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Materiel Test Procedure 6-2-245
Electronic Proving Ground

U. S. ARMY AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

RECORDING AND REPRODUCING EQUIPMENT, TAPE

1. OBJECTIVE

The objective of this materiel test procedure (MTP) is to present test methods for use in evaluating the performance of tape recording and reproducing equipment.

2. BACKGROUND

The recording of electrical signals in analog form on magnetic tape has presented a completely new tool for the purpose of data storage. It represents an extremely convenient electrical memory requiring no processing between recordings and reproduction. The record may be reproduced thousands of times for detailed analysis and may easily be edited to condense large volumes of information into the most significant and useful form. The time scale of an event or succession of events may be varied over a wide range, making possible the application of analysis instruments and techniques normally not usable. The fact that the tape can easily be erased and reused increases its value.

3. REQUIRED EQUIPMENT

- a. Audio oscillator with stable output from 30 Hz to 20 kHz
- b. Stop watch
- c. A-C vacuum tube voltmeter
- d. Distortion analyzer
- e. Oscilloscope
- f. Alignment tapes
- g. Earphones and speaker for aural monitoring
- h. Flutter bridge
- i. Testing facilities

4. REFERENCES

- A. Davies, G. L., Magnetic Tape Instrumentation, McGraw Hill, New York, 1961.
- B. Terman, F. E., and Petit, J. M., Electronic Measurements, McGraw Hill, New York, 1952.
- C. Bartholomew, D., Electrical Measurements and Instrumentation, Allyn and Bacon, 1963.

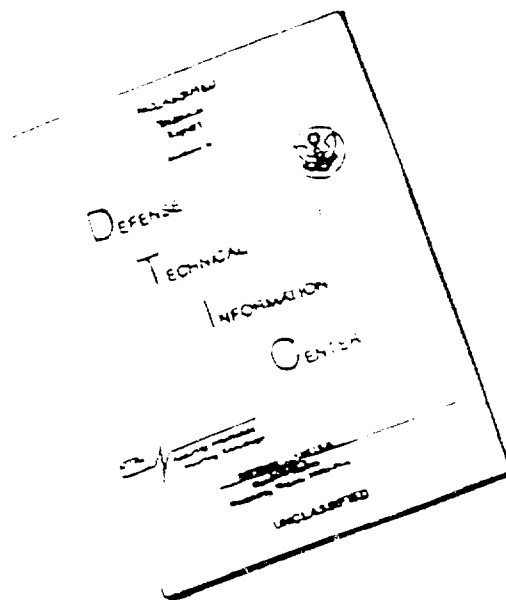
5. SCOPE

5.1 SUMMARY

The tests required to determine and evaluate the technical characteristics and performance are as follows:

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- a. Electrical Power Requirements - The objective of this subtest is as indicated in MTP 6-2-514.
- b. Frequency Response - The objective of this subtest is to determine the system's response to varied input signal frequencies. Signal input and output voltages and frequency measurements will be included in this test.
- c. Reproducibility (Playback) Response - The objective of this subtest is to determine playback response of the test item.
- d. Distortion - The objective of this subtest is to determine the amount of distortion introduced by the test item.
- e. Flutter and Wow - The objective of this subtest is to determine the flutter and wow of the test item.
- f. Signal-to-Noise Ratio - The objective of this subtest is to determine the signal-to-noise ratio, and the erase characteristics of the test item.
- g. Tape Running Time - The objective of this subtest is to determine the running time of the tape used in the test item.
- h. Calibration-Indicator Characteristics - The objective of this subtest is to determine the input frequency at which the calibration meter provides peak indication, and the input voltage at which the calibration meter provides midpoint indication.

5.2 LIMITATIONS

This MTP is limited in scope to magnetic tape recording and reproduction equipment operating in the audio frequency range only.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Item and Test Equipment Records

The following information shall be recorded:

- a. Nomenclature, serial number(s), manufacturer's name, and function of item under test
- b. Nomenclature, serial number(s), accuracy tolerances, calibration requirements, and last time of calibration of the electronic test equipment.

6.1.2 Knowledge of Technical Requirements

Test personnel shall be familiar with the required technical and operational characteristics of the item under test, as described in applicable QMR's, SDR's, and TC's.

6.1.3 Instructional Material

Instructional material issued with the test item by the manufacturer, contractor, or government shall be readily available for reference by test

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personnel. Test personnel shall be familiar with the contents of such documents prior to start of tests.

6.1.4 Inspection of Equipment

Before commencement of tests, the test item shall be thoroughly inspected for obvious physical and electrical defects such as cracked or broken parts, loose connections, bare or broken wires, loose assemblies, bent fragile parts, and corroded plugs and jacks. All defects shall be noted and corrected before proceeding with the tests.

6.1.5 Preparation of Test Equipment

Connect the test equipment to the test item as shown in figure 1.

6.2 TEST CONDUCT

The following tests shall be conducted according to the general procedures contained in this MTP. Modifications of these procedures shall be made as required by specific pertinent criteria, the particular design of the test item, and availability of test equipment. Care shall be taken to ensure that modified procedures will not degrade the validity of the test results.

6.2.1 Electrical Power Requirements

This subtest shall be conducted as indicated in MTP 6-2-514.

6.2.2 Frequency Response

NOTE 1: Frequency response is the variation of voltage gain and phase-shift plotted as a function of the frequency of the applied signal. Smooth frequency response in the range of 30 to 15,000 Hz is desirable in audio recording and reproducing equipment. Frequency response may deteriorate with age, use, or mishap. Figure 2 shows a typical frequency response curve.

NOTE 2: Test signals shall be recorded at least 20 db below the maximum level shown by the record level indicator in order to avoid saturating the tape at high frequencies due to the large amount of treble boost in the record amplifier. The test frequencies to be used in the following test are 30, 50, 100, 200, 500, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000, 11000, 12000, 13000, 14000, 15000 HZ.

- a. Apply and record the first test frequency to the audio oscillator.
- b. Measure and record the playback of the recording and reproducing equipment as indicated on the VTVM.
- c. Measure and record the output of the audio oscillator as indicated on the VTVM.
- d. Repeat steps a, b, and c, with each of the test frequencies throughout the entire audio range.

- c. Measure and record the output of the audio oscillator as indicated on the VTVM.
- d. Repeat steps s, b, and c with each of the test frequencies throughout the entire audio range.

NOTE: There are sometimes significant peaks in the treble region and there is greater chance of disclosing such a peak by using additional treble test frequencies, such as 6,500, 7,500, 8,500, 9,500, 10,500, 11,500, and 12,500 Hz.

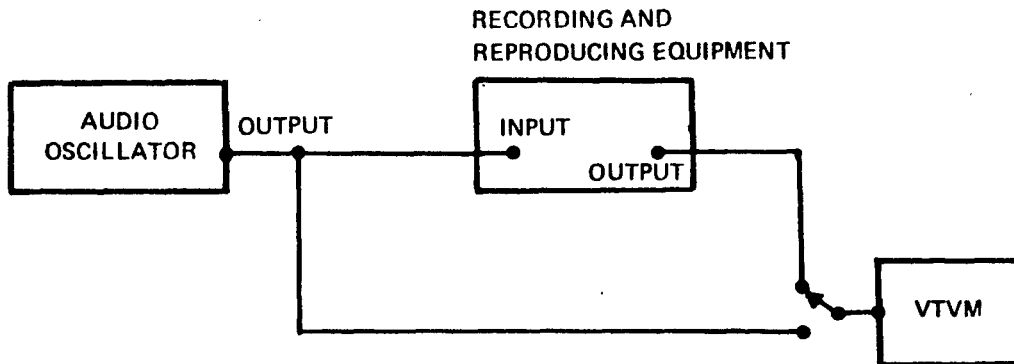


Figure 1. Frequency Response Test Equipment Setup

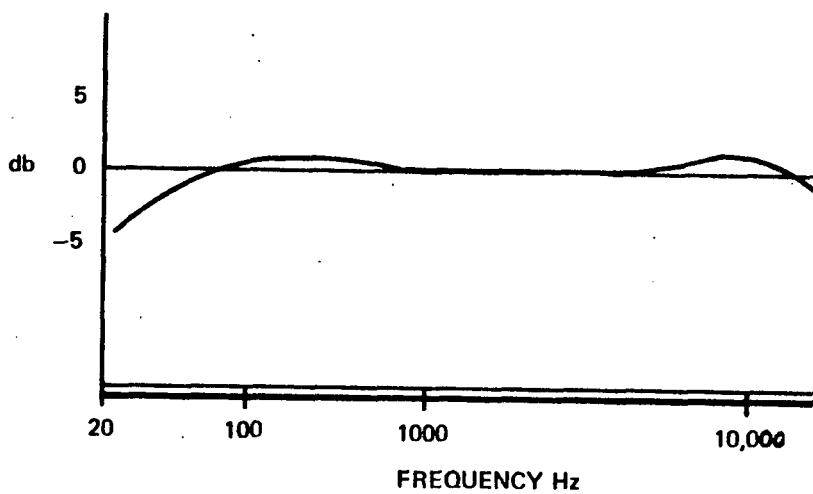


Figure 2. Typical Response Curve

6.2.3 Reproducibility (Playback) Response Tests

It is possible for the record-playback response to be flat without playback equalization being satisfactory for prerecorded tapes. If prerecorded tapes are to be played in the recording and reproducing equipment it is necessary to ensure that the playback response is reasonably correct.

If the recording and reproducing equipment contains tone controls, it is better to measure the output signal in the circuit before it reaches these controls. It is also a good procedure to measure playback response after it has passed through these controls and at various settings to ascertain the position yielding the flattest response. The best method of checking playback response is to use a test tape containing various test frequencies with voiced announcements of each frequency.

- a. Connect a VTVM to the output of the item under test.
- b. Turn the recorder-reproducer on and observe and record the VTVM readings for each test frequency on the test tape.
- c. Repeat step b with various settings of the tone controls and record each setting.
- d. Observe the VTVM and determine the tone control position that yields the flattest response.

NOTE: Steps c and d can be deleted if the item under test does not have tone controls.

6.2.4 Distortion

Harmonic distortion is ordinarily cited in tape recording and reproducing equipment specifications. To measure the distortion of the item under test, a relatively low frequency in the vicinity of 400 Hz is desirable in order to include a substantial number of harmonics. This signal is fed into the recorder and the playback signal is measured with a distortion meter for distortion content.

The distortion test must have reference to the maximum permissible recording level as indicated by the record level indicator. The output of the distortion meter is a direct measure of the distortion.

- a. Connect the test equipment as shown in Figure 3.
- b. Apply a 400 Hz input signal to the recorder reproducer.
- c. Observe and record the output signal as indicated on the distortion meter.

6.2.5 Flutter and Wow

Flutter and wow are produced by periodic irregularities in the tape speed and appear as frequency deviations in recording or reproduction. Flutter and wow are measured by means of calibrated flutter test tapes for the item under test, and a standard flutter bridge.

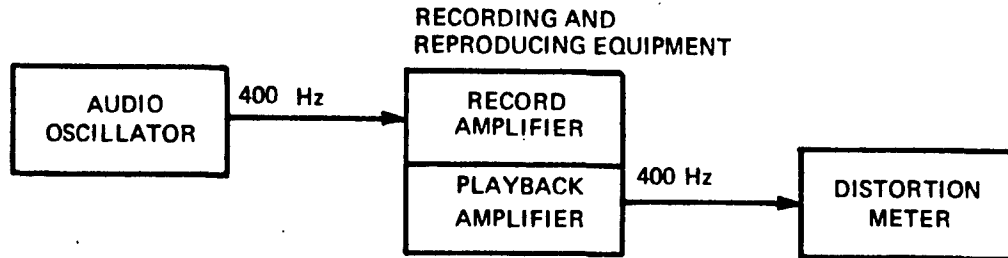


Figure 3. Use of Distortion Meter

The flutter test tapes consist of a 3,000 Hz tone with 0.03 percent or less flutter, which is reproduced on the item under test. The output of the flutter bridge is a direct measure of the flutter. The flutter bridge has a null at a specific frequency, the null point is adjusted to the frequency of the recorded tone. If the speeds were exactly the same in reproduction as in recording, and uniform, the reproduced signal would be completely eliminated by the bridge. Any variation in the average or instantaneous frequency of the reproduced tone will result in a bridge output which is proportional to the deviation from the original recorded frequency and hence a measurement of average speed change and flutter. The d-c component of the bridge output represents average speed change, while the a-c component represents flutter. The frequency of the recorded tone must be 5 to 10 times the maximum flutter frequency to be measured. For measurements of audio equipment, a tone of 3,000 Hz is generally used and all components up to 300 Hz measured.

- a. Connect the test equipment as shown in Figure 4.
- b. Emplace a test tape with a 3,000 Hz tone on the recorder-reproducer.
- c. Adjust the flutter bridge null to the 3,000 Hz tone frequency.
- d. Measure and record the variations as indicated on the flutter

bridge.

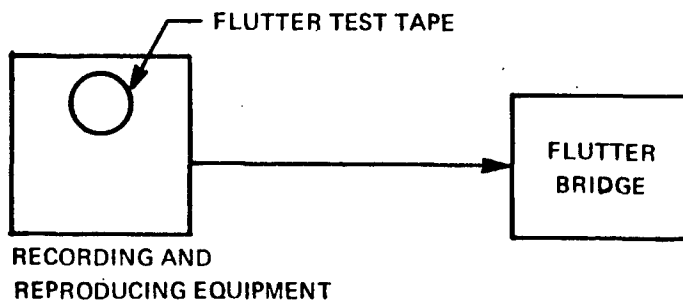


Figure 4. Distortion Measurement

6.2.6 Signal-to-Noise Ratio

Signal-to-noise ratio is measured on the basis of maximum permissible recording level as denoted by the record level indicator. If the tape is recorded at an excessively high level (enough to cause distortion), the erase characteristics will be poor. Care must be taken not to exceed the maximum recording permissible level. Typically for audio recording and reproducing equipment, a 3 percent harmonic distortion is considered the maximum permissible level. A specific frequency is recorded and the playback signal is measured on a VTVM. At the same speed the tape is then erased and the playback signal due to noise and hum of the equipment, tape hiss, imperfect erasure of the erase head, and noise caused by bias waveform distortion, is again measured on the VTVM. The ratio of the first playback signal (with audio input) is the signal-to-noise ratio.

- a. Connect an audio oscillator to the input of the item under test as shown in Figure 3.
- b. Connect a VTVM to the output of the item under test as shown in Figure 1.
- c. Emplace a reel of unrecorded tape on the recorder-reproducer under test and adjust the recording level on the recorder-reproducer to the maximum permissible level.
- c. Apply to the recorder-reproducer a specific frequency between 250 Hz and 1000 Hz from the audio oscillator and record the audio frequency.
- e. Play back the audio frequency and measure the playback signal with the VTVM.
- f. Rewind the tape and erase the audio signal.
- g. Rewind the tape and measure and record the output signal as indicated on the VTVM.

6.2.7 Tape Running Time

Tape running time depends on reel size, tape thickness, and tape speed of the recording and reproducing equipment. Tape is separated into three categories: standard-play, long-play, and double-play, according to thickness.

- a. Emplace a tape of known size and thickness on the recording-reproducer under test.
- b. Set the recorder-reproducer at a particular tape speed.
- c. Using a stop watch record the start and stop time of the recorder-reproducer.
- d. Compare running time to that given in Table I, below.
- e. Repeat steps b and d for various tape speeds, if the recorder-reproducer has tape speed settings.

Tape Speed ips	KIND OF TAPE		
	STANDARD-PLAY	LONG-PLAY	DOUBLE-PLAY
1.875	2 hrs, 8 min	3 hrs, 12 min	4 hrs, 16 min
3.75	1 hr, 4 min	1 hr, 36 min	2 hrs, 8 min
7.5	32 min	48 min	1 hr, 4 min
15.	16 min	24 min	32 min

Table I.

- NOTE:
1. For a 10 inch reel, double all playing time
 2. For a 5 inch reel, divide all playing time by two
 3. For a tape operated in two directions double all play times
 4. For 4-track mono operation, quadruple all playing times.

6.2.8 Calibration-Indicator Characteristics

The purpose of this subtest is to determine the input frequency at which the VTVM provides peak indication and the input voltage level at which the VTVM provides midpoint indication. The input frequency is adjusted to produce peak indication on the VTVM at this input frequency. The input voltage is adjusted to provide a midpoint indication on the VTVM.

- a. Connect the test equipment as shown in Figure 1.
- b. Adjust the input frequency to produce a peak indication on the VTVM and record the frequency.
- c. At the recorded frequency, adjust the input voltage to produce a midpoint indication on the VTVM and record the voltage.

6.3 TEST DATA

6.3.1 Electrical Power Requirements

Data shall be collected and recorded as described in MTP 6-2-514.

6.3.2 Frequency Response Tests

- a. Record each audio test frequency.
- b. Record audio oscillator voltage output for each test frequency.
- c. Record playback VTVM reading for each audio frequency.
- d. Record playback signal frequency for each test frequency.

6.3.3 Reproducibility (Playback) Response Test

- a. Record each test frequency of the test tape.
- b. Record playback VTVM reading for each test frequency.

6.3.4 Distortion Tests

- a. Record the input signal from the audio oscillator.
- b. Record the output signal at the distortion meter.
- c. Record the distortion meter readings.

6.3.4 Flutter and Wow Tests

- a. Record audio tone of flutter test tape.
- b. Record the flutter bridge reading.

6.3.5 Signal-to-Noise Ratio Tests

- a. Record the input signal from the audio oscillator.
- b. Record VTVM reading with audio input.
- c. Record VTVM reading without audio input.

6.3.6 Tape Running Time Tests

- a. Record tape reel size and tape thickness
- b. Record recorder-reproducer tape speed setting.
- c. Record total running time.

6.3.7 Calibration-Indicator Characteristics

- a. Record input frequency for peak indication on VTVM.
- b. Record input voltage for midpoint indication on VTVM.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Electrical Power Requirements

Data shall be reduced and presented as described in MTP 6-2-514.

6.4.2 Frequency Response

- a. A curve of the frequency response shall be plotted similar to the one shown in Figure 2.
- b. The frequency response of the item under test shall be presented.
- c. A comparison of the data from a and b with applicable criteria shall be presented.

6.4.3 Reproducibility (Playback) Response Tests

- a. Present the playback VTVM reading for each test frequency.
- b. Present a comparison of the results of those tests with applicable criteria.

6.4.4 Distortion Tests

- a. Present the distortion meter meter readings.
- b. Present a comparison of the results of distortion tests with applicable criteria.

6.4.5 Flutter and Wow Tests

Present a comparison of the results of flutter and wow tests with applicable criteria.

6.4.6 Signal-to-Noise Ratio Tests

- a. Present the signal-to-noise ratio of the first playback signal (with audio input) to the second signal (without audio input).
- b. Present a comparison of the signal-to-noise ratio with applicable criteria.

6.4.7 Tape Running Time Tests

Present a comparison of the measured tape running time with the standard time shown in Table I.

6.4.8 Calibration-Indicator Characteristics

Present the input frequency at which the VTVM provides peak indication and the input voltage level at which the VTVM provides midpoint indication.