

INCH-POUND

MIL-A-25719B (USAF)

9 February 1990

SUPERSEDING

MIL-A-25719A (USAF)

8 July 1974

MILITARY SPECIFICATION

ACCELEROMETER, MECHANICAL, AIRCRAFT, PILOT'S
WARNING, TYPE MA-1

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 This specification covers one type of 1.87 inch dial, -2 to +4 g range accelerometer, designated Type MA-1.

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 are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, 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

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SPECIFICATION

Federal

PPP-B-601	Boxes Wood, Cleated Plywood
PPP-B-636	Box, Shipping, Fiberboard

Military

MIL-P-116	Preservation, Methods Of
MIL-C-5541	Chemical Conversion Coatings For Aluminum And Aluminum Alloys
MIL-A-8625	Anodic Coatings, For Aluminum And Aluminum Alloys
MIL-C-83488	Coating, Aluminum, Ion Vapor Deposited

STANDARDS

Military

MIL-STD-100	Engineering Drawing Practices
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-810D	Environmental Test Methods & Engineering Guidelines
MIL-STD-838	Lubrication Of Military Equipment
MIL-STD-889	Dissimilar Metals
MIL-STD-970	Standards & Specifications, Order Of Preference For The Selection Of
DoD-STD-1866	Soldering Process General (Non Electrical)
MIL-STD-2073-1	DOD Material Procedures For Development And Application Of Packaging
MS33558	Numerals And Letters, Aircraft Instrument Dial, Standard Form Of
MS33585	Pointers, Dial, Standard Design Of Aircraft Instrument
MS33638	Cases, Instrument, Flange Mounted, Aircraft

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

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

Other Government Documents (AF 898894 Luminescent Material, Fluorescent).

(Copies of the Air Force Drawing is available from OC-ALC/MMIRF, Tinker AFB, OK 73145-5990.)

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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 issues of the documents cited in 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 takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First Article. When specified (see 6.2.e), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.6.

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

3.2.1 Commercial parts. Commercial parts having suitable properties may be used where, on the date of invitation for bids, there are no suitable standard parts. In any case, commercial utility parts, like screws, bolts, nuts, cotter pins, having suitable properties may be used provided:

- a. They can be replaced by the standard parts (MS or AN) without alteration.
- b. The corresponding standard part numbers are referenced in the parts list and, if practical, on the contractor's drawings.

3.2.2 Standard parts. With the exception in 3.2, MS and AN standard parts shall be used where they suit the purpose. They shall be identified on the drawings by their part numbers.

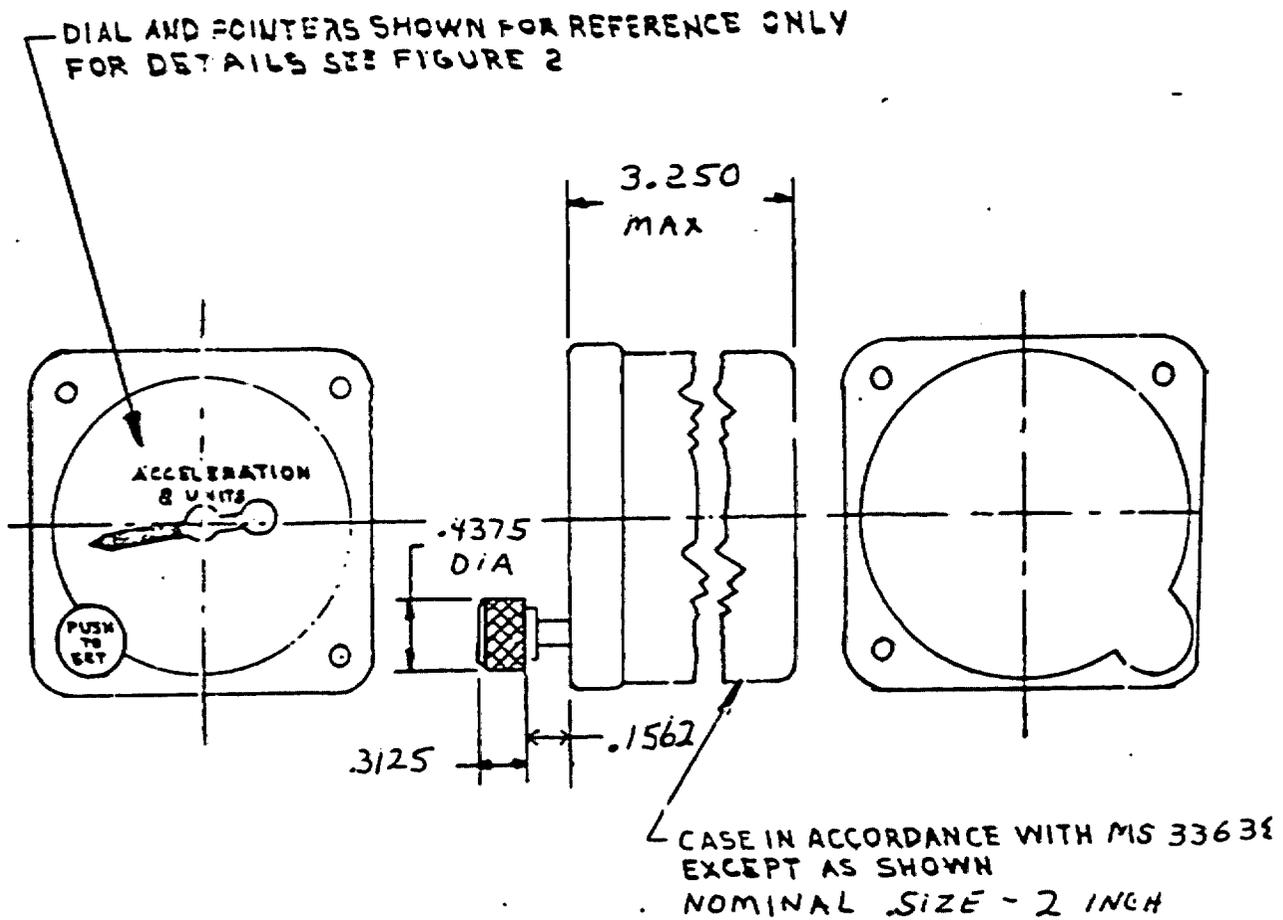
3.3 Materials.

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.

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- 3.3.2 Nonmagnetic materials. Nonmagnetic materials shall be used for all parts except where magnetic materials are essential.
- 3.3.3 Nonferrous materials. Nonferrous materials shall be used for all parts of the accelerometer except where ferrous materials are essential.
- 3.3.4 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 met in storage or normal service.
- 3.3.5 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.
- 3.3.6 Corrosive fumes. The materials as installed in the accelerometer shall not liberate deleterious fumes.
- 3.3.7 Protective treatment. When materials are used in the construction of the accelerometer that are subject to deterioration when exposed to climatic and environmental 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.
- 3.3.8 Recycled, reclaimed, and virgin materials. The use of recycled, reclaimed and virgin materials shall be used to the maximum extent possible without jeopardizing the end use of the item.
- 3.4 Design and construction.
- 3.4.1 Accelerometer. The accelerometer shall be designed to indicate aircraft accelerations in maneuvers and rough air and shall conform to figure 1.
- a. The accelerometer shall be designed with a natural frequency of 6 to 8 hz and 0.5 to 0.7 critical damping.
- 3.4.2. Accelerometer repair. The construction of the accelerometer shall be reasonably simple to permit overhaul or repair without the use of special tools or fixtures.
- 3.4.3 Indication and range. The accelerometer shall indicate vertical accelerations when the plane of the mounting lugs is vertical and the +1 graduation is at 270°. When in this position, normal gravity shall be indicated at +1 g. The accelerometer shall be designed to indicate accelerations in the range -2 to +4 g units.
- 3.5 Performance. The accelerometer shall be capable of meeting the test requirements specified in Section 4 when subjected to the following conditions:
- a. Temperature. -Temperature ranging from +71°C to -54°C.
- b. Humidity. -Relative humidity up to 100 percent.
- c. Altitude. -Pressures ranging from 30 inches Hg down to 1.31 inches Hg approximately 70,000 feet altitude.
- d. Fungus. -Fungus growth as encountered in tropical climates.

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DIMENSIONS IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES $\pm .016$

FIGURE 1. Case.

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- e. Thermal shock. -Thermal shock with alternate immersion in water at temperatures of +85°C and +5°C for 8 cycles.
- f. Acceleration and shock. -Acceleration and shock forces as anticipated.
- g. Vibration error. -When vibrated at an amplitude of 0.010 to 0.020 inch and at a frequency variation between 8.3 and 50 hz for a total of 3 hours the main pointer shall not exceed the 0.2 g to 0.4 g range and the auxiliary pointers shall not change more than 0.2 g.
- h. Vibration endurance. -The dynamic scale error shall not exceed 0.2 g when subjected to the vibration endurance test.
- i. Static scale error and friction. -Static scale error and friction shall not exceed +0.1 g and +0.2 g, respectively when tested as specified.
- k. Dynamic scale error. -Dynamic scale error shall not exceed +0.2 g at any specified test point and +0.1 g at 0.67 of the test points.
- l. Magnetic effect. -With the accelerometer revolved about a magnetic compass with a magnetic field intensity of 0.17 to 0.19 oersted, the compass shall not deflect more than 1°.
- m. Mounting lugs. -The mounting lugs shall withstand a load of 175 pounds without fracture.
- n. Response. -Response characteristics shall be within the limits specified in 4.4.5, when the accelerometer is vibrated at frequencies from 1 to 20 hz at maximum g forces for each test point.

3.5.1 Accelerometer constructed. The accelerometer shall be so constructed as to withstand the normal strains, jars, vibrations, and such other conditions as are incident to shipping, storage, installation, and service, without failure.

a. Pivots, bearings, and gears shall neither bind nor shake and shall be as near frictionless as practicable.

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 MIL-STD-100 shall govern the manufacturer's part numbers and changes thereto.

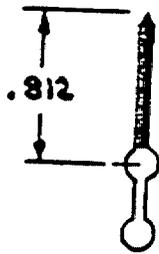
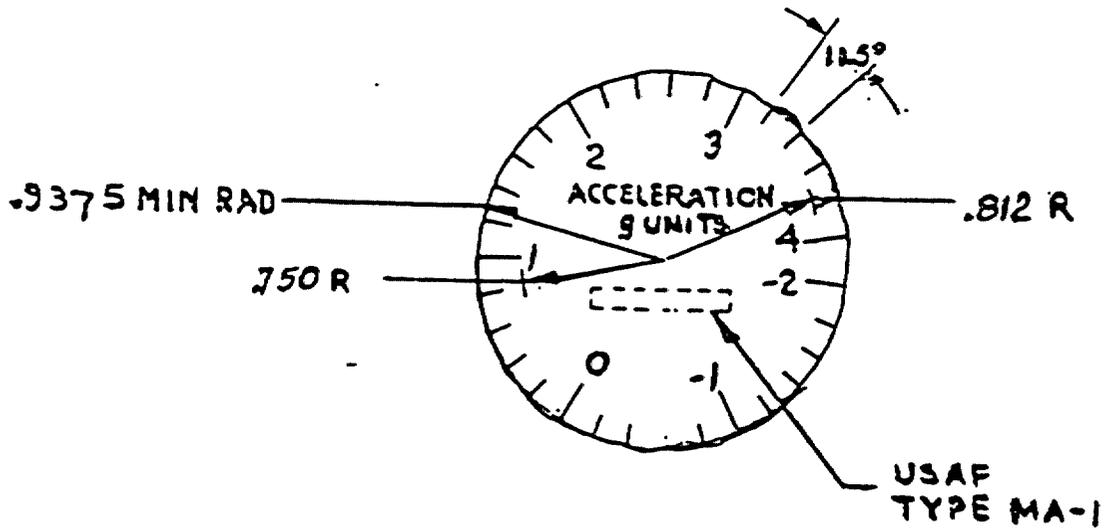
3.7 Dial. The dial shall conform to figure 2 and shall be fastened securely to the case or upon the frame of the mechanism by not less than two screws in such a manner that it will not loosen or turn when the instrument is vibrated.

3.7.1 Distance from dial to cover glass. Distance between dial and cover glass shall not be greater than 0.250 inch.

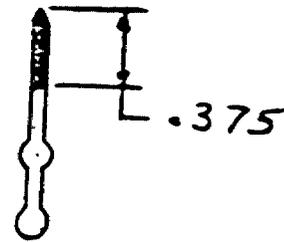
3.7.2 Numerals and letters. The style and proportion of numerals and letters, except the letter "g", placed on the dial of the accelerometer shall conform to MS33558. Numerals shall distinctly indicate graduation to which each applies.

3.8 Pointers. The accelerometer shall have three pointers. One main pointer for indicating instantaneous acceleration and two auxiliary pointers; one for indicating

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MAIN POINTER
MS 33585-3



AUXILIARY POINTER
MS 33585-2
EXCEPT AS SHOWN

DIMENSIONS IN INCHES
UNLESS OTHERWISE SPECIFIED
DECIMALS ± 0.010
ANGLES $\pm 0^{\circ}10'$

FIGURE 2. Dial and pointer.

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maximum positive acceleration; and one for indicating maximum negative acceleration. The pointers shall conform to figure 2. They shall be light and sufficiently rigid to prevent oscillation under vibration. They shall be firmly attached to the mechanism, yet shall be readily adjustable.

3.8.1 Ratchet mechanism. Each auxiliary pointer shall be provided with a ratchet device, in order that indication of maximum plus and minus deflections of the main pointer will be maintained until the auxiliary pointers are reset to obtain a new reading.

3.8.2 Auxiliary pointer return mechanism. A mechanism shall be provided for resetting the auxiliary pointers into juxta-position with the main pointer. A knob, located as shown on figure 1, shall be provided for operating the return mechanism. Stops shall be provided in order that the auxiliary pointers when reset shall not indicate a lower or higher reading than that indicated by the main pointer. Stops shall be a part of the mechanism connecting the pointers and shall directly engage them. Operation of the return mechanism shall require 2.50 to 8 pounds of force on the knob.

3.8.3 Main pointer mechanism. The main pointer mechanism shall not engage the mechanism of the auxiliary pointers when the imposed acceleration is less than the acceleration indicated by the auxiliary pointers.

3.9 Acceleration-responsive element.

3.9.1 Stops for acceleration-responsive element. Mechanical stops shall be provided for arresting the motion of the acceleration-responsive element when the accelerometer is subjected to accelerations beyond the limits specified. One stop shall engage the element at an acceleration of not less than -2.1 g and not more than -2.2 g, and the other at an acceleration of not less than $+4.1$ g and not more than $+4.2$ g.

3.9.2 Locking device. A device for manually locking the position of the acceleration-responsive element shall be provided, if the design is such as to require it in order to protect the mechanism of the accelerometer from possible damage during shipment. If provided, this device shall be controlled by means of a knurled knob located in the back of the case.

3.9.3 Adjustment. The mechanism shall be provided with means to adjust or correct the indications. This means of adjustment shall be reasonably simple to manipulate and of such a nature that adjustment can be accomplished with tools ordinarily possessed by an instrument repairman.

3.10 Case. The case shall be in accordance with figure 1 and the requirements specified herein. The design of the case shall be such that the mechanism may be removed from the case and replaced without the use of special tools and fixtures unless they are approved by the contracting activity.

3.11 Marking. All markings shall be durable to withstand the usage encountered in service. Numerals shall distinctly indicate the graduation to which each applies.

3.11.1 Fluorescent-luminescent material. The following markings shall be finished in fluorescent-luminescent material in accordance with AF 8988994, type I or III, as applicable. The dimensions of the markings shall be as follows:

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	Height or Length Inch <u>+0.015625</u>	Width of Line or Graduation Inch <u>+0.005</u>
Numerals	.1875	MS33558
Graduations corresponding to numerals	See Figure 2	0.031
Lettering "g UNITS" and "ACCELERATION"	.0625	MS33558
One "g" Graduation	-----	0.062
Shaded part of pointers	-----	-----
Knob markings	-----	-----
Small graduations	See Figure 2	0.015

3.11.2 Durable dull black. The following markings shall be durably and legibly marked on the dial. These markings, the background of the dial, and all other markings not otherwise specified shall be finished in durable dull black.

	Height or Length Inch <u>+0.015625</u>
Lettering "USAF" and "TYPE MA-1"	.0625

3.11.3 Visibility of dial. The pointers, numerals, at least 0.062 inch of the shortest graduations, and other specified markings on the dial shall be visible from any point within the frustum of a cone whose side makes an angle of 30° with a perpendicular to the dial and whose small diameter is the aperture of the instrument case.

3.12 Soldering. Soldering shall be accomplished in accordance with DOD-STD-1866.

3.13 Lubrication. The accelerometer shall be lubricated in accordance with MIL-STD-838.

3.14 Weight. The weight of each accelerometer shall not exceed 1.00 pounds.

3.15 Finishes and protective coatings.

3.15.1 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 non-aluminum 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.

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3.15.2 Steel parts. Steel parts shall be coated with ion vapor deposited aluminum, 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 cognizant engineering activity. Cadmium plating must be avoided when satisfactory alternative processes can be used.

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

3.17 Workmanship.

3.17.1 General. The accelerometer, 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 sharp edges; accuracy of dimensions, radii of fillets, and marking of parts and assemblies; thoroughness of soldering, welding, brazing, painting, and riveting; alignment of parts and tightness of assembly screws, and bolts; etc.

3.17.2 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 or threads.

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

3.17.4 Gears. Gear assemblies shall be properly aligned and meshed, and shall be operable without interference, tight spots, loose spots, or other irregularities. Where required for accurate adjustments, gear assemblies shall be free from backlash.

3.17.5 Cleaning. The accelerometer shall be thoroughly cleaned of loose, spattered, or excess solder, metal chips, and other foreign material, after final assembly. Burrs and sharp edges, as well as resin flash that may crumble, shall be removed.

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

3.18 Envelope. An envelope, containing the mounting screws, shall be furnished with each indicator. The following information shall be printed on the face of the envelope:

IMPORTANT
THIS ENVELOPE CONTAINS
MOUNTING SCREWS

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

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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 indicated or actual, nor does it commit the Government to accept defective material.

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

- a. First article inspection (see 4.6)
- b. Quality conformance inspection (see 4.6.1)

4.3 Acceptance tests. Acceptance tests shall consist of:

- a. Individual tests (see 4.3.1).
- b. Sampling plans A and B (see 4.3.2.1 & 4.3.2.2).

4.3.1 Individual tests. Each accelerometer shall be subjected to the following tests as described under 4.5 Test methods:

- a. Examination of product (see 4.5.1)
- b. Static scale error and friction (see 4.5.2)
- c. Dynamic scale error (4.5.3)
- d. Response characteristics (see 4.5.4)
- e. Return mechanism operation (see 4.5.17)

4.3.2 Sampling plans and tests.

4.3.2.1 Sampling Plan A. One accelerometer selected at random from each 100 or less produced on the contract or order shall be subjected to the following tests as described under 4.5 Test methods:

- a. Individual tests (see 4.3.1)
- b. Low temperature (see 4.5.5)
- c. High temperature (see 4.5.6)

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- d. Magnetic effect (4.5.7)
- e. Vibration error (see 4.5.8)

4.3.2.2 Sampling Plan B. Unless otherwise specified, three accelerometers selected at random from the first 15 items of the contract or order shall be subjected to the following tests as described under 4.5 Test methods:

- a. Sampling Plan A (see 4.3.2.1)
- b. Vibration endurance (see 4.5.9)
- c. Shock (see 4.5.10)
- d. Mounting lugs (see 4.5.11)
- e. Low temperature - high altitude (see 4.5.12)
- f. Humidity (see 4.5.13)
- g. Fungus (see 4.5.14)
- h. Thermal shock (see 4.5.15)
- i. High temperature exposure (see 4.5.16)

4.3.2.3 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.

4.3.2.3.1 Individual tests may continue. For operational reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of items on hand or later produced shall not be made until it is determined that items meet all the requirements of the specification.

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

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in paragraph 4.4.1 in this specification.

4.4.1 Standard atmospheric conditions. Whenever the pressure and temperature existing at the time of the test are not specified definitely, it is understood that the test is to be made at atmospheric pressure (approximately 29.92 inches Hg) and at room temperature (approximately +25°C). When tests are made with atmospheric pressure or room temperature differing materially from the above values, proper allowance shall be made for the difference from the specified conditions.

4.4.2 Tapping. Unless otherwise specified, the accelerometer shall be tested in the normal operating position and shall be tapped lightly or vibrated before a test reading is taken. Tapping shall be applied in a longitudinal direction with respect to the dial of the instrument. (see 6.2.1)

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4.4.3 Vibration stand. A vibration stand shall be used which will vibrate at any desired frequency between 500 and 3000 cpm and shall subject the accelerometer to vibration such that a point on the case will describe in a plane inclined 45° to the horizontal plane, a circle, the diameter of which is equal to the amplitude specified herein.

4.4.4 Adjustment repair. No adjustments or repairs of any type shall be performed on the qualification test samples after start of qualification tests.

4.4.5 Performance record. Prior to conducting the tests described in paragraphs 4.5.5, 4.5.6, 4.5.8, 4.5.12, 4.5.13, 4.5.14, and 4.5.16, the accelerometer shall be subjected to a comprehensive operational test under standard conditions and record shall be made of all data necessary to determine compliance with this specification. Where the test paragraph establishes the level of acceptable performance, a detailed pre-exposure performance record need not be made. For this latter category, the accelerometer shall be operated prior to test to insure that no malfunction exists.

4.4.6 Installation check. Following installation in the test facility and prior to test, the accelerometer shall be operated sufficiently to insure that no malfunction or damage was caused due to faulty installation procedure or handling.

4.4.7 Criteria for failure. Deterioration or change in performance of any components which could in any manner prevent the accelerometer from meeting functional, maintenance and service requirements during service life shall provide reason to consider the accelerometer as having failed to comply with the conditions of the test to which it was subjected.

4.4.8 Evaluation of accelerometer. When so directed in individual test procedures, the accelerometer shall be operated to permit performance data to be obtained, or inspected for evidence of deterioration. The performance data under test conditions shall be satisfactorily comparable to that obtained in compliance with 4.4.5. Any deterioration observed shall not exceed that defined in 4.4.7.

4.5 Test methods.

4.5.1 Examination of product. Each accelerometer shall be examined externally to determine conformance with this specification with respect to material, workmanship, marking, and envelope.

4.5.2 Static scale error and friction. The position error shall be observed with accelerometer held in each of the following positions:

- a. Plane of dial vertical with +1 g graduation at 270° .
- b. Plane of dial horizontal.
- c. Plane of dial vertical with +1 g graduation at 90° .

In each position, the main-pointer reading obtained shall be due entirely to gravity and not to motion in change of position of instrument. The static scale error shall not exceed ± 0.1 g in any of the three positions tested. The accelerometer shall also be tested for friction at the three positions mentioned above. The amount of tapping or vibration applied shall be sufficient to remove all friction from the accelerometer. In going from one position to the next, one of the memory pointers shall be engaged. After the desired test position is reached two readings shall be

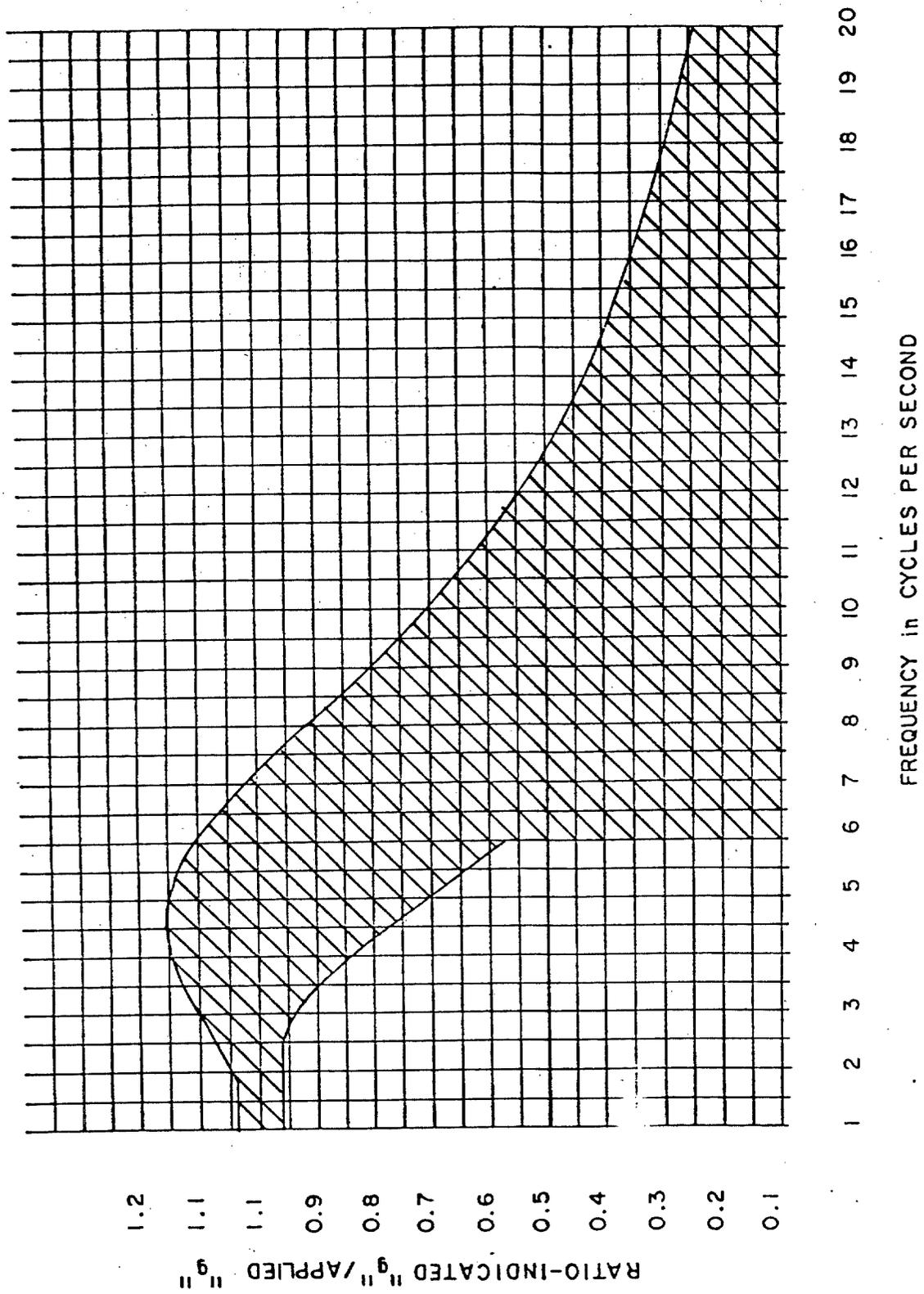


FIGURE 3. Cycle graph.

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recorded as friction and shall not exceed 0.2 g with the plane of the dial vertical and 0.3 g with the plane of the dial horizontal.

4.5.3 Dynamic scale error. The accelerometer shall be mounted on a suitable centrifuge and the scale errors determined for accelerations of -2, -1, +1, +2, +3, and +4 and at any other points deemed necessary to determine accuracy. The steady state scale error shall not exceed ± 0.1 g for 0.67 of the test points.

4.5.4 Response characteristics. The accelerometer shall be subjected to vibration along an axis parallel to the motion of the sensing element and with the plane of the dial vertical. The test apparatus used shall be as specified in 4.5.4.1. The accelerometer shall be tested at each of a minimum of 16 different frequencies. These tests shall be approximately equally spaced through the frequency range from 4 to 20 hz. The amplitude of vibration at each test point shall be such that the maximum g forces practicable for that test point shall be obtained. The indicated g shall be recorded and a plot made for each test point of indicated g/applied g vs frequency. The points so plotted shall fall within the shaded area of graph on figure 3. These graphs shall be a part of the qualification test data.

4.5.4.1 Test apparatus. The equipment shall impose linear sinusoidal motion to the accelerometer and shall be capable of procuring the frequencies and double amplitude required for each test point. The acceleration vector of any harmonic measured on the test table shall not exceed 10 percent of the fundamental acceleration vector.

4.5.5 Low temperature. The accelerometer shall be placed within the test chamber and the chamber cooled to and maintained at a temperature of -54°C (-65°F) for 4 hours. Upon completion of the test period and while at the test temperature, the accelerometer shall be subjected to and meet the individual tests (see 4.3.1).

4.5.6 High temperature. The accelerometer shall be placed within the test chamber. The internal temperature of the chamber shall then be raised to 71°C (160°F). The accelerometer shall be exposed to that temperature for a period of 4 hours. A relative humidity of not more than 15 percent shall be maintained in the test chamber throughout the exposure period. Upon completion of the test period and while at the test temperature, the accelerometer shall be subjected to and meet the individual tests (see 4.3.1).

4.5.7 Magnetic effect. The accelerometer shall be revolved about a short bar magnet compass with the nearest part of the indicator 5.50 inches from the bar magnet, and in a vertical plane which is a perpendicular disector of the North-South axis of the bar magnet. Starting directly under the compass, the indicator shall be held in positions, 0° , 45° , 90° , 135° , 180° , 225° , 270° , and 315° from the initial position. At each of these positions, the indicator shall be rotated on its horizontal axis until it is in its normal operating position. The horizontal magnetic field intensity shall be 0.17 to 0.19 oersted. The deflection of the compass at any of the specified positions shall not exceed 1° .

4.5.8 Vibration error. The accelerometer shall be mounted on a suitable vibration stand with the dial in a vertical plane and with the graduation +1 at 270° . The auxiliary pointers shall be displaced approximately 1 g from the main pointer and the readings noted. The reset mechanism shall not be operated until the completion of the tests. For a total of 3 hours the accelerometer shall be vibrated at the specified frequencies at an amplitude between 0.018 and 0.020 inch, and the pointer oscillation shall be noted. The frequency shall be varied from 500 to 3000 cycles per minute in a period of not more than 60 minutes. The natural frequency of the

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seismic system shall be noted during the frequency variation between 500 and 3000 cpm. For the remainder of the 3 hours test period, the accelerometer shall be vibrated at a frequency of 1,800 cpm. At the end of the test period, the indication of the auxiliary pointer shall be read before operating the reset mechanism. At frequencies below 1,200 cpm the oscillation of the main pointer shall not exceed 0.2 g and at frequencies over 1,200 cpm, the oscillation shall not exceed 0.3 g. After vibration, the indications of the auxiliary pointers shall not be changed by more than 0.1 g. The accelerometer shall not be damaged as a result of this test.

4.5.9 Vibration endurance. The accelerometer shall be mounted on the apparatus in its normal operating position. The accelerometer shall be vibrated with circular motion of 0.018 to 0.020 inch diameter in a plane inclined 45 degrees to the horizontal plane and the frequency of vibration shall be varied uniformly from 5 to 50 Hz and reset once each hour for a 50-hour period. Upon completion of the test period, the accelerometer shall be subjected to the test specified in 4.5.3. The dynamic scale error shall not exceed 0.2g.

4.5.10 Shock. The accelerometer to be installed in the normal operating position is a free-fall apparatus as described in 4.5.10.1. If provided with a locking device, the accelerometer mechanism shall be locked. The accelerometer shall be allowed to fall from a height of 8 inches, then examined for damage and subjected to the test specified in 4.5.3. There shall be no damage to the accelerometer and the steady state scale error shall not exceed 0.2 g.

4.5.10.1 Apparatus. A rigidly constructed device provided with a panel mounting for installing the accelerometer in the specified position, and vertical guides to allow free-fall from the specified height shall be used. A bumper on the free-fall element shall arrest its fall by striking the center of a rounded projection on a metal cross section with an unsupported length of 5 inches between points of attachment to the free-fall element. The bumper shall contact the metal block at the midpoint of a broad side. The center of gravity of the instrument under test and the contact point of the bumper shall be aligned vertically within 0.125 inch. The weight of the free-fall element shall be approximately 12 pounds. The metal block shall weigh not less than 50 pounds.

4.5.11 Mounting lugs. The accelerometer case with mechanism and cover glass removed shall be mounted face downward on the movable head of a suitable testing machine with the diameter of the case in a horizontal plane so that the mounting lugs receive no added support. A suitable pin shall be inserted through the hole in the mounting lug and attached to a pull strap in the stationary head of the machine. a load of 175 pounds shall be applied along the axis of the mounting hole and toward the front of the case for a period of 1 minute. There shall be no fracture.

4.5.12 Low temperature - high altitude. The accelerometer shall be placed within the test chamber and the chamber cooled to and maintained at a temperature of -62°C (-80°F) and at an altitude of 70,000 feet (1.31 inches Hg) for a period of 72 hours, at which time the accelerometer shall be inspected in accordance with the requirements of 4.4.8. The temperature of the chamber shall then be raised to -54°C (-65°F) and maintained for an additional 24-hour period. At the conclusion of this exposure period and while at this temperature, the accelerometer shall be inspected and operated in accordance with 4.4.8. The accelerometer temperature shall then be returned to that of standard conditions and the accelerometer operated and inspected visually as specified in 4.4.8. There shall be no damage to the accelerometer as a result of this test.

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4.5.13 Humidity. The accelerometer shall be placed in the test chamber and set up to simulate installed conditions. The test chamber shall be vented to the atmosphere to prevent the build-up of pressure. Prior to the starting of the test period, the chamber temperature shall be between 20° and 38°C (68° and 100°F) with uncontrolled humidity. During the first 2-hour period, the temperature shall be gradually raised to 71°C (160°F). This temperature shall be maintained during the next 6-hour period. The velocity of the air throughout the test area shall not exceed 150 feet per minute. During the following 16-hour period, the temperature in the chamber shall be gradually reduced to 20° to 38°C (68° to 100°F) which constitutes one cycle. The relative humidity throughout the cycle shall be 95 percent. Steam or distilled water having a pH value between 6.5 and 7.5 at 25°C (77°F) shall be used to obtain the desired humidity. The cycle shall be repeated a sufficient number of times to extend the total time of the test to 240 hours (10 cycles). At the conclusion of the 240 hour period, the accelerometer shall be returned to standard conditions. The accelerometer shall then be operated and inspected within 1 hour as directed in 4.4.8.

4.5.14 Fungus. The accelerometer shall be subjected to the fungus resistance test in accordance with MIL-STD-810D, Method 508.3.

4.5.14.1 Organism.

Group I	-	Chaetomium globosum	6205
		Myrothecium verrucaria	9095
Group II	-	Memnoniella echinata	9597
		Aspergillus niger	6275
Group III	-	Aspergillus flavus	10836
		Aspergillus terreus	10690
Group IV	-	Penicillium citrinum	9849
		Penicillium ochrochloron	9112

4.5.14.2 Stock culture designation and source. When ordering cultures, request the cultures by name and serial number. The serial number of the cultures remain the same regardless of source.

Source - American Type Culture Collection
2112 M Street, N. W.,
Washington 6, D. C.

4.5.15 Thermal shock cycling. The accelerometer shall be alternately subjected to a total of 8 cycles of immersion in tap water maintained at 85° \pm 2°C and 5° \pm 2°C. The length of time for each immersion shall be 30 minutes; not more than 5 seconds shall elapse between immersions. No evidence of moisture penetration or damage to the inclosure shall result from this test.

4.5.16 High temperature exposure. The accelerometer shall be placed within the test chamber. The internal temperature of the chamber shall then be raised to 71°C (160°F). The accelerometer shall be exposed to that temperature for a period of 48 hours. A relative humidity of not more than 15 percent shall be maintained in the test chamber throughout the exposure period. At the conclusion of the test period and while still at the test temperature, the accelerometer shall be operated in accordance with 4.4.8. The accelerometer temperature shall then be returned to that

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of standard conditions and the accelerometer again operated and inspected visually as specified in 4.4.8. No damage to the accelerometer shall result from this test.

4.5.17 Return mechanism operation. The accelerometer shall be placed in operating position with the pointers deflected to the maximum indication, the reset knob shall then be operated to return the pointers to zero. The force applied to the reset knob shall be between 2.50 and 8 pounds.

4.6 First article inspection.

4.6.1 Quality conformance inspection samples. The quality conformance inspection samples shall consist of three accelerometers. Samples shall be identified with the manufacturer's own part number and any additional information required by the letter of authorization.

4.6.2 First article required. Prior to actual procurement, the product which this specification covers shall pass the qualification tests specified herein. If the product is later modified in any way, the modified form shall be subjected to and shall pass the same qualification tests.

4.6.3 First article inspection. The first article inspection shall consist of the tests specified under 4.5 Test methods.

4.7 Inspection and test. Tests of methods of preservation and packaging shall be accomplished in accordance with Section 4 of MIL-P-116 to insure compliance with Section 5 of this specification.

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. Accelerometer shall be cleaned in accordance with process C-1 of MIL-P-116.

5.1.1.2 Drying. Accelerometer 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 Accelerometer shall be packaged in quantity unit packs of one each in accordance with Method IC-1 of MIL-P-116. Each Accelerometer 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 Accelerometer when completed packs are subjected to the rough handling drop tests of MIL-P-116.

5.1.2 Level C. Each Accelerometer 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.

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5.1.3 Industrial. The Industrial preservation of the Accelerometer 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. Accelerometer 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. Accelerometer packaged as specified in 5.1.1 shall be packed in shipping containers conforming 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.

5.2.4 Industrial. The packaged Accelerometer 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 Type MA-1 accelerometer covered by this specification is intended for use on aircraft to indicate vertical acceleration in maneuvers and in rough air.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- c. Whether sampling plan B is to be omitted.
- d. Level of packaging and packing desired.
- e. Whether a first article is required for inspection and approval.

6.3 First article. When a first article is required, the item will be inspected and tested in accordance with Section 4 of this document. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, test and approval of the first article.

6.4 Definitions.

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

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6.4.2 Hermetic seal. A hermetic seal is defined as a perfectly closed and airtight seal made between vitric or metallic materials, or both. A hermetic seal is not intended to include seals accomplished by gaskets.

6.4.3 Tapping. The phrase "TAPPED LIGHTLY" is defined as meaning the application of a light vibration sufficient to overcome that amount of residual friction normally associated with good quality aircraft instruments.

6.4.4 The "g" unit. The "g" unit is defined as an acceleration due to gravity of 32.2 feet per second, per second.

6.5 Subject term (key word) listing.

Aircraft
g-meter
-2 to +4g

6.6 International agreement. Certain provisions of this specification are the subject of international standardization agreement AIR-STD-10/4 and NAT-STD-3330. When amendment, revision, or cancellation of this specification is proposed which 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 Change 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

Project Number
6610-F289

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER <i>MTL-A-257198(USA)</i>		2. DOCUMENT TITLE <i>Accelerometer, Aircraft, Pilot's Warning</i>	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify): _____	
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.)