A STUDY OF AUDIO TAPE: PART II

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EDITOR'S NOTE: Noel K. Reen recently (1975) studied and compared the common data base for several common brands of audiotape in cassette and reel format. Variables considered for cassettes included signal-to-noise ratio, harmonic distortion, dynamic response, frequency response, bias and virgin noise, and oxide coating uniformity.

Part I of the report, dealing with cassette tapes, appeared in the Summer 1975 issue of the *NALLD JOURNAL*. The report herein reveals similar information for reel tapes.

REEL TAPE

APPARATUS AND TEST PROCEDURES

For reel tests, tapes were considered as similar in published characteristics, although some were listed as low noise, while others were described as low noise/high output types. For convenience, Scotch AV 17,-1200 was chosen as a comparison standard, and the test recorder bias and equalization were set to Standard for all tests. The correction factor of -7.4 Db., for impedence mismatch, is applied to all measurements.

TEST EQUIPMENT

1. Pioneer Model RT 1050 reel tape recorder.
2. General Radio Model 1523-P2 graphic level recorder with sweep oscillator.
3. Jeolco Model JSM-U3 Scanning Electron microscope.
4. General Radio Model 1932A distortion and noise analyzer.
5. Hewlett Packard Model 400L vacuum tube voltmeter.
6. General Radio Model 1310 sine wave oscillator.
7. General Radio Model 1192B electronic counter.
8. Model 1 dropout counter analyzer (Purdue Built)

TEST PROCEDURE

To evaluate reel audio tape, tests were performed to identify the following characteristics:

SIGNAL-TO-NOISE RATIO—The test procedure is the same as that for the cassette, with the exception of a change in test frequency to 1000 Hz *Table 3* lists the Biased Tape Noise. The results shown in Table 3 list the 3% THD level, Db. Table 3 shows the Signal-To-Noise Ratio for the tape tested. Table 4 defines the effect of changes in bias and equalization for three of the tapes tested.

TOTAL HARMONIC DISTORTION—Except for increasing the recording level to -10 Db., and using a 1000Hz test frequency, the test procedure is the same as for cassettes.

DYNAMIC RESPONSE—The test procedure is identical to that for the cassette, except for a change in test frequency to 1000 Hz. Results of the tests are shown in Table 3 as 3% THD, Db.

FREQUENCY RESPONSE—Other than increasing the recording level to - 10 Db., the test procedure is identical to that for the cassette. Response plots for all tapes appear in Figure 7 and 8. Effects of changes in bias and equalization are illustrated in Figure 9.

BIASED AND VIRGIN TAPE NOISE—The test procedure is identical to that for the cassette. Table 3 lists Biased Tape Noise and Virgin Tape Noise for tapes under test.

DROPOUT SUSCEPTABILITY—The test procedure is identical to that for the cassette.

OXIDE COATING UNIFORMITY—The test procedure is the same as for cassette tape.

SUMMARY OF RESULTS AND CONCLUSIONS

REEL TAPE

An evaluation of Table 1 shows variations in Signal-to-Noise Ratio of only 4 Db. for the tapes tested. Included in the tests were premium and standard tapes with all but two types having ferric oxide formulations. The Scotch Classic, and TDK Audua were described as having a composite ferric oxide-chromium dioxide formulation.

Signal-to-Noise Ratios, for three of the test tapes, were affected as test recorder bias and equalization were changed. Table 2 shows that for variations in bias and equalization, Signal-to-Noise Ratios degraded, due to a slight increase in biased tape noise level. Conversely, the three tapes showed slightly improved 3% Total Harmonic Distortion levels, or headroom.

Total Harmonic Distortion data could not be obtained due to failure of the Distortion and Noise Analyzer. Only commercial testing lab data was available for the test recorder which showed less than 1%

Dynamic Response for the test tapes is shown in Table 1. It is seen that the variation does not exceed 4 Db. It is noteworthy that four test samples had improved performance exceeding 12.6 Db. at the test frequency. Had time permitted the measurement of Dynamic Response at several frequencies, the results would have been similar to that shown in Table 3 and Figure 1.

Frequency Response Characteristics for the test tapes, the test recorder, and the sweep oscillator are shown in Figure 2 and 3. The vertical scale factor for all response plots is 5 Db. per major division with all curves originating at 20 HZ. The relative position of each curve, from O Db., is indicative of tape sensitivity as the record level was continuously monitored at -10 Db. to avoid tape saturation and the resulting distortion.

Frequency Response is dramatically changed when bias and equalization of the test recorder are varied, and Figure 4 shows these variations for three types of tape.

The Scotch AV176 was arbitrarily chosen as the reference tape. The response curve for this tape shows the typical rising high frequency response of a low noise tape played on a recorder biased and equalized for standard tape. It can be seen that the response curves for the reference tape is slightly different in each plot, evidence of oxide non-uniformity over the length of the tape.

Figure 2 shows two tapes which exhibited erratic Frequency Responses. The curves represent two different reels of the same type of tape, showing aberrations up to 2 Db. Scanning electron micrographs of one of the tapes showed the probable cause to be holes in the oxide coating along with numerous piles of oxide on the tape surface.

Biased Tape Noise, on an average, is about 22 Db. greater than Virgin Tape Noise, as seen in Table 3. An average Biased Tape Noise figure for the tested tapes is 4.6 Db., while variation from tape is not more than 0.7 Db.

Virgin Tape Noise, the base figure for all tape noise measurements, varied not more than 08 Db. with the average 66.6 Db.

Oxide Coating Uniformity of three tape samples was evaluated by obtaining micrographs from a scanning electron microscope equipped with an energy dispersive x-ray detector.

Frequency response tests revealed two tapes with large aberrations in response level. These tapes were compared to the reference tape and one additional tape. Results of the microscope scan showed the offending tape to have much coarser grain than either of the other two tapes. At higher magnifications holes in the oxide layer were seen along with numerous piles of oxide on the tape surface. High magnification showing oxide particle forms could not be obtained, apparently due to a lubricant coating over the surface of the oxide. Even though several samples were vapor coated to improve conduction, the electron beam could not penetrate the lubricant coating and get down to the oxide particle layer.

At a later date, additional experimentation and refinement of techniques may permit micrographs of oxide particles on each of the test tapes.

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TABLE 1

Virgin and Biased Tape Noise, 3% THD., and Signal-to-Noise Ratio

TABLE 2

Virgin and Biased Tape Noice, 3% THD., and Signal-to-Noise Ratio with Varying Bias and Equalization

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TABLE 1
Virgin and Biased Tape Noise, 3% THD, and Signal-to-Noise Ratio

TAPE TYPE	VIRGIN NOISE, Db. re 1mw/600 ohm	BIASED TAPE NOISE, Db. re 1mw/600 ohm	3% THD LEVEL, Db. 1000Hz, re 1mw/600 ohm	SIGNAL-TO-NOISE RATIO Db.
Scotch Av176	-66.6	-44.6	9.1	53.7
Sony PR150	-66.6	-44.7	10.4	55.1
Tracs Plus 1200	-66.4	-44.6	12.8	57.4
Capitol #1	-66.9	-44.6	9.4	54.0
Scotch 228	-67.2	-44.6	10.8	55.4
Sony PR200	-66.9	-44.6	10.6	55.2
Capitol Music Tape 1800	-66.4	-44.9	12.4	57.3
Capitol Music Tape 1200	-66.4	-44.8	12.6	57.4
Scotch 208	-66.6	-44.6	10.9	55.5
Maxell LNE 35-7	-66.6	-44.6	10.8	55.4
Maxell UD 50-7	-66.4	-14.6	13.1	57.7
Memorex 1200	-66.4	-44.6	11.1	55.7
Sony SLH 180	-66.6	-44.2	11.4	55.6
Scotch Classic 1200	-66.6	-44.9	12.6	57.5
TDK Audua 1200	-66.6	-44.6	12.4	57.0
Scotch 206	-66.6	-44.9	12.2	57.1

TABLE 2
Virgin and Biased Tape Noise, 3% THD., and Signal-to-Noise Ratio with Varying Bias and Equalization

Scotch 206	-66.9	-44.4	12.6	LH 1	LH	57.0
Scotch 206	-66.6	-41.9	12.8	LH 2	STD	54.0
Scotch 206	-66.6	-44.9	12.2	STD	STD	57.1
Maxell LNE 35-7	-67.4	-42.7	11.1	LH2	LH	53.8
Maxell UD 50-7	-66.4	-43.6	12.6	LH1	LH	56.2
Maxell UD 50-7	-66.4	-43.6	12.7	LH1	STD	56.3

TABLE 3
Total Harmonic Distortion, Test Oscillator and Test Recorder

EQUIPMENT	333Hz	1KHz	2KHz	4KHz	8KHz	10KHz	12KHz	14KHz	16KHz	AVG.
General Radio Mod. 1310 Oscillator (ODB.)	.110	.105	.110	.095	.130	.130	.128	.130	.140	.119
Nakamichi Mod. 700 Recorder (-20Db.)	.038	.028	.020	.015	.020	.020	.020	.010	.020	.019

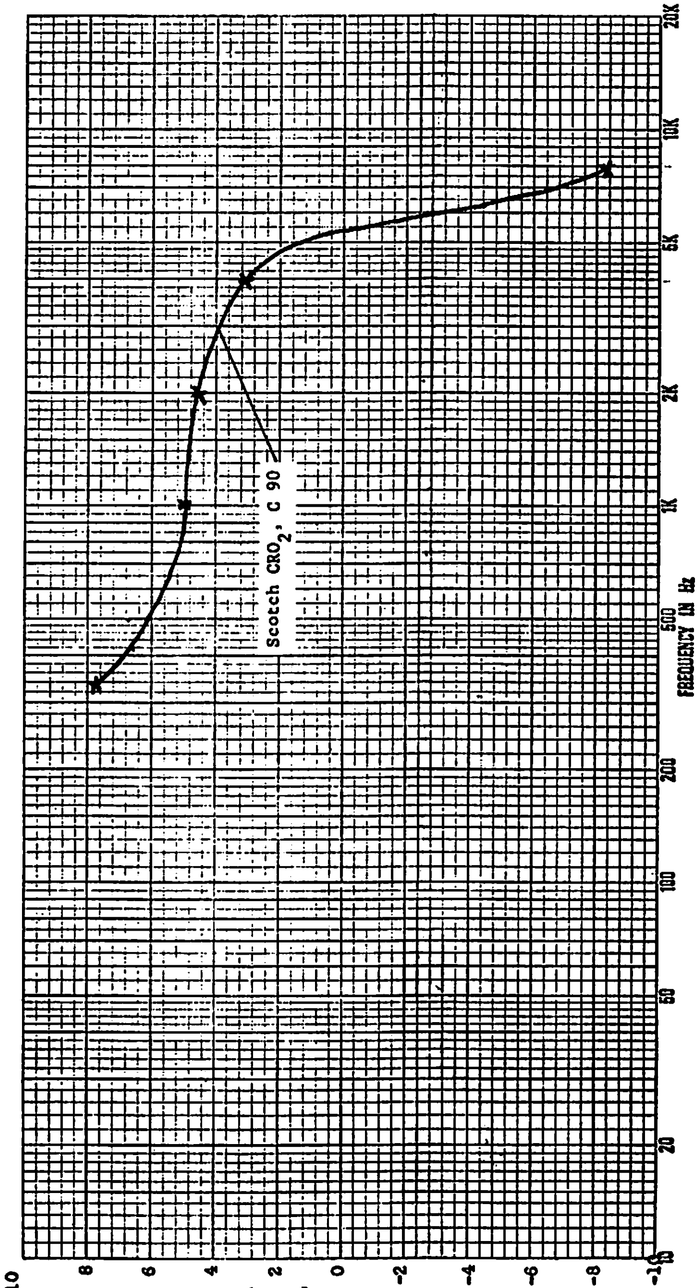

FIGURE 1
Dynamic Response Vs. Frequency

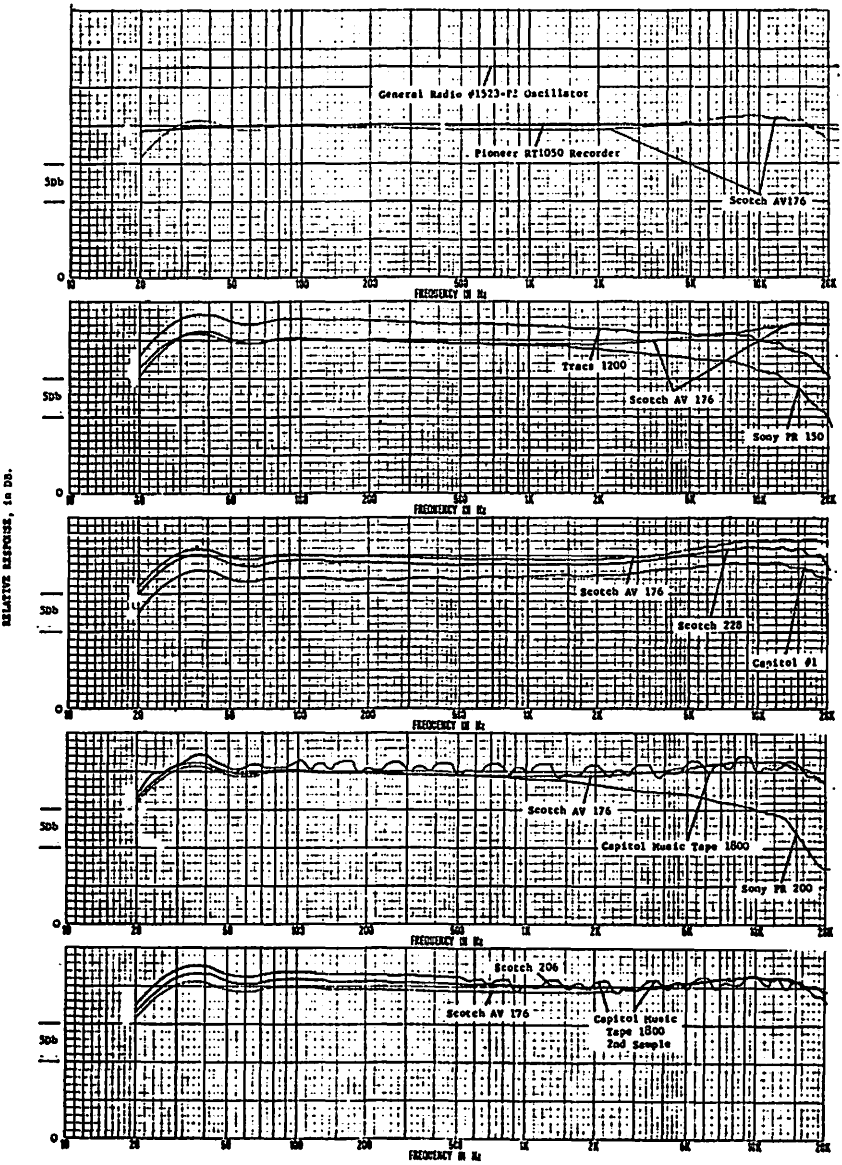

FIGURE 2
FRENQUENCY RESPONSE, REEL TAPE

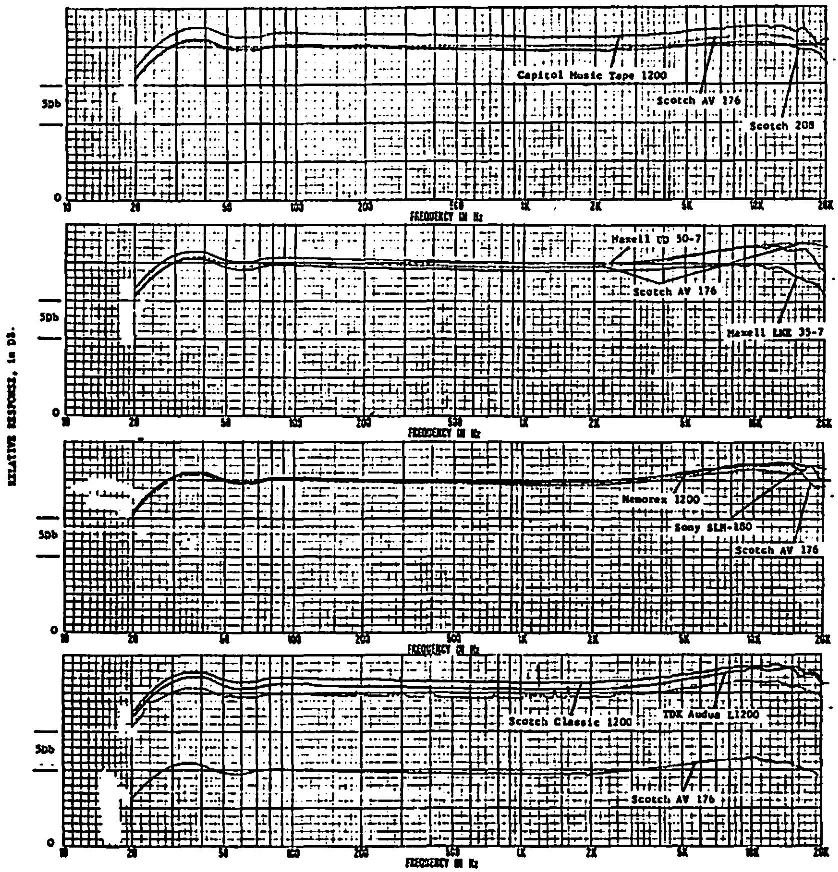

FIGURE 3
FREQUENCY RESPONSE, REEL TAPE

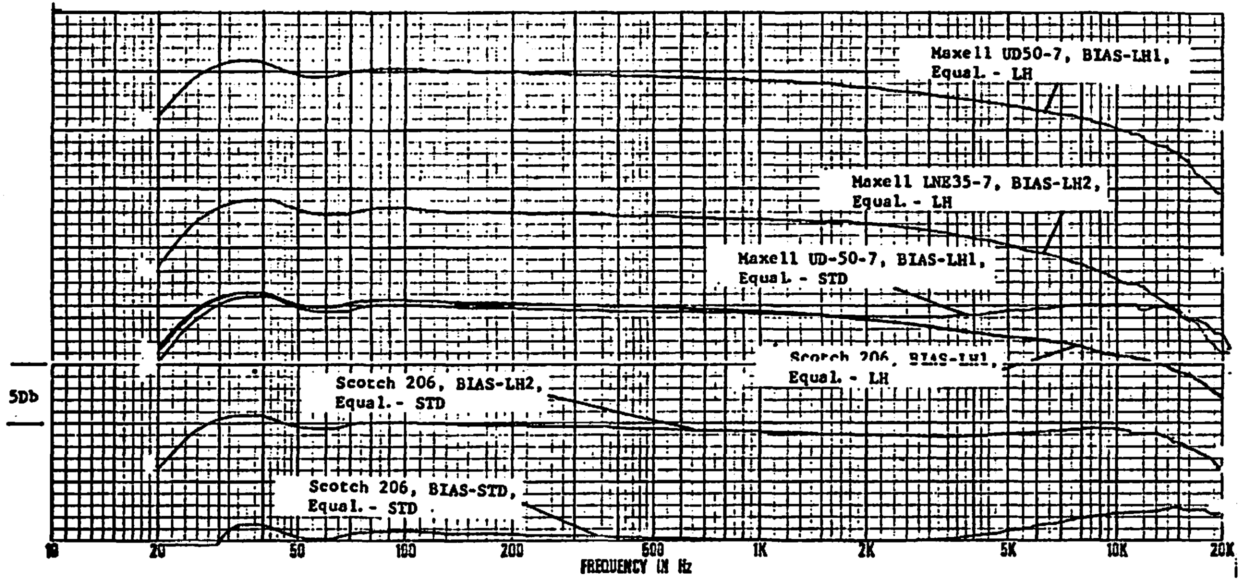

FIGURE 4
FREQUENCY RESPONSE VARIATIONS WITH CHANGES IN BIAS AND EQUALIZATION