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Materiel Test Procedure 6-3-170
General Equipment Test Activity

3469

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

LOUDSPEAKERS

1. OBJECTIVE*

This document provides the test methodology and test techniques to determine the degree to which loudspeakers and their associated tools and equipment perform their mission as indicated by the particular design in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), and Military Characteristics (MC's); and to determine test item and maintenance package suitability for use by the Army.

2. BACKGROUND

A requirement exists for a device that converts electrical signals into audio signals. The loudspeaker is a transducer capable of performing this mission over a large range of frequency and amplitude. By far the most common loudspeaker type is the permanent magnet, dynamic design. Electrical signals from an audio amplifier are applied to the loudspeaker voice coil. Due to the nature of the voice coil, input electrical signals result in functionally dependent magnetic fields; these dynamic fields interact with the field of a conveniently placed stationary permanent magnet. Magnetic interactions between the moveable voice coil and stationary magnet result in mechanical forces that push and pull the voice coil. This voice coil-magnet combination constitutes the driver section of the loudspeaker. The sound reproduced by only this system would be inaudible, since only a negligible amount of air would be moved. Mechanical amplification is obtained by attaching to the voice coil a large conical sheet, appropriately called a cone, that is capable of moving large volumes of air. In this way, the loudspeaker generates pressure waves, or sound waves, that are controlled by the input electrical signals.

3. REQUIRED EQUIPMENT

a. Still Picture Cameras and Film to record test results.
b. Program Material (i.e. Turntable or Tuner)-Amplifier Combination which matches the impedance of the test item.
c. Small Battery or other low power DC source.
d. Equipment and Facilities as specified in the referenced MTP's.

4. REFERENCES

A. USATECOM Regulation 385-6, Verification of Safety of Material During Testing.
B. USATECOM Regulation 700-1, Value Engineering.

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*This MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal of pertinent QMR's, SDR's, MC's, TC's and any other applicable documents.

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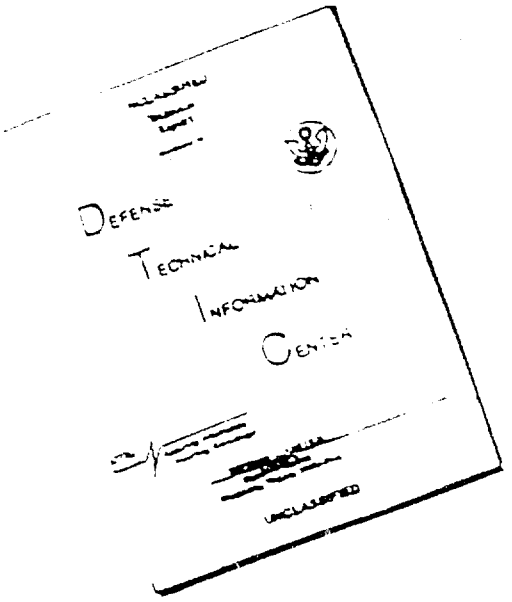

THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

C. USATECOM Regulation 705-4, Equipment Performance Reports.
D. USATECOM Regulation 750-15, Maintenance Portion of the Service Test.
E. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE).
F. MTP 6-3-500, Physical Characteristics.
G. MTP 6-3-501, Pre-Test Inspection for Service Test.
H. MTP 6-3-502, Personnel Training Requirements.
I. MTP 6-3-506, Durability.
J. MTP 6-3-510, Transportability of Communication, Surveillance, and Electronic Equipment.
K. MTP 6-3-523, Safety.
L. MTP 6-3-524, Maintenance Evaluation.
M. MTP 6-3-525, Human Factors.
N. MTP 7-3-515, Air Transport, Internal (Suitability of Equipment for).
O. MTP 10-3-511, Quality Assurance.

5. SCOPE

5.1 SUMMARY

This materiel test procedure describes the following loudspeaker tests:

a. Preparation for Test - An evaluation to determine the completeness of the test item, its physical characteristics, that it is in satisfactory condition prior to testing, and operator training and familiarization procedures.

b. Operational Performance - An evaluation to determine, through operations, the ability of the test item to operate under the intended conditions.

c. Transportability - An evaluation to determine the ability of the test item to be prepared for transport and to be transported by service personnel.

d. Maintenance - An evaluation to determine and appraise the test item's maintenance characteristics and requirements, a verification and appraisal of its malfunctions, an evaluation of the test item's associated publications and other common and special support elements (maintenance test package), an appraisal of the test item's design for maintainability (AMCP 706-134: accessibility, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculation of indicators which express the effects of appropriate preceding aspects.

e. Durability - An evaluation to determine the durability of the test item when used under TOE type conditions.

f. Safety - An evaluation to determine the test item compliance with safety requirements and to confirm the item's safety characteristics during conduct of all tests.

g. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of compatibility with the capabilities and limitations of specified user personnel with the test item under the environmental and operational conditions for which it was designed. Characteristics of the test item as related to human factors and revealed during the conduct of each test shall be examined.

h. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

i. Quality Assurance - A study to determine the quality of the test item.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Inspection

Perform the following procedures upon arrival of the test item at the test site:

6.1.1.1 Arrival Inspection

Conduct an initial inspection of the test item as described in the applicable sections of MTP 6-3-501 and the following:

a. Visually inspect the test item package and record the following:

1) All identification markings
2) Evidence of damage

b. Remove the test item from its shipping container and record the following:

1) Equipment required to unpackage the test item
2) Time required to unpackage the test item
3) Personnel required to unpackage the test item
4) Method and materials used to package the test item

c. Visually inspect the test item and record the following:

1) All identification markings.
2) List of accompanying printed material and any instances of disagreement with the test item markings.

d. Photograph all test item damage.

6.1.1.2 Inventory Check

a. Conduct an inventory against the Basic Issue Item List (BIIL) and record any discrepancies as regards the maintenance literature, repair parts, associated tools, associated equipment and components.

b. Record all shortages and prepare an Equipment Performance Report (EPR) when applicable.

6.1.1.3 Physical Characteristics

Determine the physical characteristics of the loudspeaker in accordance with the applicable sections of MTP 6-3-500 including the following:

a. Rated power capacity
b. Rated impedance
c. For the enclosure (if enclosed):

1) Construction material
2) Acoustic type

d. Type (e.g. permanent magnet, dynamic).

e. Frequency response specifications supplied or obtained from the draft technical manual.

f. Other distinguishing characteristics.

6.1.1.4 Pre-Operational Inspection

Perform the applicable portions of MTP 6-3-501 and the following:

a. Mount the speaker in a suitable enclosure or secure the speaker on its existing mount.

b. Inspect the test item for functional deficiencies or disabilities such as the following:

1) Damages (e.g. torn speaker cone)
2) Defects (e.g. cone not properly glued)
3) Missing components
4) Other

6.1.2 Test Item Installation

Mount the speaker in a suitable enclosure or secure the speaker on its existing mount and record the following:

a. Personnel required
b. Tools required
c. Materials required
d. Time, in minutes, to mount speaker in enclosure
e. Difficulties experienced and suggestions for improvement

6.1.3 Pre-Operational Functional Check

a. Measure and record the DC resistance of the voice coil. Avoid applying too much power to the voice coil.

b. For those loudspeakers that are subsystems of a commodity, such as a radio, apply power to the commodity and listen closely for background "noise" that sounds like rushing air.

c. For those loudspeakers that are the entire test item, perform the following:

1) Obtain a low voltage DC source (e.g. a 1.5 volt battery).

NOTE: Be certain that the battery voltage is sufficiently low. In particular, V^2/R must be much less than P, where V is the voltage of the battery, P is the power rating of the speaker, and R is the DC resistance of the voice coil measured in a.

2) Connect the battery across the speaker terminals; break and

make the connection several times. Listen for and record presence of "clicking" noises in the speaker corresponding to making and breaking the battery connection across the speaker terminals.

d. Record the following for all operational deficiencies observed:

1) Type of deficiency
2) Corrective action taken
3) Time to perform corrective measures

6.1.4 Operator Training and Familiarization

Service test personnel will be oriented according to the applicable sections of MTP 6-3-502 and the following:

a. All members of the test team shall receive a review of operator safety precautions listed in the technical manuals or developed from previous test experience.

b. Service Test personnel will be instructed in the capabilities of the test item and in the objectives and procedures of the test.

c. The set up, operating, and maintenance procedures for the loudspeaker will be presented. Precautions for operating and transporting will be reviewed. The technical manuals will be made available for study.

d. Record the amount of time and type of training or familiarization required for each operator.

e. Record the rank, training, and MOS of service test personnel.

6.2 TEST CONDUCT

NOTE: All equipment failures shall be reported in accordance with USATECOM Regulation 705-4.

Safety personnel shall observe all safety precautions listed in the test item's technical manual.

6.2.1 Operational Performance

Determine the operating characteristics of the test item observing the following general considerations:

a. The operational performance of the test item shall be determined by placing the test item in extended service in actual mission-type assignments, under actual or simulated TOE environments.

b. Authorized MOS-qualified personnel shall operate and maintain the test item using appropriate products, tools and equipment.

c. The duration of each operational period shall be planned using designated unit mission times and shall include sustained mission operations and provisions for scheduled maintenance and allowable downtime.

d. In cases where mobility is a requirement, moves and relocations shall be accomplished using TOE transportation.

e. Suitability of the test item for task operations and its con-

formance to the specified QMR or SDR requirements shall be determined by conducting various mission tasks, different test item applications, and usage under environmental conditions, as required.

f. The ability of the test item to perform its intended mission shall be determined, using the manufacturer's instructions, wherever possible.

6.2.1.1 Preparations for Test

NOTE: The evaluation of frequency response and faithfulness of reproduction are to be measured by appropriate equipment.

a. Apply the output of the program material source (e.g. a turntable or tuner) to an audio amplifier.

b. Apply the audio amplifier output to the loudspeaker.

NOTE:
1. Be certain that the program material-amplifier combination delivers only a safe amount of power to the speaker. Failure to do this may result in equipment damage.
2. Be certain that the amplifier output impedance matches the loudspeaker input impedance. Failure to do this may result in increased distortion, power loss, and equipment damage.
3. Choose a program material-amplifier combination that is capable of driving the loudspeaker through its performance limits (e.g. choose a program material-amplifier combination having a frequency response band-width greater than the loudspeaker frequency response band-width). If the loudspeaker is an integral part of a commodity, such as a radio, use the commodity for the program material-amplifier combination.

c. Record the following:

1) Type of program material
2) Type of physical reproduction source used:
   a) Name
   b) Model number
   c) Serial number
   d) Other identification
3) For the amplifier used during test conduct:
   a) Name
   b) Model number
   c) Serial number
4) For the test conduct area used:
   a) For essentially free field or outdoors:
      (1) Low, medium, or high ambient noise level

(2) Weather conditions (e.g. windy, raining, etc.)

b) For indoor test areas:

(1) Estimate of room dimensions.
(2) Description of walls and ceilings (e.g. painted plaster, acoustic tile, etc.).
(3) Low, medium, or high ambient noise level.

6.2.1.2 Test Conduct

Operate the loudspeaker in its intended mission, using the program material-amplifier source specified above. Perform the following as mission use allows:

a. Determine and record the following mission information:

1) Type of mission.
2) Ambient temperature and humidity.
3) Hazards the mission presents to the speaker (e.g. salt exposure on board ship).
4) Demands or requirements the mission makes on the speaker (e.g. volume requirements).

b. Listen for and record evidences of annoying disturbances such as the following:

1) Garble
2) Hiss
3) Rattles and other spurious noises

c. Listen for and record evidences of unfaithful (not realistic) reproduction. If mission use permits, use piano music as a program material source. Perform the following:

1) Determine and record whether or to what degree the reproduced program material (piano music) simulates the original (piano).
2) Record the type of program material used for the evaluation.

d. Stand directly in front of the speaker, about ten feet from the cone. Listen to the speaker and perform the following:

1) Listen for the presence of high note (pitch) reproduction, and record evidences of the following:

a) Clarity
b) "Break-up" or dispersion
c) Strident reproduction (harsh)

2) Listen for presence of low note (pitch) reproduction, and record evidence of the following:

a) Bass boom (certain particular bass notes are over-emphasized by the speaker-enclosure combination due to natural resonance frequencies).
b) Rattling caused by low bass notes.
c) Other.

3) Listen to reproduced speech program material (if mission use allows) and record the following:

a) Description of clarity of enunciation.
b) Intelligibility.
c) Evidences of indistinct consonants (e.g. a "p" that pops or an "s" that hisses).

e. Sound Distribution:

1) Move left and right along a semicircle of radius 10 feet, symmetric to the point used in step d. Listen for evidences of change in sound quality along the semicircle. Especially listen for high notes in this evaluation.
2) Move the speaker up and down along a semicircle of radius 10 feet from an observer, symmetric to the point used in step d. Listen for evidences of change in sound quality along the semicircle. Especially listen for high notes in this evaluation.

f. Increase the volume, listen to the speaker for and record any evidences of sound quality changes due to the volume increase.

g. Vary each tone control present on the program material-amplifier source. Record all evidences of sound quality change.

h. Repeat steps a. through d. for any environmental condition necessary for mission completion, and as required by QMR's, SDR's, or other developmental criteria.

i. Accumulate sufficient operating hours on the loudspeaker to verify mission reliability. The number of operating hours required depends on the specified mission time, reliability, confidence level, and use factors. Operating hours will include transport and set up time.

6.2.1.3 Securing

Load all components of the loudspeaker into its transit case(s). Record the following:

a. Ease of loading and security
b. Time required to load and secure for transport

6.2.2 Transportability Test

NOTE: Transportability evaluation of this item will be conducted in conjunction with other commodity items, as applicable or convenient. If this is not feasible, data from the

Engineering Test on the test item shall be sufficient to verify transportability.

6.2.2.1 Preparation for Test

Package the loudspeaker, free of defects, for shipment. Record the following:

a. Organization/Unit selected for this test
b. Type, size and serial number of loudspeaker
c. Type of container used for packing
d. Dimensions of container
e. Weight of container
f. Time required to disassemble test item for packing, if applicable
g. Degree of disassembly required, if applicable
h. Time required to pack the test item
i. Method of packing
j. Gross weight of packing container plus test item

6.2.2.2 Surface Transportability

Determine the surface transportability of the test item by performing the procedures described in the applicable sections of MTP 6-3-510 including the following:

a. Subject the fully packaged test item to the following modes of transport:

1) Railway transport: 50 miles
2) Motor vehicle transport: 50 miles
3) Marine transport: 5 hours

b. Visually inspect the test item at the completion of the transportability test and record the following for each mode of transport:

1) Mileage traveled or time of travel.
2) Damage incurred, if any, and cause of damage, e.g., improper packing, inadequate container, inadequate tie-down, etc.

6.2.2.3 Air Transportability

NOTE: Air transport will be performed by TOE type units or personnel of appropriate airborne MOS.

a. Subject the fully packaged test item to the applicable procedures of MTP 7-3-515.

b. At the completion of each phase of testing visually inspect the test item and record any damage incurred, if any, and the cause of damage.

6.2.3 Maintenance

Evaluate the maintenance-related factors of the test item as described in MTP 6-3-524 with emphasis on the following:

a. Organization (O), Direct Support (F), and General Support (H) Maintenance requirements.
b. Operator through General Support Maintenance Literature.
c. Repair parts.
d. Tools.
e. Test and handling equipment.
f. Calibration and maintenance facilities.
g. Personnel skill requirements.
h. Maintainability.
i. Reliability.
j. Availability.

6.2.4 Durability

Determine the durability of the test item by subjecting it to the applicable procedures of MTP 6-3-506.

6.2.5 Safety

Determine the safety characteristics of the test item by performing the applicable procedures of MTP 6-3-523 and the following:

a. Service personnel will observe all safety precautions listed in the technical manual and make appropriate suggestions to improve these precautions.
b. Throughout the test, observe hazards to personnel resulting from inherent design features and from use during mission operations.

6.2.6 Human Factors Evaluation

Determine the effectiveness and characteristics of the man-item interaction as related to human factors and revealed during the conduct of all tests by performing the applicable procedures of MTP 6-3-525 and the following:

a. Prepare man/item task checklists to assist personnel in evaluating the man/item performance using the criteria of Human Factors Evaluation Data for General Equipment (HEDGE) ClassIV-A equipment and including the following considerations:

1) Assemble/disassemble and locate:

a) Unstow/restow
b) Assemble, connect, emplace

2) Prepare for use:

a) Align, calibrate, adjust
b) Check out

3) Utilization:

a) Activate test item
b) Receive information

b. Evaluation of the tasks of step a shall include but not be limited to the following:

1) Adequacy of instructions and tools to perform the task
2) Mental and physical effort required
3) Design of the test item as it affects the task
4) Time required to perform the task
5) Personnel required for task

6.2.7 Value Analysis

Throughout the test, the test item shall be examined for any unnecessary, costly, or "nice-to-have" features as described in USATECOM Regulation 700-1.

a. During the operation of the test observe features which could be eliminated without compromising performance, reliability, durability, or safety.

b. Informally question test personnel for features of the test item that may be eliminated without descreasing the functional value of the test item.

c. Record the following:

1) Non-functional, costly, or "nice-to-have" features on the test item.
2) Test personnel's comments.

6.2.8 Quality Assurance

Determine the quality of the test item as described in the applicable sections of MTP 10-3-511.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Inspection

6.3.1.1.1 Arrival Inspection -

Record data collected as described in the applicable sections of MTP 6-3-501 and the following:

a. For the test item package:

1) All identification markings
2) Evidence of damage

b. For unpacking operations:

1) Equipment required
2) Time required
3) Personnel required
4) Methods and materials used to package the test item

c. For the test item:

1) All identification markings.
2) List of accompanying printed material and any instances of disagreement with the test item markings.

d. Retain all photographs

6.3.1.1.2 Inventory Check -

Record any deficiencies or shortages in the material listed in the Basic Issue Item List (BILL).

6.3.1.1.3 Physical Characteristics -

Record the physical characteristics of the loudspeaker in accordance with the applicable sections of MTP 6-3-500 and the following:

a. Rated power capacity in watts
b. Rated input impedance at 1 kc, in ohms
c. For the enclosure (if enclosed):

1) Construction material
2) Acoustic type (i.e. bass reflex, folded horn)

d. Type (i.e. permanent magnet, dynamic)
e. Frequency response specifications
f. Other distinguishing characteristics

6.3.1.1.4 Pre-Operational Inspection -

Record the following:

a. Damages
b. Defects
c. Missing components
d. Other (describe)

6.3.1.2 Test Item Installation

Record the following:

a. Personnel required
b. Tools required
c. Materials required
d. Time, in minutes, to mount speaker in enclosure
e. Difficulties experienced and suggestions for improvement

6.3.1.3 Pre-Operational Functional Check

Record the following:

a. Voice coil DC resistance, in ohms

b. For all deficiencies in equipment operation:

1) Statement or description of deficiency
2) Action taken
3) Time, in days and hours, to perform action taken

6.3.1.4 Operator Training and Familiarization

Record pertinent data collected as described in the applicable sections of MTP 6-3-502 and the following:

a. Rank
b. Training time, in MOS, in months
c. Experience, in MOS, in months
d. MOS

6.3.2 Test Conduct

6.3.2.1 Operational Performance

6.3.2.1.1 Preparations for Test -

Record the following:

a. For the program material source used during test conduct:

1) Type of program material
2) Type of physical reproduction source used:

a) Name
b) Model number
c) Serial number
d) Other identification

b. For the amplifier used during test conduct:

1) Name
2) Model number
3) Serial number

c. Test conduct area description:

1) For essentially free field or outdoors.

a) Low, medium, or high ambient noise level
b) Weather conditions (e.g. windy, raining, etc.)

2) For indoors:

a) Estimate of room dimensions, in feet.
b) Description of walls and ceilings (e.g. painted plaster, acoustic tile, etc.).

6.3.2.1.2 Test Conduct -

a. Record the following mission information:

1) Type of mission
2) Environmental conditions including:

a) Ambient temperature in °F
b) Humidity in percent

3) Hazards the mission presents to the speaker
4) Demands or requirements the mission makes on the speaker:

a) Volume
b) Sound quality
c) Size
d) Other

b. Evidences of annoying disturbances such as the following:

1) Garble
2) Hiss
3) Rattles or other spurious sounds

c. Evidences of unrealistic reproduction:

1) Degree to which reproduced program material simulates the original.
2) Type of program material used for evaluation.

d. Sound quality data:

1) For high pitch reproduction

a) Degree of clarity
b) Evidences of "break-up" or dispersion
c) Evidences of strident or harsh reproduction

2) For low pitch reproduction:

a) Evidences of bass boom
b) "Noises" induced by low pitch reproduction

3) For speech reproduction:

a) Degree of clarity of enunciation
b) Degree of intelligibility
c) Evidences of indistinct consonants:

(1) "Popping" p's
(2) "Hissing" s's

(3) Indistinct b's or p's
(4) Other

e. Sound Distribution:

1) For changes in sound in the horizontal plane:

a) Description of change in quality
b) Estimated position at which change occurs

2) For changes in sound in a vertical plane:

a) Description of change in quality
b) Estimated height at which change occurs

f. Sound quality changes due to volume increase
g. For tone control adjustments:

1) Tone control position.
2) Sound quality changes due to change in tone control position.

h. Number of operating hours accumulated

6.3.2.1.3 Securing -

Record the following:

a. Ease of loading and securing
b. Time required to load and secure for transport

6.3.2.2 Transportability Test

6.3.2.2.1 Preparation for Test -

Record the following:

a. Organization/Unit.
b. Type, size, and serial number of loudspeaker.
c. Type of container used for packing.
d. Dimensions of container, in inches.
e. Weight of container, in lbs.
f. Time required to disassemble test item for packing, in minutes, if applicable.
g. Degree of disassembly required.
h. Time required to pack item, in minutes.
i. Method of packing.
j. Gross weight, in pounds of packing container plus test item.

6.3.2.2.2 Surface Transportability -

Record data collected as described in the applicable sections of MTP 6-3-510 and the following:

a. Mode of transport
b. Mileage or time of travel
c. Damage incurred and cause of damage, if known

6.3.2.2.3 Air Transportability -

Record the following:

a. Data collected as described in the applicable sections of MTP 7-3-515.
b. Damage incurred and causes of damage, if known.

6.3.2.3 Maintenance

Record data collected as described in the applicable sections of MTP 6-3-524.

6.3.2.4 Durability

Record data collected as described in the applicable sections of MTP 6-3-506.

6.3.2.5 Safety

Record data collected as described in the applicable sections of MTP 6-3-523 and the following:

a. Suggested improvements to safety precautions
b. Inherent safety hazards in the design of the test item

6.3.2.6 Human Factors Evaluation

a. Record data collected as described in the applicable sections of MTP 6-3-525.
b. Retain completed HEDGE checklists.

6.3.2.7 Value Analysis

Record the following:

a. Non-functional, costly, or "nice-to-have" features
b. Test personnel's comments

6.3.2.8 Quality Assurance

Record data collected as described in the applicable sections of MTP 10-3-511.

6.4 DATA REDUCTION AND PRESENTATION

All data will be summarized using tabulations and/or charts as applicable. The data will be analyzed to determine the extent that the test item and maintenance package meet the requirements of the QMR's, SDR's and detail specifications of the test item.

Photographs will be properly identified.

Issue a Safety Confirmation in accordance with USATECOM Regulation 385-6.