

INCH-POUND

MIL-DTL-25547C  
w/AMENDMENT 1  
6 December 2013  
SUPERSEDING  
MIL-DTL-25547C  
21 June 2002

## DETAIL SPECIFICATION

### LOUDSPEAKER, PERMANENT MAGNET LS-211/AIC-13

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

#### 1. SCOPE

1.1 Scope. This specification covers one type of loudspeaker, designated loudspeaker, permanent magnet, LS-211/AIC-13. This loudspeaker is a horn type unit with a frequency response of 200-7,000 Hz, nominal 16 ohms voice coil impedance, and a 20 watt peak power output (see 6.1).

#### 2. APPLICABLE DOCUMENTS

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

##### 2.2 Government documents.

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

##### FEDERAL STANDARD

FED-STD-595/36270 - Gray, Flat or Lusterless.

##### COMMERCIAL ITEM DESCRIPTION

A-A-52024 - Compass, Magnetic: Surveyor's and Transit, Pocket; with Optional Ball and Socket Joint or Ball and Socket Head, and Jacob's Staff.

Since Navy-EC is the Navy custodian for this document, all Navy review activities should forward their comments directly to DLA Land and Maritime. Comments, suggestions, or questions on this document should be addressed to: DLA-CC, DLA Land and Maritime, ATTN: VAI, P.O. Box 3990, Columbus, Ohio 43218-3990 or emailed to [sound@dsc.dla.mil](mailto:sound@dsc.dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

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DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-130 - Identification Marking of U. S. Military Property.
- MIL-STD-202 - Electronic and Electrical Component Parts.
- MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.

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

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

ASTM INTERNATIONAL

- ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

(Copies of this document are available online at <http://www.astm.org> or from the ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO 10012 - Measurement management systems - Requirements for measurement processes and measuring equipment

(Copies of this document are available online at [www.ansi.org](http://www.ansi.org) or from the ANSI Customer Service Department, 25 W. 43<sup>rd</sup> Street, 4<sup>th</sup> Floor, New York, NY 10036.)

NCSL INTERNATIONAL

- NCSL-Z540.3 - Requirements for the Calibration of Measuring and Test Equipment

(Copies of this document are available online at <http://www.ncsli.org> or from NCSL International, 2995 Wilderness Place, Suite 107 Boulder, Colorado 80301-5404.)

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), loudspeakers shall be subjected to first article inspection in accordance with 4.4.

3.2 Materials (see 6.6). Materials shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the loudspeaker to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.2.1 Aluminum. Aluminum shall conform to ASTM B209, Alloy 3003, or equivalent.

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3.2.2 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of handset components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.5).

3.2.3 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Design and construction.

3.3.1 Dimensions. The dimensions of the loudspeaker shall be as shown on figure 1.

3.3.2 Width of air gap. The air gap for the voice coil in the permanent magnet shall be such that the difference between the minimum width of the radial air gap and the maximum thickness of the voice coil shall be at least 0.014 inch.

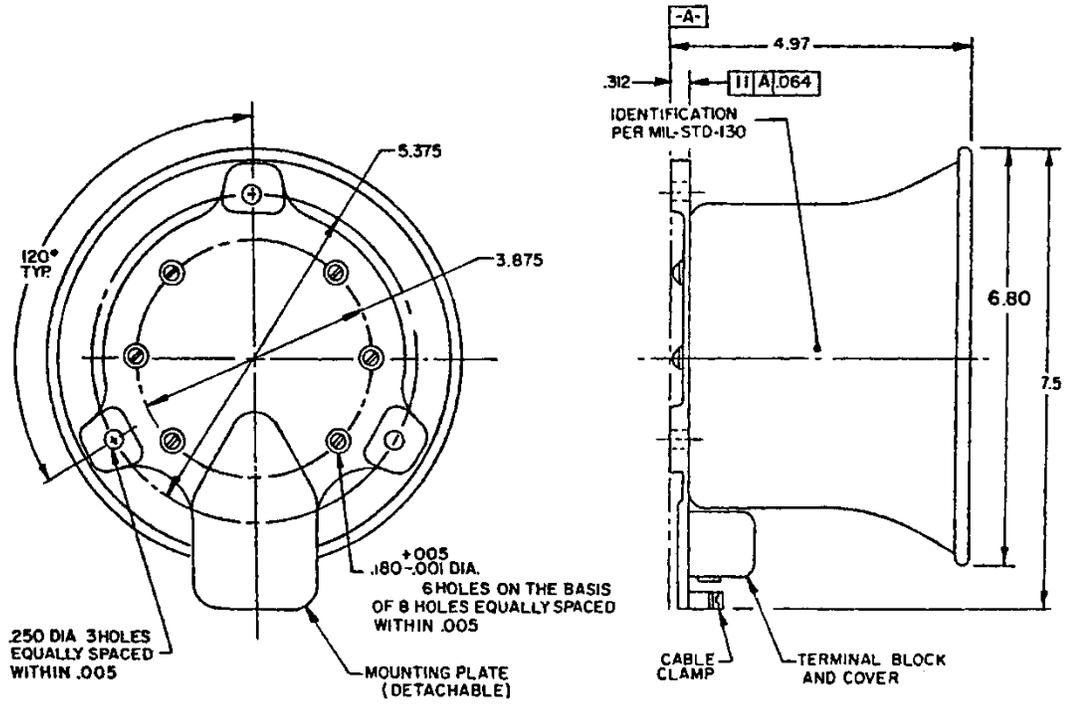
3.3.3 Weight. The weight of the loudspeaker shall not exceed 1.6 kilograms.

3.3.4 Color. The loudspeaker color shall be lusterless gray, color #36270 in accordance with FED-STD-595/36270.

3.3.5 Terminal board. The voice-coil lead wire of the loudspeaker shall be brought to a terminal board on the mounting plate of the loudspeaker assembly, as shown on figure 1. The terminal board shall be covered with a metal protective shield with a grommet to permit the entry of a 5/16 (0.3125) inch diameter cable. The terminal board shall be constructed of a suitable high-grade insulating material and shall contain a minimum of two screws, which will accept a No. 6 wire terminal.

3.4 Voice coil impedance. When loudspeakers are tested as specified in 4.6.2, the impedance of the voice coil, mounted in a complete loudspeaker assembly, shall be  $16 \pm 3.2$  ohms.

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| Inches | mm   | Inches | mm     |
|--------|------|--------|--------|
| .001   | .03  | 3.875  | 98.43  |
| .005   | .13  | 4.97   | 126.24 |
| .180   | 4.57 | 5.375  | 136.53 |
| .250   | 6.35 | 6.80   | 172.72 |
| .312   | 7.92 | 7.5    | 190.50 |

NOTES:

1. Dimensions are in inches.
2. Unless otherwise specified tolerances are  $\pm .015$  (.38 mm) for three place decimals and  $\pm .06$  (1.52 mm) for two place decimals.
3. Metric equivalents are given for information only and are based upon 1 inch = 25.4 mm.

FIGURE 1. Outline drawing loudspeaker LS-211/AIC-13.

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3.5 Voice coil polarity. When tested as specified in 4.6.3, the polarity of the voice coil shall be determined and the positive terminal of the voice coil shall be marked with a red dot. The marking shall not interfere with the electrical connections and shall not be impaired by soldering or unsoldering operations.

3.6 Stray magnetic field. When tested as specified in 4.6.4, the loudspeaker shall not cause a deflection of more than 5 degrees on a magnetic compass.

3.7 Sensitivity.

3.7.1 At sea level. When loudspeakers are tested as specified in 4.6.5.1, the average sensitivity above a reference level of 20 micropascal's ( $\mu\text{PA}$ ) (0.0002 dyne per square centimeter), for each of the indicated frequency bands, shall be not less than the values shown in table I.

TABLE I. Sensitivity.

| Frequency Band (Hz) | Average Sensitivity (dB) |
|---------------------|--------------------------|
| 500 – 800           | 97.0                     |
| 800 – 1,250         | 102.0                    |
| 1,250 – 2,000       | 103.0                    |
| 2,000 – 3,200       | 106.0                    |
| 3,200 – 5,000       | 103.5                    |
| 500 – 5,000         | 103.0                    |

3.7.2 At altitude. When loudspeakers are tested as specified in 4.6.5.2, the sensitivity measured at an altitude of 15,000 feet, shall not differ by more than  $\pm 3$  dB from the sensitivity measured at sea level (see 4.3).

3.8 Frequency response. When loudspeakers are tested as specified in 4.6.6, the frequency response shall be within the limits specified on figure 2, except that sharp peaks and dips may extend beyond these limits provided the width of the extension is not greater than 0.1 octave at the limit, and the number of extensions does not exceed 1 peak or dip per octave below 3,000 Hz, and 3 peaks or dips above 3,000 Hz.

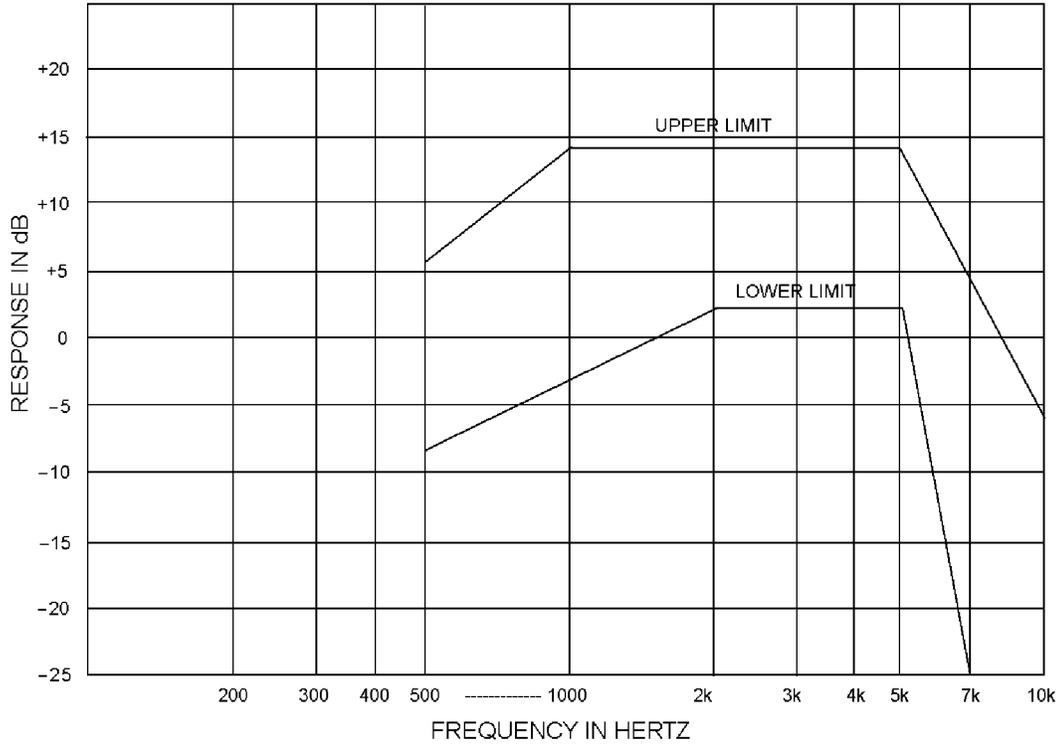
3.9 Directional characteristics. When loudspeakers are tested as specified in 4.6.7, the sound pressure measured 4 feet away from the loudspeaker in a free field at the indicated angles in all four quadrants with respect to the principal axis shall not deviate from the sound pressure measured on the principal axis by an amount greater than the values shown in table II, for a frequency of 1,000 Hz. The same input signal shall be applied for both on-axis and off-axis sound pressure measurements.

TABLE II. Directional characteristics.

| Frequency (Hz) | Maximum sound pressure deviation (dB) |            |
|----------------|---------------------------------------|------------|
|                | Off-Axis Angles                       |            |
|                | 15 degrees                            | 30 degrees |
| 1,000          | -3.0                                  | -6.0       |

3.10 Linearity. When loudspeakers are tested as specified in 4.6.8, the acoustic output of the loudspeaker shall not deviate from a linear function of the input voltage by more than 1 dB.

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NOTES:

1. Zero (0) on the Response scale =  $95 \pm 2$  dB

| Frequency Points (Hz) | 500   | 1,000 | 2,000 | 5,000 | 7,000  | 10,000 |
|-----------------------|-------|-------|-------|-------|--------|--------|
| Upper Limits (dB)     | +6.0  | +14.0 | +14.0 | +14.0 | + 4.0  | - 6.0  |
| Lower Limits (dB)     | - 8.0 | -3.0  | +2.0  | +2.0  | - 25.0 | -      |

FIGURE 2. Frequency response.

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3.11 Distortion. When loudspeakers are tested as specified in 4.6.9, the harmonic distortion in the acoustic output shall not exceed the values given in table III.

TABLE III. Distortion.

| Frequency<br>range | Signal input |           |
|--------------------|--------------|-----------|
|                    | 3.9 volts    | 8.8 volts |
| Hz                 | Percent      | Percent   |
| 500 - 1,000        | 9            | 14        |
| 1,000 - 6,000      | 3.5          | 5         |

3.12 Acoustic quality. When loudspeakers are tested as specified in 4.6.10, there shall be no buzzes, rattles, or other spurious sounds that would impair the quality of reproduced audio signal in the output.

3.13 Dielectric withstanding voltage. When tested as specified in 4.6.11, there shall be no arcing or breakdown of the voice coil insulation. Following the test, the loudspeaker shall meet the following requirements:

Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value.

3.14 Life. When tested as specified in 4.6.12, the loudspeaker shall meet the following requirements:

- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
- Sensitivity variation: Not more than  $\pm 3$  dB from the initial measured value (see 3.7.1).
- Frequency response: As specified in 3.8.
- Dielectric withstanding voltage: As specified in 3.13.
- Visual examination: There shall be no visual or mechanical failures (see table VIII).

3.15 Endurance. When tested as specified in 4.6.13, loudspeakers shall meet the following requirements:

- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
- Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
- Frequency response: As specified in 3.8.
- Dielectric withstanding voltage: As specified in 3.13.
- Visual examination: There shall be no visual or mechanical failures (see table VIII).

3.16 Temperature cycling. When tested as specified in 4.6.14, the loudspeaker shall meet the following requirements:

- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
- Sensitivity variation: Not more than  $\pm 3$  dB from the initial measured value (see 3.7.1).
- Frequency response: As specified in 3.8.
- Dielectric withstanding voltage: As specified in 3.13.
- Visual examination: There shall be no visual or mechanical failures (see table VIII).

- 3.17 Vibration. When tested as specified in 4.6.15, the loudspeakers shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
- 3.18 Shock. When tested as specified in 4.6.16, the loudspeakers shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
- 3.19 Pressure cycling. When tested as specified in 4.6.17, the loudspeakers shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
- 3.20 Explosive decompression. When tested as specified in 4.6.18, the loudspeakers shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
  - Visual examination: There shall be no visual or mechanical failures (see table VIII).
- 3.21 Humidity. When tested as specified in 4.6.19, loudspeakers shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
  - Visual examination: There shall be no visual or mechanical failures (see table VIII).
- 3.22 Fungus. When tested as specified in 4.6.20, loudspeaker shall meet the following requirements:
- Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
  - Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
  - Frequency response: As specified in 3.8.
  - Dielectric withstanding voltage: As specified in 3.13.
  - Visual examination: There shall be no visual or mechanical failures (see table VIII).

3.23 Salt fog. When tested as specified in 4.6.21, loudspeakers shall meet the following requirements:

- a. Voice coil impedance variation: Not more than 1 ohm maximum from the initial measured value, except when measurements are made immediately after hot and cold exposures of the last cycle (see 3.4).
- b. Sensitivity variation: Not more than  $\pm 2$  dB from the initial measured value (see 3.7.1).
- c. Frequency response: As specified in 3.8.
- d. Dielectric withstanding voltage: As specified in 3.13.
- e. Visual examination: There shall be no visual or mechanical failures (see table VIII).

3.24 Marking. Equipment assemblies and parts shall be marked for identification in accordance with MIL-STD-130.

3.25 Workmanship. The loudspeaker shall be processed in such a manner as to be uniform in quality and shall be free from defects that will affect life, serviceability or appearance.

#### 4. VERIFICATION

4.1 Classification of inspections. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ISO 10012 and NCSL-Z540.3. The inspection requirements specified herein are classified as follows:

- a. Materials inspection (see 4.2).
- b. First article inspection (see 4.4).
- c. Conformance inspection (see 4.5).

4.2 Materials inspection. Material inspection shall consist of certification supported by verifying data that aluminum used in fabricating the loudspeaker conforms to ASTM B209, Alloy 3003 or equivalent.

4.3 Inspection conditions. Unless otherwise specified, loudspeakers shall be tested under the following conditions:

- |             |   |   |
|-------------|---|---|
| Temperature | - | Room ambient, +15 degrees C (+59 degrees F) to +35 degrees C (+95 degrees F). |
| Pressure    | - | Normal atmospheric.   |
| Humidity    | - | Room ambient up to 90 percent relative humidity.                              |

All acoustical testing shall be made in a free field environment (see 6.3), or at the option of the contractor, the testing may be performed using a non-anechoic test chamber, provided that the relationship between the results of the free field tests and the results in the particular non-anechoic chamber is known and verified in a manner acceptable to the procuring agency.

4.4 First article inspection. When specified (see 6.2), first article inspection shall be performed by the contractor, after award of contract and prior to production, at a location acceptable to the Government. First article inspection shall be performed on sample units, which have been produced with equipment and procedures normally, used in production. First article approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders.

4.4.1 Sample size. Six loudspeakers shall be subjected to first article inspection.

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table IV, in the order shown. All sample units shall be subjected to the inspections of group I. The sample shall then be divided equally into two groups; one shall be subjected to the group II inspections, and the other shall be subjected to group III inspections.

4.4.3 Failures. Failures in excess of those allowed in table IV shall be cause for refusal to grant first article approval.

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TABLE IV. First article inspection.

| Examination or test               | Requirement paragraph   | Method paragraph | Number of units to be inspected | Acceptable number of defects permitted |
|-----------------------------------|-------------------------|------------------|---------------------------------|--|
| <u>Group I</u>                    |                         |                  |                                 |  |
| Visual and mechanical examination | 3.2, 3.3, 3.24 and 3.25 | 4.6.1            | 6                               | 0                                      |
| Voice coil impedance              | 3.4                     | 4.6.2            | 6                               | 0                                      |
| Voice coil polarity               | 3.5                     | 4.6.3            | 6                               | 0                                      |
| Stray magnetic field              | 3.6                     | 4.6.4            | 6                               | 0                                      |
| Sensitivity                       | 3.7                     | 4.6.5            | 6                               | 0                                      |
| Frequency response                | 3.8                     | 4.6.6            | 6                               | 0                                      |
| Directional characteristics       | 3.9                     | 4.6.7            | 6                               | 0                                      |
| Linearity                         | 3.10                    | 4.6.8            | 6                               | 0                                      |
| Distortion                        | 3.11                    | 4.6.9            | 6                               | 0                                      |
| Acoustic quality                  | 3.12                    | 4.6.10           | 6                               | 0                                      |
| Dielectric withstanding voltage   | 3.13                    | 4.6.11           | 6                               | 0                                      |
| <u>Group II</u>                   |                         |                  |                                 |  |
| Life                              | 3.14                    | 4.6.12           | 3                               | 0                                      |
| Endurance                         | 3.15                    | 4.6.13           | 3                               | 0                                      |
| Temperature cycling               | 3.16                    | 4.6.14           | 3                               | 0                                      |
| Vibration                         | 3.17                    | 4.6.15           | 3                               | 0                                      |
| Shock                             | 3.18                    | 4.6.16           | 3                               | 0                                      |
| <u>Group III</u>                  |                         |                  |                                 |  |
| Pressure cycling                  | 3.19                    | 4.6.17           | 3                               | 0                                      |
| Explosive decompression           | 3.20                    | 4.6.18           | 3                               | 0                                      |
| Humidity                          | 3.21                    | 4.6.19           | 3                               | 0                                      |
| Fungus                            | 3.22                    | 4.6.20           | 3                               | 0                                      |
| Salt fog                          | 3.23                    | 4.6.21           | 3                               | 0                                      |

4.5 Conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.5.1.1 Inspection lot. An inspection lot shall consist of all loudspeakers produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.2 Group A inspection. Group A inspection shall consist of the examination and tests specified in [table V](#) in the order shown.

4.5.1.2.1 Sampling plan. The sampling plan shall be accept-on-zero, as specified in [table VI](#). The classification of defects for the visual and mechanical examination is specified in [table VIII](#).

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TABLE V. Group A inspection.

| Examination or test               | Requirement paragraph   | Method paragraph |
|-----------------------------------|-------------------------|------------------|
| Visual and mechanical examination | 3.2, 3.3, 3.24 and 3.25 | 4.6.1            |
| Voice coil impedance              | 3.4                     | 4.6.2            |
| Voice coil polarity               | 3.5                     | 4.6.3            |
| Acoustic quality                  | 3.12                    | 4.6.10           |

TABLE VI. Sampling plan.

| Lot size     | Sample size |
|--------------|-------------|
| 2 to 13      | 1/          |
| 14 to 150    | 13          |
| 151 to 280   | 20          |
| 281 to 500   | 29          |
| 501 to 1200  | 34          |
| 1201 to 3200 | 42          |

1/ Indicates entire lot must be inspected. In no case will the sample size exceed the lot size.

4.5.1.2.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.5.1.3 Group B inspection. Group B inspection shall consist of the tests specified in [table VII](#) and shall be made on sample units which have been subjected to and have passed group A inspection.

4.5.1.3.1 Sampling plan. The sampling plan shall be accept-on-zero, as specified in [table VI](#).

4.5.1.3.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

TABLE VII. Group B inspection.

| Test                            | Requirement paragraph | Method paragraph |
|---------------------------------|-----------------------|------------------|
| Sensitivity                     | 3.7                   | 4.6.5            |
| Frequency response              | 3.8                   | 4.6.6            |
| Directional characteristics     | 3.9                   | 4.6.7            |
| Distortion                      | 3.11                  | 4.6.9            |
| Dielectric withstanding voltage | 3.13                  | 4.6.11           |

4.5.1.3.3 Disposition of sample units. Sample units which have passed all the group B inspection may be delivered on the contract or purchase order, if the lot is accepted.

#### 4.6 Methods of examination and test.

4.6.1 Visual and mechanical examination. The loudspeaker shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements in [table VIII](#) (see [3.2](#), [3.3](#), [3.24](#), and [3.25](#)).

4.6.2 Voice coil impedance (see [3.4](#)). The loudspeaker shall be hand held on the side opposite the cone. There shall be no obstruction within 3 feet of the front of the cone. The voice coil terminals shall be connected in series with a variable resistor across the output of a low-impedance 1,000 Hz signal source. The voltage drops across the voice coil and the variable resistor shall be determined with an electronic voltmeter. The value of the variable resistor shall be adjusted until the voltage drops are equal. The resistance of the variable resistor shall then be measured with a resistance bridge or other suitable equipment. The voice coil impedance shall be considered as numerically equal to the measured value of resistance of the variable resistor.

4.6.3 Voice coil polarity (see [3.5](#)). A direct current voltage of  $4.5 \pm 1.5$  volts shall be applied to the terminals of the voice coil so that it causes the diaphragm of the loudspeaker to move in a direction away from the magnetic assembly. The terminal connected to the positive voltage potential shall be marked (with a red dot), as the positive terminal of the voice coil.

4.6.4 Stray magnetic field (see [3.6](#)). The stray magnetic field of the loudspeaker shall be determined, by using a compass that meets the requirements of A-A-52024 or engineering approved equivalent. The loudspeaker shall be placed with the geometric center of the magnet structure 20 inches  $\pm$  1 inch from the pivot point of the compass needle and in the plane of rotation of the needle (see [figure 3](#)). The loudspeaker shall be oriented in all directions and the maximum deflection of the compass observed. The test shall be made in a location substantially free from stray magnetic disturbances. The maximum deflection of the compass shall be determined as specified in [4.6.4.1](#) or [4.6.4.2](#) at the option of the manufacturer.

4.6.4.1 Constant compass location (six permanently mounted compasses). With a compass permanently mounted in each location indicated on [figure 3](#), the readings shall be observed on each compass, as the loudspeaker is oriented in all directions.

4.6.4.2 Changing compass location (one movable compass). In each direction that the loudspeaker is oriented, the compass shall be relocated to each of the six compass locations and oriented so that the degree markings on the compass line up (within  $\pm 0.5$  degrees) with the degree markings on the table as shown on [figure 3](#). The reading on the compass shall be observed in each location for each direction the loudspeaker is oriented.

#### 4.6.5 Sensitivity.

4.6.5.1 At sea level (see [3.7.1](#)). A sensitivity measurement shall be made with a constant signal input  $3.94 \pm .01$  volts in a free field at a point on the principal axis 4 feet  $\pm$  1 inch from the front of the loudspeaker. The average sensitivity for each frequency band may be obtained by measuring the area between the frequency response and any reference line over the appropriate frequency band, provided this line was established from a basic reference level of 20  $\mu$ PA (0.0002 dyne per square centimeter).

4.6.5.2 At altitude (see [3.7.2](#)). The sensitivity test specified in [4.6.5.1](#) shall be repeated at a simulated altitude of 15,000 feet above sea level.

4.6.6 Frequency response (see [3.8](#)). The loudspeaker shall be mounted and placed 4 feet  $\pm$  1 inch from a calibrated Western Electric Type 640AA (or equal) condenser microphone and amplifier. The microphone shall be placed on the axis of the loudspeaker. A constant voltage having an rms value of  $3.94 \pm .05$  volts shall be applied to the voice coil terminals and the frequency varied continuously from 200 to 7,000 Hz. The acoustic output shall be recorded on a direct-writing strip graph chart using an automatic plotter or curve tracer with a minimum writing speed of 10 inches per second and a maximum chart speed of 30 inches per minute; or, at the option of the manufacturer, point-to-point measurements may be made every 50 Hz from 200 to 600 Hz; every 100 Hz from 600 to 1,500 Hz; every 250 Hz from 1,500 Hz to 2,000 Hz; every 100 Hz from 2,000 to 2,500 Hz; every 250 Hz from 2,500 to 3,000 Hz; and every 500 Hz from 3,000 to 7,000 Hz with the data recorded and a graph drawn.

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TABLE VIII. Classification of defects for visual and mechanical examination.

| Defect type          | Classification  |   |
|----------------------|---|---|
|                      | Major   | Minor   |
| Dimensions           | Dimensions not as specified.  | N/A   |
| Materials and finish | Materials not as specified.<br>Wrong or incomplete finish.<br>Large amounts of flaking, peeling, or chipping of finish.   | Scratches, cuts, abrasions, etc., causing exposure of base metal, or relatively small amounts of flaking, peeling, or chipping.   |
| Parts                | Missing parts.<br>Inoperative, improperly assembled, or defective parts which could cause the loudspeaker to fail in service.<br>Wrong parts.   | Defective parts which would reduce efficiency of use, but not cause failure in service.<br>Cracks or chipped surfaces having no effect on the functioning, assembly, maintenance, or life of the loudspeaker.   |
| Marking              | Marking missing, illegible, or incorrect.   | Markings dirty or smudged, but legible.   |
| Foreign objects      | Any metallic foreign object, not firmly attached <sup>1/</sup> , which could cause a short circuit, or acoustical malfunctioning of the loudspeaker.<br>Any nonmetallic foreign object such as insulation, dirt, or phenolic chips which could cause acoustical malfunctioning of the loudspeaker.  | Any metallic or nonmetallic foreign object which affects appearance but which could not cause acoustical malfunctioning of the loudspeaker.   |
| Soldering            | Improper wrap — Less than 1/2 turn.<br>Unsoldered joint - Solder not applied where intended.<br>Insufficient solder - Minimum dimension of solder bridge less than twice the diameter of the wire or less than 3/32 inch, whichever is greater. Entire area of contact between wire and terminal not joined by solder bridge.<br>Cold solder joint - Chalky appearance, lacks metallic luster, presents rough "pile-up" appearance; movement of wire or solder upon pick application.<br>Rosin joint - Presence of excess rosin; relative movement of wire or solder upon pick application.<br>Insulation in terminal hole - Solder over insulation; no appearance of visible wire contour. | Improper wrap — 1/2 turn or more, but less than one turn.<br>Excess solder - Build-up solder on joint greater than necessary for good soldering, usually resulting in obliteration of wire contour.<br>Cold solder joint - Chalky appearance, lacks metallic luster, presents rough "pile-up" appearance; no relative action between wire and solder upon pick application. |
| Wiring               | Broken strands - More than 20 percent; except in a 7-strand conductor, more than 2 broken strands.<br>Insulation burned, abraded, pinched, or deteriorated between two or more conductors, resulting in a potential short circuit.<br>Taut wire - Wire exhibits no slack and subsequent breakage may occur due to stress on terminal or part.<br>Insulation frayed to the extent that a potential short circuit exists.   | Broken strands - 20 percent or less. In a 7-strand conductor, 2 broken strands.<br>Insulation burned, abraded, pinched, or deteriorated, with exposure of bare wire, but short circuit not possible.<br>Taut wire - Slight stress on conductor, but not possibility of subsequent breakage.   |

<sup>1/</sup> Foreign objects that cannot be dislodged by the moderate application of pressure with a pick or spudger shall be considered to be firmly attached.

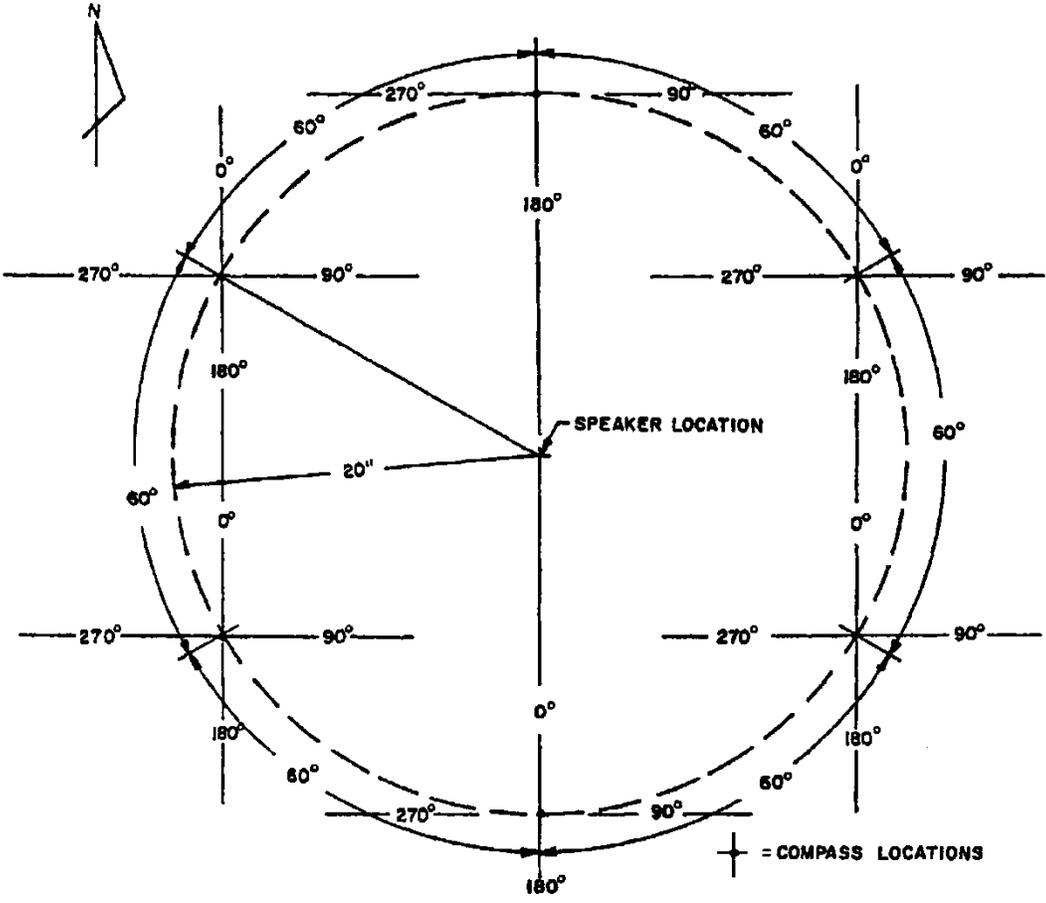


FIGURE 3. Stray magnetic field test table.

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4.6.7 Directional characteristics (see 3.9). The on-axis sound pressure shall be measured in a free field at a point 4 feet ±1 inch from the front of the loudspeaker on the principal axis. The off-axis sound pressure shall be measured:

- a. In a free field at a point 4 feet ±1 inch from the front of the loudspeaker.
- b. At angles of 15 degrees and 30 degrees with respect to the principal axis.
- c. At the indicated angles in all four quadrants with respect to the principal axis.

The vertices of the angles shall be the intersection point of the loudspeaker principal axis and the plane containing the front face of the loudspeaker. The same input signal, at 1,000 Hz shall be applied for both on-axis and off-axis sound pressure measurements.

4.6.8 Linearity (see 3.10). The acoustic output of the loudspeaker in dB relative to 20 μPA (0.0002 dyne per square centimeter) shall be measured by using a warble signal having a frequency range from 750 Hz to 1,250 Hz and a rate of sweep of 5-1/2 times per second. Input voltages shall be 0.313, 0.557, 0.99, 1.76, 3.13, 5.57, 9.9, and 17.6 volts. The acoustic output shall be plotted as a function of the input voltage.

4.6.9 Distortion (see 3.11). The harmonic distortion in the acoustic output of the loudspeaker at a certain frequency of the fundamental shall be determined by the following formula:

$$\text{RMS distortion (in percent)} = 100 \frac{\sqrt{P_2^2 + P_3^2 + \dots + P_n^2}}{\sqrt{P_1^2 + P_2^2 + P_3^2 + \dots + P_n^2}}$$

Where  $P_1$  is the pressure amplitude of the fundamental, and  $P_2, P_3, P_4$ , etc., are the pressure amplitudes of the harmonic components in the output, the distortion may also be determined by using a total distortion analyzer.

4.6.10 Acoustic quality (see 3.12). A constant voltage having a root mean square (rms) value of 4 volts and a frequency between 500 and 5,000 Hz shall be applied to the input terminals of the loudspeaker, and the frequency shall be varied from 500 Hz to 5,000 Hz and back to 500 Hz in not less than 1 minute.

4.6.11 Dielectric withstanding voltage (see 3.13). The loudspeaker shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

- a. Test voltage: 400 volts.
- b. Nature of potential: 60 Hz, ac.
- c. Points of application: The test voltage shall be applied between one of the voice coil terminals and the loudspeaker frame; simultaneously, the voice coil shall be excited with a minimum of 2.85 volts rms at 300 Hz.
- d. Measurement after test: Voice coil impedance shall be measured as specified in 4.6.2.

4.6.12 Life (see 3.14). Life test shall consist of the cycles specified in table IX in the order shown. The loudspeaker shall be placed in the test chamber with the front face exposed. Upon completion of each different temperature cycle of the test, the loudspeaker(s) under test shall be transferred immediately from one chamber to another. Following the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.2, 4.6.6, and 4.6.11, respectively, and the loudspeaker(s) shall be examined for evidence of damage.

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TABLE IX. Life.

| Cycle | Temperature<br>(± 2 degrees C,<br>± 5 degrees F) | Periods<br>of signal<br>applied          | Voice coil input<br>in volts<br>(± .01) rms | Hz<br>(±10) | Duration in<br>hours<br>(± 5 minutes) |
|-------|--|--|---|-------------|---------------------------------------|
| 1     | +71 degrees C<br>(+160 degrees F)                | 15 seconds "on"<br>&<br>15 seconds "off" | 17.6  | 1200        | 3                                     |
| 2     | -55 degrees C<br>(-67 degrees F)                 | none                                     | none  | none        | 3                                     |
| 3     | -55 degrees C<br>(-67 degrees F)                 | 15 seconds "on"<br>&<br>15 seconds "off" | 17.6  | 1200        | 3                                     |
| 4     | Room<br>ambient                                  | none                                     | none  | none        | 3                                     |
| 5     | +25 degrees C<br>(+77degrees F)                  | 15 seconds "on"<br>&<br>15 seconds "off" | 17.6  | 1200        | 100                                   |
| 6     | Room<br>ambient                                  | none                                     | none  | none        | 3                                     |
| 7     | Room<br>ambient                                  | Continuously                             | 3.94  | 1200        | 240                                   |

4.6.13 Endurance (see 3.15). The loudspeaker shall be operated for 150 hours + 0 or - 2 hrs. at a simulated altitude of 15,000 feet with a warble signal input of 17.6 volts, having a frequency range from 1,000 Hz to 3,000 Hz and a rate of sweep of approximately six times per second. The signal shall be applied intermittently, for 1 minute ± 0.5 seconds in every 3 minutes. Following the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.14 Temperature cycling (see 3.16). The loudspeaker shall be placed in the test chamber with the front face exposed. The loudspeaker shall be exposed to a temperature of +85 degrees C + 3 degrees or -0 degrees (+185 degrees F) for 1 hour, placed in room temperature for 15 minutes, then exposed to a temperature of -65 degrees C (-85 degrees F) for 1 hour ± 1 minute, and again placed in room temperature for 15 minutes ± 1 minute. The loudspeaker shall be subjected to 10 such temperatures cycles. Immediately after the +85 degrees C exposure and -65 degrees C exposure during the last cycle, and 1 hour after completion of the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.15 Vibration (see 3.17). The loudspeaker shall be tested in accordance with method 514 of MIL-STD-810. The following details and exceptions shall apply:

- a. Procedure - 1, part 1.
- b. Categories 7, 8, and 9. (Aircraft, jet, propeller and helicopter).

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- c. Measurements after the test - Within 1 hour after the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.16 Shock (see 3.18). The loudspeaker shall be tested in accordance with test method 516 of MIL-STD-810. The following details and exceptions shall apply:

- a. Procedure I.

- b. Shock pulse.

- (1) Saw tooth wave shape.
- (2) 20g peak value.
- (3) 11 millisecond (ms) duration.

- c. Measurements after the test. Within 1 hour after the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.17 Pressure cycling (see 3.19). The loudspeaker shall be placed in the test chamber with the face of the loudspeaker exposed and the absolute internal pressure of the chamber reduced to 3.44 inches of mercury (corresponding to an altitude of 50,000 feet above sea level) and allowed to remain at the reduced pressure for 5 minutes  $\pm$  0.5 seconds. The rate of change of pressure shall correspond to approximately 50,000 feet per minute. The loudspeaker shall be subjected to three such pressure cycles and shall be operated throughout the test with a warble signal input of 17.6 volts, having a frequency range from 1,000 Hz to 3,000 Hz, and a rate of sweep of approximately six times per second. Following the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.18 Explosive decompression (see 3.20). The loudspeaker shall be subjected to 10 consecutive explosive decompressions from an altitude of 8,000 feet to an altitude of 35,000 feet (corresponding to pressures of [10.90 PSI] 22.2 inches of mercury to [3.46 PSI] 7.04 inches of mercury). Each complete decompression or change of pressure shall take place in 0.1 second or less. The loudspeaker shall be placed in the test chamber with the front face of the loudspeaker exposed. Following the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.19 Humidity (see 3.21). The loudspeaker shall be subjected to humidity testing in accordance with method 507 of MIL-STD-810. The following details and exceptions shall apply:

- a. Procedure I.

- b. Measurements after the test. Within 1 hour after the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage, shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.20 Fungus (see 3.22). The loudspeaker shall be tested in accordance with method 508 of MIL-STD-810. The following details shall apply:

Measurements after the test. Within 1 hour after the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage, shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

4.6.21 Salt fog (see 3.23). The loudspeaker shall be tested in accordance with method 509 of MIL-STD-810. The following detail shall apply:

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Measurements after the test. Within 1 hour after the test, voice coil impedance, sensitivity, frequency response, and dielectric withstanding voltage shall be measured in accordance with 4.6.2, 4.6.5.1, 4.6.6, and 4.6.11, respectively, and the loudspeaker shall be examined for evidence of damage.

## 5. PACKAGING

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

## 6. NOTES

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

6.1 Intended use. Loudspeaker, permanent magnetic LS-211/AIC-13 is intended to be used as part of public address set AN/AIC-13 to transmit audio messages at low altitudes or at ground level within a military aircraft or from a military aircraft on the ground to personnel in the immediate vicinity. This loudspeaker is a horn type unit with a frequency response of 200-7000 Hz, nominal 16 ohms voice coil impedance, and a 20-watt peak power output.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. If required, the specific issue of individual documents referenced (see 2.2.1).
- c. Packaging requirements (see 5.1).
- d. When first article is required, based upon contractor performance history.

6.3 Free field environment. The acoustic environment should simulate free-field conditions to the extent that the inverse-pressure versus distance law should hold within  $\pm 1$  dB at all frequencies at which measurements are made. Ambient noise should not affect the measurements to an extent greater than  $\pm 1$  dB.

6.4 Design activity. The design agency for this item is AFLC/MMGE.

6.5 Tin whisker growth (see 3.2.2). The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to ASTM B 545 (Standard Specification for Electrodeposited Coatings of Tin). Copies of this document are available from <http://www.astm.org> or ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

6.6 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals and additional information is available on their website <http://www.epa.gov/osw/hazard/wastemin/priority.htm>. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see 3.2).

6.7 Subject term (key word) listing.

Acoustic quality  
Air gap  
Directional characteristic  
Horn type unit  
Impedance  
Polarity  
Sound pressure  
Stray magnetic field  
Transmit audio messages  
Voice coil

6.8 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. 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.

CONCLUDING MATERIAL

Custodians:

Army - CR  
Navy - EC  
Air Force - 85  
DLA - CC

Preparing activity:

DLA - CC

(Project 5965-2013-015)

Review activities:

Army - AV, CR4  
Navy - OS  
Air Force - 99

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