reference control providing transmitting synchro pitch and roll output signals and a flight director computer providing director signals for the d-c meter movement.

6.2 Acquisition Requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. When sampling plan B tests are not to be conducted.
- c. Level of packaging and packing desired.
- d. Issue of DODISS to be cited in the solicitation, and if required, the specified issues of individual documents referenced (see 2.1).

6.3 Definition.

6.3.1 Hermetic Seal. Hermetic sealing is the process by which an item is totally enclosed by a suitable metal structure or case and sealed airtight by fusion of metallic or ceramic materials.

This includes the fusion of metals by welding, brazing, or soldering; the fusion of ceramic materials under heat or pressure; and the fusion of ceramic materials into a metallic support. Elastomeric or resinous materials or combinations of these materials may be used as a cover-glass seal provided that the specific leak-rate requirements are met under all tests and environmental conditions listed herein and prior approval of the contracting activity. A hermetic seal is not intended to include seals accomplished by gaskets.

6.4 Qualifications. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-27193 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is OC-ALC/MMEOR, Tinker AFB, OK 73145-5990 and information pertaining to qualification of products may be obtained from that activity.

6.5 Subject term (key word) listing.

Flight Remote
Instrument
Primary

6.6 International interest. Certain provisions of this specification are the subject of international standardization agreement NAT-STD-3637, AIR-STD 10/54 and AIR-STD 10/42. When amendment, revision, or cancellation of this specification is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels including departmental standardization offices to change the agreement or make other appropriate accommodations.

6.7 Changes from Previous Issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CUSTODIAN:
AIR FORCE - 99

PREPARING ACTIVITY:
AIR FORCE - 71

REVIEWER:
DEPSO - 01

PROJECT NO.
6610-F265

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER

2. DOCUMENT TITLE

MIL-I-27193C(USAP)

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

☐

VENDOR

☐

USER

☐

MANUFACTURER

☐

OTHER (Specify):

b. ADDRESS (Street, City, State, ZIP Code)

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

b. WORK TELEPHONE NUMBER (Include Area Code) - Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional

8. DATE OF SUBMISSION (YYMMDD)

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)