MIL-A-83419C(USAF)
15 October 1979
SUPERSEDING
MIL-A-83419B(USAF)
8 April 1977

MILITARY SPECIFICATION

# ALTIMETER, SERVO CONTROLLED, AUTOMATIC PRESSURE STANDBY

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 servo-controlled altimeters with counter-drum-pointer display featuring pneumatic standby and an electrical output of barosetting.

* 1.2 Classification. Altimeters covered by this specification shall be of the following types, as specified (see 6.2).

| | |
|---|---|
| AAU-19B/A | Barometric setting output device removed, indicator face is in increments of 50 feet, PNEU position identified as STBY, and ELECT position identified as RESET. |
| AAU-34/A | Barometric Counter display is in units of Inches of Mercury |
| AAU-37/A | Barometric Counter display is in units of Millibars |

NOTE: For the AAU-19B/A only, references to PNEU refer to the STBY position or flag and references to ELECT refer to the RESET position. References made herein to barometric setting in units of inches of Mercury apply to the AAU-34/A and AAU-19B/A while units of millibars apply to the AAU-37/A.

## 2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

| | |
|---|---|
| QQ-P-416 | Plating, Cadmium (Electrodeposited) |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson AFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MILITARY

| | |
|---|---|
| MIL-P-116 | Preservation-Packaging, Methods of |
| MIL-E-5400 | Electronic Equipment, Airborne, General Specification for |
| MIL-C-5541 | Chemical Conversion Coatings on 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-C-14806 | Coating, Reflection Reducing, for Instrument Cover Glasses and Lighting Wedges |
| MIL-P-21563 | Paint System Fluorescent, for Aircraft Application |
| MIL-L-25467 | Lighting, Integral, Aircraft Instrument, General Specification for |
| MIL-L-27160 | Lighting, Instrument, Integral, White, General Specification for |
| MIL-B-27497 | Bearing, Jewel, Sapphire or Ruby, Synthetic |
| MIL-C-27889 | Computer, Transducer, Altitude, Altitude Encoding, CPU-46/A, General Specification for and MTU-38/A Mounting Tray |
| MIL-C-38240 | Computer, Altitude, Altitude Encoding CPU-66, General Specification for and MTU-39/A Mounting Tray |
| MIL-C-83723 | Connector, Electric, Circular, Environment Resisting, General Specification for |

DOD AIMS

| | |
|---|---|
| 65-852(1) | Test Set, Automatic Altitude Reporting Encoders and Altimeters, TTU-229/E |

STANDARDS

FEDERAL

| | |
|---|---|
| FED-STD-595 | Colors |

MILITARY

| | |
|---|---|
| MIL-STD-100 | Engineering Drawing Practices |
| MIL-STD-105 | Sampling Procedures and Tables for Inspection by Attributes |
| MIL-STD-130 | Identification Marking of US Military Property |
| MIL-STD-143 | Standards and Specifications, Order of Precedence for the Selection of |
| MIL-STD-454 | Standard General Requirements for Electronic Equipment |
| MIL-STD-461 | Electromagnetic Interference Characteristics Requirements for Equipment |
| MIL-STD-462 | Electromagnetic Interference Characteristics, Measurements of |
| MIL-STD-470 | Maintainability Program Requirements (For Systems and Equipment) |
| MIL-STD-471 | Maintainability Verification/Demonstration/Evaluation |
| MIL-STD-704 | Electric Power, Aircraft, Characteristics and Utilization of |
| MIL-STD-749 | Preparation and Submission of Data for Approval of Nonstandard Electronic Parts |
| MIL-STD-781 | Reliability Tests Exponential Distribution |
| MIL-STD-785 | Reliability Program for Systems and Equipment Development and Production |
| MIL-STD-794 | Parts and Equipment, Procedures for Packaging and Packing of |
| MIL-STD-810 | Environmental Test Methods |
| MIL-STD-831 | Test Reports, Preparation of |

| | |
|---|---|
| MIL-STD-859 | Standard Calibration Table for Aeronautical Pressure Measuring Equipment |
| MIL-STD-882 | System Safety Program Requirements |
| MS24266 | Connector, Plug, Electrical Straight, Miniature |
| MS28105 | Window, Dial - Aircraft Instrument Cover, Glass |
| MS33556 | Case, Aircraft Instrument, 3-1/4 Inch Size, Standard Dimensions for |
| MS33558 | Numerals and Letters, Aircraft Instrument Dial, Standard Form of |
| MS33649 | Bosses, Fluid Connection - Internal Straight Thread |

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 3. REQUIREMENTS

3.1 Qualification. Altimeters furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.4).

3.2 Selection of standards and specifications. Standards and specifications for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.2.1 Nonstandard parts. Standard MS- and AN- parts shall be used where they suit the purpose. When no standard part is available, a nonstandard part may be used with prior approval of the procuring activity. Preparation and submission of data for approval for nonstandard parts shall be in accordance with MIL-STD-749.

3.2.2 Microelectronic devices. Microelectronic devices shall be in accordance with requirement 64 of MIL-STD-454.

3.3 Materials

3.3.1 Nonmagnetic materials. Nonmagnetic materials shall be used for all parts of the altimeter, except where magnetic materials are essential.

3.3.2 Toxic and corrosive fumes. Materials, as installed in the altimeter and under the service conditions specified herein, shall not liberate deleterious or corrosive fumes. This shall include any fungicidal agents that are used.

3.3.3 Protective treatment. When materials are used in the construction of the altimeter 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 the specification. The use of any protective coating that will crack, chip, or scale with age or extremes of climatic or environmental conditions shall be avoided.

3.3.4 Fungusproof 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 procuring activity. However, if they are used in a hermetically sealed enclosure, fungicidal treatment will not be necessary.

3.3.5 Metals. Metals shall be of the corrosion-resistant type, unless suitably protected to resist corrosion during the normal service life of the altimeter.

3.3.5.1 Dissimilar metals. Unless protected against electrolytic corrosion by means of a protective coating or hermetic sealing, intimate contact of dissimilar metals shall be avoided. Dissimilar metals are defined in requirement 16 of MIL-STD-454.

3.3.6 Nonferrous materials. Nonferrous materials shall be used for all parts of the altimeter, except where ferrous materials are essential.

3.3.6.1 Protection of nonferrous materials. Nonferrous materials contained within hermetically sealed enclosures shall be considered suitably protected from corrosion. Requirements specified for fungicidal and corrosion protective treatment and anodizing of aluminum alloy parts will not be applicable for parts within hermetically sealed enclosures.

* 3.3.7 Recycled material. Recycled and recovered raw materials should be used to the maximum extent possible in lieu of virgin raw materials as long as these materials do not jeopardize the intended use and fully comply with all contract requirements. Materials used shall be free from defects which would adversely affect the performance or maintainability of individual components or the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practices. None of the above shall be interpreted to mean that the use of used or rebuilt products will be allowed.

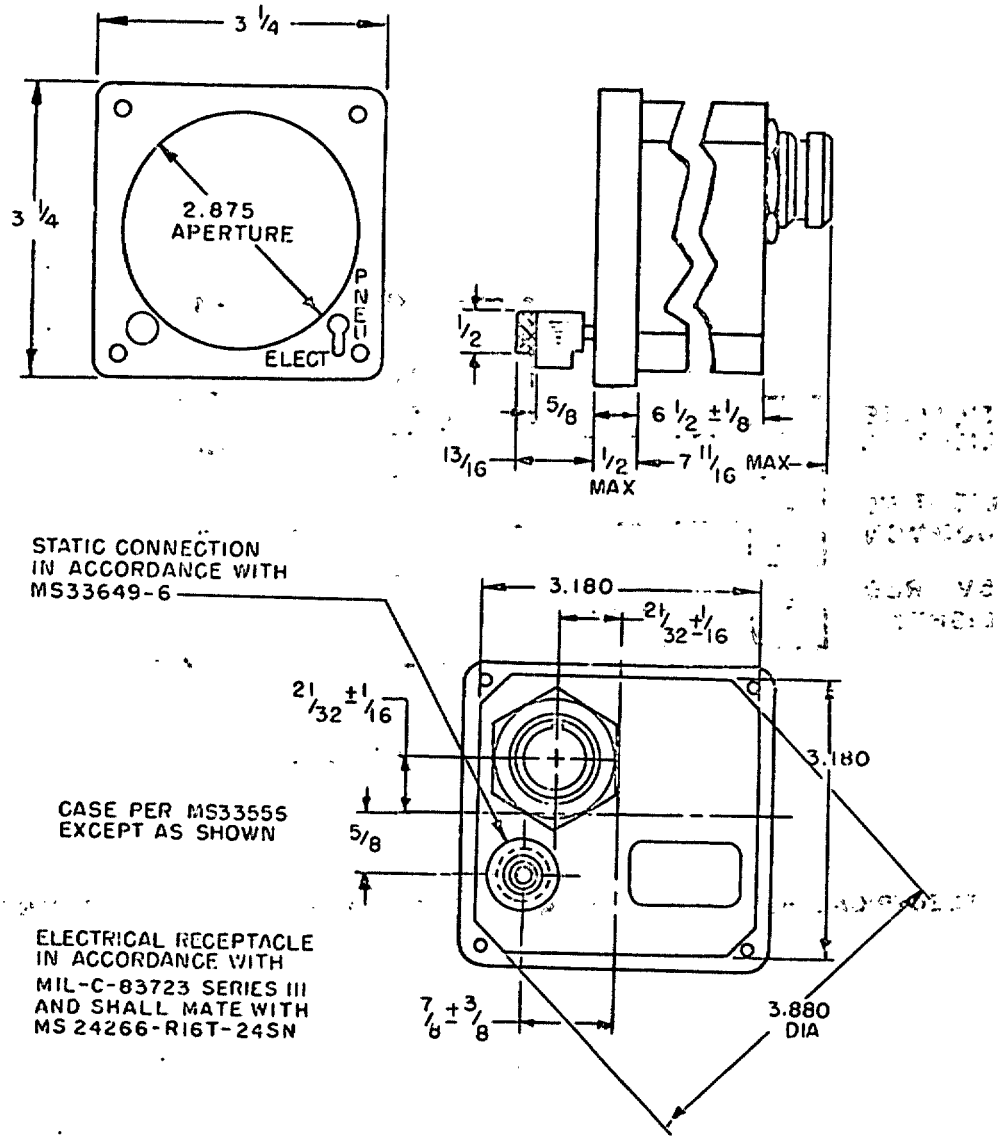
3.4 Design and construction

3.4.1 Case. The size and configuration of the case shall be as shown on figure 1. The case shall consist of a body and bezel.

3.4.1.1 Body. The body of the case shall be made of nonferrous low-density metal, shall be uniform in texture, and shall have a smooth surface with a durable black finish. The mounting flange portion of the body shall have a lusterless black finish. The rear surfaces of the two upper mounting flanges of the bezel shall be free of paint and shall be treated with a conductive finish to allow for grounding to the aircraft instrument panel.

3.4.1.2 Bezel. The bezel of the case shall be made of nonferrous low-density metal and shall have a durable black finish. The bezel shall be held in place by means of screws properly secured by lockwashers or similar devices of a design approved by the procuring activity.

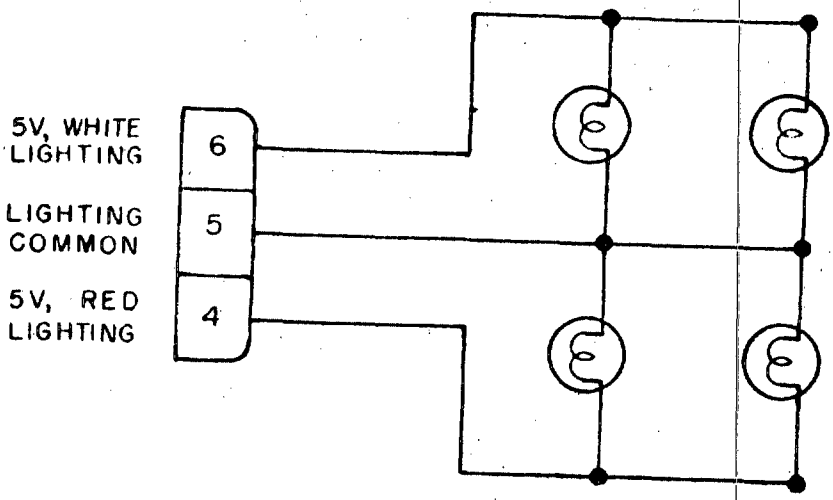
3.4.2 Cover glass and lighting wedge. The cover glass shall conform to MS28105. It shall be properly sealed and shall be replaceable by removing the bezel. If the cover glass is used as part of the lighting system, a glass may be used that deviates from the glass specified herein to the extent required for the lighting function, provided it does not interfere with the readability of the instrument. All reflecting glass surfaces shall be provided with a reflection-reducing coating in accordance with MIL-C-14806. The distance from the dial to the cover glass shall be as small as practicable and shall not exceed 0.156 inch.




DIMENSIONS IN INCHES, UNLESS OTHERWISE SPECIFIED,
TOLERANCES: FRACTION ±1/64
DECIMALS ±.016

NOTE: A BOSS MAY BE USED IN AREA OF CONNECTORS WITH PRIOR APPROVAL OF PROCURING ACTIVITY

FIGURE 1. Case.




ELECTRICAL RECEPTACLE IN ACCORDANCE WITH MIL-C-83723 SERIES III

FIGURE 2. Lighting circuits.

3.4.3 Integral lighting. The altimeter shall be integrally lighted with both red and white lighting circuits as shown on figure 2. The red lighting shall be in accordance with MIL-L-25467, and the white lighting shall be in accordance with MIL-L-27160. Lighting shall operate on 5V ac or dc. Lighting acceptability of production altimeters shall be based upon visual comparison with a prime standard. Prior to fabrication, the method of lighting shall be approved by the procuring activity.

3.4.3.1 Prime standard. The prime standard lighting reference shall be prepared as specified herein. A minimum of 20 areas covering the entire face of the altimeter shall be measured for brightness level. A minimum of 10 areas covering the entire face of the altimeter shall be measured for color. The prime standard and its recorded overall brightness and color measurements shall be approved by the procuring activity. The standard shall be checked at least every 100 hours of operation to determine any change in brightness and color. The results of this check shall be submitted to the procuring activity for approval.

3.4.4 Static connection. The static connection shall be as shown on figure 1 and shall be located as shown thereon. A 150- to 200-wire mesh filter screen (either stainless steel or monel) shall be firmly installed in the static connection to prevent dirt particles from entering the case. It shall be provided with a vented plug of acceptable material and design. Each plug shall incorporate a vent consisting of a hole 0.063 ±0.016 inch in diameter.

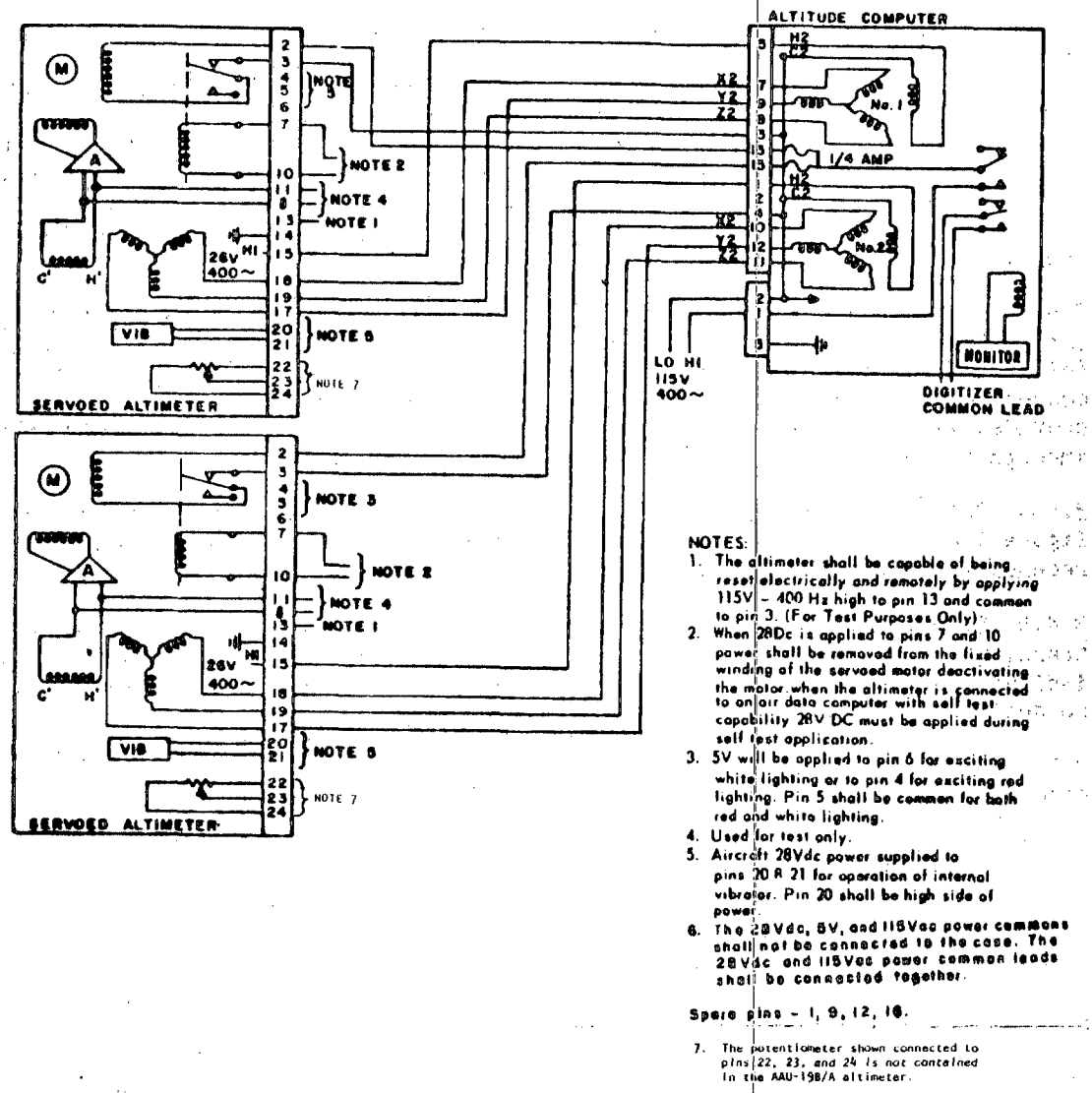
3.4.5 Electrical connector. The electrical connector shall be as shown on figure 1 and shall be located as shown thereon. The connection to the receptacle shall be as shown on figure 3.

3.4.6 Servo system. The servo system shall contain a servo motor, synchro, transistor amplifier, transistor failure detection circuit, and failure warning indicator. Vacuum tubes shall not be used in the circuitry. The system shall be designed to provide a stable operating display of altitude.

3.4.7 Case grounding. The case shall be internally grounded to pin 14. The electrical system in the altimeter shall not be grounded.

3.4.8 Power common leads. The 28V dc and 115V ac power common leads shall be connected together. The 5V lighting common shall not be connected to the 28V dc and 115V ac common leads.

3.4.9 Internal vibrator. An internal vibrator system shall be incorporated into the altimeter which will effectively decrease the friction in the mechanism. The vibrator shall be self-starting upon being energized by monitor action or control knob operation and shall start without tapping or other external assistance. The vibration units shall be capable of running, starting, and producing effective vibration for a period of 1,000 hours. The design shall be such that extended use of the vibrator will not result in deposits of foreign material nor produce deleterious fumes that could result in adverse effects on altimeter performance. The vibrator circuit shall be of such design that the vibrator will operate only when the altimeter is in the pneumatic mode of operation. When used to revert the instrument to pneumatic operation, the monitor circuit and control level shall activate the vibrator circuit.




NOTES:

1. The altimeter shall be capable of being reset electrically and remotely by applying 115V - 400 Hz high to pin 13 and common to pin 3. (For Test Purposes Only)
2. When 28Dc is applied to pins 7 and 10 power shall be removed from the fixed winding of the servoed motor deactivating the motor when the altimeter is connected to an air data computer with self test capability 28V DC must be applied during self test application.
3. 5V will be applied to pin 6 for exciting white lighting or to pin 4 for exciting red lighting. Pin 5 shall be common for both red and white lighting.
4. Used for test only.
5. Aircraft 28Vdc power supplied to pins 20 & 21 for operation of internal vibrator. Pin 20 shall be high side of power.
6. The 28Vdc, 5V, and 115Vac power commons shall not be connected to the case. The 28Vdc and 115Vac power common leads shall be connected together.

Spare pins - 1, 9, 12, 18.

7. The potentiometer shown connected to pins 22, 23, and 24 is not contained in the AAU-19B/A altimeter.

* FIGURE 3. System interwiring diagram.

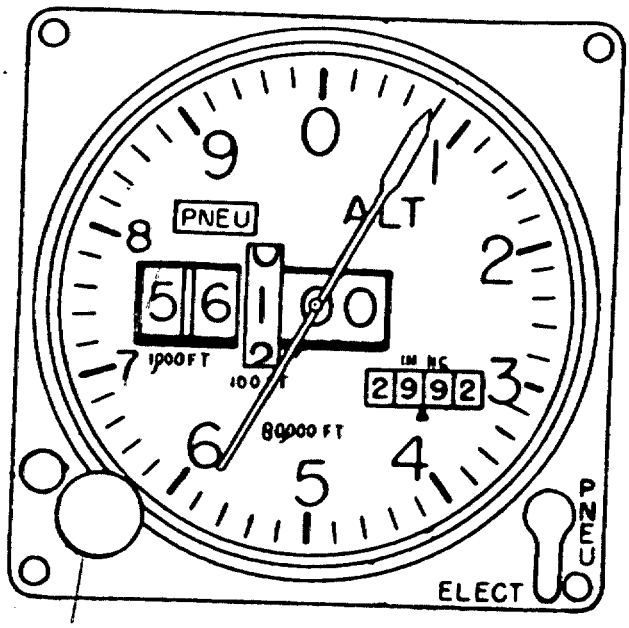



FIGURE 4. AAU-34/A Presentation.

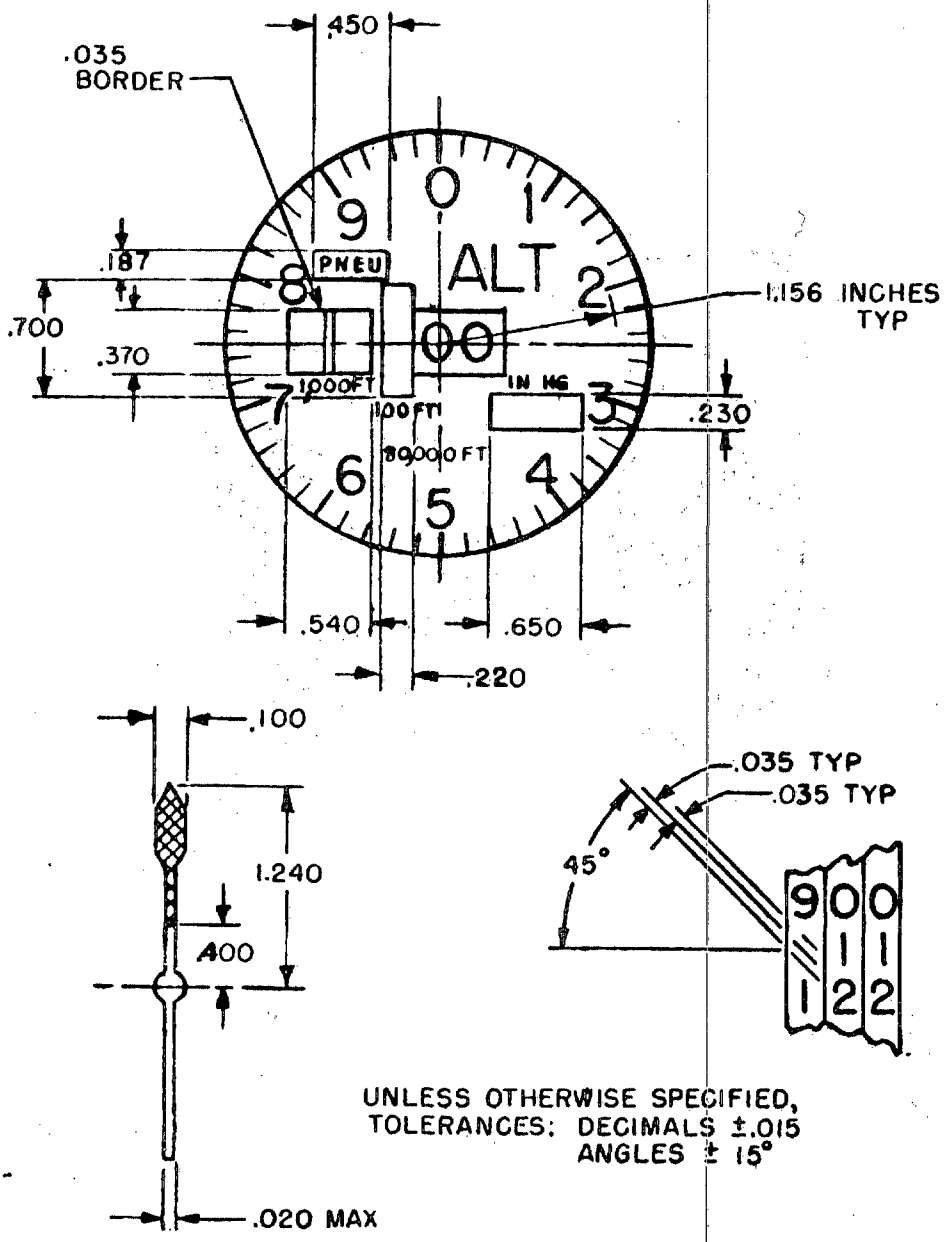



FIGURE 5. AAU-34/A Dial.

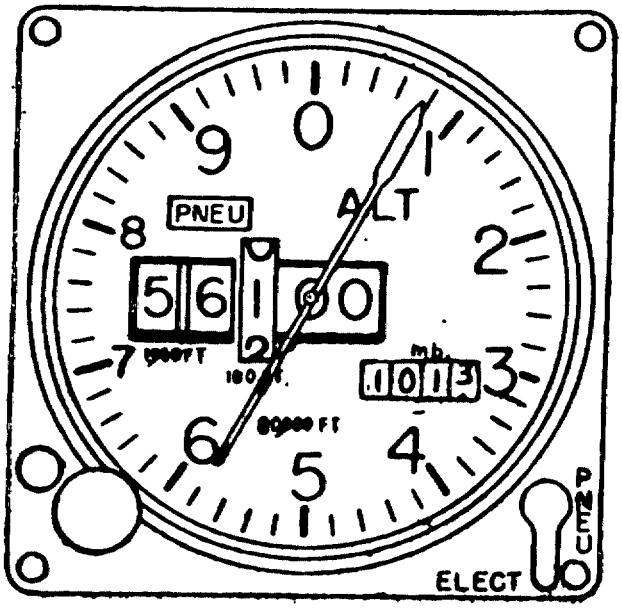



FIGURE 6. AAU-37/A Presentation.

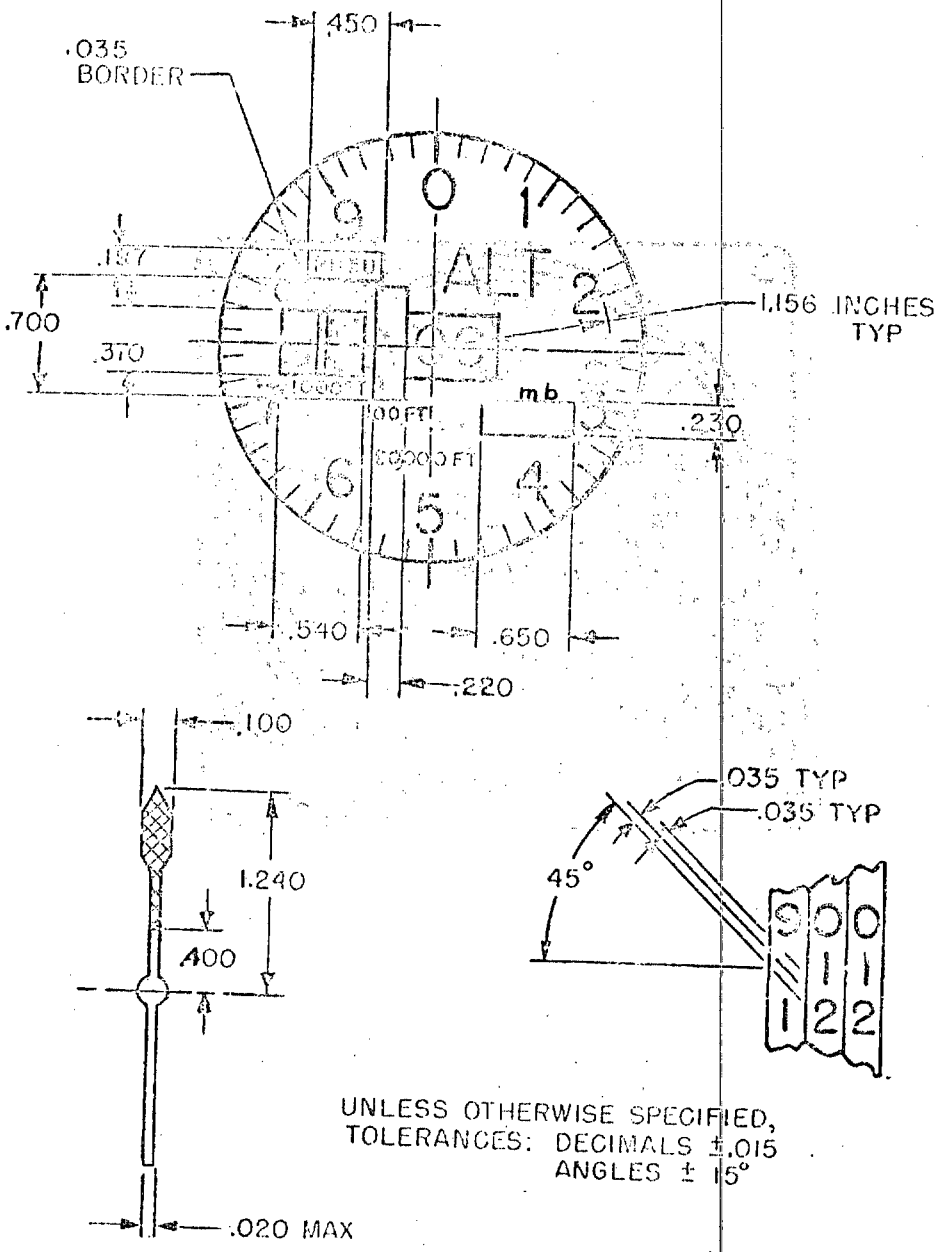



FIGURE 7. AAU-37/A Dial.

* 3.4.10 Display. The display shall consist of a counter-drum-pointer for altitude, a counter for the barometric setting, and a pneumatic flag for indication of operation in the power-off mode. The display for the AAU-34/A altimeter shall be as shown on figures 4 and 5. For the AAU-37/A, the display shall be as shown on figures 6 and 7. The display for the AAU-19B/A shall be as shown on figures 10 and 11. The location and size of display information, not otherwise specified herein, shall be approved by the procuring activity.

3.4.10.1 Pneumatic indication. A failure warning flag indicated by PNEU in block letters on a yellow background shall be provided to indicate when the instrument reverts to mechanical operation. The flag shall be hidden when the instrument is set to electrical operation.

* 3.4.10.1.1 Pneumatic indication for AAU-19B/A. A failure warning flag indicated by STBY in block letters on a red background shall be provided to indicate when the instrument reverts to mechanical operation. The flag shall be hidden when the instrument is reset to electrical operation.

3.4.10.2 Pointer adjustment. The pointer shall be firmly attached to the mechanisms, but shall be readily adjustable.

3.4.10.3 Pointer and counter relationship. The pointer shall indicate readings in feet with reference to a single circular uniform graduated scale making one revolution for each 1,000 feet of altitude. The pointer shall be positively geared to the drum so that as the pointer moves clockwise (increasing altitude), the drum will rotate for increasing numbers synchronized with the pointer. The numerals on the drum shall represent hundreds of feet. The first counter nearest the drum shall be driven by the drum so that it will index one digit as the drum moves through the 9 to 0 position in either direction. During the long period between 0 and 9, the first counter shall be locked in position. Each digit on the first counter nearest the drum shall represent 1,000-foot intervals. The second counter shall be driven by the first counter so that the second counter will index a 9 in either direction. During the long period between 0 and 9 of the first counter, the second counter shall be locked in position. Each digit of the second counter shall represent 10,000-foot levels. The combined readings of the counters and drum shall indicate the pressure altitude in thousands and hundreds of feet. The pointer shall act as a vernier of the hundreds drum as well as being an indication of trend information. With the pointer on the zero graduation, the zero numeral of the hundreds drum shall be centered within one-half the line thickness of the fixed zeros. The center hub of the pointer shall not in any position obscure the indication of the drum or the fixed zero digit in the tens place. The tip of the pointer shall overlap one-fifth of the shortest graduation on the dial within the tolerance of ±0.016 inch.

3.4.11 Electrical power

3.4.11.1 Servo power. The altimeter shall be designed to operate from a 115-V, 400-Hz single-phase power supply in accordance with MIL-STD-704, except that the frequency range shall be from 320 to 480 Hz. The altimeter shall not require more than 25 va for normal operation.

3.4.11.2 Vibrator power. The internal vibrator shall be designed to meet the power requirements of MIL-STD-704, category B, as specified for 28-V dc power. The current shall not exceed 90 milliamperes.

3.4.12 Reliability program. The contractor shall establish a reliability assurance program in accordance with applicable features of MIL-STD-785.

3.4.12.1 Reliability. The altimeter shall have a contract specified mean-time-between-failures (MTBF) of 2,000 hours, tested as specified in 4.6.41.

3.4.12.1.1 Longevity. The altimeter shall be designed for a useful life (longevity) of 3,000 hours.

3.4.13 Maintainability program. The contractor shall establish a maintainability program in accordance with MIL-STD-470. The following shall be considered in the design of the altimeter:

a. Minimization of complexity of maintenance tasks (for example: calibration, adjustments, inspections, et cetera) by maximum use of simple design which induces optimum interchangeability and use of standardized equipment or commercial items

b. Optimum accessibility in all systems, equipments, and components requiring maintenance, inspections, removal, or replacement.

3.4.13.1 Maintenance and repair cycles. The altimeter shall be completely repairable at depot level, down to the smallest, replaceable component part. The maintenance task time, which includes preparation (setup) for test, recognition (validation) of a fault, isolation of the cause of the fault, repair of the fault, realignment and recalibration, and preliminary checkout shall not exceed 8 hours repair time for any single failure in an instrument. This requirement shall be achieved by utilizing the equivalent of one depot technician, authorized depot AGE (or equivalent), and authorized technical information.

3.4.13.1.1 Maintenance task test and demonstration. If any failures occur during reliability testing, the cognizant Government inspector shall be notified to witness the fault isolation, repair, and checkout of the repair. The altimeter shall then be returned to reliability testing. All failures, actual and simulated, shall be considered as being a part of the timed corrective maintenance task demonstration; therefore, a record of the events shall be submitted to the procuring activity in accordance with the appropriate line items of DD Form 1423 entitled Maintainability Demonstration Reports. When demonstrating simulated failures, the replacement components shall be from a simulated spares inventory and not the same parts that were just removed for the demonstration. Also, alternate source components shall be used as the replacement component or parts on all simulated failure demonstrations.

3.4.13.1.2 Measurement of task times. Only the active time required to complete a maintenance task, i.e., recognition, isolation repair, realignment and recalibration, and preliminary checkout of the repaired altimeter shall be considered and used in the compilation of maintenance task time. Preliminary checkout shall include all required temperature compensation and position error measurements, rough-ranging, and cursory electrical-mechanical tests. Supply downtime, delays such as waiting for parts or their rework, relief breaks, test equipment downtime, etc., shall be excluded from pertinent accumulated task times. Likewise, complete specification performance (quality conformance tests (i.e., scale error, friction, altitude deviation, etc.) under specified, extreme environmental conditions, shall not be included in this maintenance

task time computation. However, if the specification performance testing reveals repair-related malfunctions, the time required to correct these malfunctions shall be included in the final maintenance task time figure.

3.4.13.1.3 Service and removability. Other than the zero setting system adjustment, the altimeter shall be designed to require no corrective or preventative maintenance while installed in the aircraft. The altimeter shall be removable by disconnection of the static pressure line and electrical connector, removing four mounting screws, and lifting the altimeter from the aircraft instrument panel. All other repair service shall be accomplished at depot-level facilities.

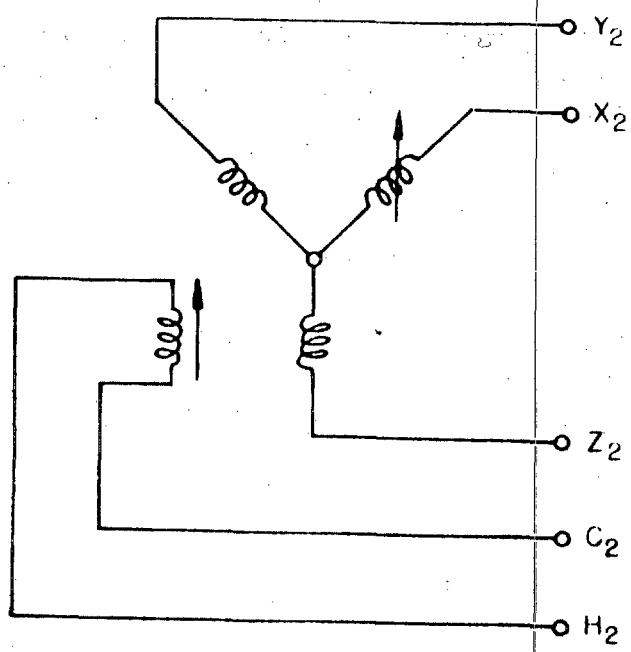
3.4.13.2 Safety. The altimeter shall present no danger, injury, or hazard to operating and service personnel.

3.4.13.2.1 Hazard analysis. A safety hazard analysis shall be performed to determine, from a safety consideration, the functional relationships of components and equipments interfacing with the altimeter. The safety analysis shall identify all components, equipments, and materials whose performance degradation or functional failure could result in category III or IV hazards as defined in MIL-STD-882, paragraph entitled Hazard Level. This analysis shall include a determination of the failure modes and the effects on safety should failures occur. Areas to be considered are the appropriate sections of MIL-STD-882, as listed under paragraph entitled System Hazard Analyses, and the effects of storage, shelf life, transportation, and packaging. Where practicable, design changes shall be made to eliminate or minimize the hazards. If the hazards cannot be eliminated, alternative controls such as recommended changes to interfacing equipment shall be presented to the procuring activity for resolution. The analysis shall be presented at the final design review.

3.4.14 Synchro input. The altimeter shall be designed to operate electrically from a synchro signal originating in an altitude computer. The computer synchro shall be a Bendix AY100GZ-88-A1, or approved equivalent. The computer synchro shall be excited by 26-V, 400 Hz power from the altimeter power supply through pins 3 and 15 of the receptacle as shown on figure 3. The 26-V, 400 Hz synchro excitation signal available from the altimeter on pin 15 shall be in phase with the 115V, 400 Hz input to pin 2. The synchros in the altitude computer shall be as shown on figures 8 and 9. Scale factor of the altitude computer altimeter synchros shall be 36°/1,000 feet. Electrical zero shall be at zero altitude with barometric setting at 29.92 inches Hg or 1013.25 millibars.

3.4.15 Servo disable. A circuit shall be provided which will disable the servo motor when 28-V dc is supplied to designated pins of the altimeter. The circuit is depicted as a relay as shown on figure 3 for explanation purposes.

* 3.4.16 Synchro signal. The altimeter shall be electrically operated from a synchro signal supplied by an altitude computer in accordance with MIL-C-27889 or an air data computer with equivalent and compatible synchro signals as approved by the procuring activity. The electrical synchro signals corresponding to pressure-altitudes shall be permitted to differ from the pneumatic mode indication of the altimeter by up to 3,500 feet depending on the altitude as specified in 3.5.10. Rotation of the input synchro through 360° while the altimeter is in pneumatic mode shall not cause a deviation of the pointer of more than 25 feet at sea level or more than 50 feet at 50,000 feet.



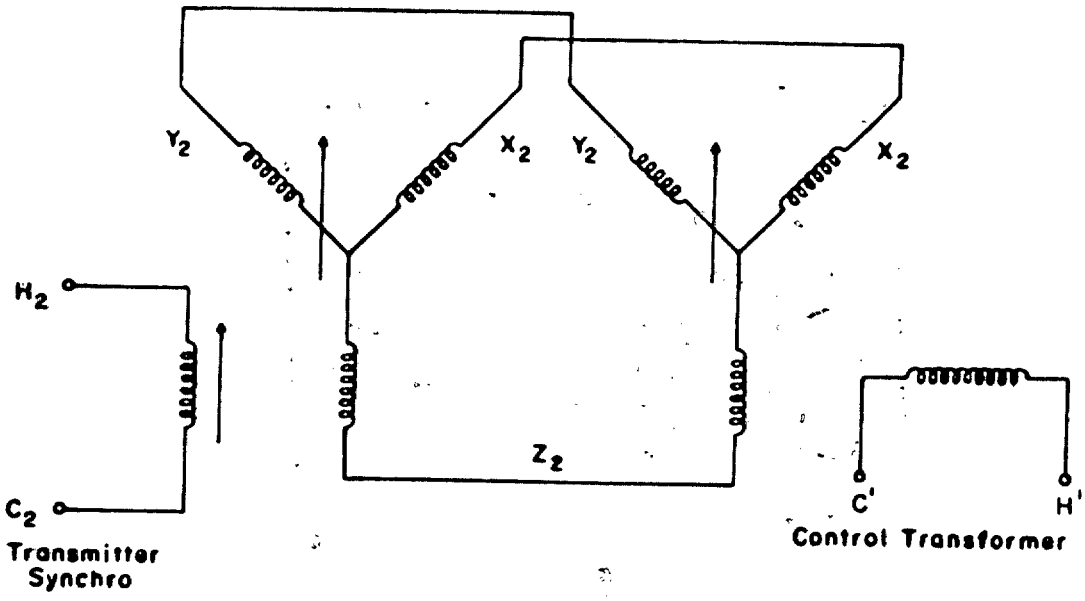

a. The rotor shall be excited with rated voltage so that voltage $C_2$ to $H_2$ is in phase with power excitation ground to phase.

b. At the electrical zero position, the voltage from $Z_2$ to $X_2$ and, $Z_2$ to $Y_2$ shall be in phase with $C_2$ to $H_2$ and the power excitation. Voltage $X_2$ to $Y_2$ shall be null. If $C_2$ is connected to $Z_2$ then the voltage $H_2$ to $X_2$ is less than $H_2$ to $C_2$.

c. Rotation of the synchro to an increasing function (schematically shown as synchro rotor clockwise), the voltage $Y_2$ to $X_2$ shall increase in phase with $C_2$ to $H_2$ and the power excitation.

d. The $X_2$, $Y_2$, and $C_2$ designations will be assigned to the wiring diagram of the component connector.

FIGURE 8. Electrical zero transmitter.




a. The control transformer shall be connected to an electrical servoed transmitter synchro. The voltage C' to H' shall be null.

b. If the transmitter synchro is rotated to an increasing function (schematically shown as rotor clockwise), the voltage C' to H' shall increase in phase with $C_2$ to $H_2$.

FIGURE 9. Electrical zero control transformer.

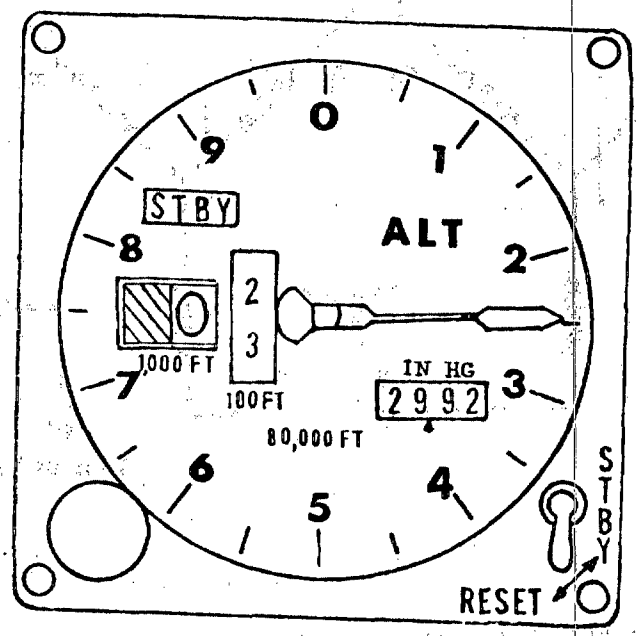



FIGURE 10. Presentation.

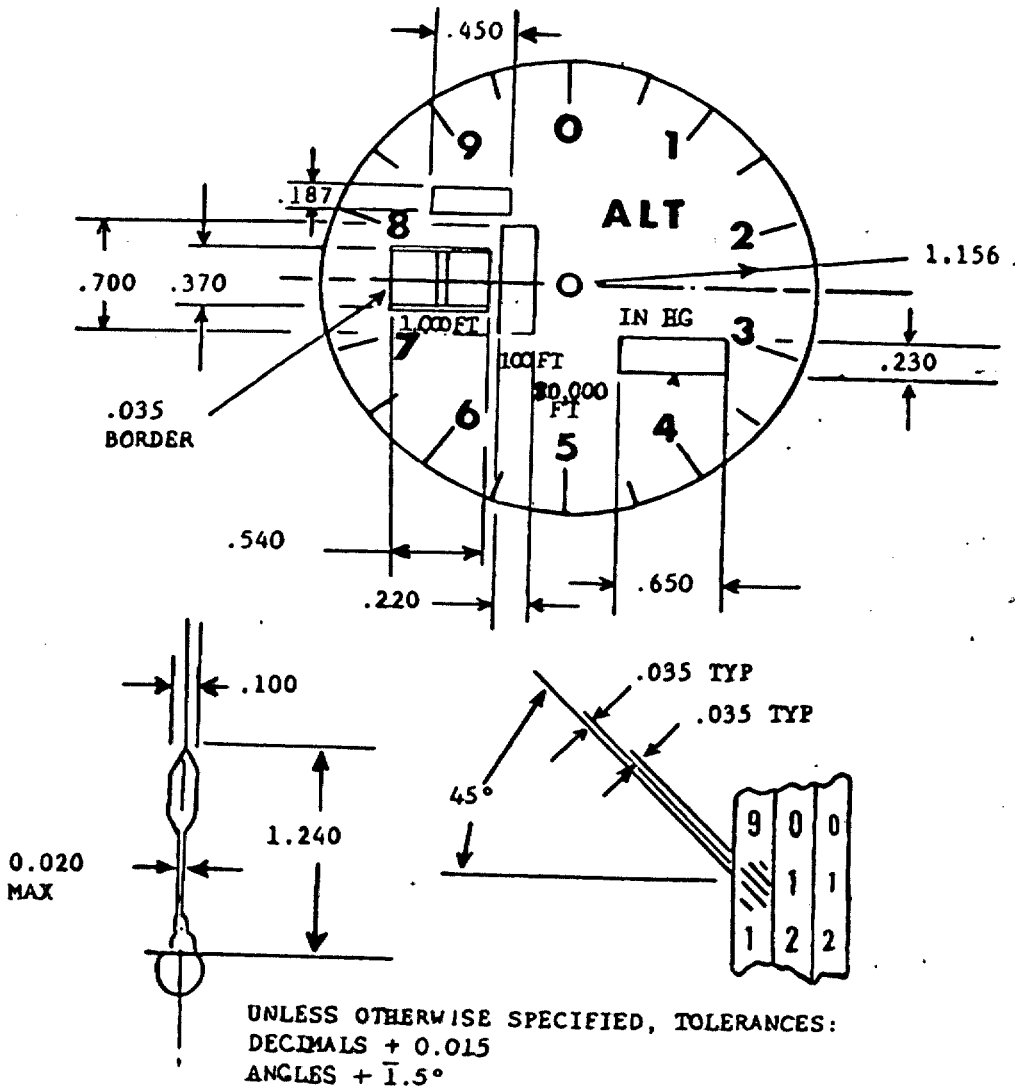



FIGURE 11. Dial.

When the synchro is rotated away from the pneumatic position by the equivalent of 500 feet, there shall be no more than 10 feet of pointer movement at any altitude up to 20,000 feet. An additional 10 feet of pointer movement shall be permitted at and below-35°C bringing the total amount of pointer movement to 20 feet up to 20,000 feet.

3.4.17 Pneumatic mechanism. The altimeter shall contain an integral pneumatic mechanism of the aneroid type that will operate the instrument display presenting pneumatic pressure-altitude in accordance with MIL-STD-859 and with normal barosetting correction.

3.4.18 Zero setting knob and control lever. The zero setting knob and the control lever shall be attached to their respective shafts in such a manner that they may be easily removed from their shafts and replaced with knobs or levers of different lengths. An attachment means, equivalent to a flattened surface on the shaft, and a set screw shall be used to provide positive securing for turning. The zero setting knob operating torque and the torque that the mechanism or knob shall withstand is specified in 3.8.1. The elect-pneu control lever shall operate with a torque not to exceed 1 inch-pound and shall withstand a torque of 15 inch-pounds without damage to the lever or mechanism.

3.4.18.1 The barosetting knob and the elect-pneu control lever shall withstand a force of 15 pounds applied at the extreme outward end of the setting knob or control lever without bending or without damaging the mechanism.

* 3.4.19 Time delay. A time delay shall be incorporated to prevent nuisance trips from occurring due to power fluctuations or pressure disturbances as encountered in turbulent air conditions. Normal power fluctuations as defined in MIL-STD-704 shall not cause failure trips. The time delay shall be between .5 and 1.0 seconds.

3.4.20 The switchover from electrical to pneumatic operation shall not be dependent upon mechanical (i.e., hydraulic, electromagnetic, pneumatic, et cetera) engagement or disengagement of any mechanism, clutch, brake, et cetera, that could directly or indirectly impair any of the pneumatic mode performance requirements.

3.4.21 Internal circuitry. The internal circuitry shall be such that under the following conditions of failure, the altimeter will automatically revert to mechanical pneumatic operation:

a. Primary power failure

b. Servo amplifier failure

c. Servo motor failure

d. Switch failure

e. Relay failure

f. Monitor failure.

* 3.4.22 The altimeter shall not re-energize itself unless directed by the pilot by use of the control lever located on the face of the bezel. The switch shall energize the electrical system when the control lever is rotated clockwise (elect), and shall de-energize the electrical system when the control lever is rotated counterclockwise (pneu) as noted on the face of the instrument. The switchover from one mode to the other shall not require holding the control lever in the fully rotated positions for more than 1.0 seconds. The 26-V, 400 Hz synchro excitation signal on pin 15 shall not be interrupted when the control lever is placed in the electrical or the pneumatic mode.

3.4.23 A means shall be provided so that the torque applied to the pneumatic mechanism by the electrical system will not structurally damage the pneumatic mechanism under any condition of operation or malfunction of either the computer or altimeter.

3.4.24 Compatibility. The altimeter input requirements shall be compatible with the output characteristics of the CPU-46/A or CPU-66/A computer in accordance with MIL-C-27889 or MIL-C-38240, respectively. The altimeter shall be compatible with the TTU-229/E test set in accordance with DOD AIMS 65-852(1).

3.5 Performance. The altimeter shall indicate pressure altitudes within the limits specified under the following environmental conditions or combinations thereof:

a. Altitudes ranging from -1,000 to +80,000 feet at rates up to 80,000 fpm

b. Continuous operation at temperatures ranging from -54° to +71°C (-65° to +160°F) and storage temperatures ranging from -62° to +71°C (-80° to +160°F)

c. Humidity up to 95 percent

d. Exposure to salt-sea atmosphere

e. 0.10 double amplitude (inches) between 5 and 20 Hz and 2g from 20 to 500 Hz

f. Fungus growth as encountered in tropical climates

g. Sand and dust particles as encountered in desert areas

h. Shock fores of 15g for basic design, and 30g for crash safety for 11 milliseconds

i. Acceleration:

(1) Structural g levels

| | | |
|---|---|---|
| (a) | Fore: | 3.0 |
| (b) | Aft: | 9.0 |
| (c) | Up: | 13.5 |
| (d) | Down: | 4.5 |
| (e) | Lateral: | 6.0 |

TABLE I. Scale errors.

| EQUIVALENT PRESSURE UNITS OF MERCURY AT 0°C | | STANDARD ALTITUDE | SYNCHRO POSITION | PNEUMATIC | | | POWER ON +25°C |
|---|---|---|---|---|---|---|---|
| | | | | ROOM TEMP +45°C | -35°C | #-54°C #+71°C | +45°C #+71°C -35°C #-54°C |
| MM | INCHES | FEET | DEGREES | FEET | FEET | FEET | FEET |
| 787.87 | 31.018 | -1,000 | 324 | 30 | | | |
| 760.00 | 29.921 | 0 | 0 | 30 | 45 | 60 | 20 |
| 746.37 | 29.385 | 500 | 18 | 35 | | | 20 |
| 732.93 | 28.856 | 1,000 | 36 | 35 | 50 | 70 | 20 |
| 719.70 | 28.335 | 1,500 | 54 | 40 | | | 20 |
| 706.65 | 27.821 | 2,000 | 72 | 40 | 60 | 80 | 20 |
| 693.80 | 27.315 | 2,500 | 90 | 45 | | | 20 |
| 681.14 | 26.817 | 3,000 | 108 | 45 | 70 | 90 | 20 |
| 656.38 | 25.842 | 4,000 | 144 | 50 | | | 20 |
| 632.36 | 24.896 | 5,000 | 180 | 55 | 80 | 110 | 20 |
| 609.05 | 23.978 | 6,000 | 216 | 60 | | | 20 |
| 564.51 | 22.224 | 8,000 | 288 | 70 | | | 20 |
| 522.65 | 20.577 | 10,000 | 0 | 80 | 120 | 160 | |
| 483.34 | 19.029 | 12,000 | 72 | 90 | | | |
| 446.34 | 17.577 | 14,000 | 144 | 100 | | | |
| 428.90 | 16.886 | 15,000 | 180 | 105 | 155 | 210 | |
| 411.90 | 16.216 | 16,000 | 216 | 110 | | | |
| 379.53 | 14.942 | 18,000 | 288 | 120 | | | |
| 349.25 | 13.750 | 20,000 | 0 | 130 | 195 | 260 | 20 |
| 320.96 | 12.636 | 22,000 | 72 | 140 | | | # 20 |
| 282.03 | 11.103 | 25,000 | 180 | 155 | 235 | 310 | # 20 |
| 225.69 | 8.885 | 30,000 | 0 | 180 | 270 | 360 | # 20 |
| 178.83 | 7.041 | 35,000 | 180 | 205 | 300 | 410 | |

TABLE I. Scale errors. - Continued

| EQUIVALENT PRESSURE UNITS OF MERCURY AT 0°C | | STANDARD ALTITUDE | SYNCHRO POSITION | PNEUMATIC | | | | POWER ON +25°C |
|---|---|---|---|---|---|---|---|---|
| | | | | ROOM TEMP +45°C | -35°C | #-54°C #+71°C | +45°C -35°C | #+71°C #-54°C |
| MM | INCHES | FEET | DEGREES | FEET | FEET | FEET | FEET | |
| 140.66 | 5.538 | 40,000 | 0 | 230 | 345 | 460 | | # 20 |
| 110.62 | 4.355 | 45,000 | 180 | 255 | 380 | 510 | | # 20 |
| 86.99 | 3.425 | 50,000 | 0 | 280 | 420 | 560 | | # 20 |
| 68.40 | 2.693 | 55,000 | 180 | 600 | 900 | 1,600 | | |
| 53.79 | 2.118 | 60,000 | 0 | 800 | 1,200 | 1,600 | | # 20 |
| 33.28 | 1.310 | 70,000 | 0 | 1,200 | 1,800 | 2,400 | | # 20 |
| 20.70 | 0.815 | 80,000 | 0 | 1,500 | 2,250 | 3,000 | | # 20 |

NOTE: Test to be run up and down scale. The total number of test points used in testing at 200 hour reliability intervals and after environmental exposure may be reduced to ten points which are approved by the procuring activity. Final reliability testing and testing after the last environmental exposure must include all test points.

# To be tested during qualification and sampling testing only.

TABLE II. Friction errors.

| Column A | Column B | Column C | Column D | Column E |
|---|---|---|---|---|
| Test Point Altitude (Feet) | Rate of Ascent or Descent (Feet/Min) | Tolerance Vibrator Operative (Feet) | Tolerance Vibrator Inoperative (Feet) # (Initial) | Tolerance Vibrator Inoperative (Feet)## |
| 0 | 500 | 25 | --- | --- |
| 1,000 | 500 | 25 | 125 | 200 |
| 3,000 | 500 | 25 | 150 | 225 |
| 5,000 | 500 | 25 | 175 | 250 |
| 10,000 | 500 | 25 | 250 | 400 |
| 20,000 | 3,000 | 25 | 350 | 575 |
| 30,000 | 3,000 | 25 | 500 | 800 |
| 40,000 | 3,000 | 50 | 750 | 1,200 |
| 50,000 | 3,000 | 50 | | |
| 60,000 | 3,000 | 50 | | |
| 70,000 | 3,000 | 50 | | |

| Static Friction Error -- Vibrator Inoperative | | |
|---|---|---|
| Test Point Altitide (Feet) | Tolerance (Feet) Initial Tests# | Final Tests## |
| 500 | 75 | 125 |
| 1,500 | 75 | 125 |
| 2,500 | 75 | 125 |
| 3,500 | 75 | 125 |
| 7,500 | 100 | 175 |
| 12,500 | 100 | 175 |
| 17,500 | 125 | 225 |
| 22,500 | 150 | 250 |
| 32,500 | 200 | 350 |
| 45,500 | 325 | 500 |

NOTES:
# "Initial Tests" are those tolerances which all instruments must meet when first subjected to friction tests.
## "Final Tests" are those tolerances which must be met at the completion of the reliability testing.

(2) Operational g levels

(a) Fore: 2.0

(b) Aft: 6.0

(c) Up: 9.0

(d) Down: 3.0

(e) Lateral: 4.0

3.5.1 Electromagnetic interference. The altimeter shall be in accordance with the electromagnetic interference requirements of MIL-STD-461 as specified for class A1 equipment.

TABLE III. Hysteresis tolerance.

| Test Point | Altitude (Feet) | Tolerance (Feet) |
|---|---|---|
| First | 40,000 | 100 |
| Second | 20,000 | 70 |
| Third | 0 | 40 |

3.5.2 Pressurization. The altimeter shall withstand compartment pressurization up to an absolute pressure of 28 psi at standard sea level conditions.

3.5.3 Dielectric strength. The altimeter shall withstand application of 500V at a frequency of 60 Hz for 30 seconds.

3.5.4 Magnetic property. The altimeter shall not cause the reading of an aircraft magnetic compass to change more than 1° at a distance of 8 inches from and magnetically East or West of the center of the compass.

3.5.5 Position error. Position error shall not exceed 20 feet in the pneumatic mode nor 10 feet in the electrical mode under the conditions specified in 4.6.8.

3.5.6 Scale error. Scale error shall not exceed the tolerances specified in table I.

3.5.7 Friction error. Friction error shall not exceed the tolerance specified in table II.

3.5.8 Hysteresis. Hysteresis shall not exceed the tolerance specified in table III.

3.5.9 Response. The altimeter shall track altitude rates of change up to and including 80,000 fpm in both modes of operation. The lag in the electrical mode at a rate of 25,000 fpm shall not exceed 50 feet. In the pneumatic mode, lag at a rate of 10,000 fpm with the vibrator on shall not exceed 100 feet more than specified in table II; column C. The lag shall be decreasingly less as the rate is reduced to 0.

3.5.10 Altitude deviation. The altimeter shall be capable of accepting electrical signals which differ from the pneumatic mode by as much as 2,000 feet up to 3,000 feet pneumatic indication and linearly increasing to 3,500 feet at 30,000 feet pneumatic indication over the temperature range of -54° to +71°C (-65° to +160°F) and input power range specified herein. Altitude deviation signals shall not affect the standby scale error by more than 15 feet immediately after application. The altimeter shall meet the scale error requirements within 2 hours after signal application.

3.5.11 Pneumatic failsafe. Malfunction of the altimeter shall not result in structural damage of the pneumatic mechanism by the electrical system.

3.5.12 Sensitivity and damping. The altimeter shall respond to and display changes in electrical input signals equivalent to 5 feet. The servo damping shall be such that a step input of 500 feet will cause no more than 210 feet overshoot and shall return to a value within the specified electrical scale error limits within 1 second. The system shall be so designed that the servo mode display will present no noticeable oscillation, jitter, or erratic motion exceeding one major graduation width.

3.5.13 Failure detection. Under the electrical failure conditions specified in 3.4.21, the altimeter shall automatically operate in the pneumatic mode, the altimeter display shall immediately follow changes in pressure, and the altimeter shall meet the accuracy and friction requirements specified herein. In the event of a servo amplifier or motor failure, operation in the pneumatic mode as specified above without immediate activation of the pneumatic flag and energizing of the integral vibrator will be acceptable until the difference between the display altitude differs from the electrical altitude input signal by the amount not to exceed that specified in 4.6.19. Under the other failure conditions, the failure warning flag shall appear immediately and the integral vibrator shall be energized simultaneously, except under primary power failure for which the time delay applies.

3.5.14 Shelf life. The altimeter shall have a minimum shelf life of 30 days.

3.5.15 Overpressure. The altimeter shall withstand a pressure of 35 inches Hg without a zero or calibration shift.

3.5.16 Underpressure. The altimeter shall withstand a pressure-altitude of 100,000 feet without a zero or calibration shift.

3.5.17 Case leakage. Case leakage shall be such that the altimeter reading will change no more than 100 feet in 1 minute at an altitude of 40,000 feet.

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 Barometric scale setting. A zero setting system shall be provided to permit the altimeter to be set to indicate zero altitude with any existing ground level pressure throughout the range of 28.10 to 31.00 inches Hg or 950 to 1048 millibars. Application of the setting system shall not introduce additional scale errors in the servo mode of more than 15 feet or in the

pneumatic mode of more than 25 feet. The servo-mode scale-error requirements specified herein shall be met without regard to the direction of setting the standard barometric pressure (29.92 inches Hg or 1013.25 millibars).

3.8 Zero setting system.

3.8.1 Barometric scale setting. A zero setting system, controlled by the setting knob in its normal position, shall be provided to permit the altimeter to be set to indicate zero altitude at any existing ground level pressure throughout the range of 28.10 to 31.00 inches Hg or 950 to 1048 millibars. The digits 31.00 through 28.10 in 0.01-inch increments or 1048 through 950 in 1 millibar increments shall be provided on a 4-digit, Veeder-type counter barometric scale or equivalent. The counter shall be located as shown on figures 4 and 6. When rotated clockwise, the barometric scale setting knob shall cause the scale value to increase. Positive stops shall be provided that prohibit the setting of ground level pressures outside the range of 27.90 to 31.20 inches of Hg or 945 to 1056.7 millibars. There shall be no damage to the stops nor displacement of the mechanism when a twisting force of 6 inch-pounds is applied at the barosetting knob. The mechanism of the instrument shall not be damaged or dislocated when a pulling or pushing force of approximately 15 pounds is applied at the barosetting knob. The torque applied to the setting knob, as required for normally setting barometric pressure, shall not exceed 7 nor be less than 2 inch-ounces throughout the setting range.

3.8.2 Adjustment of barometric scale counter to pointers. The zero setting system, controlled by the setting knob in its extended position, shall permit adjustment of the relative setting of the pointer and barometric scale counter while maintaining the relative setting of the barometric scale counter and electrical synchro. The system shall be capable of correcting for a zero shift of at least 140 feet in either direction. The relationship between the electrical output device, specified in 3.8.5, and the barometric counter shall not be affected by this adjustment.

3.8.3 Adjustment of electrical synchro to pointer. The zero setting system, controlled by the setting knob in its depressed position, shall permit adjustment of the relative setting of the pointer and electrical synchro while maintaining the relative setting of the pointer and barometric scale counter. The relationship between the electrical output device, specified in 3.8.5, and the barometric counter shall not be affected by this adjustment.

3.8.4 Setting knob position and lock. The zero setting system shall be provided with two locks which will hold the setting knob in its normal position and allow indications as specified in 3.8.1. One lock shall be accessible and shall operate from the face of the altimeter when installed on the instrument panel. The locking technique shall be so designed that complete removal of any part of the locking device will not be necessary for operation of the zero setting system. The unlocked position shall allow adjustment as specified in 3.8.2. The second lock shall not be easily accessible nor completely operable from the face when installed in a panel. The unlocked position shall permit adjustments as specified in 3.8.3.

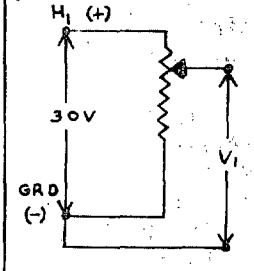
* 3.8.5 Electrical output device. An electrical output device shall be provided to indicate the position of the barometric scale setting. The scale factor shall be such that with excitation of 30 volts across the potentiometer, the output voltage from wiper to ground ($V_1$ of table IV) will change linearly by +1 volt per -100 feet change of correction and be 10 volts at zero correction

(setting of 29.92 inches of mercury or 1013.25 millibars). The wiper to ground voltages ($V_1$ of table IV with an excitation of 30 volts) are given in table IV for various pressure settings. Any settable pressure setting below 28.10 inches of mercury or 950 millibars shall not make the voltage from wiper to ground, $V_1$, become greater than 29 volts or less than the voltage measured at setting 28.10 inches of mercury or 950 millibars. Any settable pressure setting above 31.00 inches of mercury or 1048 millibars shall not make the voltage from wiper to ground, $V_1$, become less than .17 volts or greater than the voltage measured at setting 31.00 inches of mercury or 1048 millibars. The system accuracy shall be such that the output voltage will be the design voltage plus or minus the voltage equivalent to 25 feet when the wiper is loaded by 1 megohm, except at pressure setting 31.00 inches of mercury or 1050 millibars where the tolerance is the voltage equivalent to plus zero feet correction and minus 25 feet correction. Barometric settings approached from any direction shall reproduce output voltages within a plus or minus voltage equivalent to 20 feet. Regardless of the direction, the output voltage must agree with the design voltage within a voltage equivalent of ±25 feet when the wiper is loaded by 1 megohm.

NOTE: The device described by this paragraph is not to be included in the AAU-19B/A.

TABLE IV. Baroset - Volts - Feet correction relationship.

| AAU-34/A | | | AAU-37/A | | |
|---|---|---|---|---|---|
| Setting | Volts | Feet Corr. | Setting | Volts | Feet Corr. |
| 28.10 | 27.27 | -1727 | 950 | 27.73 | -1773 |
| 28.50 | 23.40 | -1340 | 965 | 23.44 | -1344 |
| 28.86 | 19.96 | - 996 | 980 | 19.20 | - 920 |
| 29.00 | 18.63 | - 863 | 1000 | 13.64 | - 364 |
| 29.31 | 15.70 | - 570 | 1013.25 | 10.00 | 0 |
| 29.50 | 13.92 | - 392 | 1030 | 5.46 | + 454 |
| 29.92 | 10.00 | 0 | 1045 | 1.44 | + 856 |
| 30.03 | 9.00 | + 100 | 1048 | .64 | + 936 |
| 30.50 | 4.69 | + 531 | High Stop | Greater | |
| 30.73 | 2.60 | + 740 | | than .17 | - |
| 30.90 | 1.07 | + 893 | | | |
| 31.00 | 0.17 | + 983 | | | |
| High Stop | Greater than .17 | - | | | |




* Potentiometer is isolated from all altimeter circuits.

3.9 Electronic components. Standard electronic components shall be in accordance with MIL-E-5400. Approval of nonstandard parts shall be as specified in MIL-STD-749.

3.10 Weight. The weight of the completely assembled altimeter, excluding connecting fittings and screws, shall not exceed 4-1/2 pounds.

3.11 Markings and finishes

* 3.11.1 White. The following markings shall be furnished in lusterless white, Color No. 37875 of FED-STD-595. The dimensions shall be as specified. Numeral width size used on the 100-foot drum may be decreased, with prior approval from the procuring activity. The PNEU, ELECT, and arrow markings may be furnished in a different white color if contrast ratio of greater than 12 is maintained and prior approval of the procuring activity is granted.

| Marking | Height or Length (Inch ±0.015) | Width of Line or Graduation (Inch ±0.005) |
|---|---|---|
| Numerals 0, 1, 2, 3 4, 5, 6, 7, 8, 9 on counter & drum and 0, 1, 2, 3, 4, 5, 6, 9 on dial | 0.281 | 0.035 |
| Numerals 7, 8 on dial | 0.220 | 0.023 |
| Lettering PNEU, ELECT | 0.093 | 0.015 |
| PNEU, ELECT arrow | --- | 0.015 |
| 100-foot graduations | 0.172 | 0.030 |
| 20-foot graduations | 0.109 | 0.015 |
| Baro counter numerals | 0.156 | 0.025 |
| Lettering ALT | 0.188 | 0.025 |
| Lettering (IN. HG) or (mb.) | 0.046 | 0.008 |
| 100 FT | 0.046 | 0.008 |
| 1,000 FT | 0.046 | 0.008 |
| Shaded portion of pointer | 0.840 | --- |
| Border on altitude counter window | --- | 0.035 |
| 45° stripes | --- | 0.035 |
| Fixed zeros to the right of the drum | 0.281 | 0.035 |

* 3.11.2 Black. The following markings shall be finished in lusterless black, Color No. 37038 of FED-STD-595. The dimensions shall be as specified.

| Marking | Height or Length (Inch ±0.015) | Width of Line or Graduation (Inch ±0.005) |
|---|---|---|
| 80,000 FT | 0.062 | 0.011 |
| Lettering PNEU FLAG | 0.125 | 0.015 |
| Unshaded portion of pointer | --- | --- |

NOTE: For the AAU-19B/A only, the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 on 100-foot drum shall be finished in lusterless black rather than lusterless white.

3.11.3 Background. The background of the PNEU flag shall be finished in fluorescent yellow, Color No. 38907 of FED-STD-595. The background of the baro counter; dial; 100-foot drum; 1,000-foot counter; and 10,000-foot counter shall be lusterless black, Color No. 37038 of FED-STD-595.

* 3.11.3.1 Background for AAU-19B/A. The background of the STBY flag shall be lusterless red orange, Color No. 38903 of FED-STD-595. The background of the 100-foot drum shall be lusterless gray, Color No. 36622 of FED-STD-595. The 45° stripes on the 10,000 feet counter shall be lusterless white, Color No. 37875 of FED-STD-595. The width of the line shall be 0.035 ± 0.005.

3.11.4 Dial. The style and proportions of the numerals and letters on the dial shall be in accordance with MS33558. Dial markings shall be so durable as to withstand service use. Each numeral shall distinctly indicate the graduation to which it applied and, if practicable, shall be so placed that the center of mass of the numeral will be on the radial line joining the appropriate graduation and the center of the dial. When several numerals are used in a group, the space between the numerals shall be approximately 0.016 inch.

3.12 Dial visibility. The pointer, numerals, at least 0.063 inch of the shortest graduations, and all other dial markings shall be visible from any point within the frustum of a cone whose side makes any angle of 20° with a perpendicular to the dial and whose small diameter is the aperture of the instrument case.

3.13 Jewel bearings. When used, sapphire and ruby jewel bearings shall be in accordance with MIL-B-27497.

3.14 Screw threads. Unless otherwise specified, the threads of all machine screws shall be in accordance with MIL-S-7742.

3.15 Finishes

3.15.1 Aluminum alloy parts. Aluminum alloy parts shall be covered with anodic film be in accordance with MIL-A-8625, except that the dial, small holes, and case inserts, need not be anodized. Parts which do not anodize satisfactorily may be coated in accordance with MIL-C-5541.

3.15.2 Steel parts. Where practical, steel parts shall be cadmium plated in accordance with QQ-P-416, and of a class that is adequate to achieve the degree of protection required.

3.15.3 Plating. Plating shall not be required on normally lubricated parts, such as gears, bearings, and shafts fabricated from brass, bronze, or corrosion-resistant steel.

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

3.17 Government-loaned property. Upon request, one TTU-229/E test set in accordance with DOD AIMS 65-852(1) and one CPU-46/A or CPU-66/A computer in accordance with MIL-C-27889 or MIL-C-38240, respectively, will be loaned by the Government to the contractor for compatibility testing. (See 3.4.24.)

3.18 Workmanship. The altimeter shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of soldering, wiring, marking of parts and assemblies, plating, painting, riveting, machine screw assemblies, welding, brazing, and freedom of parts from burrs and sharp edges.

3.18.1 Dimensions and tolerances. 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 altimeter, they shall be held or limited accordingly.

3.18.2 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 threads.

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

3.18.4 Gears. Gear assemblies shall be properly aligned and meshed and shall operate without interferences, tight spots, loose spots, or other irregularities.

3.18.5 Cleaning. The altimeter shall be thoroughly cleaned and loose, spattered, or excess solder; metal chips; or other foreign material shall be removed after final assembly. Burrs and sharp edges as well as resin flash which might crumble shall also be removed.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests. The inspection and testing of the altimeter shall be classified as follows:

a. Qualification testing . . . . . See 4.4

b. Quality conformance tests . . . See 4.5.

4.3 Test conditions

4.3.1 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 conducted at atmospheric pressure (approximately 29.92 inches Hg) and room temperature, approximately 25°C (77°F). When tests are conducted with atmospheric pressure or room temperature differing materially from the above values, proper allowance shall be made for the difference from the specified condition.

4.3.2 Reference standard barometer. The reference standard for atmospheric pressure shall be a mercury barometer which is maintained in accordance with the manufacturer's recommendations and is accurate (with corrections) within ±0.005 inch traceable to the National Bureau of Standards. A reference

barometer newly introduced into service shall be checked at intervals of approximately 6 months until the stability of its calibration has been established.

4.3.3 Attitude and friction removal. Unless otherwise specified, the altimeter shall be tested in its normal operating position, and when in pneumatic mode shall be tested with the internal vibrator operating. No vibration shall be applied in the power-on mode.

4.3.4 Standard pressures. The standard pressures used in calibrating and testing the altimeter shall be in accordance with MIL-STD-859.

4.3.5 Rate of pressure change. Unless otherwise specified, the rate of change in pressure during all tests shall be such as to not exceed the following changes in height indications:

| | |
|---|---|
| Decreasing pressure | 10,000 ft/min |
| Increasing pressure | 25,000 ft/min |

This rate shall be progressively reduced to 500 fpm as the checkpoints are approached to avoid passing the checkpoint. The movement of the pointer during decreasing and increasing pressures shall be smooth and free from irregular motion when friction is removed as specified in 4.3.3.

4.3.6 Adjustments. Except as specified herein, adjustments shall not be made to the altimeter after initiation of testing. All samples shall contain a Government seal prior to test initiation.

4.3.7 Barometer. During testing, a type A-1 barometer with photoscanner or equivalent, properly calibrated for accuracy, shall be used to measure scale errors, hysteresis, and after effect. The barometer shall be properly maintained and checked in accordance with the handbook of instructions furnished by the barometer manufacturer. Altitude settings shall be in terms of the certified scale.

4.3.8 Master synchro control transmitter and setting dial. A master synchro shall be mounted on a turntable with a readability of at least $0.1^{\circ}$ and a calibration chart which is accurate to at least $\pm 0.10^{\circ}$. This synchro, with suitable calibration data, shall be used for the electrical input signal. The synchro shall be a Bendix AY100GZ-88-Z1, or equivalent. An equivalent shall be approved by the procuring activity.

4.3.9 Electrical supply. Unless otherwise specified, all power shall be 115 $\pm$3V and 400 $\pm$5 Hz.

4.3.10 Pneumatic mode. Unless otherwise specified, all tests shall be conducted in the pneumatic mode.

4.3.11 Test sequence. Any variation from the test sequence specified under 4.5 must be approved by the procuring activity.

4.4 Qualification testing

4.4.1 Test samples. The test samples shall consist of 11 altimeters representative of the production equipment. The samples shall be identified

with the manufacturer's part number and such other information as required by the qualifying activity. The tests shall be conducted on three groups of samples as follows:

a. Group 1: (Three altimeters) All tests, except reliability, longevity, and shelf life

b. Group 2: (Six altimeters) Reliability and longevity

c. Group 3: (Two altimeters) Individual and shelf life.

4.4.1.1 Disposition of samples. Any sample tested may be delivered on contract provided the sample has been operated less than 10 percent of the specified MTBF operation or has been completely overhauled and meets the individual tests and is representative of production units currently being accepted. Longevity and sampling plan B test samples shall not be delivered as production items, but shall be delivered to the qualifying activity as test samples.

4.4.2 Test report. The contractor shall prepare a test report in accordance with MIL-STD-831.

4.4.3 Qualification tests. The qualification tests shall consist of all the tests specified under 4.6.

4.5 Quality conformance tests. The quality conformance tests shall consist of the following:

a. Individual tests . . . . . See 4.5.1

b. Sampling tests . . . . . See 4.5.2.

4.5.1 Individual tests. Each altimeter shall be subjected to the following tests as described under 4.6: (Tests marked # are not required to follow sequence order).

a. Examination of product

# b. Zero setting scale, electrical and pneumatic modes test

# c. Backlash test

# d. Barosetting knob functional test

# e. Control switch operation and servo damping test

# f. Position error (standby and power-on) test

g. Scale error at room temperature (pneumatic and power-on)

# h. Static friction (pneumatic) test

# i. Case leakage test

j. Hysteresis test

# k. Stop and jump friction (pneumatic) test

l. Scale error at -35°C (-31°F) (pneumatic and power-on) tests

m. Scale error at +45°C (+113°F) (pneumatic and power-on) tests

n. Failure detection at room temperature, -35°C (-31°F), +45°C (+113°F)

o. Altitude deviation at room temperature, -35°C (-31°F), +45°C (+113°F)

# p. Individual tests of MIL-L-25467 and MIL-L-27160

# q. Barometer potentiometer output test.

4.5.2 Sampling tests

4.5.2.1 Sampling plan A tests. Samples shall be selected at random in accordance with the following schedule and subjected to the tests specified in 4.6. No more than 3 month's production shall be shipped prior to satisfactory completion of the sample plan A testing for that lot. Failure of sample plan A will invoke MIL-STD-105 sampling procedure as specified in 4.5.2.4.3.

| Quantity | Samples |
|---|---|
| First 15 | 3 (Zero when sampling plan B is invoked) |
| Next 50 | 1 |
| Each additional 100 or fraction thereof | 1 |

a. Individual tests

b. Torque, push and pull tests

c. Bending test

d. Scale error at -54°C (-65°F) (power-on and pneumatic)

e. Scale error at +71°C (+160°F) (power-on and pneumatic)

f. Vibration error (pneumatic and power-on)

g. Response (power-on) test

h. Pneumatic failsafe test

i. Voltage variation test

j. Sampling plan A tests of MIL-L-25467 and MIL-L-27160

k. Dielectric strength test

l. Failure detection at +71°C (+160°F), -54°C (-65°F)

m. Altitude deviation at +71°C (+160°F), -54°C (-65°F)

n. Shelf life test

o. Loading test

p. Barometric scale rezero test.

4.5.2.2 Sampling plan B. Unless otherwise specified (see 6.2), three altimeters shall be selected at random from the first 15 units on the contract or order for a quantity up to 500 units. Three altimeters shall be selected from the first month's portion of each additional quantity of 500 units. The selected quantities shall be subjected to the following tests as described under 4.6: (Tests marked # need not follow the sequence stated). No more than 6 months production shall be shipped prior to satisfactory completion of the sample plan B testing specified for each quantity. No samples shall be selected from the last two monthly production quantities on contracts where sampling plan B tests have previously been performed.

a. Sampling plan A tests

# b. Magnetic property test

# c. Power consumption test

# d. Compatibility tests

# e. Electromagnetic interference test

f. High temperature exposure test

g. Low temperature exposure test

h. Vibration failure test

i. Acceleration tests

j. Humidity test

k. Salt fog test

l. Dust test

m. Fungus test

n. Shock test

o. Sampling plan B tests of MIL-L-25467 and MIL-L-27160

# p. Overpressure and underpressure tests

q. Stop and jump friction at 45° attitudes

r. Internal examination.

4.5.2.3 Sampling plan C. Unless otherwise specified (see 6.2), four altimeters shall be selected at random from the first 10 of each quantity of 500 units produced and shall be subjected to the following tests as described under 4.6. No samples shall be selected from the last two monthly production quantities.

a. Individual tests

b. Reliability tests.

4.5.2.4 Rejection and retest. When one altimeter selected from a production run fails to meet the specification, items still on hand or later produced shall not be accepted until the extent and cause of failure are determined and appropriately corrected. The contractor shall explain to the Government representative the cause of failure and the action taken to preclude recurrence. After corrections have been made, all necessary tests shall be repeated.

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

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

4.5.2.4.3 MIL-STD-105 Sampling procedure. A failure of sampling plan A tests, except torque, push and pull, bending, Plan A lighting, and shelf life tests, shall invoke an increase in quality assurance through MIL-STD-105 sampling procedures. The MIL-STD-105 procedure will be in addition to the sample plans required under contract or order. The MIL-STD-105 procedure will be performed until five consecutive lots are accepted. The MIL-STD-105 inspection level shall be II and the AQL (normal inspection) shall be 1.5. Testing under the procedure will include individual tests and the test or tests of sample plan A which invoked MIL-STD-105 sampling procedure.

4.6 Test methods

4.6.1 Examination of product. The altimeter shall be examined thoroughly to insure compliance with requirements of this specification with respect to materials, workmanship, markings, outline dimensions, connectors, and display using whatever tools, gauges, scales, et cetera, that are necessary.

4.6.2 Zero setting scale, electrical and pneumatic modes test. The altimeter shall be subjected to atmospheric pressure for the PNEU mode test. An electrical signal approximately equivalent to atmospheric pressure shall be used for the servo mode tests. The pressure scale shall be set successively to the values specified in table V beginning with 28.10 inches of mercury or 950 millibars and the pointer indication noted. After the series of readings has been recorded, the difference between the readings at the setting of 29.92 inches of mercury or 1013.25 millibars and each other setting shall be determined. The differences shall be recorded and compared with the column titled Correct Difference. The recorded difference shall not vary from the

correct difference at any setting specified in table V by more than 25 feet in PNEU mode or 15 feet in servo mode. There shall be no pointer erratic motion, oscillation, or lag and jump during this test. *f.* test shall be conducted to show compliance with 3.8.5.

TABLE V. Zero setting scale.

| AAU-34/A | | AAU-37/A | |
|---|---|---|---|
| Pressure Scale Setting | Correct Difference | Pressure Scale Setting | Correct Difference |
| 28.1 | -1,727 | 950 | -1773 |
| 28.5 | -1,340 | 965 | -1344 |
| 29.0 | - 836 | 980 | - 920 |
| 29.5 | - 392 | 1000 | - 364 |
| 29.92 | 0 | 1013.25 | 0 |
| 30.5 | 531 | 1030 | 454 |
| 30.90 | 893 | 1045 | 856 |
| 31.0 | 983 | 1048 | 936 |

* 4.6.2.1 Barometric potentiometer output test. The electrical position of the barometric potentiometer shall be accurately measured with the barometric counter centered successively to the following settings without overshoot. The settings for the AAU-34/A are; 28.10, 29.00, 29.92, 30.03, 31.00, High Stop, 30.50, 29.92, and 28.50. The settings for the AAU-37/A are; 950, 980, 1013.25, 1030, High Stop, 1048, 1013.25, and 965. The electrical position of the potentiometer shall be within the equivalent of ±25 feet of the position defined in 3.8.5, except at setting 31.00 where the position shall be within the equivalent of +0 -25 feet. The High Stop position shall provide a voltage greater than 0.17 volts when the potentiometer is excited with 30 volts. The two readings at 29.92 inches of mercury or 1013.25 millibars shall be compared and shall not differ by more than the equivalent of 20 feet. This test may be conducted in conjunction with the tests specified in 4.6.2 and 4.6.3.

NOTE: The barometric setting potentiometer is not included in the AAU-19B/A.

4.6.3 Backlash test. Immediately following the test specified in 4.6.2, the scale shall be set successively to the values specified in table V starting at 31.0 inches of mercury or 1048 millibars and the pointer indication noted at each value. The difference between the indications noted and those specified in 4.6.2 shall not exceed 20 feet. Each indication shall be compared to the 29.92 inches of mercury or 1013.25 millibars indication of 4.6.2 and shall be within 25 feet of the corrected difference of table V.

4.6.4 Bending test. The barosetting knob and the servo-reset-control lever shall withstand a force of 15 pounds applied at the extreme outward end of the setting knob or control lever without bending or without damaging the mechanism.

4.6.5 Torque, push and pull tests. The following tests shall be conducted to demonstrate that the altimeter meets the requirements specified in 3.8.1:

a. The presence of the required stops shall be verified. A twisting force of 6 inch-pounds shall be applied at the barosetting knob against each stop.

b. A pulling force of 15 pounds shall be applied to the barosetting knob. While the force is applied, the knob shall be rotated at least 90°. This shall be repeated with a pushing force of 15 pounds.

c. A torque of 15 inch-pounds shall be applied to the control lever in both directions.

d. The operating torque of the control lever shall not exceed one inch-pound.

4.6.6 Barosetting knob functional test. The barosetting system shall be operated from 28.10 to 31.00 and back to 28.10 inches of mercury or 950 to 1048 and back to 950 millibars. The torque required for operation shall be within the values specified in 3.8.1.

4.6.7 Control switch operation and servo damping test. With the barometric scale set at 29.92 inches Hg or 1013.25 millibars, the altimeter shall be electrically connected to the master synchro which is electrically zeroed as specified in 3.4.14. The synchro input shall be set to a point 500 ±50 feet from the ambient pressure altitude. The system shall then be energized with the 115V 400-Hz single-phase power. The altimeter shall not respond electrically until the control switch on the face of the altimeter is rotated to the ELECT position. The altimeter shall then read the electrical altitude ±25 feet. The barometric setting knob shall be used to produce a reading of 250, 500, and 750 feet. At each 250-feet point, the altimeter shall be changed from servo mode to pneumatic mode and back to servo mode by use of the control knob. The altimeter point shall be observed for stable operation. The control switch shall then be rotated to the PNEU position, and the altimeter shall immediately return to the pressure altitude. The altimeter shall then be reset by use of the remote reset. The line voltage shall be interrupted externally which shall cause the altimeter to revert to pneumatic. Upon re-energizing the line, the instrument shall not become electrically actuated until the reset switch is again actuated. When the altimeter is in the power-on mode, the flag shall be concealed and when in the pneumatic mode, the flag shall be visible as shown on figures 4 and 6. During this test, the internal vibrator shall start and stop, as applicable, without tapping of the altimeter. When the altimeter is reset, the pointer shall not overshoot the electrical altitude by more than 210 feet and shall return to a value within the specified electrical scale error limits within 1 second. The pointer shall present no noticeable oscillation, jitter, or erratic motion exceeding one major graduation width after 1 second. During qualification and sampling testing, a test shall be conducted to show compliance with 3.4.19.

4.6.8 Position error (standby and power-on) test. The altimeter position error reading shall be taken while the instrument is vented to atmosphere and in each of the following positions. The reading in positions b, c, d, and e shall not differ from the reading in the normal position by more than 20 feet in pneumatic mode or by more than 10 feet in the servo mode. The test shall be run with the pointer at the 500-feet position of the dial.

a. Normal operating position

b. Rotated about the longitudinal axis 90°

c. Rotated about the longitudinal axis 180°

d. Rotated about the longitudinal axis 270°

e. Dial face up.

4.6.9 Scale error (pneumatic) test. For a period of not less than 3 hours prior to this test, the altimeter shall not have been subjected to any testing involving operation at other than atmospheric pressure. The altimeter shall be tested for scale errors as follows: The barometric setting shall be set at 29.92 (approaching the setting from 28.10) inches of mercury or 1013.25 (approaching the setting from 950) millibars and shall remain at this setting during all scale error tests. The altimeter shall be subjected to successively decreasing and increasing pressures as specified in table I. If this test is combined with the friction test specified in 4.6.10, the rate of change of pressure for that test shall govern. The altimeter shall remain at the pressure corresponding to each test point for at least 1 minute but not more than 2 minutes before a test reading is taken. The scale error shall not exceed the tolerance specified in table I. This test may be conducted with the altimeter in an altitude chamber.

4.6.10 Static friction (pneumatic) test. The altimeter, with the vibrator inoperative, shall be subjected to a constant rate of decreasing pressure not exceeding 3,000 fpm until the pressure reaches the equivalent of 500 ±100 feet of the desired test point specified in table II under STATIC FRICTION ERROR, at which time the rate of pressure change shall be decreased to a maximum of 600 fpm. The pressure shall be changed at this rate until the pressure equivalent to the desired test point is reached and held constant while two readings are taken, the first with the vibrator not operating, and the second with the vibrator operating. The difference between the two readings shall be recorded as static friction and shall not exceed the tolerances listed in table II. This test may be combined with the test of 4.6.9.

4.6.11 Case leakage test. A vacuum sufficient to produce a reading of approximately 40,000 feet shall be slowly applied to the static pressure connection of the altimeter, at which point the connection tubing shall be pinched off or otherwise completely sealed. The change in reading in 1 minute shall not exceed 100 feet. Altimeters shall be tested individually. The baroset knob shall be turned 90° and the control lever moved through its range, and the test repeated. The test shall then be repeated for the remaining 90° positions of the knob. This test may be combined with the test of 4.6.9.

4.6.12 Scale error (power-on) test. If this test is combined with the tests specified in 4.6.9 and 4.6.10, the altimeter shall remain in pneumatic mode until the data specified therein is recorded at the applicable pressure setting. The master synchro shall then be set to its proper electrical position corresponding to the altitude value specified in table I. The barometric setting shall be set to 29.92 inches of mercury or 1013.25 millibars (from either direction) and shall remain at this setting during the test. Power shall be turned on, data recorded, and power turned off before proceeding to the next pressure setting in 4.6.8. Scale errors in the power-on mode shall not exceed the tolerances specified in table I. During this test, the pointer and counters shall be observed for stability. Oscillation or dither, or erratic motion exceeding one major graduation width shall be cause for rejection.

4.6.13 Hysteresis test. Not more than 15 minutes after the altimeter has been first subjected to the pressure corresponding to 80,000 feet as specified in 4.6.9, the pressure shall be increased until the pressure corresponding to the first test point specified in table III is reached. The altimeter shall remain at this pressure at least 1 minute, but not more than 5 minutes, before the test reading is taken. The pressure shall again be increased at the same rate until the pressure corresponding to the second test point in table III is reached. The altimeter shall remain at this pressure for at least 1 minute, but not more than 5 minutes, before the test reading is taken. The pressure shall again be increased at the same rate until zero feet is reached and shall remain at this pressure for at least 1 minute, but not more than 5 minutes, before the test reading is taken. The readings of the altimeter at the test points shall not differ from the readings of the altimeter for the same test points specified in 4.6.9 by more than the tolerance specified in table III. All test readings shall also be within the tolerances of table I. This test may be combined with the test specified in 4.6.9.

4.6.14 Stop and jump friction (pneumatic) test. The altimeter shall be tested in both ascending and descending directions for friction at the test points specified in table II with the internal vibrator in operation. The altimeter shall be subjected to a constant rate of decreasing and increasing pressures equivalent to the rate of descent indicated at the test points specified in table II. The change in reading of the pointer due to its stopping and jumping or hesitation that causes a lag at any point throughout any part of a revolution of the 100-foot pointer, including the counter as it is turning, shall be recorded as friction and shall not exceed the tolerances specified in table II, column C. This test shall be repeated with the internal vibrator inoperative. The stop and jump friction shall not exceed the tolerances specified in table II, column D.

4.6.14.1 Upon satisfactory completion of the testing specified in 4.6.14, the altimeter shall again be subjected to the vibrator operative test, except the rate-of-change of altitude shall be 20,000 fpm and the face of the unit shall be inclined down 45° during ascent and inclined up 45° during descent. The tolerance during this portion of the test shall be increased by 50 feet over the values listed in column C of table II.

4.6.15 Scale error at -35°C (-31°F) (pneumatic) test. For a period of not less than 3 hours prior to this test, the altimeter shall not be subjected to any test involving operation at other than atmospheric pressure. The test specified in 4.6.9 shall be repeated, except that during this test and for a period of 3 hours before the test, the altimeter shall be at a temperature of -35° ±5°C (-31° ±9°F). The test points and scale error tolerances shall be as specified in table I. The test specified in 4.6.11 shall also be conducted while at this temperature, except the baro and control knobs need not be rotated.

4.6.16 Scale error at -35°C (-31°F) (power-on) test. For a period of not less than 3 hours prior to this test, the altimeter shall not be subjected to any test involving operation at other than atmospheric pressure. The test specified in 4.6.12 shall be repeated, except that during the test and for a period of 3 hours before the test, the altimeter shall be at a temperature of -35° ±5°C (-31° ±9°F). The test points and scale error tolerances shall be as specified in table I.

4.6.17 Scale error at +45°C (+113°F) (pneumatic) test. For a period of not less than 3 hours prior to this test, the altimeter shall not be subjected to any test involving operation at other than atmospheric pressure. The test specified in 4.6.9 shall be repeated, except that during this test and for a period of 3 hours before the test, the altimeter shall be at a temperature of +45° ±5°C (+113° ±9°F). The test points and scale error tolerances shall be as specified in table I.

4.6.18 Scale error at +45°C (+113°F) (power-on) test. For a period of not less than 3 hours prior to this test, the altimeter shall not be subjected to any test involving operation at other than atmospheric pressure. The test specified in 4.6.12 shall be repeated, except that during this test and for a period of 3 hours before the test, the altimeter shall be at a temperature of +45° ±5°C (+113° ±9°F). The test points and scale error tolerances shall be as specified in table I.

4.6.19 Failure detection (servo motor and amplifier) test. The amplifier shall be energized for power-on operation and set to zero altitude with both pressure and electrical inputs. The relay (pins 7 and 10) shall be excited with 28V dc in order to disable the motor (only the motor shall be disabled). The pressure shall then be increased slowly. The pointer shall follow the change in pressure as specified in 3.5.13. The pneumatic flag shall appear, and the internal vibrator shall be energized between a 100- and 300-foot displacement of the pointer. This procedure shall be repeated using decreasing pressures. The test shall be conducted under the following conditions:

| Power | Temperature (°C) |
|---|---|
| 115V, 400 Hz | +25, +45, +71, -35, -54 |
| 108V, 380 Hz | +71, -54 |
| 108V, 320 Hz | +71, -54 |
| 121V, 320 Hz | +71, -54 |
| 121V, 420 Hz | +71, -54 |
| 121V, 480 Hz | +71, -54 |

NOTE: This test may be conducted immediately after the scale error test at each specified temperature.

4.6.19.1 During the test specified in 4.6.19, when the altimeter reverts to the pneumatic mode, the internal vibrator shall start without the help of any physical disturbances (i.e., external vibration, tapping, et cetera). The pressure-altitude display shall be as specified in 4.6.9 with allowances for friction as specified in 4.6.10. The altimeter pointer shall follow any change in pressure and shall operate as specified in 4.6.14 with the vibrator inoperative. After the pointer is displaced as specified, the pneumatic flag shall appear and the vibrator shall be activated as specified in 3.4.9. Operation shall be as specified for pneumatic operation.

* 4.6.20 Altitude deviation test. With the altimeter in the pneumatic mode and the barometric scale set to 29.92 inches of mercury or 1013.25 millibars the pressure shall be set so that the altimeter indicates 3,000 feet. The

electrical synchro input shall be set to 3,000 feet. The altimeter shall be energized and the synchro input shall be adjusted to the values in table VI. The readings of the altimeter shall be within the tolerances specified. This test shall be conducted at each of the power, temperature, and altitude conditions of table VI. While the altimeter is indicating 3,000 feet in the pneumatic mode, the electrical synchro input shall be rotated to an angle equivalent to 500 feet correction. The pointer shall not deviate from 3,000 feet by more than 10 feet at +71°C, +45°C and +25°C. The pointer shall not deviate from 3,000 feet by more than 20 feet at temperatures of -35°C and below. During qualification and sampling testing, the following tests shall be conducted:

a. The 2,000-foot altitude deviation shall be established at the 3,000-foot test altitude with the temperature at 71°C (160°F) and with standard power input. This deviation shall be maintained for 1 hour and shall meet the tolerance specified in table VI for room temperature

b. At +45°C (+113°F) each deviation specified in table VI shall be held for 15 minutes prior to taking a reading

c. With the altimeter in the pneumatic mode and the barometric scale set at 29.92 inches of mercury or 1013.25 millibars the pressure shall be so that the altimeter indicates 3,000 feet. The electrical synchro input shall be set to the altitude deviation values specified in table VI. At each test point, the control switch shall be placed in the elect position. The altimeter indication shall change to the electrical synchro input setting within the tolerances specified in table VI. This test shall be conducted at each power, temperature, and altitude condition specified in table VI.

4.6.21 Scale error at -54°C (-65°F) (power-on and pneumatic) test. For a period of not less than 3 hours prior to this test, the altimeter shall not have been subjected to any testing involving operation at other than atmospheric pressure. The altimeter, in pneumatic mode, shall be tested as specified with 4.6.9, except that during the test and for a period of 3 hours before the test, the altimeter shall be at a temperature of -54° ±5°C (-65° ±9°F). After data is recorded at each applicable test station in table I, the master synchro shall be set to its electrical position corresponding to the altitude value. Power shall be turned on, the data recorded, and the power turned off before proceeding to the next pressure setting. Checks for proper operation of the lighting system, the baroset knob, and the control lever shall be made.

4.6.22 Scale error at 71°C (160°F) (power-on and pneumatic) test. The test specified in 4.6.21 shall be conducted, except that the temperature shall be 71° ±5°C (160° ±9°F).

TABLE VI. Altitude deviation.

| Altitude Deviation | Room, +45°C, -35°C 115V, 400 Hz Tolerances (Ft) | | +71°C, -54°C 108V, 380 Hz; 121V, 420 Hz Tolerances (Ft) | +71°C, -54°C 108V, 320 Hz; 121V, 480 Hz Tolerances (Ft) |
|---|---|---|---|---|
| (Feet) | 3000 Test Point | 30,000 Test Point | 3000 Test Point | 3000 Test Point |
| 0 | 20 | 20 | 40 | 40 |
| ±500 | 25 | 25 | 45 | 45 |
| ±1000 | 30 | 30 | 50 | 50 |
| ±1500 | 35 | 35 | 55 | 55 |
| ±2000 | 40 | 40 | 60 | 60 |
| ±2500 | | 45 | | |
| ±3000 | | 50 | | |
| ±3500 | | 50 | | |

4.6.23 Vibration error (pneumatic) test. The altimeter shall be mounted on the vibration stand in its normal operating position and secured by flange screws in the same position as on an aircraft panel. The altimeter shall be subjected to vibration with an amplitude between 0.003 and 0.005 inch at frequencies from 500 to 3,000 cpm so that any point on the altimeter case will describe a circular path of the amplitude stated inclined at an angle of 45° to the horizontal and dial planes. The natural frequency of the altimeter shall not occur in this frequency range. While the altimeter is being vibrated, the maximum amplitude of the pointer oscillation shall not exceed 20 feet and the pointer variation from its original position shall not exceed 20 feet. The test shall be conducted with the pointer at the 0- and 500-foot positions at approximately sea level and 40,000-foot altitudes.

* 4.6.24 Vibration error (power-on) test. Following the test specified in 4.6.23, the altimeter shall be connected electrically as in 4.6.12 and while energized, shall be subjected to the vibration test of MIL-STD-810, curve B of figure 514.2-2. While the altimeter is being vibrated, the maximum amplitude of pointer oscillation shall not exceed ±25 feet and the pointer variation from its original position shall not exceed ±15 feet. The lighting system shall be checked for proper operation during this test. The barometric potentiometer shall be excited with 30 volts, set at 29.92 inches of mercury or 1013.25 millibars, and the output recorded before, during, and after vibration. The barometric potentiometer output shall not change by more than 0.1 volt when measured with a recording device which has a frequency response greater than 1 Hz. The potentiometer output shall not fluctuate more than 1 volt when measured with a recording device which has a frequency response greater than 100 KHz.

NOTE: The barometric setting potentiometer is not included in the AAU-19B/A.

4.6.25 Response test. The altimeter in the power-on mode shall be connected electrically to a synchro transmitter which shall be capable of being driven at a rate of 80,000 fpm. The pressure shall be adjusted to produce approximately the same indication and rate. For increasing and decreasing altitudes, the altimeter shall not revert to pneumatic, and when the synchro comes to an abrupt stop, the altimeter shall stop at the appropriate electrical value within 2 seconds. The stops of the transmitting synchro shall be set at 0 and 70,000 feet. A test shall be conducted to show compliance with 3.5.9 and 3.5.12.

4.6.26 Pneumatic failsafe test. The altimeter in the power-on mode shall be connected electrically to a synchro transmitter which shall be capable of being driven at a rate of 80,000 fpm. The altimeter shall then be placed in the elect mode and both the electrical and pneumatic modes shall be set at the 5,000-foot altitude. The pressure shall be held constant while the synchro transmitter is driven toward an increasing altitude direction, at a rate of 80,000 fpm, until the monitor circuit trips the altimeter into the standby mode. The pneumatic flag shall appear when the instrument returns to the pneumatic mode. Upon completion of the test, the altimeter may be corrected to zero by means of the zero setting system. The correction shall be limited to 25 feet. The altimeter shall then be tested for scale error in accordance with 4.6.9 and 4.6.12 within 15 to 30 minutes after it returns to ambient pressure conditions and shall meet the tolerances specified in table I. This test shall then be repeated in a decreasing direction which shall also be performed at a 30,000-foot altitude.

4.6.27 Dielectric strength test. The altimeter shall be checked for insulation resistance by testing from the terminals indicated to ground at the potentials indicated for no more than 30 seconds. The maximum voltage shall be raised from zero by rheostat control. Switching to the voltage from zero shall not be permitted.

| Pins | Potential to Case |
|---|---|
| 2, 3, 8, 15, 17<br>18, 19, 20, 21, 22, 23, 24 | 500V 60 Hz |

4.6.28 Electromagnetic interference test. The altimeter shall be tested in accordance with MIL-STD-462 to determine compliance with the electromagnetic interference requirements of MIL-STD-461. The following test methods shall apply: CE03, CE04, CS01, CS02, CS06, RE02, RS02, and RS03. There shall be no deviations from MIL-STD-461 limits for switching transients. During measurement of emissions, the altimeter shall be dynamically operated. Emission measurements shall include the interference produced during operation of the control lever and baroset knob. Susceptibility tests shall be performed with the altimeter displaying a static nonzero reading.

4.6.29 Magnetic property test. The altimeter, not operating, shall be rotated in a vertical plane about a short bar magnetic compass with the nearest part of the altimeter 8 inches from the magnetically East or West of the center of the compass. Starting directly under the compass, the altimeter shall be held in positions 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315° from the initial position. At each of these positions, the altimeter shall be rotated about on its own horizontal axis until it is in the normal upright position. The horizontal magnetic field intensity shall be 0.17 to 0.19 oersted. With the altimeter at any specified position, the compass deflection shall not exceed 1°. This test shall be repeated with the altimeter operating at rated voltage.

4.6.30 Voltage variation test. The altimeter, connected electrically, shall be tested for accuracy at all test points of table I from 0 to 10,000 feet at power conditions of 115V-400 Hz, 108V-320 Hz, 108V-380 Hz, 121V-320 Hz, 121V-420 Hz, and 121V-480 Hz. The change in reading from that obtained at normal power (115V-400 Hz) shall not exceed 20 feet.

4.6.31 Power consumption test. The altimeter shall be tested to determine compliance with 3.4.11.1 and 3.4.11.2.

4.6.32 Ligting tests. Lighting tests shall be conducted in accordance with MIL-L-25467 and MIL-L-27160.

4.6.33 Compatibility tests. Compatibility tests as required to demonstrate compliance with 3.4.24 shall be conducted in accordance with the applicable document for the equipment specified herein. (See 6.2 and 6.2.1.)

4.6.34 Environmental tests. The altimeter shall be subjected to the following tests conducted in accordance with the specified methods and procedures of MIL-STD-810. Upon completion of each test, the altimeter shall meet the tests specified in 4.6.9, 4.6.10, 4.6.11, 4.6.12, 4.6.14, 4.6.19, and 4.6.20 for room temperature. When external connections are required to simulate installed conditions, they shall consist of standard AN- or MS- fittings and at least 10 feet of 1/4-inch copper tubing coiled and so arranged as to allow drainage of condensed vapors. They shall be attached to the static pressure port of the

altimeter. During all environmental tests (excluding nonoperating environments), the lighting circuits shall be energized and checked for proper operation.

4.6.34.1 High temperaure exposure test. The high temperature exposure test shall be conducted in accordance with Method 501.1, procedure I.

4.6.34.2 Low temperature exposure test. The low temperature exposure test shall be conducted in accordance with Method 502.1, procedure I.

4.6.34.3 Vibration failure test. The vibration failure test shall be conducted in accordance with Method 514.2, procedure I, figure 514.2-2, curve B at frequencies from 5 to 500 Hz.

4.6.34.4 Acceleration tests. The acceleration tests shall be performed in accordance with Method 513.2, procedures I and II, except where noted herein.

4.6.34.4.1 Structural test. The altimeter shall be subjected to acceleration of the magnitudes in directions specified in 3.5(i) and in accordance with Method 513.2, procedure I. The test time duration in each direction shall be at least 1 minute following centrifuge stabilization.

4.6.34.4.2 Operational test. The altimeter operating in electrical mode shall be subjected to acceleration of the magnitudes and directions specified in 3.5(i), and in accordance with Method 513.2, procedure II. This test shall be repeated for each of the following altitudes.

a. Ambient pressure altitude

b. Approximately 5,000 feet (24.896 inches Hg)

c. Approximately 25,000 feet (11.103 inches Hg).

4.6.34.4.3 Readings shall be taken prior to and during acceleration. The change in reading shall not exceed the values of table VII. Readings shall be taken after the test and shall not deviate from the initial reading by more than 10 feet.

TABLE VII. Operational acceleration tolerances.

| Direction and g level | | 0 Ft Alt. | 5K Ft Alt. | 25K Ft Alt. |
|---|---|---|---|---|
| Fore | 2 g | 20 | 30 | 40 |
| Aft | 6 g | 30 | 40 | 60 |
| Up | 9 g | 40 | 50 | 80 |
| Down | 3 g | 20 | 30 | 40 |
| Lateral | 4 g | 30 | 40 | 60 |

4.6.34.5 Humidity test. The altimeter shall be subjected to a humidity test in accordance with Method 507.1, procedure I. It shall be thoroughly examined

not sooner than 48 hours after completion of this test and there shall be no evidence of internal or external corrosion or deterioration that would affect subsequent operation of the altimeter.

4.6.34.6 Salt fog test. The salt fog test shall be conducted in accordance with Method 509.1, procedure I. There shall be no corrosion or damage as a result of this test that would affect subsequent operation of the altimeter.

4.6.34.7 Dust test. The dust test shall be conducted in accordance with Method 510.1, procedure I.

4.6.34.8 Shock test. The shock test shall be performed in accordance with Method 516.2, procedures I and III, figure 516.2-2, amplitude (a), time duration (c).

4.6.34.9 Fungus test. The altimeter shall be subjected to a fungus test in accordance with Method 508.1, procedure I after which it shall be thoroughly examined. There shall be no evidence of fungus growth.

4.6.35 Overpressure test. The altimeter shall be subjected to a pressure of 35 inches Hg absolute with the baroset at 29.92 inches of mercury or 1013.25 millibars. The pressure application shall not damage any part of the altimeter or cause a permanent zero or calibration shift that results in the altimeter failing specification requirements.

4.6.36 Underpressure test. The altimeter shall be subjected to a pressure equivalent to an altitude of 100,000 feet. The vacuum application shall not damage any part of the altimeter or cause a permanent zero or calibration shift that results in the altimeter failing specification requirements.

4.6.37 Stop and jump friction at 45° attitudes. The testing specified in 4.6.14 only shall be conducted at the following positions:

a. 90° rotation from normal about the longitudinal axis, and then 45° rotation counterclockwise

b. 90° rotation counterclockwise from normal about the longitudinal axis, and then 45° rotation clockwise.

4.6.38 Internal examination. Upon completion of all environmental tests, the altimeter shall be subjected to the room temperature tests specified in 4.5.1. The altimeter shall then be disassembled and thoroughly examined to determine compliance with 3.3.1 through 3.3.6.1, 3.14, 3.15.2, and 3.18. In addition, there shall be no evidence of corrosion, deterioration of any external or internal component, or accumulation of any foreign material which would adversely affect performance or most probably induce a malfunction of the altimeter.

4.6.39 Shelf life test. The altimeter shall be placed in storage for a period of not less than 30 days. During a 30-day period, the altimeter shall remain as dormant as practical. The mechanism shall not be exercised other than that caused by normal atmospheric pressure variation. The temperature shall remain constant; however, normal room temperature variations will be permitted. At the end of the 30-day period, the altimeter shall meet the individual tests.

The scale error tolerances shall be as specified in table I, and the readings shall not vary from the original (PNEU) scale error readings by more than the values specified in table VIII.

TABLE VIII. Scale error variation.

| Standard Altitude (Feet) | Scale Error Variation Tolerances (Feet) |
|---|---|
| 0 | 15 |
| 2,000 | 20 |
| 6,000 | 30 |
| 10,000 | 40 |
| 20,000 | 65 |
| 30,000 | 100 |
| 50,000 | 140 |

4.6.40 Maintainability demonstration test. A maintainability demonstration test shall be conducted in accordance with MIL-STD-471 to show compliance with the specified requirements of 3.4.13. This test may be conducted in conjunction with the test specified in 4.6.38.

4.6.41 Reliability test. The altimeter shall be subjected to a reliability test in accordance with MIL-STD-781, test level F, except as modified herein, which shall demonstrate a contract specified MTBF of 2,000 hours by test plan III in qualification testing and test plan IV in production testing. The peak vibration acceleration level shall be .6g ±.1g. Each altimeter input shall be electrically and pneumatically cycled. A cycle shall consist of operation from minimum to maximum altitude and return to minimum within approximately 15 minutes. A minimum of 3 cycles per hour shall be performed. The electrical input shall differ from the pressure input by at least 1,000 feet during cycling. Period B of MIL-STD-781 shall be approximately 4 hours duration. During the cooling period, the power shall be turned off and the altitude inputs returned to sea level. The vibrator shall operate during this cooling period which shall be at least 2 hours duration. Each 24-hour period, the baroset knob shall be rotated once throughout the complete range and the control lever shall be exercised 10 times throughout the full excursion. In case of malfunction, the malfunction shall be recorded, the test interrupted while repairs are made, and the test then continued from the point of interruption. At approximately 200-hour intervals and at the conclusion of this test, the altimeter shall be subjected to the tests specified in 4.6.2, 4.6.3, 4.6.6, 4.6.7, 4.6.9, 4.6.10, 4.6.11, 4.6.12, 4.6.14, 4.6.19, and 4.6.20 at room temperature. If recalibration, adjustment or repair is required to pass any test, a failure shall be charged against this test. Out-of-tolerance conditions in the pneumatic mode will be permitted to the extent of 25 feet per 250 hours, if rezeroing by use of the baroset system corrects the condition. Time accrued during electrical operation of the altimeter in previous tests may be used as part of the time required by this test, if approved by the procuring activity. This test may be interrupted for normal weekend shutdown.

Accept-reject criteria shall be in accordance with MIL-STD-781, test plan III for qualification testing and test plan IV for production testing (see 4.5.2.3). The altimeter will have failed the test if five or more failures occur.

4.6.41.1 Longevity test. Unless otherwise specified (see 6.2), two of the reliability test samples shall be continued under test until 3,000 hours of testing has accrued on each altimeter. If pattern failures do not occur prior to termination of the test, the altimeter shall have passed the test.

4.6.42 Loading test. The altimeter shall be placed in the pneumatic mode and shall be stabilized at approximately 0 feet (29.921 inches Hg) where the pointer is set to zero error. While the external transmitter synchro is rotated through 360° twice, the altimeter shall be observed for induced errors. The maximum error at 0 feet shall be 25 feet. The test shall be repeated with a pneumatic input approximately 50 K feet (3.425 inches Hg). The maximum error shall be 50 feet.

4.6.43 Barometric scale rezero test. The altimeter pointer shall be adjusted to read 0 feet with a pneumatic input of 29.9213 inch Hg input and the baro counter set to 29.92 inches of mercury or 1013.25 millibars. The zero setting knob shall be unlocked and placed in the extended position to allow adjustment of the relative setting of the pointer and barometric setting scale counter. The zero setting adjustment shall be varied to displace the pointer by 140 feet in the positive direction. The zero setting knob shall be relocked and the barometric setting knob shall be set to each value of table V, column I to verify that the barometric setting range is maintained. The test shall then be repeated with a zero setting adjustment which displaces the pointer 140 feet in the negative direction from 0. At the completion of the test the pointer shall be rezeroed with a pneumatic input of 29.9213 and the baro counter reading 29.92 inches of mercury or 1013.25 millibars and the rezero mechanism shall be locked.

4.7 Packaging inspection. The packaging, packing, and marking shall be inspected for conformance to section 5.

## 5. PACKAGING

5.1 Preservation-packaging. The altimeter shall be packaged in accordance with MIL-STD-794, level A or C as specified in the contract or order. For level A packaging, the method of preservation shall be in accordance with MIL-P-116, Method 1A-5 without preservation compound, using reusable metal containers.

5.2 Packing. The altimeter shall be packed in accordance with MIL-STD-794, level A, B, or C, as specified in the contract or order.

5.3 Marking. The interior and exterior containers shall be marked as specified in MIL-STD-794 with the following precautionary markings appearing conspicuously on two opposite sides of each interior package and each shipping container:

FRAGILE - DELICATE INSTRUMENTS HANDLE WITH CARE.

6. NOTES

* 6.1 Intended use. The AAU-19B/A, AAU-34/A, and AAU-37/A altimeters are intended for use with air-data and altitude computers conforming to MIL-C-27889 and MIL-C-38240 in supplying an indication of static pressure defect corrected altitude in the power on mode.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Type of indicator (see 1.2)

c. When sampling plan B and C tests are not to be conducted (see 4.5.2.2 and 4.5.2.3)

d. Compatibility test requirements (see 4.6.33)

e. When longevity is not to be conducted (see 4.6.41.1)

f. Levels of packaging and packing required.

6.2.1 Government-loaned property. Within 60 days of receipt of contract, the contractor will inform the procuring activity of the date on which a TTU-229/E test set and a CPU-46/A or CPU-66/A computer will be required.

6.3 Data. Data generated by this document is not deliverable unless specified on the Contract Data Requirements List (DD Form 1423) referencing the appropriate data item description in the military departments' Authorized Data List (ADL). The data produced by this specification is as follows:

a. Data for approval for nonstandard parts (see 3.2.1)

b. A record of events during corrective maintenance task demonstration as specified in 3.4.13.1.1

c. A safety hazard analysis (see 3.4.13.2.1)

d. Test report in accordance with MIL-STD-831 (see 4.4.2).

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Aeronautical Systems Division, Attn: ASD/ENAID, Wright-Patterson Air Force Base, Ohio 45433.

6.5 Identification of changes. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to

evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodian:
Air Force - 11

Preparing activity:
Air Force - 11

Review activity:
Air Force - 99

Project No. 6610-F295

☆U.S. GOVERNMENT PRINTING OFFICE: 1979-603-022/4423

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