

NAB AUDIO
RECORDING AND REPRODUCING
STANDARDS FOR
AUDIO CASSETTE TAPE SYSTEMS

The NAB Recording and Reproducing Standards Committee was originally organized in 1941. Standards proposals issuing from the Committee have been adopted by the Board of Directors in 1942, 1949, 1950, 1953, 1964 and 1965. The Standards contained herein were adopted by the Board on June 16, 1972.

These standards and recommended good engineering practices are for the guidance of the broadcasting industry, and represent the contributions of many of the nation's authorities on the various phases of recording as used by the industry. The NAB Recording and Reproducing Standards Committee has also benefited by contributions made by several international organizations. The committee was open to participation by any interested individual or organization and consisted of representatives from the manufacturers, broadcasters and producers. Close liaison was maintained with other organizations (as well as foreign countries) to insure the maximum degree of coordinated understanding and recommended standardization, to permit interchangeability and, at the same time, to embrace the latest technological advances of the art.

Nothing in these standards prohibits or discourages continued progress or advancement of the art. On the contrary, the standards are intended to provide stimulus for continued scientific exploration in the field of recording. It is anticipated that when new techniques and developments are evident the NAB Recording and Reproducing Standards Committee may request submissions thereon looking toward any needed amendments and additions to keep pace with the art as it affects all forms of AM, FM and TV broadcasting.

THE NATIONAL ASSOCIATION OF BROADCASTERS
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The following organizations contributed to the formulation of these standards:

Spotmaster, Silver Spring, Maryland
Sparta East Rockville, Maryland
Sono-Mag Corporation, Bloomington, Illinois
The Telex Corporation, Minneapolis, Minnesota
Radio Corporation of America, Camden, New Jersey
American Broadcasting Company, New York
Columbia Broadcasting System, New York
National Broadcasting Company, New York
Public Broadcasting Service, Washington, D.C.
Cybrix Corporation, Woodland Hills, California
International Tapetronics Corp. Bloomington, Illinois
Gates Radio Company, Quincy, Illinois
Tele-Tape Productions, New York
Nortronics Company, Inc., Minneapolis, Minnesota
Marathon Broadcast Equipment Sales Co., West Boylston, Mass.
Audio Devices, Inc. Glenbrook, Connecticut
Ampex Corporation, Redwood City, California
Philips Broadcast Equipment Corp., Montvale, New Jersey
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Conrac Corporation, Long Island City, New York

NAB AUDIO CASSETTE RECORDING AND REPRODUCING STANDARDS

I. MECHANICAL SPECIFICATIONS

1.05 Cassette Size

It shall be standard that there be a co-planar magnetic tape cassette physically identified and designed as shown in Figures A, B, and C, with a window area as specified in Figure C.

1.10 Tape Thickness

It shall be standard that the thickness of the magnetic tape for use in an NAB Audio Cassette be 800 micro inches (20.3 microns) maximum and 600 micro inches (15.2 microns) minimum.

1.15 Tape Width

It shall be standard that the magnetic tape and leaders for use in an NAB Audio Cassette be 0.150 ± 0.000 , -0.002 inches (3.81 mm ± 0 , -50.8 microns) wide.

1.20 Standard Tape For Measurements

The standard measurement tape shall be equivalent to 3M magnetic tape type #277. This is a 500 micro inch (12.7 microns) tensilized polyester backed tape with a 200 micro inch (5.1 microns) low noise oxide coating. The tape has a minimum yield strength of 1.5 pounds (.650 Kg) at 5% elongation under environmental test conditions. (see Section 1.80)

1.25 Tape Wind

It shall be standard that the magnetic tape be wound on both hubs within the cassette with the magnetic coating facing out from the hub and out of the cassette head openings and with the tape travel direction as specified in Figure D.

1.30 Tape Length Within Cassette

It shall be standard that an NAB Audio Cassette labeled as "NAB-300" contain 295 ± 5 feet (89.9 ± 1.52 meters) of splice free magnetic tape. The "NAB-150" cassette shall contain 150 ± 5 feet (45.7 ± 1.52 meters) of splice free magnetic tape.

1.35 Cassette Head Shield

It shall be standard that an NAB Audio Cassette contain a hum reducing magnetic shield behind the pressure pad as located in Figure D.

1.40 Pressure Pad¹

It shall be standard that an NAB Audio Cassette have a pressure pad which is located and sized as described in Figure D. The pressure the pad exerts on the record/play head, when placed in the cassette in accordance with Figure E, shall be 11.4 to 34.1 oz/in² (0.5 to 1.5 gm/mm²).

1.45 Cassette Torque

It shall be standard that the maximum friction torque of the full hub in the cassette be 0.28 oz in (20 gm cm). The maximum friction torque of both hubs measured in the cassette itself at the nearly full hub shall be 0.38 oz in (27 gm cm). With the holdback torque of 0.11 oz in (8 gm

¹ Record/play as used in these standards may be either a record head, a play head, or a combination record/play head.

cm) applied to the nearly empty hub, the required maximum torque to be applied to the nearly full hub shall not exceed 0.78 oz in (55 gm cm).

1.50 Cassette Leaders

1.150.01 It shall be standard that an NAB Audio Cassette have a leader on each end of the tape having a minimum light transmittance of 75 % and that the tape have a maximum light transmittance of 5% when using a light source having a color temperature of $2000 \pm 200^\circ \text{K}$ and using a silicon phototransistor for detection.

1.50.02 It shall be standard that the leader be 12 to 15 inches (30.48 to 38.10 cm) long with a typical thickness of 0.0015 inches (38.1 microns).

1.50.03 It shall be standard that the leaders not part from the hub with a force of 2.20 lbs (1000 grams) under operating environment.

1.50.04 It shall be standard that the leader-to-tape splice not separate with a force of 1.54 lbs (700 grams) under operating environment.

1.55 Tape Position and Travel Direction

It shall be standard that the magnetic tape position and travel direction in the cassette head openings correspond to Figure D.

1.60 Cassette Breakage

It shall be standard that an NAB Audio Cassette withstand 10 random drops of 12 inches (30.48 cm) onto concrete without causing functional damage.

1.65 Track Designation

It shall be standard that the track numbering be as shown in Figure G.

170. Cassette Support Planes

It shall be standard that the cassette be supported by the record/play instrument on only the cross hatched areas in Figure B designated as support planes.

1.75 Label

It shall be standard that the label be located on side one only and shall fit within the area defined in Figure C.

The label shall include the following:

Side 1 designation, manufacturer, NAB designation (NAB-150 or NAB-300 per paragraph 1.30) and a blank area for content identification.

1.80 Cassette Environmental Conditions

Test environmental conditions are $70 \pm 5^\circ \text{F}$ ($21 \pm 3^\circ \text{C}$) and $50 \pm 10\%$ relative humidity.

Operating environmental conditions shall be 20 to 125°F (-7 to $+52^\circ \text{C}$) and 5 to 85% relative humidity non-condensing.

Storage environmental conditions shall be a maximum of 125°F , minimum -40°F ($+52^\circ$, -40°C) and maximum 85% relative humidity. After a period of 24 hours storage at these extremes and then normalized at the test environment, the NAB cassette shall meet the NAB specification.

II. MECHANICAL SPECIFICATIONS FOR CASSETTE TRANSPORT

2.05 Transport Cassette Acceptance

It shall be standard that the transport accept the standard NAB Audio Cassette.

2.10 Tape Speeds

It shall be standard that the tape speeds be $1\frac{7}{8}$ and $3\frac{3}{4}$ ips $\pm 0.3\%$ (4.76 cm/s & 9.53 cm/s $\pm 0.3\%$).

2.15 Flutter and Wow

It shall be standard that the flutter and wow not exceed 0.2% NAB weighted rms in the play mode at either speed.

2.20 Tape Guides

It shall be standard that the tape guides have a width of 0.151 ± 0.001 inches (3.84mm \pm 25.4 microns) and be centered on the nominal centerline of the cassette within 0.010 inches (254 microns). Two guides shall be provided, one located each side of (but not necessarily adjacent to) the record/play head.

2.25 Head Configuration

It shall be standard that the magnetic record/play head be $\frac{1}{4}$ track 4 track in-line. The erase head shall be $\frac{1}{2}$ track $\frac{1}{4}$ track with $\frac{1}{2}$ track covering tracks 1 and 2 and with $\frac{1}{4}$ track covering track 3.

2.30 Head Track Dimensions

It shall be standard that the track dimensions of the magnetic record/play head be in conformity with the track dimensions shown in Figure F. (Track width is the effective track defined as the region of the common interface on the abutting pole pieces).

2.35 Head Penetration

It shall be standard that the head penetration be in accordance with Figure E.

2.40 Head Phasing and Azimuth

It shall be standard that the phasing between tracks 1 and 2 result in no more than 90° difference at 10 kHz when the head is adjusted within 1 db of peak azimuth at $1\frac{7}{8}$ ips (4.76 cm/s). The head may be adjusted for optimum within the phase and azimuth loss limits.

2.45 Head Zenith

It shall be standard that the head face be no more than 2° out of perpendicularity with respect to the cassette support planes.

2.50 Tape Wrap

It shall be standard that the tape wrap extend a minimum of 0.030 inches (762 microns) on each side of the head gap.

2.55 Spindle Take Up Torque

It shall be standard that the spindle take up torque during play or record mode be within 0.41 to 0.83 oz in (30 to 60 gm cm).

2.60 Fast Wind Torque

It shall be standard that the fast wind torque be within the range of 1.39 to 3.47 oz in (100 to 250 gm cm).

2.65 Fast Wind Times

It shall be standard that the minimum fast forward or rewind time of a machine be 30 seconds for an NAB 300 cassette.

2.70 Maximum Tape Tension

It shall be standard that the maximum tension exerted on the tape not exceed 1.32 lbs (600 gm) for any mode of operation.

2.75 Start-Stop Time

It shall be standard that the tape motion start and meet all applicable standards within 500 milliseconds. The tape motion shall stop within 50 milliseconds from play speed.

2.80 Cueing Accuracy

It shall be standard that the machine cue and stop within 75 milliseconds of the leading edge of the primary cue tone in the play mode.

III. SYSTEM ELECTRICAL SPECIFICATIONS²

3.05 Standard Operating Reference Levels

It shall be standard that the operating reference level be a recorded 400 Hz signal that produces an rms short circuit tape flux per unit track width of 200 nWb/m at $1\frac{7}{8}$ and $3\frac{3}{4}$ ips (4.76 and 9.53 cm/s) speeds. (This is approximately 3 to 4 dB below 3% third harmonic tape distortion).

3.10 Cue and Function Tone Recorded Level

It shall be standard that the cue and function tones be recorded at a level which produces an output 15dB below the standard operating reference level.

3.15 Playback Equalization Time Constants

It shall be standard that the higher frequency equalization time constant at $3\frac{3}{4}$ ips (9.53 cm/s) be 90 microseconds. The lower frequency equalization time constant shall be 3180 microseconds.

At $1\frac{7}{8}$ ips (4.76 cm/s) the higher frequency equalization time constant shall be 120 microseconds and the lower frequency equalization time constant shall be 1590 microseconds.

3.20 Signal-to-Noise Ratio (either audio channel)³

It shall be standard that at $3\frac{3}{4}$ ips (9.53 cm/s) the signal-to-noise ratio be not less than 48 dB weighted (NAB) below standard operating level (Reference Figure H).

At $1\frac{7}{8}$ ips (4.76 cm/s) it shall not be less than 45 dB.

The foregoing figures shall include residual noise contributed by machine erasing and biasing functions.

3.25 Frequency Response⁴

It shall be standard that the system response be within the limits shown in Figure I.

² All recordings to be made on bulk erased tape.

³ Weighted noise shall be measured using the weighting curve of figure H in the measuring circuit. This curve is based on the ASA "A" curve (ASA Standard S1.4-1961). The noise measurement shall be made using a tape previously recorded with bias but with no signal. The reference level is to be established, with the weighting network inserted, at 1000 Hz using the 1000 Hz noise reference level signal included for this purpose on the NAB Test Tape. The indicator meter shall have the dynamics of the Standard Volume Indicator (ASA Standard C16.5-1961) and the measuring system shall conform with a full-wave rectified average measurement law.

⁴ Frequency response measurements shall be made at a level of at least 20 dB below the standard operating reference level.

3.30 Control Tones

Seven control tones shall be standard for use in NAB Cassette Machine control: 261 Hz, 408 Hz, 639 Hz, 1000 Hz, 1565 Hz, 2449 Hz, and 3833 Hz, each within a tolerance of $\pm 4\%$.

3.35 Primary Cue Tone⁵

It shall be standard that 639 Hz be used as the Primary Cue Tone on tracks 3 or 4 for both "address" and "non-address" services. A tone burst of 0.75 ± 0.25 seconds shall be employed for the Primary Cue Tone, with the machine cueing at the beginning of the tone at play speed. An inhibit circuit shall be employed to prevent the operation of the primary cue tone sensor for a period of 2 seconds ± 0.5 seconds after machine start.

3.40 Secondary Cue Tone

It shall be standard that 1 kHz be used as the Secondary Cue Tone on track 3 as the "End of Message" and "Overlap" tone. There shall be no constraint on the length of the tone. The "End of Message" function shall operate by sensing the leading edge of the tone. (The "Overlap" function may be used to start the next programmed event on the leading edge and drop the current even on the trailing edge).

3.45 Tertiary Cue Tone

It shall be standard that 3833 Hz be used as the Tertiary Cue Tone on track 3 for special requirements, e.g. digital logging (coded numeric) or alphaneumeric (plain english). For logging systems using FSK, 3833 Hz may be replaced with tones in the 2.5 to 5 kHz region.

3.50 Address Code

It shall be standard that an 8-bit binary code for two digit addresses (0-99) be recorded on tracks 3 and 4.

A 261 Hz tone shall be employed for encoding the address in pulse groups of 8 cycles per group (making each group 30.64 milliseconds long).

A zero bit shall be defined as a tone burst on track 3 immediately followed by a tone burst on track 4. A one bit shall be defined as a tone burst on track 4 immediately followed by a tone burst on track 3. A single set of simultaneous tone bursts at the leading edge of the code group on tracks 3 and 4 shall be recorded to denote the forward direction of the tape. A double set of simultaneous tone bursts shall be recorded at the trailing edge of the address code group. (The reading of a double set of simultaneous tone bursts prior to the address code indicates a reverse motion of the tape) ⁶.

In address type service, the primary cue tone shall follow the address code.

3.55 Auxiliary Tones

It shall be standard that 408, 1565, and 2449 Hz be designated as Auxiliary Tones for use as required. (2449 Hz shall be eliminated if FSK tones in the 2.5 kHz region are used).

3.60 Track Code

It shall be standard that the following track configuration be utilized:

⁵ The Primary Cue Tone may be used on track 4 when it is desired to retain a semi-permanent cue (which must be bulk-erased); or on track 3 when it is desired that it be erased as a normal machine function. The sensor shall react to a Primary Cue Tone on either track 3 or 4 at play speed.

⁶ An example is shown in Figure J of a recorded code group, address 48, with directions sensing marker. A leading and YZ trailing in the forward direction. Immediately following direction sensing marker A is the most significant bit of the least significant digit. After the first four bits (which comprise the least significant digit) there follows the most significant bit of the most significant digit.

Stop Tone (non-address) — Tracks 3 and/or 4.
Address/Stop Tone — Tracks 3 and 4.
Secondary, Tertiary and
Auxiliary Tones — Track 3.

3.65 Crosstalk

It shall be standard that the playback crosstalk be not less than 26 dB between tracks 3 and 4, and tracks 1 and 2 within the frequency range of 50 to 10,000 Hz.

The crosstalk shall be not less than 40 dB between tracks 2 and 3, 2 and 4, 1 and 4, or 1 and 3 within the frequency range of 50 to 10,000 Hz.⁷

3.70 Transient Noise

It shall be standard that any transients generated within the machine result in an oscilloscope measurement at least 40 dB below the standard operating reference level.

IV. TEST TAPE SPECIFICATIONS

There shall be two NAB Audio Cassette Test Tapes, one for use at 1 $\frac{7}{8}$ ips (4.76 cm/s) and one for use at 3 $\frac{3}{4}$ ips (9.53 cm/s) which shall conform to the following specifications.

4.05 Cassette and Tape

The cassette and tape shall conform with the requirements of Section I of this Standard except for tape length.

4.10 Track Width

All recorded tones shall be full track.

4.15 Tone Spacing

There shall be a 2 second interval between tones which may be used for voice announcements.

4.20 Tape Erasure

All tape shall be bulk erased prior to recording the test tones.

4.25 Recorded Level

All levels shall be as specified within ± 0.5 dB.

All test tones specified in 4.35 having a level of -20 dB shall be recorded so as to produce a uniform response when the test tape is reproduced through an ideal reproducing system. (See annex A)

In lieu of the ± 0.5 dB tolerance specification, a ± 3 dB tolerance specification may be used provided that the deviation from uniform response when the test tape is reproduced on an ideal reproducing system is supplied for each test frequency.

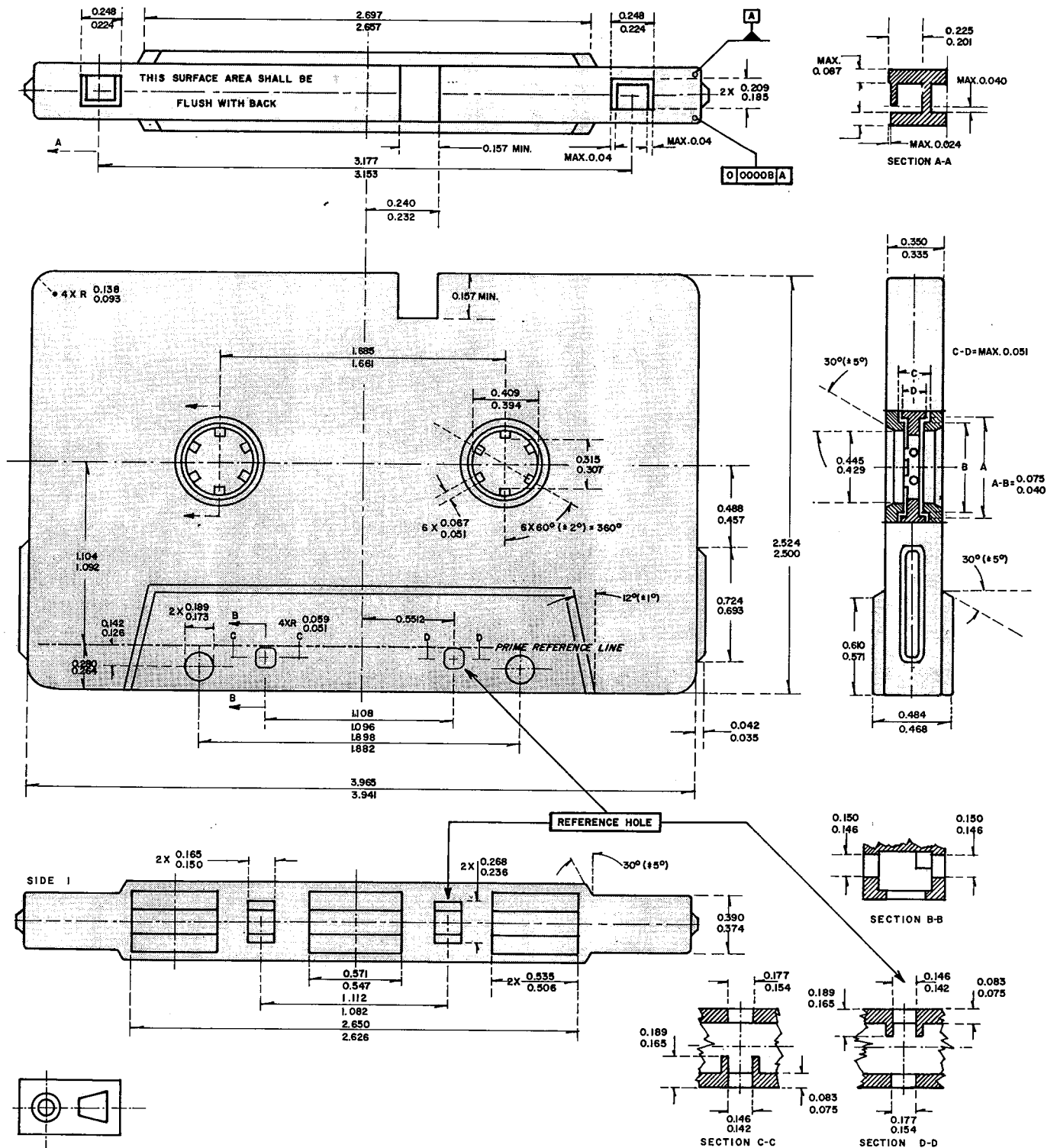
4.30 Frequency Accuracy

All frequencies recorded on the test tape shall be within 1% of the specified frequency when the tapes are reproduced

⁷ Since control tones are recorded at a level 15 dB below standard operating reference level, this results in an effective crosstalk level from the control tracks to the program tracks of 55 dB below standard operating reference level.

4.35 Test Tape Format

<i>Time (Seconds)</i>	<i>Frequency (Hz)</i>	<i>Level (DB)</i>	<i>Function</i>
0.5-1	639	—15	Stop tone to cue tape
10	400	0	Operating reference level
10	400	—20	Calibration level
30	10,000	—20	Azimuth
3	6,000	—20	Frequency Response
3	3,000	—20	Frequency Response
3	1,000	—20	Frequency Response
3	500	—20	Frequency Response
3	100	—20	Frequency Response
3	50	—20	Frequency Response
15	Blank		To allow meter scale adjustment
10	1,000	0	Signal reference for signal/noise measurement
20	Blank		Noise measurement segment
0.030	1,000	—15	Tone bursts for cue tests
0.030	1,000	—15	Tone bursts for cue tests
0.030	3833	—15	Tone bursts for cue tests
0.030	3833	—15	Tone bursts for cue tests
0.030	3833	—15	Tone bursts for cue tests
0.5-1	639	—15	Stop tones
0.5-1	639	—15	Stop tones
0.5-1	639	—15	Stop tones



DIMENSIONS IN INCHES

WHERE TWO NUMBER ARE MENTIONED, THE UPPER ONE GIVES THE MAXIMUM, THE LOWER ONE THE MINIMUM DIMENSION.

FIGURE A

EXTERNAL DIMENSIONS

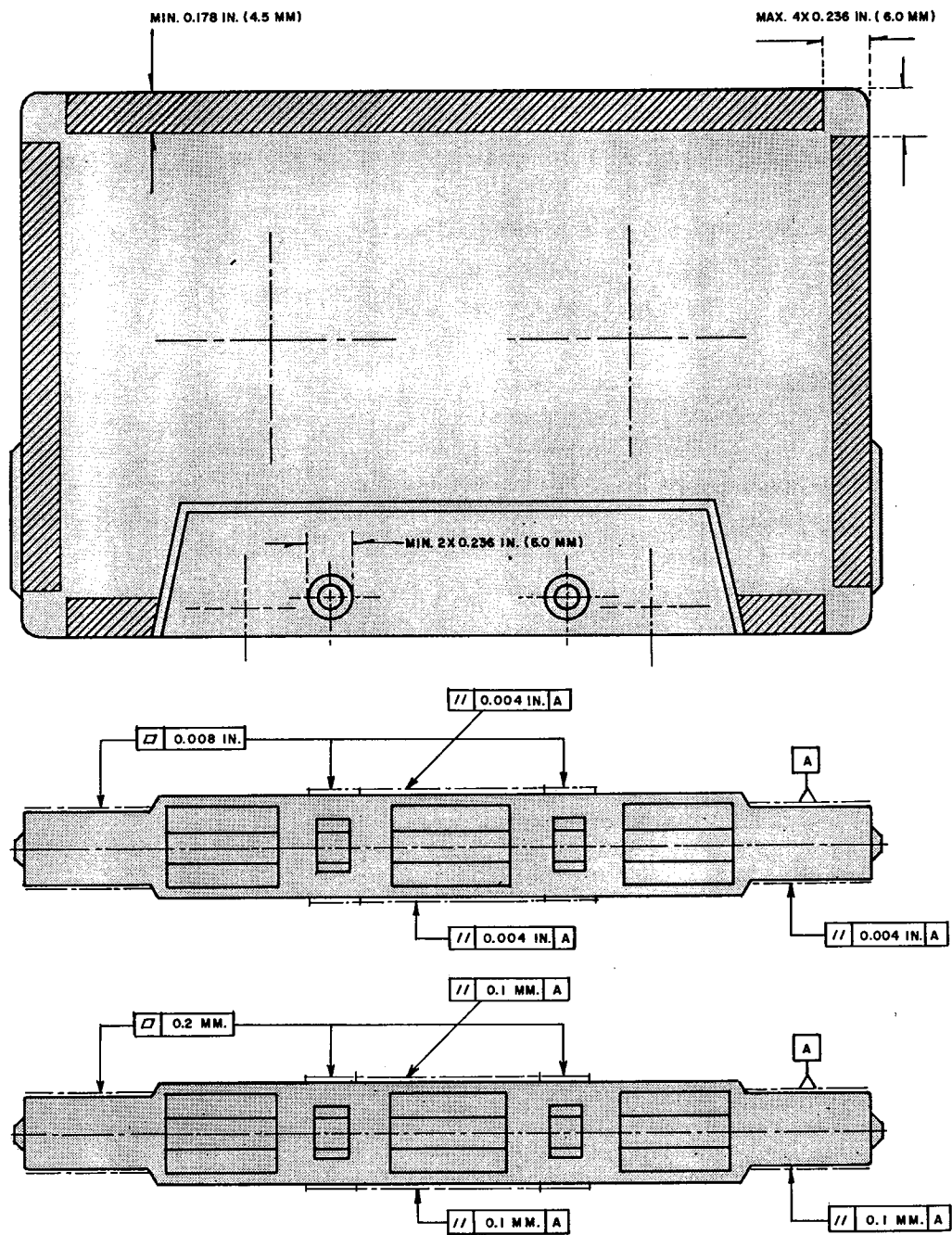


FIGURE B
SUPPORT PLANES

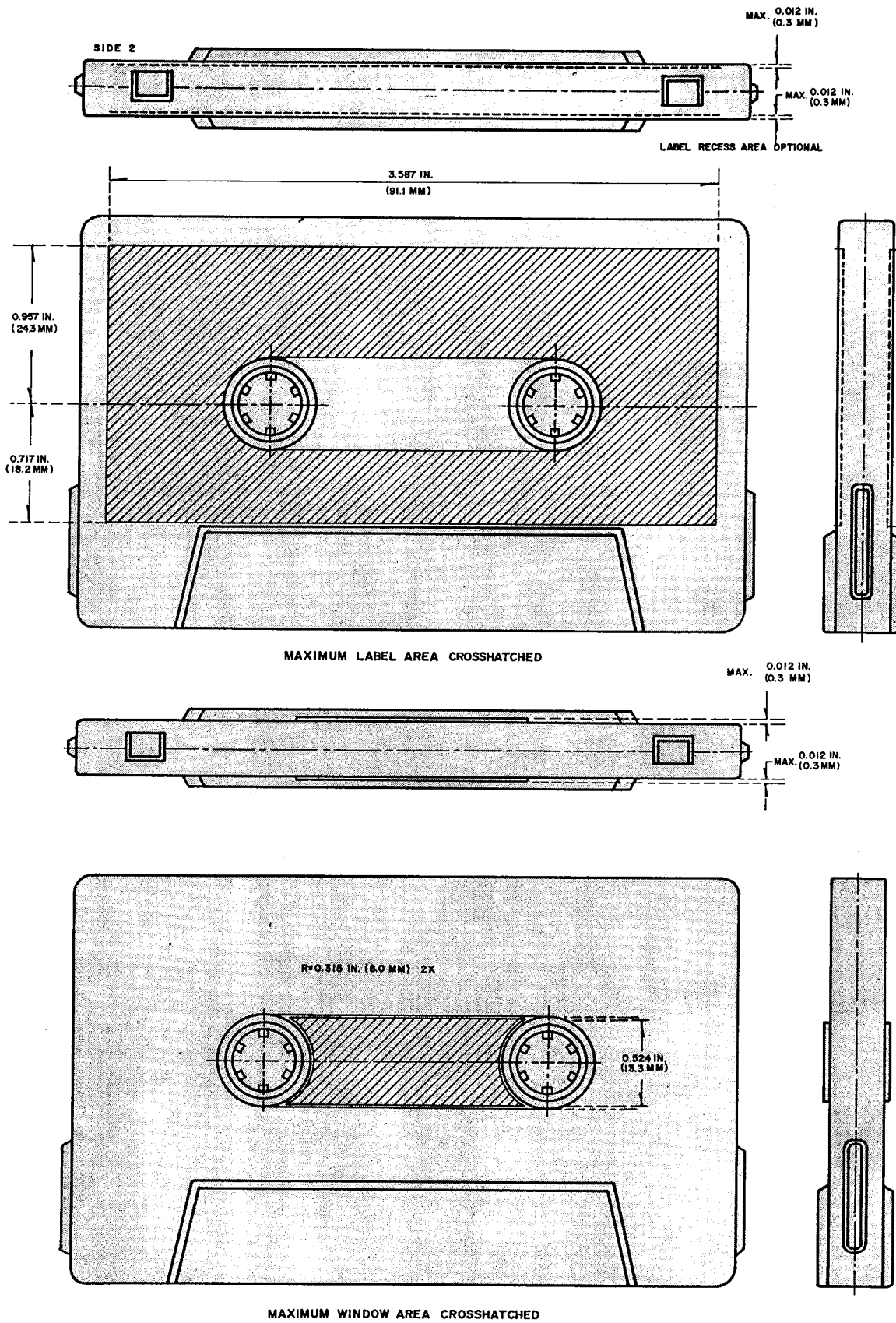


FIGURE C

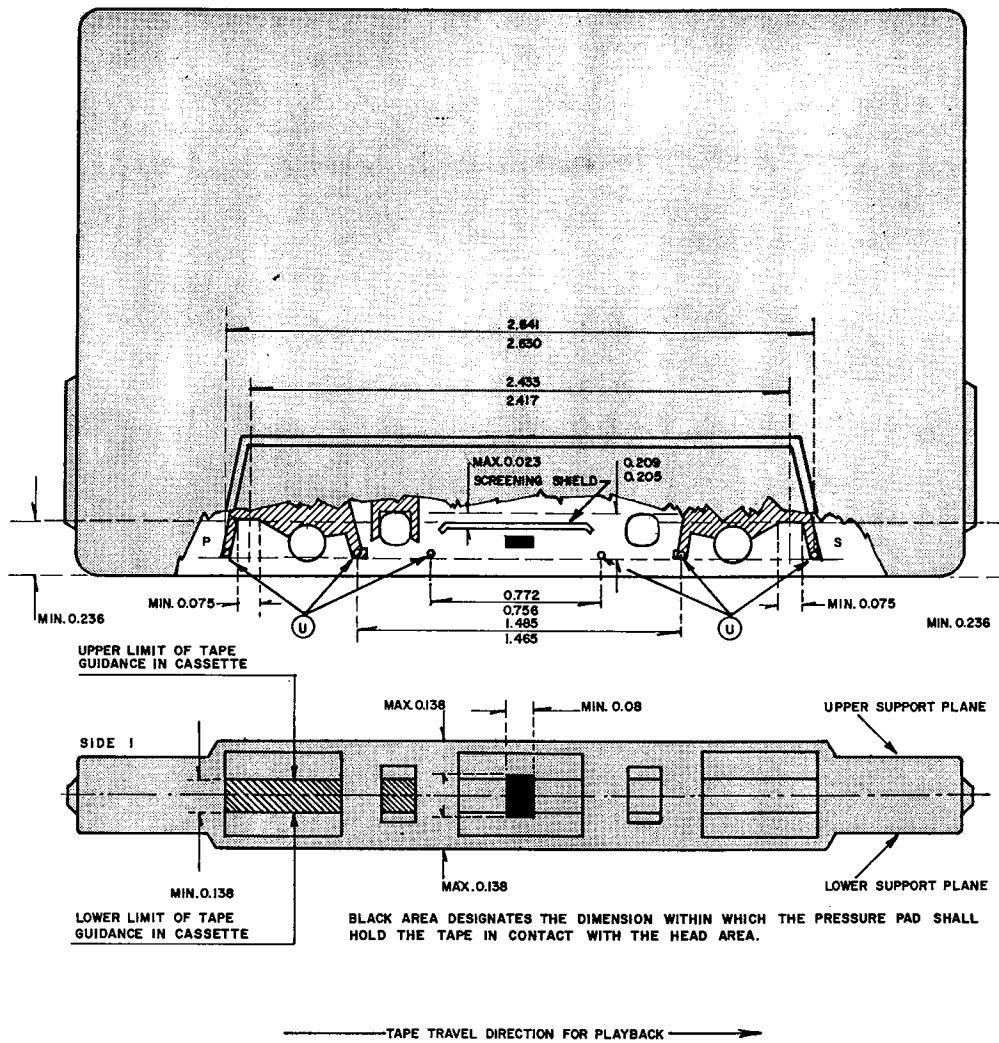


FIGURE D

TAPE PATH DIMENSIONS AND TRAVEL DIRECTION

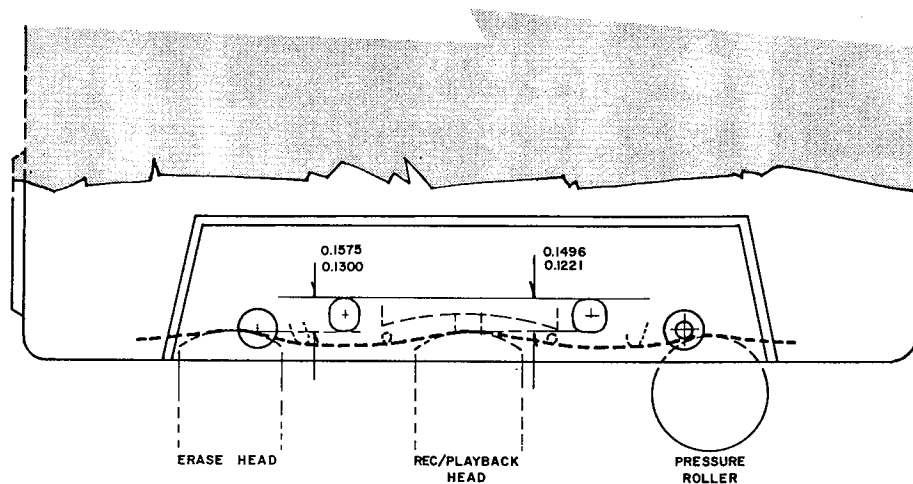
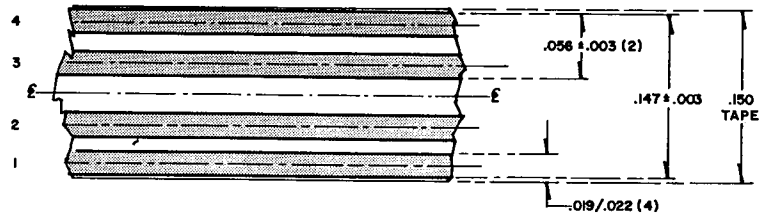


FIGURE E

HEAD PENETRATION DIMENSIONS IN RECORD/PLAY MODE

HEAD TRACK

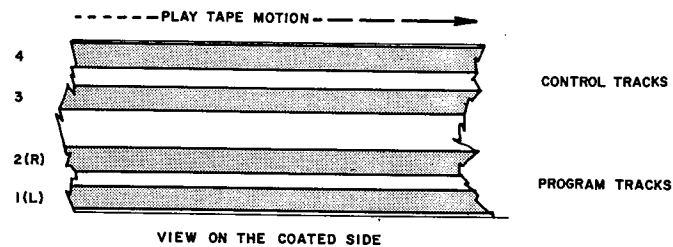


NOTE:

THE OUTSIDE EDGES OF EFFECTIVE HEAD TRACK NUMBERS ONE AND FOUR SHALL NOT OVERLAP THE TAPE GUIDE AREA BY MORE THAN 0.002 INCHES.

FIGURE F

HEAD TRACK DIMENSIONS



NOTE:

FOR MONOPHONIC OPERATION COMBINE TRACKS ONE AND TWO.

FIGURE G

TAPE TRACK DESIGNATION

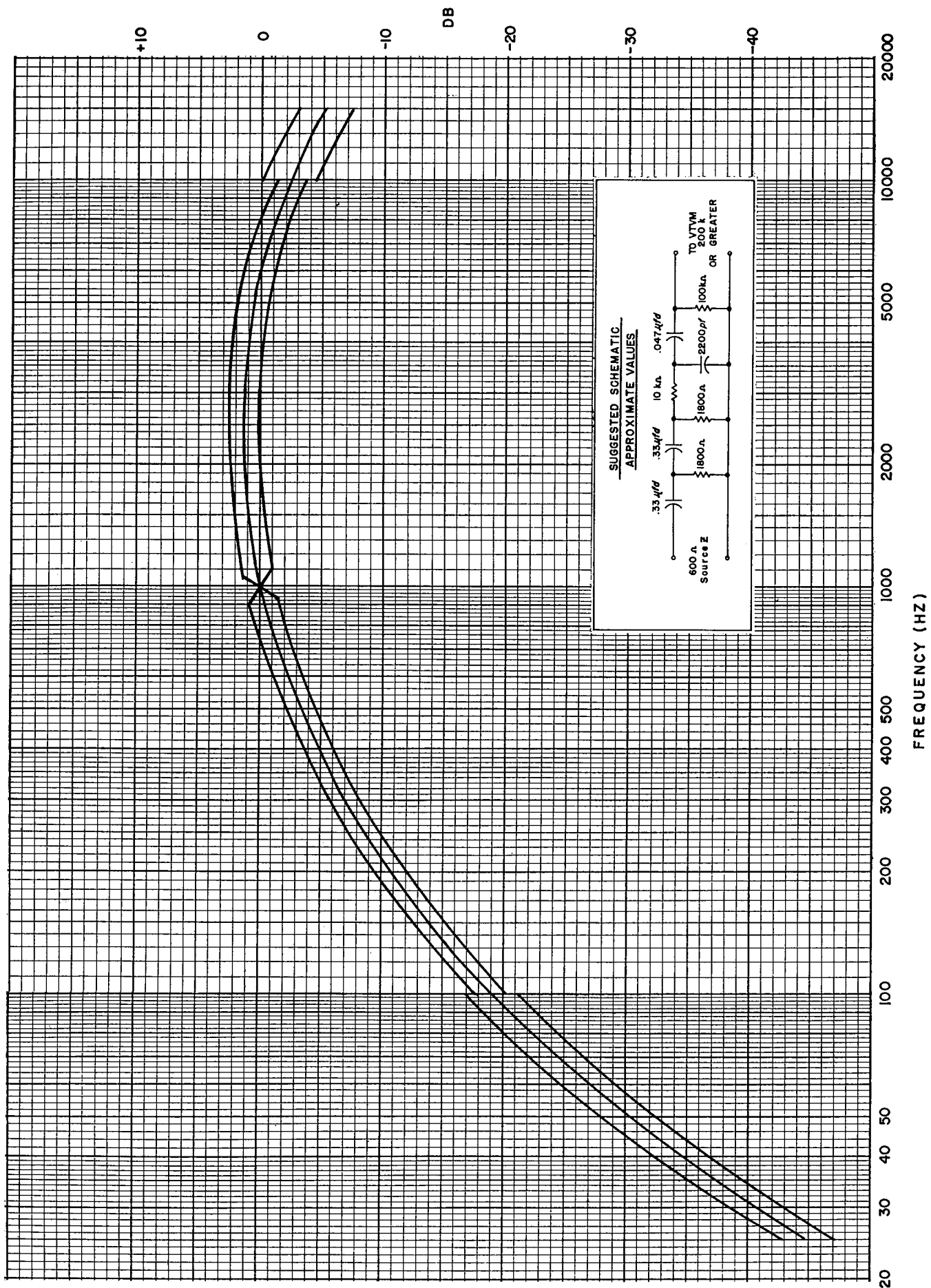


FIGURE H

WEIGHTING CURVE FOR WEIGHTED NOISE MEASUREMENTS

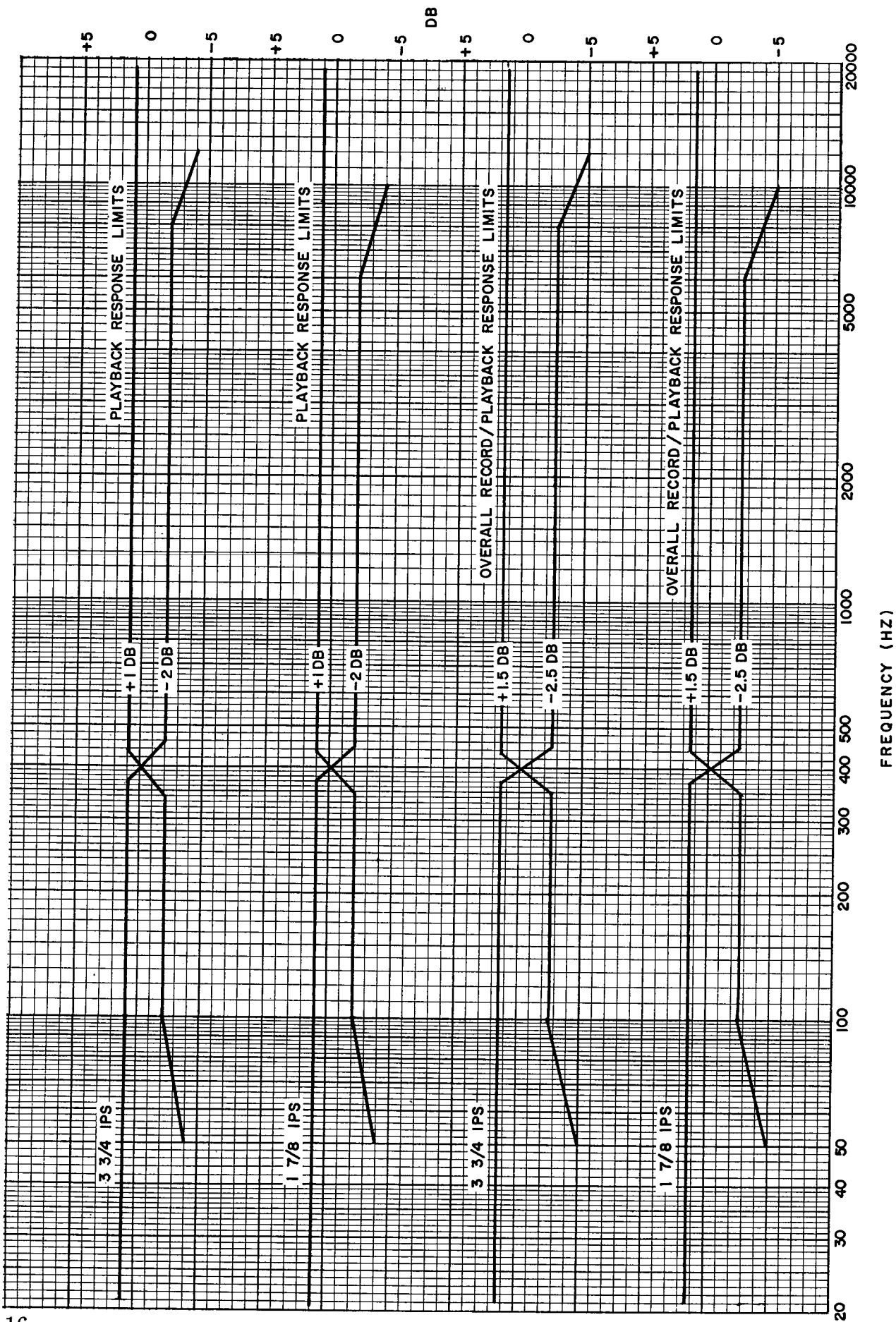


FIGURE 1
FREQUENCY RESPONSE LIMITS

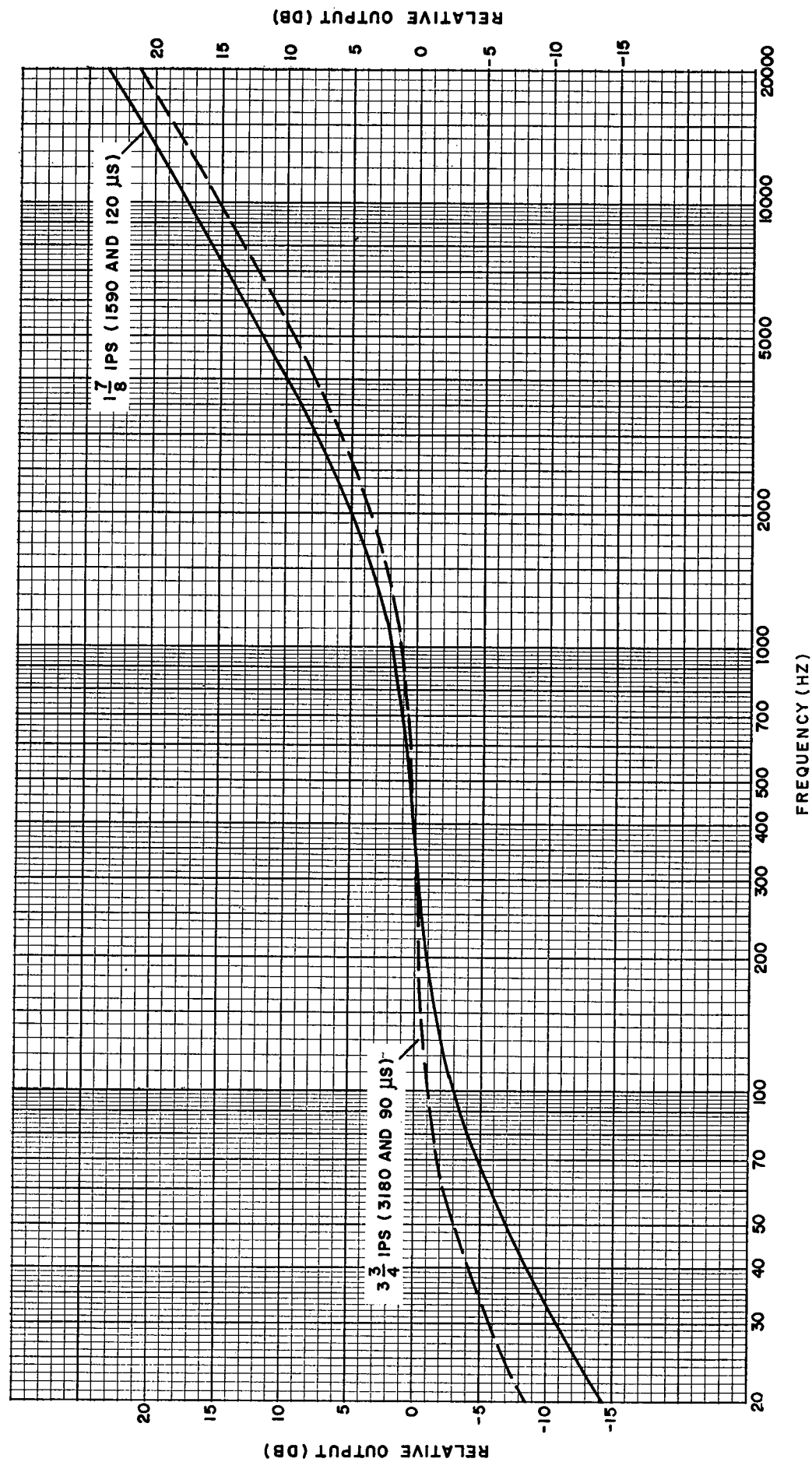


FIGURE K
 REPRODUCING CHARACTERISTIC
 REPRODUCING AMPLIFIER OUTPUT FOR
 CONSTANT FLUX IN THE CORE OF
 AN IDEAL REPRODUCING HEAD

NAB STANDARD REPRODUCING CHARACTERISTIC

3-3/4 ips (3180 and 90 μ s)

Reproducing Amplifier Output for Constant Flux
in the Core of an Ideal Reproducing Head

<u>Frequency</u>	<u>Response</u>	<u>Frequency</u>	<u>Response</u>
20 Hz	-8.6 db	1.5 kHz	+2.4 db
25	-7.0	2	+3.6
30	-5.8	2.5	+4.8
40	-4.1	3	+5.8
50	-3.0	4	+7.9
60	-2.3	5	+9.5
70	-1.8	6	+10.9
75	-1.6	7	+12.2
80	-1.4	7.5	+12.8
90	-1.2	8	+13.3
100	-1.0	9	+14.3
150	-0.4	10	+15.2
200	-0.2	11	+16.0
250	-0.1	12	+16.7
300	± 0	13	+17.4
400	+0.1	14	+18.0
500	+0.3	15	+18.6
600	+0.4	16	+19.2
700	+0.6	17	+19.7
750	+0.7	18	+20.2
800	+0.8	19	+20.6
900	+1.0	20	+21.1
1 kHz	+1.2		

NAB STANDARD REPRODUCING CHARACTERISTIC

1-7/8 ips (1590 and 120 μ s)

Reproducing Amplifier Output for Constant Flux
in the Core of an Ideal Reproducing Head

<u>Frequency</u>	<u>Response</u>	<u>Frequency</u>	<u>Response</u>
20 Hz	-14.2 db	1.5 kHz	+3.5 db
25	-12.3	2	+5.1
30	-10.9	2.5	+6.6
40	-8.6	3	+7.9
50	-7.0	4	+10.0
60	-5.8	5	+11.8
70	-4.8	6	+13.3
75	-4.4	7	+14.6
80	-4.1	7.5	+15.2
90	-3.5	8	+15.7
100	-3.0	9	+16.7
150	-1.5	10	+17.6
200	-1.0	11	+18.4
250	-0.5	12	+19.2
300	-0.2	13	+19.8
400	+0.1	14	+20.4
500	+0.4	15	+21.1
600	+0.6	16	+21.7
700	+1.0	17	+22.1
750	+1.1	18	+22.7
800	+1.3	19	+23.1
900	+1.6	20	+23.6
1 kHz	+1.9		

ANNEX A

1. Ideal Reproducing System

The standard NAB Ideal Reproducing System is a theoretical reproducing system. It consists of an "ideal" reproducing head¹ and an amplifier the output voltage of which shall conform to the voltage-frequency curve of Figure K with constant flux vs frequency in the core of the head.²

The curve of voltage amplification vs frequency shall be uniform with frequency except where modified by the following equalizations:

(a) The voltage attenuation of a single resistance—capacitance high pass filter having an RC time constant t_1 .

(b) The inverse of the voltage attenuation of a single resistance capacitance low pass filter having an RC time constant t_2 . The curve expressed in decibels is represented by the following expression:

$$N_{db} = 20 \log_{10} \omega t_1 \sqrt{\frac{1 + (\omega t_2)^2}{1 + (\omega t_1)^2}}$$

$$\omega = 2\pi \text{ times frequency}$$

At 3-3/4 ips tape speed $t_1 = 3180$ us and $t_2 = 90$ us

At 1-7/8 ips tape speed $t_1 = 1590$ us and $t_2 = 120$ us

2. Standard Reproducing System³

It shall be standard that an NAB Standard Reproducing System shall consist of a suitable tape transport, reproduce head and amplifier equalized to compensate for head losses insofar as possible and to produce a reproduce response from an NAB Standard Test Tape, within the limits specified in Figure I. It shall also meet the specifications for distortion, signal-to-noise ratio and other applicable parts of this Standard.

¹ An "ideal" reproducing head is defined as a ferromagnetic head, the losses of which are negligible. This means that the gap is short and straight, the long wave-length flux paths are controlled so that no low frequency contour effects are present, and the losses in the head materials are negligibly small.

² It is recognized that the flux in the core of an "ideal" head is not necessarily the same as the surface flux on a tape in space for various reasons. Since most of these effects are not readily measured it has been decided to base this standard on "ideal" head core flux rather than surface induction.

³ It is recommended that the Reproducing System response roll off at the rate of at least 6 db per octave beyond the frequency limits shown in Figure I.

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E-607