

INCH-POUND

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SUPERSEDING

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PERFORMANCE SPECIFICATION

COMPASS, MAGNETIC, MOUNTED



Comments, suggestions, or questions on this document should be addressed to: Oklahoma City Air Logistics Center/ENSDAA, 3001 Staff Drive, Suite 1AC-82A, Tinker AFB, OK 73145-3036 or emailed to af71@tinker.af.mil. Since contact information can change you may want to verify the currency of this address using the ASSIST database at <http://assist.daps.dla.mil>.

MIL-PRF-38214D

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

1. SCOPE

1.1 Scope. This specification covers the requirements for four types of integrally-lighted, flange-mounted, pilot's standby magnetic compasses (see 6.4.7).

1.2 Classification. Compasses shall be of the following types, as specified (see 6.2):

<u>Type</u>	<u>Reference Number</u>	<u>Description</u>
<u>Type I</u>		<u>Dual Lamp, low voltage</u>
	AQU-3/A	White light.
	AQU-5/A	Red light.
	AQU-14/A	White light, (4.5VDC).
<u>Type II</u>		<u>Dual Lamp, normal voltage</u>
	MS17983-4/Y	Yellow Markings / Red Light.
	MS17983-4	White Markings / Red Light.
<u>Type III</u>		<u>NVIS Green High Intensity Lighting.</u>
	AQU-3/AN5	NVIS Green light (low voltage).
	AQU-3/AN24	NVIS Green light (normal voltage).
<u>Type IV</u>		<u>Special Applications</u>
	160J18047	A-10 Aircraft, NVIS Green, High Vibration.
	AQU-3A/SJP	AH-64D Longbow Apache, High Vibration

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. These lists do not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of these lists, document users are cautioned that they must meet the requirements specified in the documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

MIL-PRF-38214D

DEPARTMENT OF DEFENSE SPECIFICATION

- AN3116 - Plug Assembly, Instrument Electrical
- MIL-L-25467 - Lighting, Integral, Red, Aircraft Instrument, General Specification For
- MIL-L-85762 - Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible

DEPARTMENT OF DEFENSE STANDARDS

- FED-STD-595/37038 - Black, Lusterless
- FED-STD-595/37875 - White, Lusterless

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE/AMERICAN SOCIETY FOR QUALITY (ANSI/ASQ)

- ANSI/ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attributes (DoD-adopted)

(ANSI documents may be obtained at www.ansi.org or from American National Standards Institute, 25 West 43rd Street, New York, NY 10036.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD-adopted)

(ASTM documents may be obtained at www.astm.org or addressed to the American Society for Testing and Material, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

NORTHROP GRUMMAN CORPORATION

- SA220R0307 - Final Report, A-10A Shock, Vibration and Acoustics Qualification Procedures for Aircraft Equipment

MIL-PRF-38214D

- ES220S0013 - Product Function Specification, Integrally Illuminated Information Panels, NVIS Compatible.

(Northrop Grumman Corporation documents may be obtained at <http://www.northropgrumman.com/index.htm> or addressed to Northrop Grumman Corporation Military Aircraft Systems Division, 600 Grumman Way West, Bethpage, N.Y. 11714.)

MACAIR

- 91B0445 - General Requirements for T-45A Crew Station Instrumentation Integral Illumination
- LL0060-200 - AH-64D Vibration Requirements

(MACAIR documents may be obtained at <http://www.boeing.com/> or addressed to Boeing Technical Library at 325 McDonnell Blvd #110, Hazelwood MO 63042.)

RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)

- RTCA/DO-160 - Environmental Conditions and Test Procedures for Airborne Equipment

(RTCA documents may be obtained at www.rtca.org or addressed to RTCA Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The compasses furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL) before contract award (see 4.2 and 6.3). Qualification for one type of compass shall neither preclude nor include qualification for the other types of compasses.

3.2 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the materials meet or exceed the operational and maintenance requirements, and promote economically advantageous life cycle cost.

3.3 Materials. All materials shall be suitably treated to resist corrosion due to electrolytic decomposition, fungus, salt fog, and any other atmospheric condition that may be encountered

MIL-PRF-38214D

during operational use or storage. Non-magnetic materials shall be used to the maximum extent possible. The use of toxic chemicals, hazardous substances, or ozone depleting chemicals shall be avoided, whenever feasible.

3.3.1 Plastic. No part of the compass case or internal assembly shall be made of plastic.

3.4 Interface.

3.4.1 Dimensions. The compass shall dimensionally conform to the envelope drawing in figure 2.

3.4.2 Mounting flange. The mounting flange shall be an integral part of the compass.

3.4.3 Field of vision. The face of the compass shall be visible from any point within the frustum of a cone, the side of which makes an angle of 30° from a perpendicular to the dial, where the small diameter is the aperture of the compass case and is centered on the lubber line.

3.4.4 Electrical connector. The compass shall use an electrical connector that fits the plug assembly in AN3116-2 and conforms to the external configuration shown in figure 3.

3.4.5 Color.

3.4.5.1 Visible surfaces. Unless otherwise specified (see 6.2), all visible surfaces of the compass shall be lusterless black, color number 37038 of FED-STD-595.

3.4.5.2 Lettering. Unless otherwise specified (see 6.2), all lettering on the compass shall be lusterless white, color number 37875 of FED-STD-595. MS17983-4/Y compass lettering shall utilize United Mineral & Chemical Corp UV Florescence Pigment (GBF-OR) coloring in lieu of the lusterless white.

3.4.6 Reflecting surfaces. Unless contacting the filling liquid, all reflecting glass surfaces shall be treated with a Broad Band Anti-Reflective Visible Light coating (BBAR-VIS).

3.4.6.1 Coated area. The optical elements shall be coated over their entire effective aperture except for a 0.030 inch maximum uncoated edge holding area.

3.4.6.2 Specular reflectance. When applied to the substrate materials having indices of refraction within the range of 1.47 – 1.55, the specular reflectance from each coated surface shall not exceed 0.6 %Abs. for angles of incidence from 0 to 15 degrees utilizing a 440 to 660 nanometer light source.

3.4.6.3 Light loss. Within the wavelength range of 425 to 700 nanometers, light loss (absorbance plus diffuse reflectance) in the coating shall not exceed a maximum average loss of 0.5% and a maximum absolute loss of 2.0%.

MIL-PRF-38214D

3.4.6.4 Coating quality. The coating shall be uniform in quality and condition, clean, smooth, and free from foreign materials, and physical imperfections (flaking, peeling, blistering, blemishes, discolorations, stains, smears, and streaks) nor show evidences of a cloudy or hazy appearance.

3.4.6.5 Abrasion resistance. There shall be no visible damage to the coated surface when rubbed with a Standard # 2 pencil eraser with a force of 2 pounds.

3.4.7 Visibility. The filling liquid shall not obscure the card from the user (see 6.4.2).

3.4.8 Electrical power.

3.4.8.1 Type I & AQU-3A/SJP Compasses shall be powered by 5VDC unless otherwise specified.

3.4.8.2 Type II Compasses shall be exclusively powered by 24VDC.

3.4.8.3 Type III Compasses shall be powered by either 5VDC or 24VDC as specified in 3.5.5.5.

3.5 Performance.

3.5.1 Reliability. The compass shall have a mean time between failures (MTBF) of at least 3,000 flight hours with a discrimination ratio of 2 and a confidence factor of 0.9.

3.5.2 Operational life. The compass shall have an operational life of at least 5 years.

3.5.3 Operation. When properly installed in the aircraft, the compass shall continuously indicate the heading of the aircraft with reference to the magnetic field of the earth.

3.5.4 Weight. The compass shall weigh no more than 14 ounces.

3.5.5 Lighting. The compass shall incorporate an integral lighting system. The lighting system shall permit replacement of incandescent bulbs or the lighting assembly.

3.5.5.1. Lamp location. Lamps shall be accessible from the front (dial side) of the instrument case.

3.5.5.2. Lamp life. The lighting system lamps shall be designed for a life of 1,000 operating hours.

3.5.5.3 AQU-3/A & AQU-3A/SJP (white light). The compass shall incorporate an integral white lighting system using incandescent lamps or light emitting diodes (LED) as a light source.

3.5.5.3.1 Color. The color of the white portions of the indicator with a 4.5 ± 0.050 VDC power applied to the lighting terminals shall have a chromaticity coordinates of $x = 0.440 \pm 0.020$ and $y = 0.405 \pm 0.020$.

MIL-PRF-38214D

3.5.5.3.2 Brightness. When a 4.5 ± 0.050 VDC power applied to the lighting terminals, the light intensity and distribution shall be as follows:

a. White areas. 1.00 ± 0.50 foot-lamberts. The average of all reading taken in the white areas shall be 1.00 ± 0.30 foot-lamberts.

b. Black areas. 0.05 ± 0.03 foot-lamberts when reflected light (wedge and ring lighting) is used and 0.04 ± 0.02 foot-lamberts for refracted light (back lighting).

c. Pointer and lubber lines. 1.20 ± 0.50 foot-lamberts. The average brightness of all the pointer readings shall be 0.10 to 0.50 foot-lamberts higher than the average brightness of the dial white areas.

3.5.5.3.3 Stray light. The lighting system shall be so housed as to prevent the leakage of stray light and to shield the lamp filaments from direct view.

3.5.5.3.4 Light leakage. The lighting system shall in no way restrict the visibility of any graduations, numerals, pointers, or other specified markings.

3.5.5.3.5 Contrast. Contrast between the white and black portions of the indicator scale shall be 12 or greater. Contrast, C, is defined as:

$$C = [B_2 - B_1] / B_1$$

Where: B_2 is the brightness of the white, and B_1 is the brightness of the black portion of the instrument scale.

3.5.5.4 AQU-5/A, MS17983-4 AND MS17983-4/Y (red light). These compasses shall incorporate an integral red lighting system as specified in MIL-L-25467.

3.5.5.5 Type III NVIS Green High Intensity Lighting. The compass shall incorporate an integral, NVIS-compatible, green lighting system as specified in MIL-L-85762. AQU-3/AN5 (low voltage) shall operate at a nominal voltage of 5VDC. AQU-3/AN24 (normal voltage) shall operate at a nominal voltage of 24VDC.

3.5.5.6. 160J18047 (NVIS Green). This is a special application compass design tailored specifically for the A-10 aircraft. The compass shall incorporate an integral, NVIS-compatible, green lighting system as specified in Grumman Aerospace drawing ES220S0013. This compass shall operate at a nominal voltage of 24VDC.

3.5.5.7 AQU-14/A (white light, low voltage). The compass shall incorporate an integral lighting system and operating voltage as specified in MACAIR 91B0445.

3.5.6 Compensator (see 6.8).

3.5.6.1 Adjustability. The compensators shall be manually adjustable to remove the compass deviations on north-south and east-west headings. Both compensators shall be provided with a

MIL-PRF-38214D

zero index mark to show where the compensators exert zero effect during operation. The compensators shall be adjustable from the front using a flat tip screwdriver.

3.5.6.2 Adjustment. The coupling effect between the North-South and East-West Compensators shall be no more than 2° . The change in compensation for equal angular displacements of the adjusting screws shall be the same for both North-South and East-West Compensators. Either adjustment screw may be turned continuously in one direction without meeting a stop, allowing both compensator systems to pass through the entire adjustment range continuously.

3.5.6.3 Compensation range. The compensators shall adjust the deflection of the compass by at least 32° in each direction.

3.5.6.4 Compensator cover. A cover integral to the compass shall be used to cover the compensator systems adjusting devices.

3.5.7 Mounting lugs. When mounted, the mounting lugs of the compass shall withstand 175 pounds of force to the holes of the mounting lugs for 1 minute.

3.5.8 Connector strength. The electrical connector shall withstand a torque of 25 inch-pounds.

3.5.9 Filling liquid (see 6.4).

3.5.9.1 Filler cap. The compass shall incorporate a filler cap.

3.5.9.2 Leakage. The compass shall not leak.

3.5.9.3 Seals. All gaskets and sealing agents shall not affect or contaminate the filling liquid.

3.5.9.4 Internal surfaces. The internal surfaces and the finish on the internal surfaces of the compass shall not interact with the filling liquid of the compass.

3.5.10 Error.

3.5.10.1 Static response. With no compensation applied, the compass shall indicate within 1° of the actual magnetic heading.

3.5.10.2 Time of swing. With no compensation applied, the compass reading shall be within 1° of the original heading within 1.4 to 1.8 seconds, and within 0.5° within 10 seconds after the compass card is deflected (rotated) 30° and released.

3.5.11 Lubber line. When the compass is installed in the proper operating position, the lubber line shall be within 1° of vertical.

3.5.12 Attitude. The compass shall operate when subjected to a bank or pitch up to 18° .

MIL-PRF-38214D

3.5.13 Balance. With the compass housing in a level plane, the base of the compass card shall be within 1° of horizontal. With the vertical component of the magnetic field set to 0 Oersteds, the horizontal component of the magnetic field set to 0.18 Oersteds, and the compass housing in a level plane, the base of the compass card shall be within 3° of horizontal.

3.5.14 Bubbles. No bubbles shall be in the window of the compass when it is subjected to 18° of pitch or roll.

3.5.15 Loops and rolls. The compass shall withstand the acceleration ranges in Table I.

Table I. Acceleration Ranges.

Direction of acceleration	Magnitude of acceleration (G)
Forward	6
Aft	18
Down	9
Up	27
Lateral	12

3.5.16 Rapid altitude change (see 6.5). The compass shall be unaffected by rapid altitude changes.

3.5.17 Turn rate. When the compass is rotated through 360° at a rate of 12° per second in azimuth and abruptly stopped, the heading of the compass shall not overshoot by more than 2°.

3.6 Item identification. The compass shall be permanently and legibly marked with the following information:

- a. Manufacturer's name.
- b. Manufacturer's CAGE code.
- c. Manufacturer's part number.
- d. Manufacturer's lot number.
- e. National Stock Number (NSN).
- f. Date of manufacture.
- g. Contract number.

3.7 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable.

3.8 Environmental conditions.

3.8.1 Operating temperature (see 6.6). The compass shall operate in temperatures from -54° to 71°C.

MIL-PRF-38214D

3.8.2 Storage temperature. The compass shall withstand storage temperatures from -62° to 71°C with no degradation of performance.

3.8.3 Altitude (see 6.6). The compass shall operate at altitudes from 0 to 80,000 feet.

3.8.4 Vibration.

3.8.4.1 Type I & II. These compasses shall operate under all vibration conditions described in RTCA/DO-160, category R for fixed wing and category U for rotary wing aircraft.

3.8.4.2 Type III NVIS Green High Intensity lighting and Type IV AH-64D Longbow Apache Applications. These compasses shall operate under all vibration conditions described in MAC Air specification MSIP LL0060-200.

3.8.4.3 Type IV A-10 Aircraft Application. This compass shall operate under all vibration conditions described in Northrop Grumman Report SA220R0307 for Zone 2.

3.8.5 Sand and dust. The performance of the compass shall be unaffected by sand and dust.

3.8.6 Thermal shock. The performance of the compass shall be unaffected by temperature changes from 71° to 5°C, and from 5° to 71°C, taking place within 5 minutes.

3.8.7 Shock. The performance of the compass shall be unaffected by 10g shocks lasting 10 milliseconds.

3.8.8 Humidity. The performance of the compass shall be unaffected by humidity.

3.9 Maintenance.

3.9.1 Special tools. All maintenance on the compass shall not require the use of any special tools or fixtures other than non-magnetic screwdrivers for calibration.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification (see 4.2).
- b. Conformance (see 4.3).

4.2 Qualification inspection. When required (see 6.3), qualification shall be performed on six compasses. Three compasses shall be subjected to all tests, excluding the environmental tests. The remaining three compasses shall be subjected to all tests, excluding the life tests.

MIL-PRF-38214D

4.3 Conformance inspection. Compasses, sampled according to ANSI/ASQ Z1.4 with AQL 1.5, shall be subjected to the following tests:

- a. High temperature (see 4.6.5).
- b. Low temperature (see 4.6.6).
- c. Altitude (see 4.6.7).
- e. Static response (see 4.6.22).
- f. Time of swing (see 4.6.23).
- g. Turn rate (4.6.28).

4.4 Test conditions. Unless otherwise specified (see 6.2), all tests shall be performed in accordance with the test conditions specified in the applicable test method document or applicable paragraph in this specification.

4.4.1 Friction removal. Unless otherwise specified (see 6.2), the compass shall be lightly tapped with a finger before a test reading is taken.

4.4.2 Attitude. Unless otherwise specified (see 6.2), the compass shall be tested in the level position.

4.4.3 Alignment. The compass shall be tested on an index table aligned to magnetic north using a traceable standard.

4.4.4 Standard field. Unless otherwise specified (see 6.2), all tests shall be performed in a magnetic field with a horizontal component of 0.18 Oersteds and a vertical component of 0.54 Oersteds.

4.5 Requirements cross reference matrix. Table II provides a cross-reference matrix of the section 3 requirements tested or verified in the paragraphs below.

Table II. Requirements cross-reference matrix

Requirement	Verification	Requirement	Verification
3.1	4.2	3.5.8	4.6.16
3.3	4.6.1, 4.6.2, 4.6.3	3.5.9.1	4.6.1
3.3.1	4.6.1	3.5.9.2	4.6.1
3.4.1	4.6.1	3.5.9.3	4.6.18
3.4.2	4.6.1	3.5.9.4	4.6.31
3.4.3	4.6.1	3.5.10.1	4.6.22
3.4.4	4.6.1	3.5.10.2	4.6.23
3.4.5.1	4.6.1, 4.6.17	3.5.11	4.6.1
3.4.5.2	4.6.1, 4.6.17	3.5.12	4.6.24
3.4.6	4.6.4	3.5.13	4.6.30
3.4.6.1	4.6.4.1	3.5.14	4.6.20
3.4.6.2	4.6.4.2	3.5.15	4.6.29

MIL-PRF-38214D

3.4.6.3	4.6.4.3	3.5.16	4.6.21
3.4.6.4	4.6.4.4	3.5.17	4.6.28
3.4.6.5	4.6.4.5	3.6	4.6.1
3.4.7	4.6.1	3.7	4.6.1
3.4.8.1	4.6.12.1.2		
3.4.8.2	4.6.12.1.2		
3.4.8.3	4.6.12.1.2		
3.5.1	4.6.13		
3.5.2	4.6.14		
3.5.3	4.6.22		
3.5.4	4.6.1		
3.5.5	4.6.1		
3.5.5.1	4.6.12.1.1		
3.5.5.2	4.6.12.1.3		
3.5.5.3	4.6.12.2		
3.5.5.3.1	4.6.12.2.1		
3.5.5.3.2	4.6.12.2.2	3.8.1	4.6.5, 4.6.6
3.5.5.3.3	4.6.12.2.4	3.8.2	4.6.5, 4.6.6
3.5.5.3.4	4.6.12.2.4	3.8.3	4.6.7
3.5.5.3.5	4.6.12.2.3		
3.5.5.4	4.6.12.3		
3.5.5.5	4.6.12.4.1		
3.5.5.6	4.6.12.4.2		
3.5.5.7	4.6.12.5		
3.5.6.1	4.6.25		
3.5.6.2	4.6.26		
3.5.6.3	4.6.27	3.8.4.1	4.6.8.1
3.5.6.4	4.6.1	3.8.4.2	4.6.8.2
3.5.6.5	6.4.5	3.8.4.3	4.6.8.3
3.5.7	4.6.15	3.8.5	4.6.9
		3.8.6	4.6.10
		3.8.7	4.6.11
		3.8.8	4.6.19
		3.9.1	4.6.1

4.6 Tests.

4.6.1 Examination. The compass shall be inspected to determine compliance with the requirements specified herein with respect to materials, plastic, dimensions, mounting flange, field of vision, electrical connector, visible surfaces, lettering, visibility, weight, adjustability, compensator cover, filler cap, leakage, lubber line, item identification, interchangeability, and maintenance.

MIL-PRF-38214D

4.6.2 Fungus. The compass shall be subjected to the fungus test in accordance with RTCA/DO-160.

4.6.3 Salt fog. The compass shall be subjected to the salt fog test in accordance with ASTM B117 for 50 hours.

4.6.4 Reflecting surfaces. Contractor shall provide documentation stating a BBAR-VIS coating has been applied to all reflecting glass surfaces that do not contact the filling liquid.

4.6.4.1 Coated Area. Visually inspect the optical elements shall be coated over their entire effective aperture except for a 0.030 inch maximum uncoated edge holding area and any surface that is in contact with filling liquid.

4.6.4.2 Specular reflectance. Utilizing a calibrated spectrophotometer and associated equipment set to a wavelength range of 425 to 700 nanometers, the measured specular reflectance from the coated surface shall not exceed 0.6 Abs. % for angles of incidence varied from 0 to 15 degrees.

4.6.4.3 Light loss. Utilizing a calibrated spectrophotometer and associated equipment set to a wavelength range of 425 to 700 nanometers, the measured light loss in the coated optical element shall not exceed a maximum average loss of 0.5% and a maximum absolute loss of 2.0% after repeating several surface scans.

4.6.4.4 Coating quality. The coating shall be visually inspected for uniformity in quality and condition, clean, smooth, and free from foreign materials, and physical imperfections (flaking, peeling, blistering, blemishes, discolorations, stains, smears, and streaks) nor show evidences of a cloudy or hazy appearance.

4.6.4.5 Abrasion resistance. Visually inspect the coated surface for abrasion after being rubbed with a Standard #2 pencil eraser under a force of 2 pounds.

4.6.5 High temperature. The compass shall be stabilized at 71°C for 24 hours, with a humidity of no more than 15%. The compass shall then be subjected to the static response test and checked for leaks.

4.6.6 Low temperature. The compass shall be stabilized -62°C for 24 hours, with a humidity of no more than 15%. The compass shall then be stabilized at -54°C for 4 hours and subjected to the static response test and checked for leaks.

4.6.7 Altitude. The compass shall be subjected to an altitude of 80,000 feet and subjected to the static response test and checked for leaks. The compass shall then be lowered to ambient altitude, subjected to the static response test and checked for leaks.

4.6.8 Vibration.

4.6.8.1 Type I & Type II. These compasses shall be subjected to the vibration test in RTCA/DO-160 using category R for fixed wing and category U for rotary wing aircraft. The

MIL-PRF-38214D

compass shall then be subjected to the static response and liquid contamination tests and checked for leaks.

4.6.8.2 Type III NVIS & Type IV AH-64D Longbow Apache Application. This compass shall be subjected to the vibration test in MSIP LL0060-200. The compass shall then be subjected to the static response and liquid contamination tests and checked for leaks.

4.6.8.3 Type IV A-10 Aircraft Application. This compass shall be subjected to the vibration test in Northrup Grumman Report SA220R0307 for Zone 2. The compass shall then be subjected to the static response and liquid contamination tests and checked for leaks.

4.6.9 Sand and dust. The compass shall be tested according to the sand and dust test in RTCA/DO-160. The compass shall then be subjected to the static response test and checked for leaks.

4.6.10 Thermal shock. The compass shall be stabilized at 71°C. The temperature of the compass shall then be lowered to 5°C in less than 5 minutes. The temperature of the compass shall be raised to 71°C in less than 5 minutes, and then returned to ambient temperature. The compass shall then be subjected to the static response test and checked for leaks.

4.6.11 Shock. The compass shall be subjected to 10g shocks lasting 10 milliseconds in accordance with the RTCA/DO-160 Operational Shocks And Crash Safety test for Category B units. The compass shall then be subjected to the static response test and checked for leaks.

4.6.12 Lighting.

4.6.12.1.1 The compass shall be visually inspected to ensure the lamps are accessible from the front of the instrument case.

4.6.12.1.2 Verify the lamp circuit: operates with the appropriate power source applied.

4.6.12.1.3 The lighting system lamps shall operate for a total of 1,000 hours with power applied and with a power interruption every 57 minutes.

4.6.12.2 AQU-3/A (white light). The compass shall be inspected to ensure it incorporates an integral white lighting system using incandescent lamps or LEDs as a light source.

4.6.12.2.1 Color. With 4.5 ± 0.050 VDC power applied to the lighting terminals, the color of the white portions of the indicator shall be measured with a photometer. Record the Y, R, and B readings with the photometer axis perpendicular to the instrument. Calculate the chromaticity coordinate. Verify the calculated chromaticity coordinates are $x = 0.440 \pm 0.020$ and $y = 0.405 \pm 0.020$.

MIL-PRF-38214D

4.6.12.2.2 Brightness. With 4.5 ± 0.050 VDC power applied to the lighting terminals, the light intensity and distribution shall be measure with a photometer. Readings of one particular area, such as an indicia, mark, or number, shall be the average of that area with a minimum of three measurements.

a. White areas: 1.00 ± 0.50 foot-lamberts. The average of all reading taken in the white areas shall be 1.00 ± 0.30 foot-lamberts.

b. Black areas. 0.05 ± 0.03 foot-lamberts when reflected light (wedge and ring lighting) is used and 0.04 ± 0.02 foot-lamberts for refracted light (back lighting).

c. Pointer and lubber lines. 1.20 ± 0.50 foot-lamberts. The average brightness of all the pointer readings shall be 0.10 to 0.50 foot-lamberts higher than the average brightness of the dial white areas.

4.6.12.2.3 Contrast. With 4.5 ± 0.050 VDC power applied to the compass, a photometer shall be utilized to ensure the contrast between the white and black portions of the indicator scale shall be 12 or greater.

4.6.12.2.4 Stray light. With 4.5 ± 0.050 V power applied to compass, visually inspect the compass for leakage of stray light and direct view of lamp filaments. The compass shall be further checked to ensure that it in no way light leakage or reflections restrict or distort the visibility of any graduations, numerals, pointers, or other specified markings.

4.6.12.3 AQU-5/A (red light). The lighting of the AQU-5/A shall be verified as specified in MIL-L-25467.

4.6.12.4 NVIS green.

4.6.12.4.1 Type III NVIS green. The lighting of the Type III High Intensity/Low Voltage NVIS green compass shall be verified as specified in MIL-L-85762.

4.6.12.4.2 Type IV 160J18047 (A-10 NVIS Green). The lighting of the Type IV 160J18047 (A-10 NVIS Green) compass shall be verified as specified in Grumman Aircraft drawing ES220S0013.

4.6.12.5 AQU-14/A (white light, low voltage). The lighting of the AQU-14/A shall be verified as specified in MACAIR 91B0445.

4.6.13 Reliability. The manufacturer shall demonstrate an MTBF of 3,000 flight hours with a discrimination ratio of 2 and a confidence factor of 0.90 (see 6.2).

4.6.14 Operational life. The manufacturer shall demonstrate an operational life of at least 5 years (see 6.2).

4.6.15 Mounting lugs. The compass case shall be mounted to a test fixture with the face of the compass facing down where the mounting lugs receive no extra support. Then a shaft shall be placed through the hole of the mounting lug. A force of 175 pounds shall be applied to the end

MIL-PRF-38214D

of the shaft in the direction of the face of the compass. There shall be no evidence of damage to the mounting lugs. The compass shall then be checked for leaks.

4.6.16 Connector strength. The compass shall be mounted to a test fixture in the operating position. A torque of 25 inch-pounds shall be applied to the connector, which shall not be loosened or damaged. The compass shall be visually inspected for damage and checked for leaks.

4.6.17 Color. The color of the compass shall be verified as specified in FED-STD-595.

4.6.18 Seals. The manufacturer shall provide verification that all gaskets and sealing agents are compatible with the filling liquid (see 6.2).

4.6.19 Humidity. The compass shall be subjected to the Category B humidity test in RTCA/DO-160 (see 6.2).

4.6.20 Bubbles. The compass shall be tilted 18° in pitch and roll. No bubble shall appear in the face.

4.6.21 Rapid altitude change. The compass shall be subjected to the decompression test in RTCA/DO-160. The compass shall then be subjected to the static response test and checked for leaks.

4.6.22 Static response. With the compensator removed, the compass shall be mounted on an index table and aligned to magnetic north. The table shall be rotated in increments of 30°. The compass shall be within 1° of the table reading. This shall be repeated every 30° until the heading returns to magnetic north. The first time this test is conducted, the compass reading at each 30° increment shall be recorded for use with the Attitude tests (see 4.6.25.)

4.6.23 Time of swing. With the compensator removed, the compass shall be mounted on an index table and aligned to magnetic north. The compass card shall be deflected (rotated) 30°. When released, the compass card shall return to within 1° of the original reading in 1.4 to 1.8 seconds and be within 0.5° of the original reading in 10 seconds or less.

4.6.24 Attitude tests.

4.6.24.1 Pitch error. With the compensator removed, the compass shall be mounted on an index table and aligned to magnetic north. The compass shall then be tilted 18° in pitch about a horizontal axis and rotated in azimuth 360°. Every 30°, the heading shall be recorded. The pitched readings shall differ from the level readings recorded in the static response test (see 4.6.23) by no more than 2°.

4.6.24.2 Bank error. With the compensator removed, the compass shall be mounted on an index table and aligned to magnetic north. The compass shall be tilted 18° in bank about a horizontal axis and rotated in azimuth 360°. The heading shall be recorded every 30°. The banked readings

MIL-PRF-38214D

shall differ from the level readings recorded in the static response test (see 4.6.23) by no more than 5°.

4.6.25 Compensator. The compensators shall be inspected to verify the presence of a zero index mark, and that the zero index mark corresponds to the position of the compensator that has no effect on the indication of the compass.

4.6.26 Adjustment. The compensators of the compass shall be adjusted from the front of the compass using a flat tip screwdriver. No physical stops shall be present. While facing east or west, one rotation of the East-West Compensator shall cause a change in the east or west indication. While facing north or south, one rotation of the North-South Compensator shall cause an equal change in the north or south indication.

4.6.27 Compensation range.

4.6.27.1 North-South Compensator. The compass shall be aligned to magnetic north and both compensators shall be zeroed. The North-South Compensator shall be adjusted to verify that a $\pm 32^\circ$ change in indication occurs. With North-South Compensator zeroed, the East-West Compensator shall be adjusted to verify a maximum of $\pm 2^\circ$ of cross-coupling occurs.

4.6.27.2 East-West Compensator. The compass shall be aligned to east and both compensators shall be zeroed. The East-West Compensator shall be adjusted to verify that a $\pm 32^\circ$ change in indication occurs. With the East-West Compensator zeroed, the North-South Compensator shall be adjusted to verify a maximum of $\pm 2^\circ$ of cross-coupling occurs.

4.6.28 Turn rate. The compass shall be mounted to a test fixture in the level position and aligned to magnetic north. The compass shall then be rotated in azimuth at a rate of 12° per second through 360° and stopped abruptly at magnetic north. The compass card shall not overshoot the magnetic north by more than 2°.

4.6.29 Loops and rolls. The compass shall be subjected to the accelerations in Table 1 using the test procedures in RTCA/DO-160. The compass shall then be subjected to the static response test and checked for leaks.

4.6.30 Balance. With the compass in a level plane, the compass card shall not deviate from horizontal by more than 1°. With the magnetic field adjusted to 0 Oersted vertical and 0.18 Oersted horizontal, the base of the compass card shall deviate from horizontal by no more than 3°.

4.6.31 Liquid contamination. The compass shall be held face down and rocked through approximately 40° (20° either side of vertical) at a rate of approximately 1 Hz for 5 seconds. The compass shall then be placed face down for approximately 3 minutes. With the face still down, the compass shall be raised and viewed. No more than five particles, with no particle larger than 0.002 inch, may be visible on the compass glass. Particle size may be estimated by comparison with the lubber line, the width of which is approximately 0.016 inch.

MIL-PRF-38214D

5. PACKAGING

5.1 General. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packing of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Compensator shipping. The compass shall be shipped with the compensators nulled.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The magnetic compasses are intended to operate as a reference to the magnetic meridian of the earth.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification
- b. Classification of compass (see 1.2)
- c. If visible surfaces of the compass shall be other than lusterless black (see 3.4.5.1)
- d. If lettering on the compass should be other than lusterless white (see 3.4.5.2)
- e. If the test conditions are different to be different than specified in the applicable test method or test paragraph (see 4.4)
- f. If the compass is not to be tapped before a test reading is taken (see 4.4.1)
- g. If the compass is to be tested in other than the level position (see 4.4.2)
- h. If the compass is to be tested in other than a standard field (see 4.4.4)
- i. The requirement for the vendor to identify the proposed verification methods for:
 - Reliability (see 4.6.13)
 - Operational life (see 4.6.14)
 - Seals (see 4.6.19)
 - Loops and rolls (4.6.30)
- j. Data required
- k. Packaging requirements (see 5.1)

6.3 Qualification. 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 No. 38214, 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

MIL-PRF-38214D

products covered by this specification. Information pertaining to qualification of products may be obtained from af71@tinker.af.mil or addressed to Oklahoma City Air Logistics Center/ENSDDA, 3001 Staff Drive, Suite 1AC-82A, Tinker AFB, OK 73145-3036.

6.4 Filling liquid. Previously, the compass was completely filled with liquid at 20°C. The compass was then sealed. If a bellows type of compass was used, the compass was filled to allow for expansion of the liquid. With the filler cap removed, the compass was placed in a pressure chamber, the pressure was reduced to the equivalent of 50,000 feet altitude and maintained for 20 minutes. Then the pressure was increased to ambient, the filling liquid was refilled, and the filler cap was installed. All filling liquid was required to comply with MIL-DTL-5020.

6.5 Visibility. Examples of the liquid obscuring the card include, but are not limited to, foaming and clouding.

6.6 Rapid altitude change. Previous compasses made in accordance with this specification required thorough annealing of the cover glass, ensuring the cover glass would withstand the rigors of rapid altitude changes.

6.7 Operating temperature and altitude. Previous compasses made in accordance with this specification required the use of an expansion unit, allowing the filling liquid to expand and contract with changes in temperature and altitude.

6.8 Compensator vibration. Previous compasses made in accordance with this specification prevented changes in the adjustment of the compensator due to vibration by incorporating enough friction in the operation of the compensator to prevent changes during operation.

6.9 Compensator. Previous compasses made in accordance with this specification required the use of permanent bar magnets as components of the compensator.

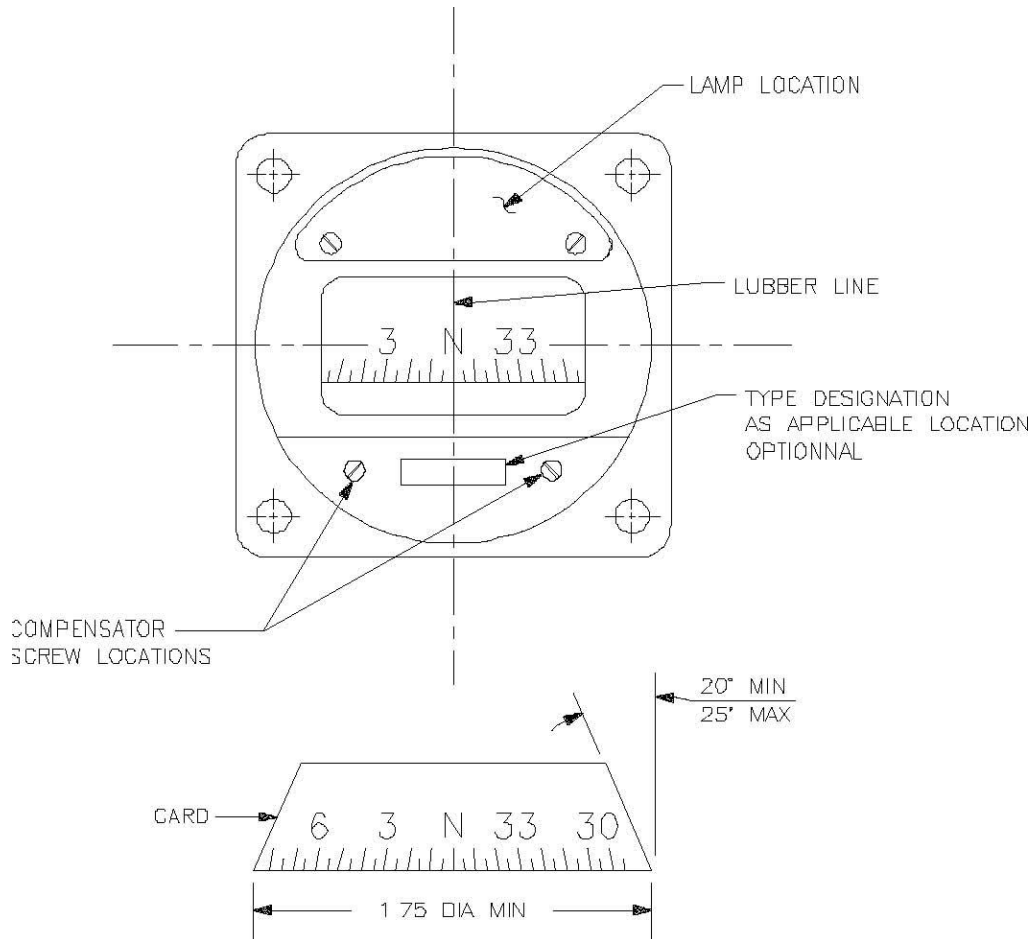
6.10 Other compasses. Similar compasses are used in Navy aircraft. This compass is described in MIL-C-5604.

6.11 Subject term (key word) listing.

Compass
Standby

6.12 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

MIL-PRF-38214D

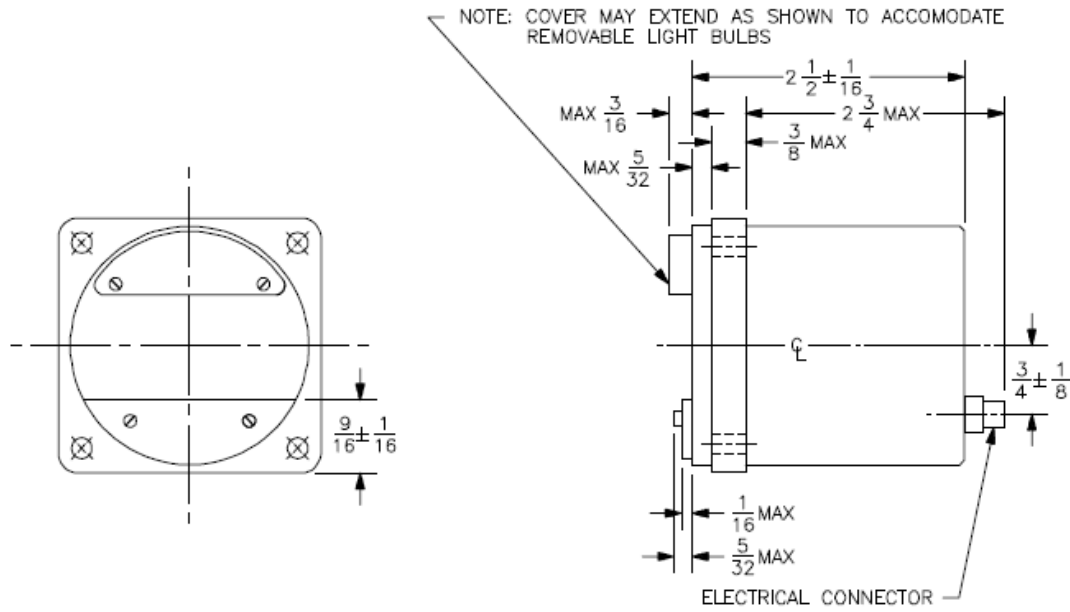


MARKING	HEIGHT OR LENGTH ± 0.010	WIDTH OF LINE ± 0.005	COLOR
Numerals 3, 6, 12, 15, 21, 24, 30 and 33	0.187	-----	White
30° Graduations	0.094	0.031	White
10° Graduations	0.094	0.016	White
Cardinal Pointers N, E, S, W	0.187	-----	White
Lubber Line (Approx) 5° Graduations	0.750 0.082	0.016 0.016	White
Type No. Designation	0.062	-----	Durable Black

NOTE: ALL DIMENSIONS IN INCHES

FIGURE 1. CASE AND CARD DETAIL

MIL-PRF-38214D



SEE FIGURE 1 FOR FACE AND CARD DETAILS

CASE IN ACCORDANCE WITH MS33638 FOR 2-INCH NOMINAL SIZE EXCEPT AS SHOWN

DIMENSIONS IN INCHES

FIGURE 2. CASE ENVELOPE

MIL-PRF-38214D

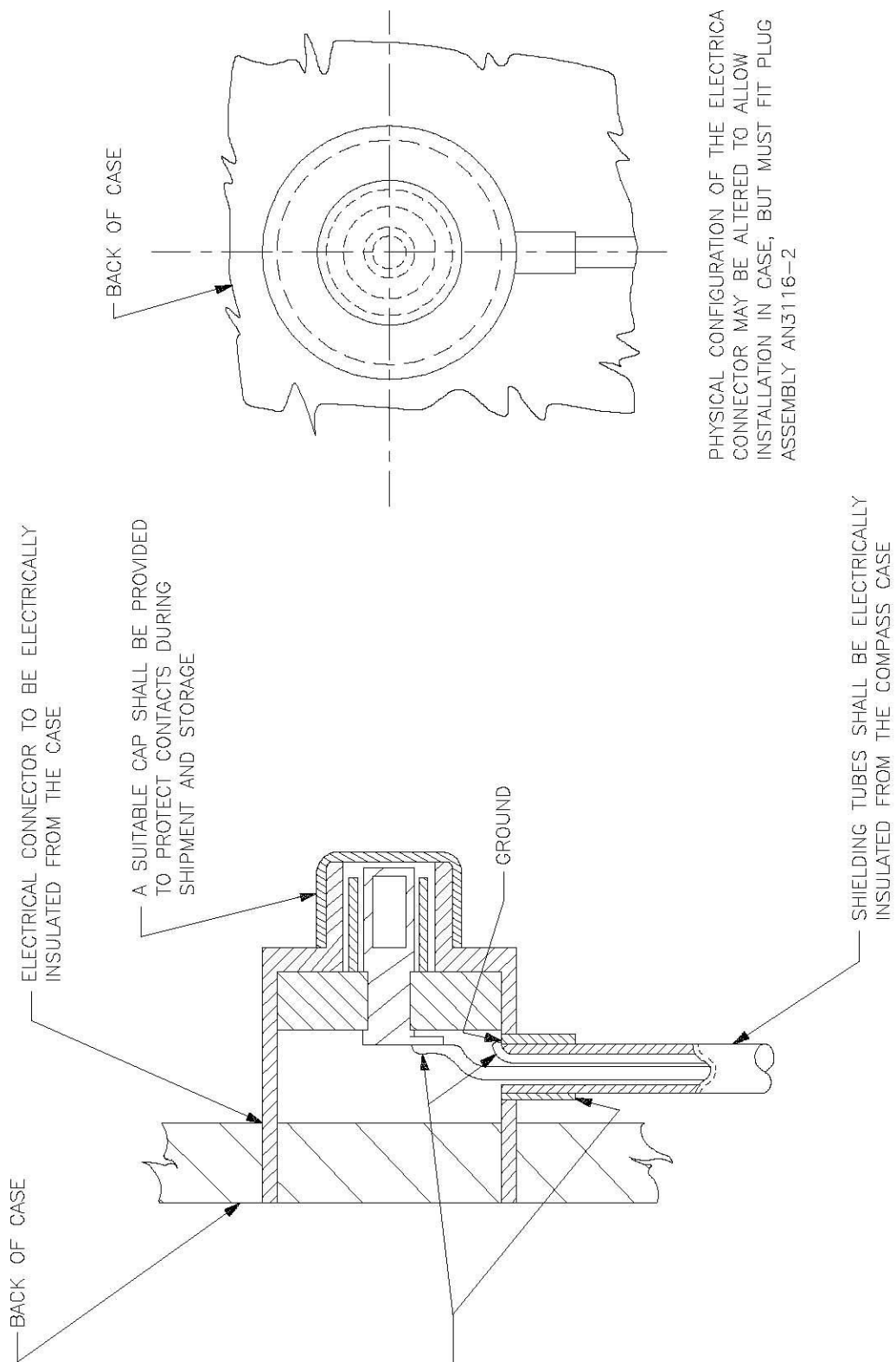


FIGURE 3. ELECTRICAL CONNECTOR

MIL-PRF-38214D

Custodian:
Air Force - 71

Preparing activity:
Air Force - 71

(Project 6605-2008-001)

Review activity:
Air Force - 99
DLA - GS

NOTE: These activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.