4

Major Standards of Interest to Broadcast Engineers

Standards relating to various areas of communications engineering and equipment are sponsored and developed through the efforts of many organizations. The principal organizations are the National Association of Broadcasters (NAB), the International Radio Consultative Committee (CCIR), the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), Electronic Industries Association (EIA), and the Society of Motion Picture and Television Engineers (SMPTE).

The standards organizations listed above are not intended to be all inclusive but only to represent those which are of general interest to the broadcaster. In addition to the above referenced organization standards are developed by the British Standards Institution (BSI), Deutscher Normenausschus (German Standards Committee, DNA); International Electrotechnical Commission (IEC); Record Industry Association of America (RIAA); Union Technique de l'Electricité; Japanese Standards Association, and the United States Government.

ELECTRONIC INDUSTRIES ASSOCIATION

2001 Eye Street, N.W.
Washington, D. C. 20006

The EIA has available numerous recommended standards and engineering publications. The following test devices are of interest to the broadcast industry. For a listing of available standards and further information contact the EIA.

Standard Color Chips

Twenty-eight nominal and limit chips.

Resolution Chart

The Resolution Chart is used to help measure the resolving power of a television system or of a part of it, such as a television camera chain. The chart is televised by the studio facility, under test, and reproduced on a suitable picture monitor. Horizontal and vertical resolution wedges cover the range from 200 to 800 lines.

Gray Scale Overlay Strips for Resolution Chart

These strips are intended to be pasted over the corresponding sections of the Resolution Chart. These highly accurate gray scales will then provide the correct logarithmic reflectance relationship for the scales on the chart.

Linearity (Ball) Chart

This Chart is used to help test geometric distortion of a television camera chain. This is done by comparing on a suitable picture monitor two superimposed patterns; one generated by an electrical pattern generator, the other by televising a chart with the equipment to be checked. The electrical pattern grating frequencies required to match the chart pattern are 315 kHz for horizontal, 900 Hertz for vertical linearity tests.

Color Registration Chart

The Color Registration Chart is used to aid in the alignment and test of the accuracy of registration of triple-pickup color television cameras. The fine black horizontal and vertical lines on a white background permit accurate alignment of the optical and electrical systems of three-pickup cameras.

Linear Reflectance Chart

The Linear Reflectance Chart with the steps of gray scales in linear relationship is used in the alignment and measurement of the transfer characteristic of television camera systems. This is of particular importance in color television, where departure from the correct characteristics may result in color error.

Logarithmic Reflectance Chart

This Chart is similar to the Linear Reflectance Chart with the exception that the steps of reflectance difference follow a logarithmic, instead of a linear relationship. It is highly useful in the alignment and measurement of the transfer characteristic of television camera systems, particularly those for color.

Facsimile Test Chart

The Facsimile Test Chart consists of a variety of patterns intended to facilitate the checking of modulation characteristics, square wave testing, power supply regulation and clamping, definition, halftone characteristics, index of cooperation, readability, jitter, and other parameters of transmitted facsimile copy.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS (SMPTE)

862 Scarsdale Avenue
Scarsdale, N.Y. 10583

The SMPTE has available numerous test films which are widely used by the television industry as yardsticks for setting performance objectives of new and operational equipment. The test films are planned by the Technical Committee of the Society after considerable research and consultation. In addition, the Society has sponsored many standards and recommended practices which have been adopted by the American National Standards Association and are identified by the ANSA designation Ph. The following test devices are available from the Society:

Sound Test Films

(Sound Only)

35-mm Magnetic Four-Track Projection Sound

Azimuth Alignment
Flutter
Signal Level
Multifrequency
Channel-Four
Loudspeaker Balance

35-mm Magnetic Three-Track Sound
(Not for use in theater projectors)

Azimuth Alignment
Flutter
Signal Level
Multifrequency

16-mm Magnetic Sound

Azimuth Alignment
Flutter
Signal Level
Multifrequency

35-mm Photographic Sound

Buzz Track
Scanning Beam
Sound Focus and Alignment, Type A
Sound Focus and Alignment, Type B
Flutter
Signal Level
Multifrequency, Type A (Laboratory)
Multifrequency, Type B (Service)

16-mm Photographic Sound

Buzz Track
Scanning Beam
Sound Focus and Alignment, Type A
Sound Focus and Alignment, Type B
Flutter
Signal Level
Multifrequency

Picture-with-Sound Test Films

Photographic Sound—Music and Dialogue

16-mm Projector Performance

Projector Performance Test Films

(Picture Only)

Projector Alignment and Registration

70-mm All-Purpose Projector Alignment
35-mm Projector Alignment—Anamorphic
35-mm Projector Alignment & Image Quality
  35-mm Projector Alignment (section)
16-mm Registration
Super-8 Registration
8-mm Registration

Projector Performance

35-mm Subjective Picture
35-mm Visual
  35-mm Focus and Alignment (section)
  35-mm Travel Ghost (section)
  35-mm Jump and Weave (section)
16-mm Travel Ghost

Film Leader Master Positives

35-mm Universal Leader
16-mm Universal Leader

Television Test Films & Slides

(Picture Only)

Monochrome Performance

35-mm Operating Performance
16-mm Operating Performance
  35-mm Alignment and Resolution (section)
  16-mm Alignment and Resolution (section)
2 x 2-in. Alignment and Resolution Slide

Operational Alignment

35-mm Television Operational Alignment
16-mm Television Operational Alignment
8 x 10-in. Operational Alignment Transparency
2 x 2-in. Operational Alignment Slide

Color Subjective Reference

35-mm Color Subjective Reference
16-mm Color Subjective Reference
2 x 2-in. Television Color Reference Slide Set

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

345 East 47th Street
New York, N.Y. 10017

The IEEE has a number of standards pertaining basically to methods of measurement as they relate to the broadcasting industry. The number of standards which have been developed are too numerous to list and the reader is requested to contact the IEEE directly. Listed below are some of the published standards that are available and of primary interest:

Definitions of Terms for Antennas, Modulation Systems, and Transmitters.
Definitions of Terms for Antennas and Waveguides.
Definitions of Terms for Waveguide Components.
Measurement of Waveguides and Components.
Test Procedure for Antennas.
Methods of Measurement of Gain, Amplification, Loss, Attenuation, and Amplitude-Frequency Response on Audio Systems and Components.
Definitions of Terms for Audio.
Recommended Practice for Volume Measurements of Electrical Speech and Program Waves.
Definitions of Terms in Electroacoustics.
Test Procedure for Facsimile.
Definitions of Terms for Facsimile.
Definitions of Terms for Modulation Systems.
Measurements of Piezoelectric Ceramics.
Definitions of Ferroelectric Crystal Terms.
Methods of Measurement of Pulse Quantities.
Definitions of Terms for Radio Transmitters.
Methods of Testing Frequency Modulation Broadcast Receivers.
Methods of Testing Amplitude Modulation Broadcast Receivers.
Open Field Method of Measurement of Spurious Radioation from Frequency Modulation and Television Broadcast Receivers.
Methods of Testing Receivers Employing Ferrite Core Loop Antennas.
Methods of Testing Monochrome Television Broadcast Receivers.
Methods of Measurement of Noise.
Methods of Calibration of Mechanically Recorded Lateral Frequency Records.
Methods of Determining Flutter Content in Sound Recorders and Reproducers.
Definitions of Terms, Pulses.
Abbreviations of Radio-Electronic Terms.
Letter Symbols and Mathematical Signs.
Definitions of Color Television Terms.
Methods of Measurement of Television Aspect Ratio and Geometric Distortion.
Definitions of Terms Relating to Television.
Measurement of Luminance Signal Levels.
Measurement of Television Differential Gain and Differential Phase.
Methods of Measurement of Television Time of Rise, Pulse Width, and Pulse Timing of Video Pulse.
Measurement of Resolution of Camera Systems.
Methods of Measurement of Television Electronically Regulated Power Supplies.
Definitions of Terms Relating to Guided Waves.
Definitions of Terms, Wave Propagation.
Graphical and Letter Symbols for Feedback Control Systems.
Methods of Measurement of Conducted Interference Output to the Power Line from FM and Television Broadcast Receivers in the Range of 300 Kc to 25Mc/s.
Construction Drawings of Line Impedance Network.
Definitions of Semiconductor Terms.
Definitions of Terms of Superconductive Electronics.
Methods of Testing Transistors for Large Signal Applications.

NATIONAL ASSOCIATION OF BROADCASTERS

1771 N Street, N.W.
Washington, D.C. 20036

The NAB Recording and Reproducing Standards are for the benefit and welfare of the broadcasting industry, and represent the contributions of more than 100 of the Nation's authorities on the various phases of recording as used by the industry. Close liaison has been 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. Standards available from NAB are as follows:

1. Cartridge Tape Recording and Reproducing (October 1964).
2. Disc Recording and Reproducing (March 1964).
3. Magnetic Tape Recording and Reproducing (Reel-to-reel) (April 1965).
4. Cassette Tape Recording and Reproducing (January 1973).

LATERAL MONOPHONIC AND STEREOPHONIC DISC RECORDING AND REPRODUCING STANDARDS[1]

Turntable Specifications

Turntable Speed (RPM)[2]

1.05 It shall be standard that the mean speed of the recording turntable be either 33-1/3 or 45 RPM ± 0.1%, and the mean speed of the reproducing turntable be either 33-1/3 or 45 RPM ± 0.3%.

1.05.01 This measurement shall be made by means of a stroboscopic disc illuminated by a neon lamp or equivalent operated from a standard frequency source. The stroboscopic disc for 33-1/3 RPM speed measurements shall have 216 spots in 360 degrees and for 45 RPM shall have 160 spots in 360 degrees.

At either 33-1/3 or 45 RPM not more than 7 dots per minute in either direction may pass or drift by a reference point for the recorder and 21 dots per minute in either direction for the reproducer.

Turntable and Disc Rotation

1.10 It shall be standard that discs intended for broadcasting application be rotated in a clockwise direction as viewed from the side being reproduced and that the direction of feed shall be outside-in.

Wow and Flutter Factor (Recording)[3]

1.15 It shall be standard that the average deviation (measured over the range 0.5-200 Hz) from the mean speed of the recording turntable, when making the recording, shall not exceed 0.04% of the mean speed. The average deviation above shall be measured by a meter the dynamics of which shall be the same as those of the VU meter as specified in ASA Standard C16.5-1961.

Wow and Flutter Factor (Reproducing)[3]

1.20 It shall be standard that the average deviation from the mean speed of the reproducing turntable when reproducing shall not exceed 0.1% of the mean speed.

Turntable Starting Time (Reproducing)

1.25 It shall be standard that the turntable platen shall attain its mean speed as defined in Section 1.05 in not more than 120 degrees rotation.

Turntable Height (Reproducing)

1.30 It is considered good practice that the vertical distance between the floor and the top of the platen be 28 inches.

Turntable Platen (Reproducing)

1.35 It is considered good practice that the diameter of the reproducing turntable platen be substantially the same as that of the largest diameter disc for which the turntable is intended.

1.35.01 Turntables for 45 RPM shall be recessed a minimum of 0.030 inches to a diameter of 3-7/8 inches ± 1/32 inches from the center pin.

1.40 It shall be standard that the diameter of the center pin of a turntable be 0.2830 inches + 0.000 inches — 0.0005 inches for 33-1/3 RPM discs. The diameter of the center pin for 45 RPM discs shall be 1.500 inches + 0 — 0.002 inches.

Disc Specifications

Outer Diameters[4]

2.05 It shall be standard that the outer disc diameter fall within the limits specified in the following table:

Nominal	*Finished Discs*
	(Pressings or Instantaneous)
12 in.	11-7/8 ± 1/32 in.
10 in.	9-7/8 ± 1/32 in.
7 in.	6-7/8 ± 1/32 in.

Center Hole Diameter

2.10 It shall be standard that the disc center hold diameter be 0.286 in. + 0.001 — 0.002 inches for 33-1/3 RPM discs and 1.504 inches ± 0.002 in. for 45 RPM discs.

[1] The term disc is used throughout these standards to indicate both types of mechanical recording commonly referred to separately as transcriptions and phonograph records.

[2] It is recognized that 78.26 RPM discs are still in existence but this speed is no longer considered a standard.

[3] The term average as used in this section shall refer to the measurement device characteristic rather than the period of time over which the observation is made.

[4] It is recognized that 16 inch transcriptions are still in limited use but this size disc is no longer considered a standard.

Concentricity of Center Hole

2.15 It shall be standard that the disc center hole be concentric with the recorded groove spiral within 0.005 in.

Disc Warp

2.20 It shall be standard that the variation of the total indicator reading (TIR) of the surface of the disc because of warping shall not be in excess of 1/16 in. and that within any 45° segment the total indicator reading (TIR) shall not exceed 1/32 in.

Outer Modulated Groove Diameter

2.25 It shall be standard that the diameter of the outermost modulated groove be within the limits specified in the following table:

12 in.—outside start—11-7/16 in. maximum
10 in.—outside start— 9-7/16 in. maximum
7 in.—outside start— 6-9/16 in. maximum

Innermost Groove Diameter

2.30 It shall be standard that the diameter of the innermost modulated groove shall be not less than 4-3/4 in. in the case of 33-1/3 RPM discs, and not less than 4-1/4 in. for 45 RPM discs.

Number of Blank Grooves

2.35 It shall be standard that there shall be at least one unmodulated groove at recording pitch before and after modulation.

Stopping Groove

2.40 It shall be standard that following the termination of the innermost recording groove, a leadout spiral and a locked concentric stopping groove shall be provided.

Minimum Label Information

2.45 It shall be standard that the label of a disc contain at least the following technical information:

a. Monophonic or Stereophonic
b. Speed—(45 or 33-1/3 RPM)
c. Recommended playback characteristic
d. Recommended type of playback stylus

Groove Shape—Monophonic[5]

2.50 It shall be standard that the groove shape for finished monophonic discs shall have an included angle of 90° ± 5°; a top width of not less than 0.0022 in. and a bottom radius not greater than 0.00025 in. (It is recommended that discs with these groove shape characteristics be reproduced with a stylus having a tip radius of 0.001 in. +0.0001 in. — 0.0002 in. and an included angle of 40-55°).

Groove Shape—Stereophonic[5]

2.55 It shall be standard that the groove shape for finished stereophonic discs shall have an included angle of 90° ± 2°; a top width of not less than 0.001 in. and a bottom radius of not greater than 0.0002 in. (It is recommended that discs with these groove shape characteristics be reproduced with a stylus having a tip radius of 0.0005 to 0.0007 in. and an included angle of 40-55°.)

Electrical Specifications

Frequency Characteristics for Monophonic and Stereophonic Discs[6]

3.05 It shall be standard that the reproduce system frequency response characteristic for monophonic and stereophonic discs shall be as shown in Fig. 1 and Table 1.

> *Reproducing characteristic* with constant velocity of the reproducing stylus tip the curve of voltage output of the reproducing system versus frequency shall be that which results from the combination of three curves as follows:
>
> one falling with increasing frequency in conformity with the impedance of a parallel combination of a capacitance and a resistance having a time constant of t_1; (75 μsec.)
>
> one falling with increasing frequency in conformity with the impedance of a series com-

[5]It has been concluded that groove shaped standards should apply to the finished disc rather than to the recording stylus. It is recognized that in some cases disc groove dimensions depart slightly from those of the recording stylus, but such deviations should be anticipated in the recording operation and controlled in the processing plant. In actual practice, standards covering reproducer stylus contour have no significance unless the groove standards refer to the finished disc. In the event that it is necessary to play both monophonic and stereophonic discs with the same reproducer, the use of a 0.0007 inch stylus is recommended.

[6]In disc recording, it is the generally accepted practice to evaluate sound quality and musical balance of a disc on a reproducer which has a specified response—frequency characteristic. This characteristic, which has become an international standard, is essentially the inverse of the NAB recording characteristic originally introduced in the NARTB Recording and Reproducing Standards (June 1953). It is considered appropriate, therefore, that NAB specify the reproducing characteristic rather than the recording characteristic in its disc standards. It should be recognized, however, that in so doing, the *basic* disc recording characteristic is implied and defined.

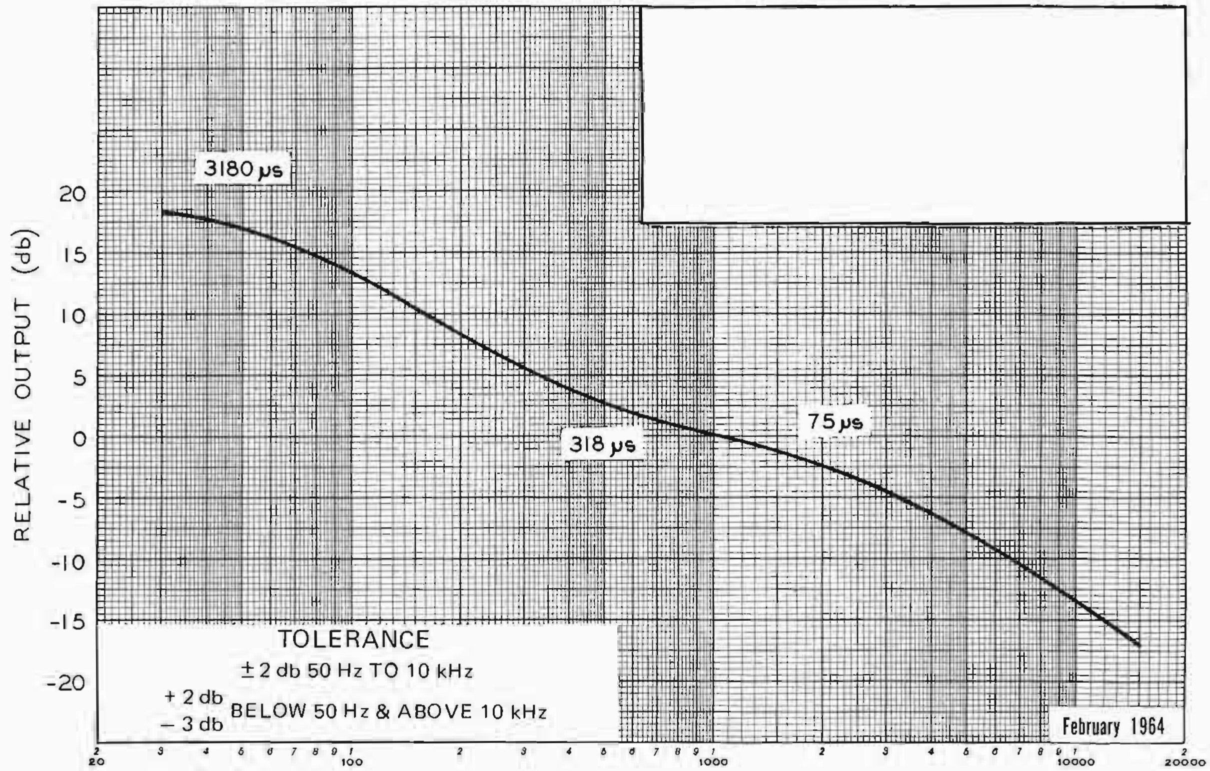

Fig. 1. NAB Standard Disc reproducing characteristic: relative output versus frequency for constant velocity input.

TABLE 1

Frequency versus NAB Monophonic and Stereophonic Reproducing Characteristic

Frequency Hz	Reproducing Characteristic dB
15,000	− 17.17
14,000	− 16.64
13,000	− 15.95
12,000	− 15.28
11,000	− 14.55
10,000	− 13.75
9,000	− 12.88
8,000	− 11.91
7,000	− 10.85
6,000	− 9.62
5,000	− 8.23
4,000	− 6.64
3,000	− 4.76
2,000	− 2.61
1,000	0
700	+ 1.23
400	+ 3.81
300	+ 5.53
200	+ 8.22
100	+ 13.11
70	+ 15.31
50	+ 16.96
30	+ 18.61

bination of a capacitance and a resistance having a time constant of t_2; (318 µsec.)

one rising with increasing frequency in conformity with the admittance of a series combination of a capacitance and a resistance having a constant of t_3; (3180 µsec.)

The combined curve is defined by:

$$N(\text{dB}) = 10\log\left(1 + \frac{1}{4\pi^2 f^2 t_2^2}\right) - 10\log\left(1 + 4\pi^2 f^2 t_1^2\right) - 10\log\left(1 + \frac{1}{4\pi^2 f^2 t_3^2}\right)$$

f = frequency in Hz.

It is recommended that the system response below 30 Hz and above 15,000 Hz be attenuated at least 6 dB per octave with the 3 dB points at 20 Hz and 16 Hz.

Reference Recorded Program Level—Monophonic[7]

3.10 It shall be standard that the reference recorded program level shall produce the same reference deflection on a standard volume indicator (ASA Standard C16.5—1961) as that produced by a 1000 Hz tone recorded at a peak velocity of 7 centimeters per second.

[7]It is well established that at least a 10 dB margin is required between the sine wave load handling capacity of a system and the level of program material measured by a

Reference Recorded Program Level—Stereophonic[7]

3.15 It shall be standard that the reference recorded program level for each channel in its plane of modulation shall produce the same reference deflection on a standard volume indicator (ASA Standard C16.5—1961) as that produced by a 1000 Hz tone recorded at a peak velocity of 5.0 centimeters per second. (Approximately 3 dB below the monophonic Reference Recorded Program Level.)

Reproducing System Noise—Monophonic

3.20 *Low frequency noise* (*rumble*): It shall be standard that for a monophonic disc reproducing system the low frequency noise voltage generated by the turntable, its associated pickup and equalizer or equalized preamplifier when playing an essentially rumble-free silent groove, shall be at least 40 dB below a reference level of 1.4 centimeters per second peak velocity at 100 Hz.

The response of the pickup and equalizer or equalized preamplifier shall conform to the NAB standard reproducing curve; the amplifier and indicating meter shall have uniform response, within ± 1 dB, between 10 and 250 Hz with 500 Hz response 3 dB below the 100 Hz response, and an attenuation at the rate of at least 12 dB per octave at frequencies above 500 Hz. The amplifier and indicating meter response shall decrease at the rate of at least 6 dB per octave below 10 Hz. The meter used shall have the same dynamic characteristics as the standard VU meter (ASA Standard C16.5—1961). If the meter reading fluctuates, maximum values shall conform to this requirement. It should be recognized that in making these measurements, the arm resonance should fall outside of the prescribed pass-band or be sufficiently damped so as not to affect the results.

This measurement is intended to give a measure of the electrical effect of the low-frequency noise output of a turntable pickup combination. Since the result depends on the equalizer, pickup and arm characteristics as much as on the turntable itself, it is not feasible to standardize the turntable alone.

The measurement reflects the electrical effect, not the aural annoyance value, of low-frequency noise. It has been found that strong low-frequency noise at a frequency and intensity below audibility may create severe intermodulation distortion in an audio system, and that in modern systems with extended low frequency response, this may be more serious than the audibility of the low frequency.

The reference level of 1.4 centimeters per second peak velocity approximates the expected program level at 100 Hz and corresponds in amplitude to 7 centimeters per second peak velocity at 500 Hz.

3.25 *High frequency noise:* [8] It shall be standard that the noise level measured with a standard volume indicator (ASA Standard C16.5—1961) when reproducing a disc on a flat velocity basis over a frequency range between 500 and 15,000 Hz shall be at least 55 dB below the level obtained under the same conditions of reproduction using a 1,000 Hz tone recorded at a peak velocity of 7 centimeters per second. Response of the system at 500 Hz shall be 3 dB below the response at 1,000 Hz, and the response shall fall at the rate of at least 12 dB per octave below 500 Hz. Response of the system at 15,000 Hz shall be 3 dB below the response at 1,000 Hz, and the response shall fall at the rate of at least 12 dB per octave above 15,000 Hz.

Reproducing System Noise—Stereophonic

3.30 *Low frequency noise* (*rumble*): It shall be standard that for a stereophonic reproducing system, the low frequency noise voltage in each channel generated by the turntable, its associated pickup and equalizer, or equalized preamplifier when playing an essentially rumble-free silent groove shall be at least 35 dB below a reference level of 1 centimeter per second peak velocity at 100 Hz in the plane of modulation.[9]

The response of the pickup, and equalizer or equalized preamplifier shall conform to the NAB standard reproducing curve; the amplifier and indicating meter shall have uniform response, within ± 1 dB, between 10 and 250 Hz, with 500 Hz response 3 dB below the 100 Hz response, and an attenuation at the rate of at least 12 dB per octave at frequencies above 500 Hz. The amplifier and indicating meter response shall decrease at the rate of at least 6 dB per octave below 10 Hz. The meter used shall have the same dynamic characteristics as the standard VU meter (ASA Standard C16.5—1961). If the meter reading fluctuates, maximum values shall conform to this

standard volume indicator. This standard would then contemplate program peaks running as high as a velocity of approximately 21 centimeters per second. This is believed to be approximately the maximum velocity which can be traced without excessive distortion at groove speeds encountered at the inner radius of a 33-1/3 RPM disc. This has also been substantiated by practical experience.

[8]This measurement is intended to give a measure of noise in terms of a fixed reference. In this way, it becomes a true figure of merit for comparisons of variations in surface noise of discs. It does not, however, take into account the program level which may happen to be recorded on a particular disc nor the dynamic range of the program material. NAB preemphasis will improve the signal-to-noise ratio by approximately 8 dB, thus resulting in an effective signal-to-noise ratio under minimum conditions of 63 dB.

[9]A 100 Hz 1.4 centimeters per second peak reference lateral signal may also be used for this measurement.

requirement. It should be recognized that in making these measurements, the arm resonance should fall outside of the prescribed pass-band or be sufficiently damped so as not to affect the results.

This measurement is intended to give a measure of the electrical effect of the low-frequency noise output of the turntable-pickup combination. Since the result depends on the equalizer, pickup, and arm characteristics as much as on the turntable itself, it is not feasible to standardize the turntable alone.

The measurement reflects the electrical effect, not the aural annoyance value, of low frequency noise. It has been found that strong low-frequency noise at a frequency and intensity below audibility may create severe intermodulation distortion in an audio system, and that in modern systems with extended low frequency response, this may be more serious than the audibility of the low frequency.

The reference level of 1 centimeter per second peak velocity at 100 Hz corresponds in amplitude to 5 centimeters per second peak velocity at 500 Hz since we are then operating on the constant amplitude portion of the recording characteristic.

3.35 *High frequency noise:*[10] It shall be standard that the noise level in each channel measured with a standard volume meter (ASA Standard C16.5—1961) when reproducing a disc on a flat velocity basis over a frequency range between 500 and 15,000 Hz shall be at least 50 dB below the level obtained under the same conditions of reproduction using a 1,000 Hz tone recorded at a peak velocity of 5 centimeters per second. Response of the system at 500 Hz shall be 3 dB below the response at 1,000 Hz, and the response shall fall at the rate of at least 12 dB per octave below 500 Hz. Response of the system at 15,000 Hz shall be 3 dB below the response at 1,000 Hz, and the response shall fall at the rate of at least 12 dB per octave above 15,000 Hz.

Stereophonic Groove Characteristics—(45°—45° system)

3.40 *Planes of modulation:* It shall be standard that in a 45°—45° stereophonic disc the groove shall have orthogonal modulation planes inclined at 45° to a radial line on the surface of the disc and the intersection of the modulation planes shall be normal to said radial lines.

3.45 *Channel orientation:* It shall be standard that the outer groove wall of the disc shall contain the right-hand channel information and the inner wall shall contain the left-hand channel information.

3.50 *Phase:* It shall be standard that the phase relationship between channels shall be such as to result in lateral groove displacement when the stereo recording system is driven with equal amplitude and in-phase signals and the groove displacement shall be vertical when the stereophonic recording system is driven by equal amplitude signals in anti-phase (180°).

Channel Separation—Stereophonic[11]

3.55 It shall be standard that the separation between recorded and unrecorded channels measured at the output of the pickup and equalizer or equalized preamplifier shall be at least 26 dB over the range between 100—7,500 Hz and above 7,500 Hz separation shall not degenerate at a rate greater than 6 dB per octave.

Channel Balance Stereophonic[12]

3.60 It shall be standard that with equal groove modulations and with the outputs of the two complete channels adjusted to be equal within 1/4 dB at 1000 Hz the frequency characteristic of each channel shall agree with the standard reproduce curve of Fig. 1 within ± 1 dB between 100 and 7,500 Hz and within ± 2 dB above and below these frequencies.

Channel Phasing—Stereophonic

3.65 *Recording:* It shall be standard that equal in-phase signals applied to the left and right channel inputs of a stereo disc recorder result in lateral modulation of the stereo groove. Conversely, equal anti-phase signals produce vertical modulation.

3.70 *Reproducing:* It shall be standard that lateral modulation of a disc groove will produce equal in-phase voltages at the output of the turntable and conversely that vertical modulation will produce equal anti-phase voltages.

Test Record Specifications

The NAB Test Record shall consist of a 12-inch double-face disc, side A of which is *Monophonic*

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[10] This measurement is intended to give a measure of noise in terms of a fixed reference. In this way, it becomes a true figure of merit for comparisons of variations in surface noise of discs. It does not, however, take into account the program level which may happen to be recorded on a particular disc nor the dynamic range of the program material. NAB pre-emphasis will improve the signal-to-noise ratio by approximately 8 dB, thus resulting in an effective signal-to-noise ratio under minimum conditions of 58 dB.

[11] It is recognized that the values specified herein are of a magnitude that may in certain cases be subject to noise influences. The measurement of separation is best accomplished by the use of tuned voltmeter.

[12] For measurement purposes it may be assumed that equal modulations are obtained by reproducing a lateral monophonic test record.

and side B *Stereophonic*, recorded at a speed of 33-1/3 RPM, with a fast spiral between bands of radial distance 3/32 inches and containing the following information.[13]

4.05 *Side A, Monophonic:*

Band 1—Level Check: A 1000 Hz tone of 20 seconds duration recorded at the NAB Standard Reference Level of 7 centimeters per second peak velocity.

Band 2—Wow and Flutter: A 3000 Hz tone recorded at 7 centimeters per second peak velocity for a duration of 2 minutes.

Band 3—Frequency Response:

1. Frequency run containing frequencies as tabulated in Table 1 of the Standards with the duration of each tone being 10 seconds except for 100, 1000, 10,000 Hz which shall be 15 seconds.
2. The recorded characteristic shall be the inverse of the NAB curve at 14 dB below the reference level of 7 centimeters per second peak velocity at 1000 Hz.
3. Between tones there shall be a fast spiral of radial distance 1/32 in., except between 100, 1000 and 10,000 Hz where the radial distance shall be 1/16 in.

Band 4—Rumble Reference Level: A 100 Hz tone recorded at 1.4 centimeters per second peak velocity for a duration of 20 seconds.

4.10 *Side B, Stereophonic:*

Band 1—Phase and Balance Test:

1. 1 kHz lateral recording at 7 centimeters per second peak velocity for 20 seconds duration.
2. Fast spiral 1/16-in. radial distance.
3. 1 kHz right channel recorded at 5 centimeters per second peak velocity for 10 seconds duration.
4. Fast spiral 1/16-in. radial distance.
5. 1 kHz left channel recorded at 5 centimeters per second peak velocity for 10 seconds duration.
6. Fast spiral 1/16-in. radial distance.
7. 1 kHz vertical recording at 7 centimeters per second peak velocity for 20 seconds duration.

Band 2—Spot Frequency Test: A series of 3 second tones as follows: Lateral recording of 100 Hz, 1 kHz, 10 kHz, 1 kHz, 100 Hz, 1 kHz, 10 kHz, 1 kHz, etc., with a total duration of 60 seconds with no interval between tones, and with levels adjusted for constant output on a reproducing system using the NAB Standard.

Band 3—Separation Test:

1. 10 kHz right channel recorded at 5 centimeters per second peak velocity for 10 seconds duration.
2. Fast spiral of 1/32 inch radial distance.
3. 10 kHz left channel recorded at 5 centimeters per second peak velocity for 10 seconds duration.
4. Fast spiral of 1/16 inch radial distance.
5. Repeat 1 through 4 at 7.5 kHz, 3 kHz, 1 kHz, 100 and 50 Hz.

Band 4—Level Check: 1 kHz lateral recording at 7 centimeters per second peak velocity ending at 5-1/4 in.

[13]A 4-inch label shall be used which contains a 33-1/3 and 45 RPM strobe.

Glossary of Disc Recording and Reproducing Terms and Definitions

Acetate Disc—An acetate disc is a recording disc consisting of a solid substrate coated with a plasticized cellulose nitrate lacquer.

Advan · Ball—An advance ball is a rounded support (often sapphire) attached to a cutter which rides on the surface of the recording medium so as to maintain a uniform mean depth of cut and correct for small irregularities of the disc surface.

Background Noise—Background noise is the total system noise output of a reproducer in the absence of signal when the system is in normal operation.

Binder—A binder is a resinous material which causes the various materials of a disc compound to adhere.

Biscuit—A biscuit is a small slab of plastic material as it is prepared for use in the presses.

Burnishing Facet (surface)—A burnishing facet in disc recording is the portion of the cutting stylus directly behind the cutting edge and which smooths the groove.

Chip—The chip, in disc recording, is the material removed from the recording medium by the recording stylus while cutting the groove.

Compression Molding—Compression molding is the process of forming a disc by means of compressing a charge of suitable plastic in a cavity.

Constant-Amplitude Recording—Constant-amplitude recording indicates a mechanical recording characteristic wherein, for a fixed amplitude of a sinusoidal signal, the resulting recorded amplitude is independent of frequency.

Constant-Velocity Recording—Constant-velocity recording indicates a mechanical recording characteristic wherein, for a fixed amplitude of a sinusoidal signal, the resulting recorded amplitude is inversely proportional to frequency.

Crystal Cutter—A crystal cutter is a cutter in which the mechanical displacements of the recording stylus are derived from the deformations of a piezoelectric material.

Cutter (mechanical recording head)—A cutter is an electromechanical transducer which transforms an electric input into mechanical motions of a cutting stylus.

Cutting Stylus—A cutting stylus is a stylus having its cutting edge at a plane substantially different from the cutting facet for the purpose of cutting and polishing the groove in an acetate disc.

Disc Recorder—A disc recorder is a mechanical device consisting of a record head with cutting stylus and a properly driven turntable to inscribe a signal on a recording disc.

Drive Pin—A drive pin is a pin similar to the center pin, but located to one side thereof, which is used to prevent a disc from slipping on the recording turntable.

Eccentricity—Eccentricity is the displacement of the center of the recording groove spiral, with respect to the disc center hole.

Equalization (corrective equalization)—Equalization is the effect of intentionally introduced electrical correction employed in the recording and reproducing process to obtain a desired overall response.

Equalization (diameter)—Diameter equalization is the increasing of the high frequency record level with respect to the decreasing groove speed (velocity) in recording to compensate for reproducing losses (see translation loss).

Fast Spiral—A fast spiral is an unmodulated groove on a disc having a spacing that is much greater than that of the modulated grooves.

Feedback Cutter—A feedback cutter is an electro-mechanical transducer which performs the same function as a "cutter." It is equipped with an auxiliary coil mechanically coupled to the driver coil in the magnetic field. Signals exciting the "cutter" are induced into the feedback coil and in turn are fed back to the input circuit of the cutter amplifier resulting in reduced distortion and substantially constant velocity response.

Flash—Flash is the excess compound generated at the edge of a disc during the compression molding operation.

Flutter (wow)—In recording or reproducing, flutter is the deviation in frequency or pitch which results from minor periodic or random changes in the motion of the medium. (*Note:* The term "flutter" usually refers to cyclic deviations occurring at a relatively high rate, as, for example, 10 cycles per second. The term "wow" usually refers to cyclic deviations occurring at a relatively low rate as, for example, a once-per-revolution speed variation of a turntable. The term "drift" usually refers to a random rate close to zero cycles per second.)

Flutter Rate—Flutter rate is the number of cyclical variations per second of the flutter.

Forty-five Disc—A "45" disc is one recorded for reproduction at 45 revolutions per minute. It is normally a seven-inch disc with a raised label area and a center hole 1.5 inches in diameter.

Frequency Record—A frequency record is a disc containing various sine-wave frequencies recorded at known amplitudes, for the purpose of measuring reproducing system frequency response characteristics.

Groove—A groove is the track inscribed in a disc by a cutting or embossing stylus including modulations caused by the vibrations of the stylus.

Groove Angle—Groove angle is the angle between the two side walls of a groove measured in a radial plane perpendicular to the disc surface.

Groove, Concentric or Stopping—A concentric groove is a locked circular groove the center of which is coincident with the center of the recording spiral.

Groove Depth—Groove depth is the vertical distance from the plane at the surface of the disc to the bottom of the groove.

Groove Depth, Variable—Variable groove depth is the technique of varying the average groove depth in relation to the vertical modulation displacement.

Groove, Fast (fast spiral)—A fast groove is an unmodulated spiral groove with groove spacing much greater than normally used for modulated grooves.

Groove, Lead-in (lead-in spiral)—A lead-in groove is an unmodulated fast spiral groove from the edge of the disc to the start of the modulated groove area.

Groove, Lead-over (crossover spiral)—A lead-over groove is a fast groove connecting two modulated sections or bands on a disc.

Groove, Lead-out—A lead-out groove is an unmodulated spiral groove at the end of a recording connecting the last groove at normal modulated groove pitch to a locked concentric or eccentric stopping groove.

Groove, Locked (concentric groove)—A locked groove is a circular continuous groove following a modulated groove section for the purpose of preventing further inward or outward travel of the pickup.

Groove Pitch, Variable—Variable groove pitch is the technique of varying the groove spacing in relation to the lateral modulation displacement of the cutting stylus.

Groove Shape—Groove shape is the contour of a disc groove in a radial plane perpendicular to the disc surface, usually specified in terms of top width, included angle, and bottom radius.

Groove Speed (linear velocity)—Groove speed is the linear speed of a disc groove with respect to a fixed point such as a stylus tip.

Groove, Unmodulated—An unmodulated groove is a groove in a disc which has been recorded with no signal applied to the cutter.

Groove Width—Groove width is the radial distance between the intersections of the groove side walls and the surface plane of the disc.

Grouping—Grouping is nonuniformity in spacing between grooves of a disc caused by irregular motion on the recording lathe feed screw.

Injection Molding—Injection molding is the process of forming a disc by injecting a liquefied plastic material into a die cavity.

Instantaneous Recording—An instantaneous recording is a disc which is intended for direct playback without further processing.

Lacquer Disc—A lacquer disc is a recording disc consisting of plasticized cellulose nitrate lacquer coated on a rigid substrate such as aluminum or glass.

Lacquer Original (*lacquer master*)—A lacquer original is an instantaneous recording on a lacquer disc made for the purpose of generating an original master by an electroforming process.

Land—Land is the flat surface of a disc between adjacent grooves.

Lateral Recording (*monophonic*)—A lateral recording is a disc containing groove modulation caused by radial recorder stylus motion in the plane of the disc surface.

Long Playing—Long playing refers to a disc having a playing time substantially greater than 5 minutes. This normally refers to a 10 or 12 in. 33-1/3 RPM disc recorded with approximately 150 to 300 grooves per inch.

Master (*master original*) (*master negative*)—A master in disc recording is a metal part generated from a Lacquer Original. It may be used to generate metal molds by electroforming or to press discs.

Master No. 2, No. 3, etc.—A No. 2 master in disc recording is a metal part generated from a No. 1 mold by electroforming; a No. 3 master is a similar part generated from a No. 2 mold, etc.

Microgroove—Microgroove is a disc groove having a nominal top width of 3 mils suitable for reproducing with a 1/2 to 1 mil stylus.

Mixer—A mixer, in a sound recording or reproducing system, is a device having two or more inputs, usually adjustable, and a common output, which operates to combine linearly the separate input signals to produce an output signal.

Modulation Noise—Modulation noise is that component of noise which exists only in the presence of a recorded signal.

Mold (*mother*) (*metal positive*)—A mold in disc recording is a metal part derived from a master by electroforming. It has grooves similar to those on a disc and thus may be played as a disc.

Mold No. 1—A No. 1 mold in disc recording is a metal disc derived from a No. 1 Master by electroforming. It may be used to generate a No. 2 master or stampers for pressing discs.

Offset Angle—In lateral disc reproduction, the offset angle is the smaller of the two angles between the projections into the plane of the disc of the vibration axis of the pickup stylus and the line connecting the vertical pivot (assuming a horizontal disc) of the pickup arm with the stylus point.

Optical Pattern (*light pattern*)—An optical pattern is a light pattern which can be observed when the surface of a recorded disc is illuminated radially by a collimated beam of light. The outline of the envelope or pattern is the function of the maximum modulation slope or recorded stylus velocity inscribed in the groove wall.

Overcutting—In disc recording, overcutting is the effect of excessive level characterized by one groove cutting into an adjacent one.

Pickup—A pickup is an electromechanical transducer which is actuated by modulations present in the groove of the recording medium and which transforms this mechanical input into an electric output.

Pickup Arm (*tone arm*)—A pickup arm is a pivoted arm arranged to hold a pickup.

Pickup, Capacitor—A capacitor pickup is a reproducer which depends for its operation upon the variation of its electrical capitance.

Pickup, Cartridge—A pickup cartridge is the removable portion of a pickup containing the electromechanical translating elements and the reproducing stylus.

Pickup, Crystal—A crystal pickup is a reproducer which depends for its operation on the piezoelectric effect of crystals.

Pickup (*variable-reluctance magnetic pickup*)—A variable reluctance magnetic pickup is a reproducer which depends for its operation on the variations in the reluctance of a magnetic circuit.

Pickup, Moving Coil (*dynamic reproducer*)—A moving-coil pickup is a reproducer, the electric output of which results from the motion of a coil in a magnetic field.

Pinch Effect—In disc recording, the pinch effect is a pinching of the reproducing stylus tip twice each cycle in the reproduction of lateral recordings, due to a decrease in angle measured in a plane perpendicular to the modulation slope at any given instant.

Pitch—Pitch is commonly used to express the number of grooves per inch.

Playback—Playback is an expression used to denote reproduction of a disc.

Plastic—Plastic is a resin or polymer suitable for molding discs by the application of heat and pressure in a mold (die) cavity.

Poid—A poid is the curve traced by the center of a sphere when it rolls or slides over a surface having a sinusoidal profile.

Postemphasis (*de-emphasis*) (*playback equalization*)—Postemphasis is the reproducing system equalization conforming to a standard response curve. (See NAB Reproducing System Characteristics.)

Pre-Emphasis (*pre-equalization*) (*record equalization*)—Pre-emphasis in recording is the pre-equalization of a recording system where the system response is the reciprocal of a standard reproduce characteristic.

Pressing—A pressing is a disc produced in a molding press from a master or stamper.

Recording Loss—Recording loss is the loss in level whereby the amplitude of the wave in the medium differs from the amplitude executed by the stylus.

Re-recording—Re-recording is the process of reproducing a recorded sound source and recording this reproduction.

Rumble (*turntable rumble*)—Rumble is low-frequency vibration mechanically transmitted to the recording or reproducing turntable and superimposed on the reproduction.

Separation—Separation is the ratio of signal in the recorded channel to the signal in the unrecorded channel of a stereophonic disc groove.

Side Thrust—Side thrust in disc reproduction is the radial component of force on a pickup arm caused by the stylus drag.

Silvering—Silvering is a process wherein the lacquer original is metalized by precipitating on to this surface the metallic silver in ammoniated silver nitrate.

Silver Spraying—Silver spraying is metalizing the Lacquer Original using a dual spray nozzle wherein the ammoniated silver nitrate and reducer are combined in an atomized spray to precipitate the metallic silver.

Sputtering (*cathode sputtering*)—Sputtering is a process sometimes used in the production of the metal master wherein the original is coated with an electric conducting layer by means of an electric discharge in a vacuum. *Note:* Obsolete.

Stamper—A stamper is a metal negative made by electro-forming from which finished pressings are molded.

Stereophonic Recording—Stereophonic recording in discs is a system where two channels are recorded in a single groove.

Stylus Drag (*needle drag*)—Stylus drag is an expression used to denote the force resulting from friction between the surface of the recording medium and the reproducing stylus.

Stylus, Embossing—An embossing stylus is a recording stylus with a rounded tip which displaces the material in the recording medium to form a groove.

Stylus Force (*static stylus force*) (*vertical stylus force*) (*needle force*)—The stylus force is the vertical force exerted by the stylus on the groove. *Note:* For convenience of measurement the stylus force may be considered equivalent to the vertical force required to just lift the stylus clear of the groove.

Stylus, Recording—A recording stylus is the tool which inscribes the grooves into the disc medium. Tips may be designed for either cutting or embossing the groove.

Stylus, Reproducing—A reproducing stylus is a mechanical transmission element consisting of a suitable tip to follow the modulation of a recorded groove and a means for transferring the resultant vibration to the transducer element of the pickup. *Note:* In many modern pickups the term "stylus" may refer to a sub-assembly comprising the entire moving system of the pickup cartridge.

Surface Noise—Surface noise is the noise component in the electric output of a pickup due to irregularities in the surfaces of the groove walls at or close to the points of stylus contact.

Tracing Distortion—Tracing distortion is the non-linear distortion introduced in the reproduction of discs, because the curve traced by the motion of the spherical tip stylus is limited to a function of the tip radius and its instantaneous acceleration in the groove. *Note:* For example, in the case of a sine-wave modulation in vertical recording the curve traced by the center of the tip of a stylus is a poid.

Tracing Angle Error (*lateral*)—Lateral tracking angle error is the angle, projected to the plane of the disc, between the vibration axis of the mechanical system of the pickup and a tangent to an unmodulated groove at the point of stylus contact.

Tracking Angle Error (*vertical*)—Vertical tracking angle error is the angle between the mechanical axis of the pickup, projected on a plane perpendicular to the disc surface and containing the tangent to the groove at the point of contact, and the effective axis of the vertical modulation of the groove.

Translation Loss (*playback loss*)—Translation loss is the loss in the reproduction of a mechanical recording whereby the amplitude of motion of the reproducing stylus differs from the recorded amplitude in the medium.

Vertical Recording (*hill and dale recording*)—A vertical recording is a mechanical recording in which the groove modulation is in a direction essentially perpendicular to the surface of the recording medium. *Note:* Obsolete.

Wax—In mechanical recording, wax refers to a blend of waxes with metallic soaps. *Note:* Obsolete.

Wax, Cake—Cake wax is a thick disc of wax upon which an original mechanical disc recording may be inscribed. *Note:* Obsolete.

Wax, Flowed—Flowed wax is a mechanical recording medium, in disc form, prepared by melting and flowing wax onto a metal base. *Note:* Obsolete.

Wax Original (*wax master*)—A wax original is an original recording on a was surface for the purpose of making a master. *Note:* Obsolete.

NAB MAGNETIC TAPE RECORDING AND REPRODUCING STANDARDS: REEL-TO-REEL

Physical and Mechanical Specifications

Magnetic Tape Dimensions

1.01 Width. It shall be standard that magnetic tape width shall be 0.246 in. ± 0.002 in. for nominal 1/4-in. sound recording tape.

1.02 Thickness. It shall be standard that the thickness of magnetic tape shall not exceed 0.0022 in.

1.03 Length. It shall be standard that magnetic tape be supplied in the following minimum lengths:

Nominal Reel Dia.	*Nominal Hub*	*1.5 mil base*	*1.0 mil base*	*0.5 mil base*
3 in.	1.75 in.	125 ft.	200 ft.	300 ft.
5 in.	1.75 in.	600 ft.	900 ft.	[14]
7 in.	2.25 in.	1200 ft.	1800 ft.	[14]
10.5 in.	NAB 4.5 in.	2500 ft.	3600 ft.	[14]
14 in.	NAB 4.5 in.	5000 ft.	7200 ft.	[14]

Magnetic Tape Wind

1.04 It shall be standard that tape shall be wound with the oxide coated surface facing toward the hub of the reel.

1.04.01 Recorded tape normally should be wound so that the start of the program material is at the outside of the reel.

1.04.02 It is good engineering practice when storing recorded tapes for long periods of time that the start of the program material be at the inside next to the hub. Tapes so stored or shipped shall be clearly marked to prevent accidental playing in the reverse direction.[15]

Magnetic Tape Level and Uniformity

1.05 It shall be standard that magnetic tape shall have an average output level at 400 Hz at a tape speed of 7-1/2 ips which is uniform within ± 0.5 dB throughout a given reel.

[14]Not recommended.

[15]Tapes stored with the end of the program toward the outside of the reel will have slightly less preprint than postprint. This is generally desirable because postprint tends to be masked by the program material and reverberation effects. Also, rewinding a tape immediately before playing tends to reduce print-through. Another advantage of rewinding before playing is that stresses are relieved and any adhesion of adjacent layers of tape will be eliminated. A further advantage is that tape wound on the take-up reel in the play mode of operation usually is wound more smoothly than when wound at high speed. Therefore, there is less chance of damage during storage or shipment or due to temperature and humidity changes.

1.05.01 This measurement is to be made at the NAB Standard Reference Level and read on a Standard Volume Indicator (ASA Standard C16.5-1961) with bias adjusted for maximum output for the tape under test.

1.06 It shall be standard that magnetic tapes of any specified type shall have an average output at 400 Hz at a tape speed of 7-1/2 ips which is uniform within ± 1 dB from reel to reel.

1.06.01 This measurement is to be made at the NAB Standard Reference Level and read on a Standard Volume Indicator (ASA Standard C16.5-1961) with bias adjusted for maximum output for the tape under test.

Magnetic Track Designations

1.07 It shall be standard that in multitrack recordings, Track One shall be the top track when the tape is moving from left to right with the coated side facing away from the observer and with the leader to the right. The next lower track is designated Track Two, and so on.

Magnetic Track Dimensions

1.08 It shall be standard that the recorded magnetic track for full track recordings be 0.238 in. + 0.010 — 0.004 in. in width.

1.09 It shall be standard that the recorded tracks for two track monophonic or stereophonic recordings be 0.082 ± 0.002 in. in width with a center-to-center spacing of 0.156 ± 0.004 in.

1.10 It shall be standard that the recorded tracks for four track recordings shall be 0.043 + 0.000 — 0.004 in. in width. The center-to-center distances between Tracks 1 and 3, and between Tracks 2 and 4 shall be 0.134 + 0.002 — 0.000 in. The four tracks shall be equally disposed across the tape with a tape width of 0.244 in. and the outer edges of Tracks 1 and 4 coincident with the edges of the tape.

Two Track Stereophonic Recordings

1.11 It shall be standard that for two track stereophonic recordings, Track 1 shall carry the recording for the left-hand channel as viewed from the audience, and Track 2 shall carry the recording for the right-hand channel.

1.12 It shall be standard that for two track stereophonic recordings, the tracks shall be recorded with head gaps in line and phased for reproduction on equipment so connected that when a full track tape is reproduced, it produces in-phase signals in the two channel outputs.

Four Track Monophonic Recordings

1.13 It shall be standard that for four track monophonic recordings, the track recording sequence shall be 1-4-3-2.

Four Track Stereophonic Recordings

1.14 It shall be standard that Tracks 1 and 3 shall be used simultaneously for one direction of tape travel and Tracks 2 and 4 for the other direction. Tracks 1 and 3 shall be used first as the tape is unwound from the supply reel.

1.15 It shall be standard that Tracks 1 and 4 shall carry the recording for the left-hand channel as viewed from the audience, and Tracks 2 and 3 shall carry the recording for the right-hand channel.

1.16 It shall be standard in four track stereophonic recordings that Tracks 1 and 3 and Tracks 2 and 4 shall be recorded with the head gaps in line and shall be phased for reproduction on equipment so connected that when a full-track tape is reproduced it produces in-phase signals at the two channel outputs.

Magnetic Tape Reel Dimensions (1/4 in. tape)

1.17 It shall be standard that NAB magnetic tape reels for 1/4 in. tape be identified as Type A or Type B reels.

1.17.01 It shall be standard that NAB Type A reels shall include 10-1/2- or 14-in. metal or filled plastic reels with a nominal 3-in. center hole and shall conform to the dimensions and specifications of Fig. 2 and Table 2.

1.17.02 It shall be standard that NAB Type B reels shall include all filled or unfilled plastic reels with a nominal 5/16-in. center hole and shall conform to the dimensions and specifications of Fig. 3 and Table 3.

Specifications for Standard Systems

The following systems specifications apply to all high quality magnetic recording and reproducing equipment used for music and speech programs where superior performance is of primary importance.

Magnetic Tape Speeds

2.01 *Preferred speed.* It shall be standard that the preferred tape speed be 7-1/2 in. per second ± 0.2%.

2.01.01 The tolerance on tape speed shall apply to any portion of the reel of tape in use and shall be measured by the method described in Annex A.

2.02 *Supplementary Tape Speeds.* It shall be standard that 15 and 3-3/4 in. per second ± 0.2% be supplementary tape speeds.

2.02.01 The tolerance on tape speed shall apply to any portion of the reel of tape in use and shall be measured by the method described in Annex A.

Standard Reference Level

2.03 It shall be standard that the NAB Standard Reference Level shall be that 400 Hz level which is equal to the recorded level on the NAB Primary Reference Tape.[16]

Standard Recorded Program Level[17]

2.04 It shall be standard that recorded program material shall produce the same reference deflection on a Standard Volume Indicator (ASA Standard C16.5—1961) as that produced by a 400 Hz sine wave signal recorded at the NAB Standard Reference Level.

Standard Reproducing System Response[18]

2.05 It shall be standard that the Reproduce System Response at 7-1/2 in. per second from a 7-1/2 NAB 65 Test Tape shall be within the tolerance limits shown in Fig. 4a, between 30 Hz and 15 kHz. The positive tolerance shall not be exceeded beyond these frequency limits.

2.06 It shall be standard that the Reproduce System Response at 15 in. per second from a 15 NAB 65 Test Tape shall be within the tolerance

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[16]The NAB Primary Reference Tape is a tape of the normal general purpose type which has been selected for average characteristics of output, sensitivity, and distortion. The 400 Hz recording on it was made at 7-1/2 ips with bias adjusted for maximum output, at an output level 8 dB below that which produced 3% third harmonic distortion. This does not imply a failure to meet the 10 dB overload margin of Footnote 17. It is rather, a practical convenient method of specification consistent with the magnetic recording and reproducing process. Since neither the tape nor the measurement conditions can be duplicated exactly in the field, all NAB Standard Test Tapes contain a 400 Hz recording at the NAB Standard Reference Level within ± 0.25 dB as a means for making this level available.

[17]It is well established that at least a 10 dB margin is required between the sine wave load handling capacity of a system and the level of program material as measured by a Standard Volume Indicator (ASA Standard C16.5—1961). These peak levels are believed to be approximately the maximum flux which can be recorded on presently available tapes without excessive distortion. This is also substantiated by practical experience.

[18]It is recommended that the Standard Reproducing System response roll off at the rate of at least 6 dB per octave beyond the frequency limits specified.

Basic Reproducing Characteristics are defined in Annex B. The curves are shown in Fig. 6 and the values listed in Tables 4 and 5. Precise methods of measuring and calibrating a reproducing system are discussed in Annex C. A reproducer calibrated by these methods and meeting all of the specifications of this Standard is considered suitable for measuring and calibrating Standard Test Tapes.

Since NAB Standard Test Tapes are recorded across the full width of the tape, per Section 4.02, a low frequency boost may be expected when the test tape is reproduced on a head of less than full-track width. Refer to the instructions supplied with the test tape for further details.

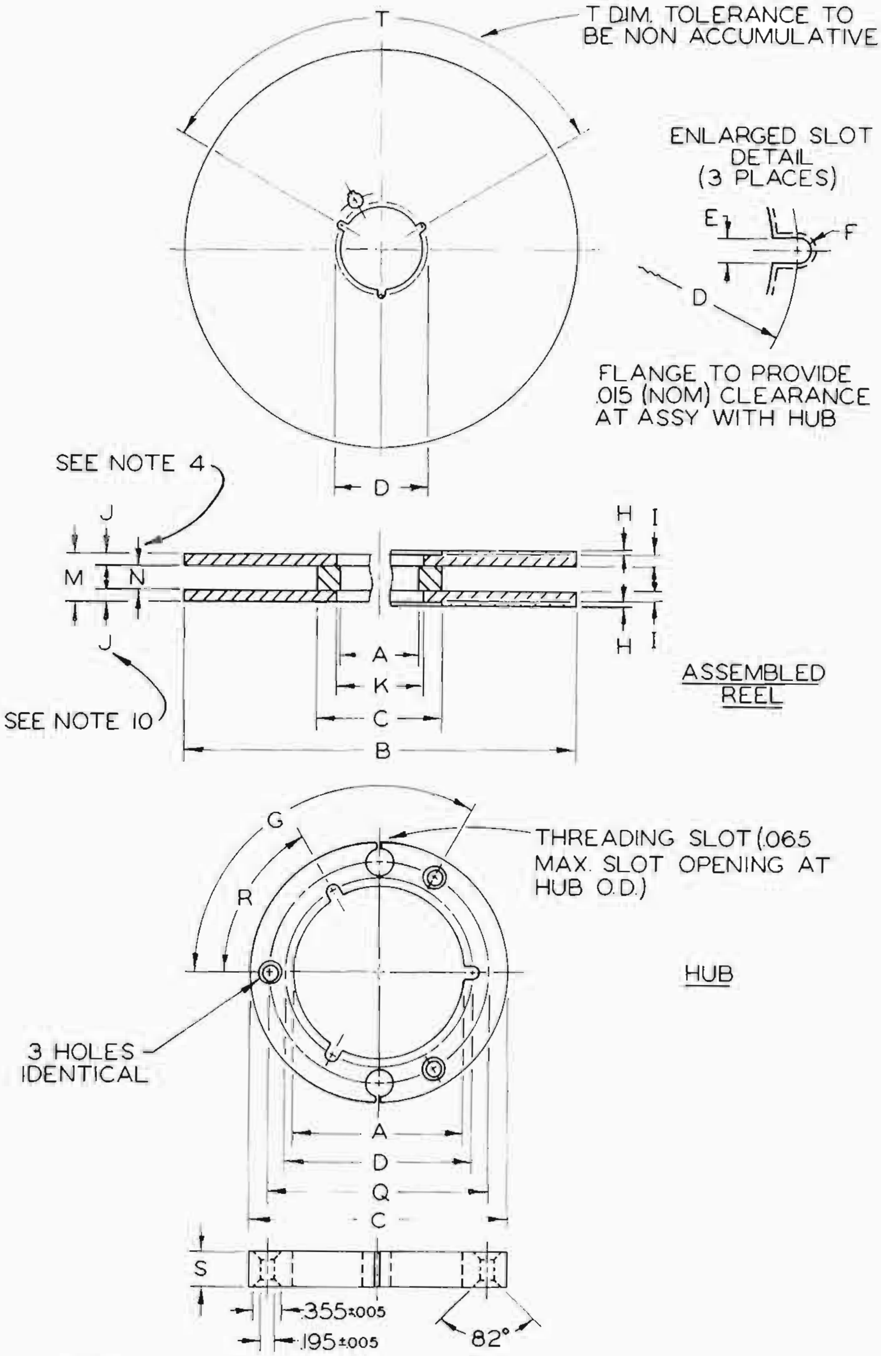

Fig. 2. NAB Type A Reels.

1. Reels shall have dimensions in inches as shown in above and Table 2.

2. Flanges may have cut outs of random shape. The flange open area shall not exceed 50% of the total flange area.

3. Threading slots are shown on the figure but are optional.

4. Dimension N is the distance between flanges at the hub and shall not vary more than ± 0.050 in. when measured from the hub to the periphery of the flanges. Flange wobble shall not extend beyond the hatched areas.

5. The outside cylindrical hub surface (Dimension C) shall be concentric to the center diameter (Dimension A) within 0.010 in. total indicator reading (TIR), and the flange rim (Dimension B) shall be concentric to the center hole within 0.050 in. TIR.

6. The real lateral mounting surfaces in the area of Dimension C of both sides of the reel shall be parallel to each other within 0.010 in. at the C diameter when machinist's flats are put in firm contact with each side. The distance between the two machinist's flats is Dimension M.

7. The outside cylindrical hub surface (Dimension C) shall have a taper no greater than 0.002 in. for metal reels and 0.003 in. for plastic reels.

8. Reels shall be symmetrical in that they shall mount and be functional when mounted on either lateral mounting surface.

9. The flanges shall be fastened to the hub with three or more fasteners which shall not protrude above the lateral mounting surface.

10. Dimension J represents flange thickness only for the NAB Type A metal reel.

TABLE 2

Dimensions for NAB Type A Reels Metal or Filled Plastic Three-Inch Center Hole

	Metal	Plastic
A	3.002 + 0.006 – 0.000	3.010 + 0.015 – 0.000
B	10.500 or 14.000 + 0.020 – 0.010	10.500 ± 0.020
C	4.500 ± 0.010	4.500 ± 0.015
D	3.250 + 0.008 – 0.002	3.250 + 0.020 – 0.000
E	0.219 + 0.010 – 0.000	0.219 + 0.013 – 0.000
F	0.109 + 0.005 – 0.000	0.109 + 0.007 – 0.000
G	120 degrees ± 0.25 degrees	Not applicable
H	0.025 maximum	0.060 maximum
I	0.080 maximum	0.115 maximum
J	0.055 maximum	Not applicable
K	3.031 + 0.006 – 0.000	Not applicable
M	0.462 ± 0.020	0.485 + 0.040 – 0.000
N	0.350 ± 0.005[a]	0.285 ± 0.015
Q	3.875 ± 0.002	Not applicable
R	60 degrees ± 0.25 degrees	Not applicable
S	0.350 ± 0.005	Not applicable
T	120 degrees ± 1/4 degrees	120 degrees ± 1/4 degrees

[a]See figure caption Part 4 of Fig. 2.

TABLE 3

Dimensions for NAB Type B Reels Plastic with Nominal 5/16-in. Center Hole

Nominal size	3	5	5	7	7	Tolerance	10-1/2	Tolerance
B	2.938	5.000	5.000	7.000	7.000	+ 0.031 – 0.000	10.500	± 0.020
C	1.750	1.750	3.000	2.250	4.000	± 0.010	4.500	± 0.015
G	120°	120°	120°	120°	120°	± 0.5°	120°	± 0.5°
H	0.050	0.050	0.050	0.050	0.050	Maximum	0.060	Maximum
I	0.115	0.115	0.115	0.115	0.115	Maximum	0.115	Maximum
M[a]	0.485	0.485	0.485	0.485	0.485	+ .040 – 0.000	0.485	+ 0.040 – 0.000
P	1.750	1.750	2.250	2.250	2.250	Minimum	4.500	Minimum
U	0.319	0.319	0.319	0.319	0.319	± 0.003	0.319	± 0.003
V	0.063	0.063	0.063	0.063	0.063	± 0.005	0.063	± 0.005
W	0.625	0.625	0.625	0.625	0.625	± 0.005	0.625	± 0.005
X[b]								
Y[b]								
Z[b]								

[a]See figure caption Part 9 of Fig. 3.
[b]See figure caption Part 3 of Fig. 3.

limits shown in Fig. 4b, between 30 Hz and 15 kHz. The positive tolerance shall not be exceeded beyond these frequency limits.

2.07 It shall be standard that the Reproduce System Response at 3-3/4 in. per second from a 3-3/4 NAB 65 Test Tape shall be within the tolerance limits shown in Fig. 4c, between 50 Hz and 10 kHz. The positive tolerance shall not be exceeded beyond these frequency limits.[19]

Standard Recorded Response

2.08 It shall be standard that the Standard Recorded Response shall be within the tolerance limits shown in Fig. 5a, 5b, or 5c, depending upon the tape speed.

[19]It should be noted that full-track operation at the lower tape speeds may cause some difficulty in consistently meeting the frequency response standards due to possible tape skew and the resultant azimuth errors.

2.08.01 The recorded response is defined as the difference between the overall record-reproduce response and the reproduce response from an NAB Standard Test Tape of the same speed.[20]

2.08.02 The measurement of recorded response shall be made at the same level as that on the NAB Standard Test Tape. Normal operating bias shall be used.

[20]The recording equalization of a recorder/reproducer should be adjusted for an overall response which matches as nearly as possible the response of the reproducer from the NAB Standard Test Tape. This response is standardized, rather than the simple overall record-reproduce response, in order to assure better interchangeability of recorded tapes.

An alternate definition of a Recorded Characteristic could be in terms of measured surface induction or remanent flux in free space. However, since such measurements are of limited value, particularly when used with ferromagnetic heads at short wavelengths, the definition in 2.08.01 has been accepted as more useful for the purpose of this Standard.

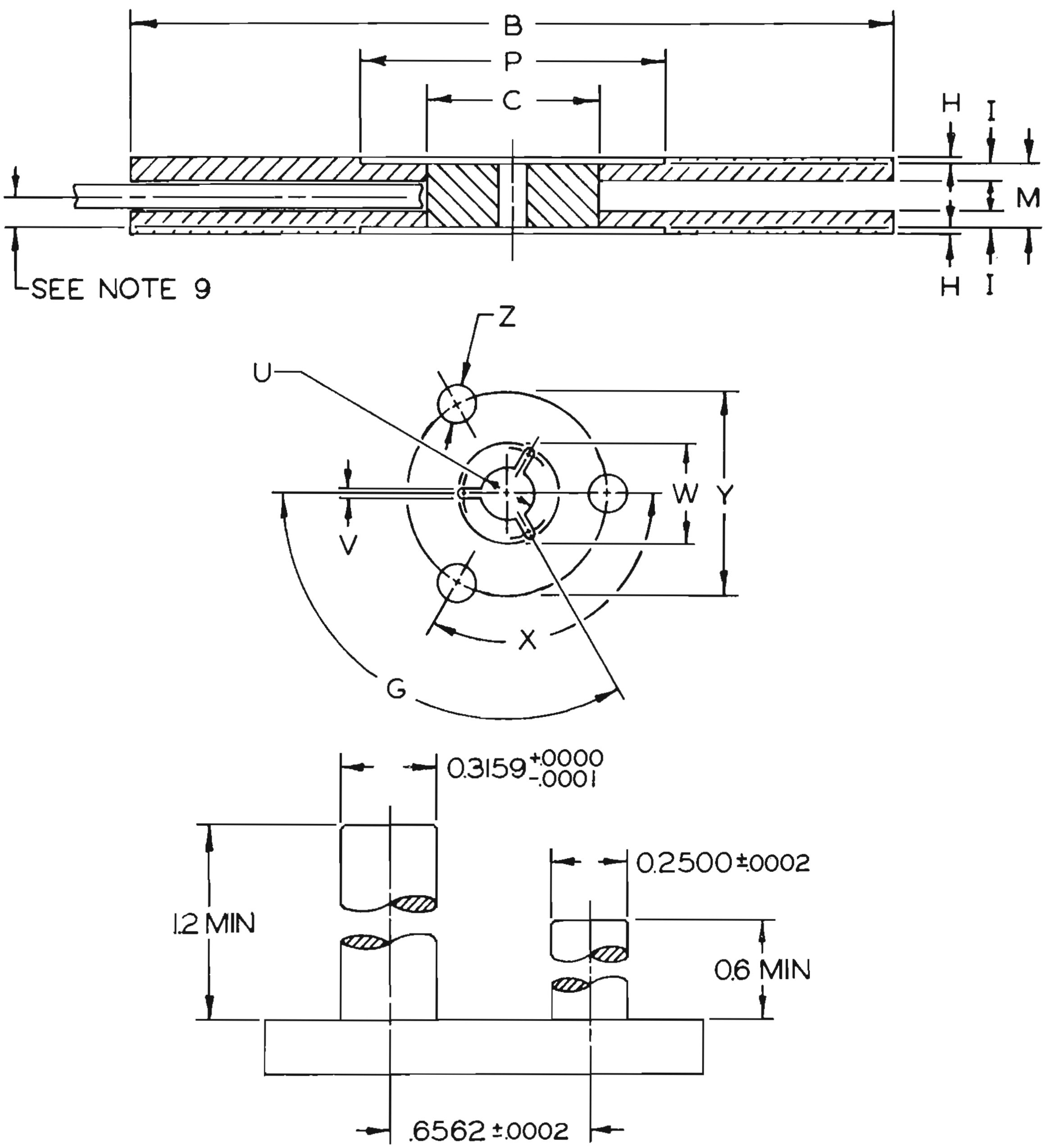

Fig. 3. NAB Type B reel and drive hole gauge.

1. Reels shall have dimensions in inches as shown in the above and Table 3.

2. Flanges may have cut outs of random shape and size, however, flange open area must not exceed 50% of the area between Dimensions B and C.

3. Reels may have one, two or three drive holes and must fit on the gauge shown on Fig. 3. If more than one drive hole is used, they shall be symmetrically spaced around the center hole.

4. Reels are to be constructed so that any profile section taken through the center axis of the reel will fall within the hatched envelope shown above. This includes warpage and lateral run out of the flanges. Bosses, ribs or other raised designs are permitted on the outside of the flange surfaces but they shall not extend beyond the envelope when the reel is rotated on its center axis.

5. The reel hub should be provided with a suitable method of tape attachment. Threading slots are optional, but, if used, shall not be wider than 0.065 in. at the hub surface.

6. The outside cylindrical hub surface (Dimension C) shall be concentric to the center diameter (Dimension U) within 0.010 in. total indicator reading (TIR), and the flange rim (Dimension B) shall be concentric to the center diameter within 0.020 in. TIR.

7. The outside cylindrical hub surface (Dimension C) shall have a taper in relation to either lateral mounting surface no greater than 0.003 in.

8. Reels shall be symmetrical in that they shall mount and be functional when mounted on either lateral mounting surface.

9. The intent of this standard is to accept all plastic reels with an M dimension between 0.485 in. and 0.525 in. With guides set for a nominal tape path center line of 0.243 in. above the reel mounting surface there will be no flange interference with the tape with the I dimension held at 0.115 in. or less and the M dimension at a minimum. A larger M dimension will merely raise the upper flange further away from the upper edge of the tape.

TABLE 4
NAB Standard Reproducing Characteristic
7-1/2 and 15 ips (3180 and 50 μs)

Reproducing amplifier output for constant flux in the core of an ideal reproducing head

Frequency (in Hz)	Response (in dB)	Frequency (in kHz)	Response (in dB)
20	− 8.6	1.5	+ 0.9
25	7.0	2	1.45
30	5.8	2.5	2.1
40	4.1	3	2.75
50	3.0	4	4.1
60	2.3	5	5.4
70	1.8	6	6.6
75	1.6	7	7.7
80	1.4	7.5	8.2
90	1.2	8	8.6
100	1.0	9	9.5
150	0.45	10	10.35
200	0.2	11	11.1
250	0.1	12	11.8
300	− 0.1	13	12.5
400	±0	14	13.1
500	+ 0.1	15	13.6
600	0.1	16	14.2
700	0.2	17	14.7
750	0.2	18	15.2
800	0.2	19	15.6
900	0.3	20	16.1
1 kHz	+ 0.4		

TABLE 5
NAB Standard Reproducing Characteristic
1-7/8 and 3-3/4 ips (3180 and 90 μs)

Reproducing amplifier output for constant flux in the core of an ideal reproducing head

Frequency (in Hz)	Response (in dB)	Frequency (in kHz)	Response (in dB)
20	− 8.8	1.5	+ 2.2
25	7.2	2	3.4
30	5.9	2.5	4.6
40	4.2	3	5.7
50	3.2	4	7.7
60	2.4	5	9.4
70	1.9	6	10.8
75	1.7	7	12.1
80	1.6	7.5	12.6
90	1.3	8	13.2
100	1.1	9	14.15
150	0.6	10	15.0
200	0.4	11	15.8
250	0.2	12	16.6
300	0.15	13	17.2
400	±0	14	17.9
500	+ 0.1	15	18.5
600	0.3	16	19.0
700	0.5	17	19.6
750	0.55	18	20.0
800	0.6	19	20.5
900	0.8	20	21.0
1 kHz	+ 1.0		

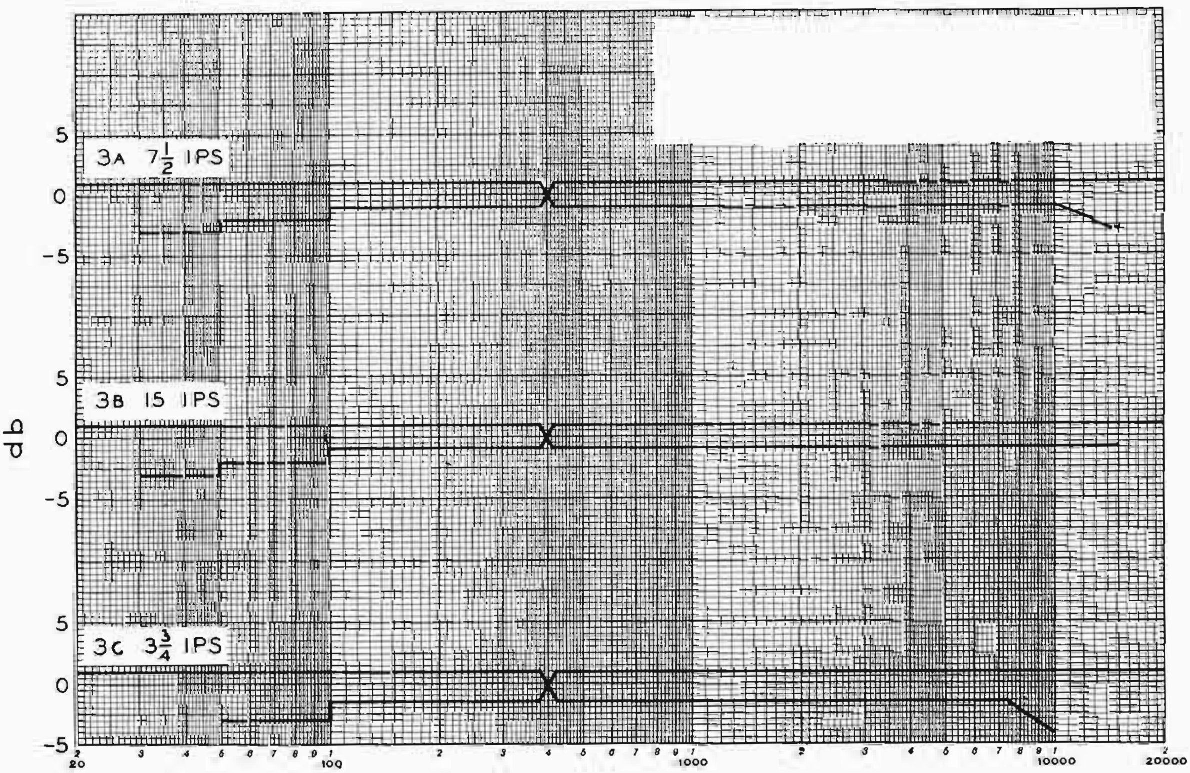

Fig. 4. NAB standard reproducing systems response limits.

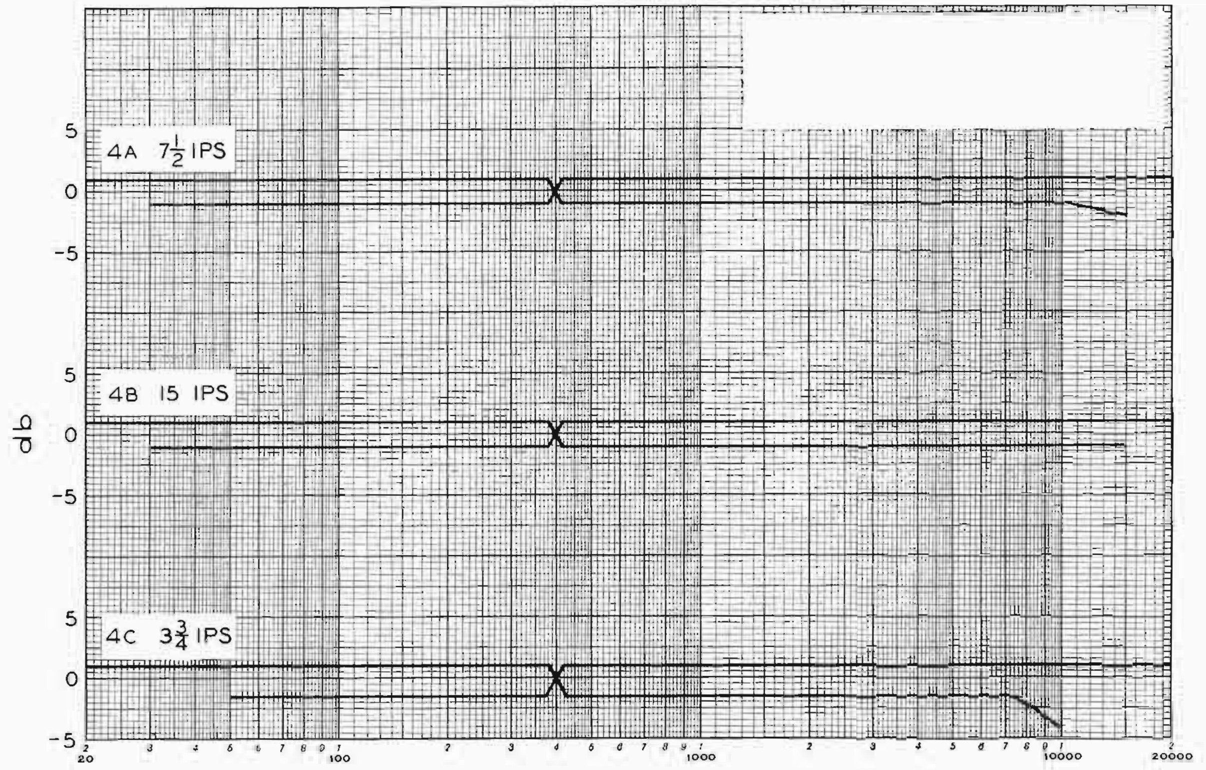

Fig. 5. NAB standard recorded response limits.

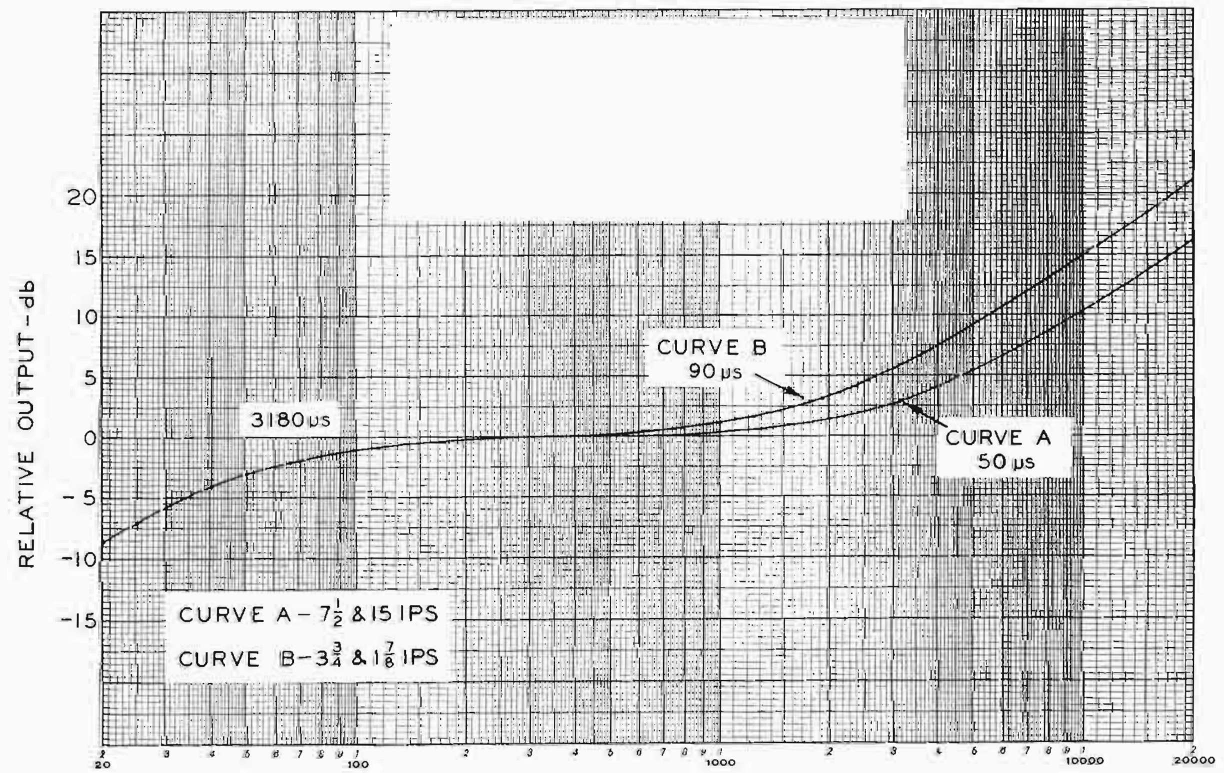

Fig. 6. NAB standard reproducing characteristic reproducing amplifier output for constant flux in the core of an ideal reproducing head.

Signal-to-Noise Ratio[21]

2.09 It shall be standard that the unweighted signal-to-noise ratio shall be not less than the following:

Tape Speed	*Full Track*	*Two Track*	*Four Track*
15 ips	50 dB	45 dB	not used
7-1/2 ips	50 dB	45 dB	45 dB
3-3/4 ips	46 dB	46 dB	45 dB

2.09.01 Unweighted noise shall be measured over the frequency range of 20 Hz to 20 kHz. The response of the measuring system shall be uniform ± 0.3 dB from 30 to 15,000 Hz. Response at 20,000 Hz shall be 3 dB below the 400 Hz value, falling at the rate of at least 12 dB per octave above 20 kHz. The noise measurement shall be made using a tape previously recorded with bias but with no signal. The reference signal level shall be the 400 Hz NAB Standard Reference Level and the indicating meter shall have the dynamics of the Standard Volume Indicator (ASA Standard C16.5—1961). The measuring system shall have a full-wave rectified average measurement law.

2.10 It shall be standard that the weighted signal-to-noise ratio shall be not less than the following:[22]

Tape Speed	*Full Track*	*Two Track*	*Four Track*
15 ips	58 dB	53 dB	not used
7-1/2 ips	60 dB	55 dB	52 dB
3-3/4 ips	57 dB	54 dB	52 dB

2.10.01 Weighted noise shall be measured using the weighting curve of Fig. 7 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. Calibration is made (with the weighting network inserted) at 1000 Hz using the 1000 Hz Standard Level which is included for this purpose on the NAB Standard Test Tape. The indicator meter shall have the dynamics of the Standard Volume Indicator (ASA Standard C16.5-1961) and the measuring system shall have a full-wave rectified average measurement law.

Distortion[23]

2.11 It shall be standard that the overall record reproduce system total harmonic distortion including tape shall be less than 3% rms for a 400 Hz sine wave signal recorded to achieve a reproduce level 6 dB above the NAB Standard Reference Level.

Flutter

2.12 It shall be standard that in the reproduce mode the unweighted flutter content when reproducing an essentially flutter-free recording of 3 kHz at any portion of the reel of tape in use shall not exceed the following:

Tape Speed	*Flutter (rms)*
15 ips	0.15%
7-1/2 ips	0.20%
3-3/4 ips	0.25%

2.12.01 Unweighted flutter content shall be measured over the frequency range of 0.5 Hz to 200 Hz. The response of the measuring system shall be 3 dB down at 0.5 Hz and 200 Hz, and falling at a rate of at least 6 dB per octave below and above these frequencies, respectively. At low frequencies where the meter pointer follows the wave form, the maximum deflection shall indicate the rms value. The indicating meter shall have the dynamics of the Standard Volume Indicator (ASA C16.5-1961), a full-wave rectified average measurement law, and shall be calibrated to read the rms value of a sinusoidal frequency variation.

2.12.02 It shall be standard that the meter be read for random periods throughout the length of the tape, noting the average of the peak readings, but excluding random peaks which do not recur more than three times in any 10-second period.

2.13 It shall be standard that in the reproduce mode the weighted flutter content when reproduc-

[21]These measurements are intended to give a measure of noise in terms of the NAB Standard Reference Level; they are therefore figures of merit for comparisons of system noise. They do not, however, take into account the program level which may be recorded on a particular tape without excessive distortion. It should be borne in mind that the peak signal-to-noise ratio may be approximately 10 dB better than the figures given when the NAB Standard Recorded Program Level is used on general purpose tape.

[22]The use of 3-3/4 ips full-track recordings may present practical difficulties in maintaining azimuth.

See Footnote 21.

The weighted noise measurement employs a frequency response similar to that of the ear at low volume levels and is intended to give a more useful indication of the subjective signal-to-noise ratio than the unweighted measurement. The noise measurement is approximately comparable to that obtained by the use of a 500 to 15,000 Hz filter in disc noise measurements.

Note that the weighted signal-to-noise ratio is poorer at 15 ips than at 7-1/2 ips. This is due to the fact that the reproduce amplifier equalizations remains the same for both speeds while the tape noise increases with tape speed.

[23]The recording amplifier should not overload with high frequency input signals equal in level to the maximum expected low frequency levels. In practice, this means that the recording high frequency pre-emphasis may place an additional demand on the undistorted amplifier output. Distortion of this type is not normally detected by harmonic distortion measurements. Bias leakage into the record or reproduce amplifier circuits may be a source of additional distortion.

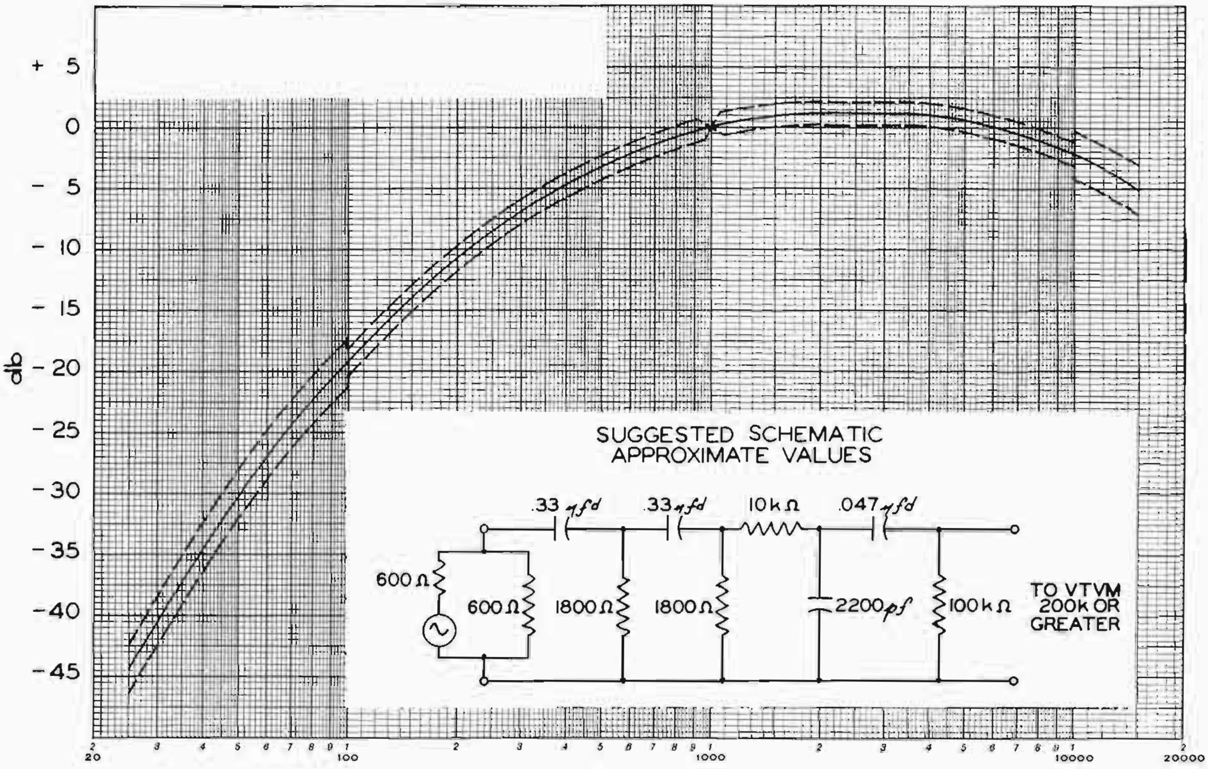

Fig. 7. Weighting curve for weighted noise measurements.

ing an essentially flutter-free recording at 3 kHz at any portion of the reel of tape in use shall not exceed the following:[24]

Tape Speed	*Flutter (rms)*
15 ips	0.05%
7-1/2 ips	0.07%
3-3/4 ips	0.10%

2.13.01 Weighted flutter shall be measured over the frequency range of 0.5 to 200 Hz. The response of the measuring system shall be as specified in Fig. 8. At low frequencies where the pointer follows the waveform, the maximum deflection shall indicate the rms value. The indicating meter shall have the dynamics of the Standard Volume Indicator (ASA C16.5-1961), a full-wave rectified average measurement law, and shall be calibrated to read the rms value of a sinusoidal frequency variation.

2.13.02 It shall be standard that the meter be read for random periods throughout the length of the tape, noting the average of the peak readings, but excluding random peaks which do not recur more than three times in any 10-second period.

[24]The weighted flutter measurement employs a frequency response similar to the sensitivity of the ear to frequency variations versus the frequency of these variations ("flutter rate") and is intended to give a more useful indication of the subjective effect of flutter than the unweighted measurement.

Crosstalk[25]

2.14 It shall be standard that for two or four track monophonic systems and for four track stereophonic systems, the adjacent track signal-to-crosstalk ratio shall be not less than 60 dB in the range from 200 Hz to 10 kHz.[26]

2.14.01 For these measurements, bias shall not be applied to the unrecorded tracks.

Stereophonic Channel Separation

2.15 It shall be standard that with stereophonic systems channel separation shall be not less than 40 dB between the frequencies of 100 Hz and 10 kHz.

2.15.01 For measurements of stereophonic systems, bias shall be applied to both tracks.

[25]These measurements shall be made at the recorded level of the frequency response portion of the NAB Standard Test Tape, and must be made with a tuned voltmeter in order to eliminate the effect of noise. The reference level shall be the 400 Hz tone in the frequency response portion of the NAB Test Tape.

[26]It should be recognized that two-track monophonic tapes which are duplicated on stereophonic equipment will have the crosstalk characteristics of a stereophonic system and therefore may not meet this crosstalk specification.

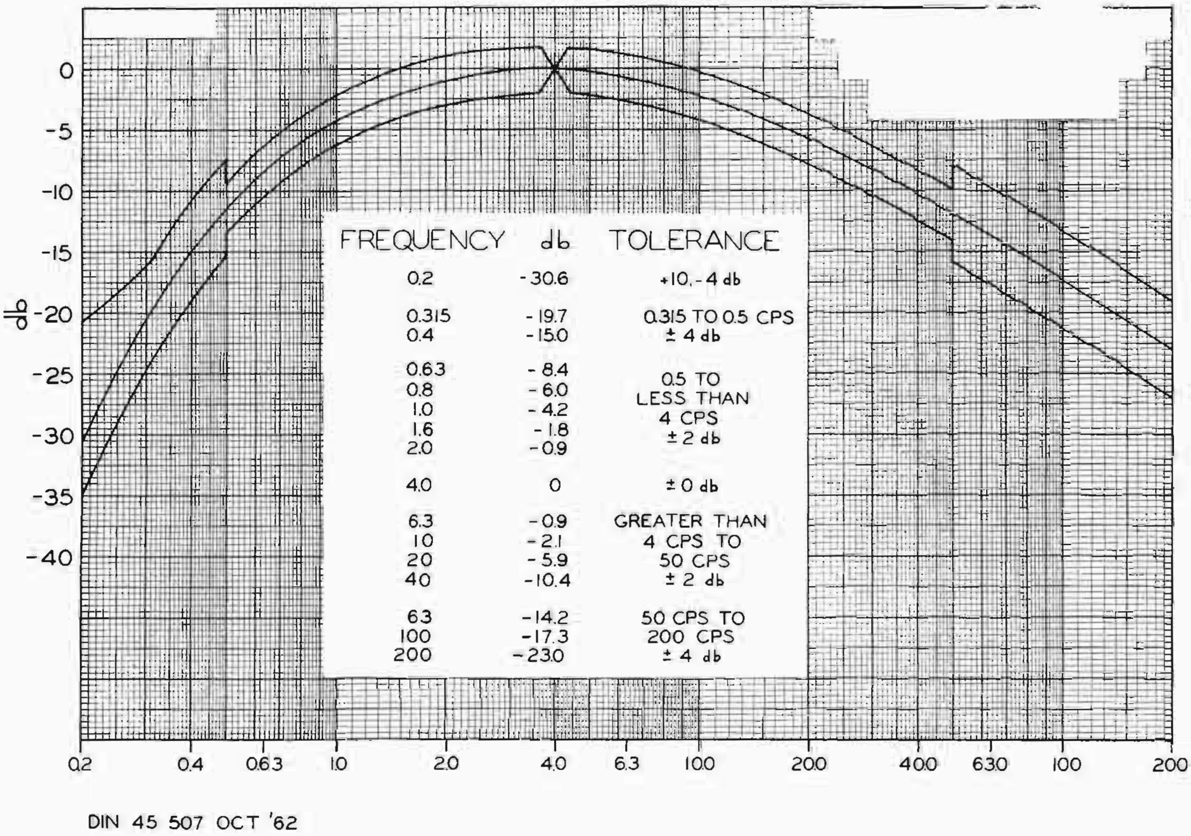

Fig. 8. Weighting curve for weighted flutter measurements.

Specifications for Special Purpose Limited Performance Systems

The use of lightweight portable magnetic recorders is recognized in this section of the Standard. It presents what are considered to be the minimum acceptable performance requirements where adequate voice intelligibility and interchangeability of recorded tapes are of primary importance. Systems meeting these specifications are not suitable for maximum fidelity recording of speech or music.

Tape Speeds

3.01 It shall be standard that tape speeds for Special Purpose Magnetic Recording and Reproducing Systems be 7-1/2, 3-3/4, or 1-7/8 in. per second, ± 2% as measured at any portion of the reel of tape in use, and shall be measured by the method described in Annex A.

Flutter

3.02 It shall be standard that in the reproduce mode, unweighted flutter content, when reproducing an essentially flutter-free recording of 3 kHz, shall not exceed 0.5% rms at any portion of the reel of tape in use.

3.02.01 Unweighted flutter content shall be measured over the frequency range of 0.5 Hz to 200 Hz. The response of the measuring system shall be 3 dB down at 0.5 Hz and 200 Hz, and falling at a rate of at least 6 dB per octave below and above these frequencies, respectively. At low frequencies where the meter pointer follows the waveform, the maximum deflection shall indicate the rms value. The indicating meter shall have the dynamics of the Standard Volume Indicator (ASA C16.5-1961), a full-wave rectified average measurement law, and shall be calibrated to read the rms value of a sinusoidal frequency variation.

3.02.02 It shall be standard that the meter be read for random periods throughout the length of the tape, noting the average of the peak readings, but excluding random peaks which do not recur more than three times in any 10-second period.

Standard Recorded Program Level[27]

3.03 It shall be standard that recorded program material shall produce the same reference

[27] It is well established that at least a 10-dB margin is required between the sine wave load handling capacity of a

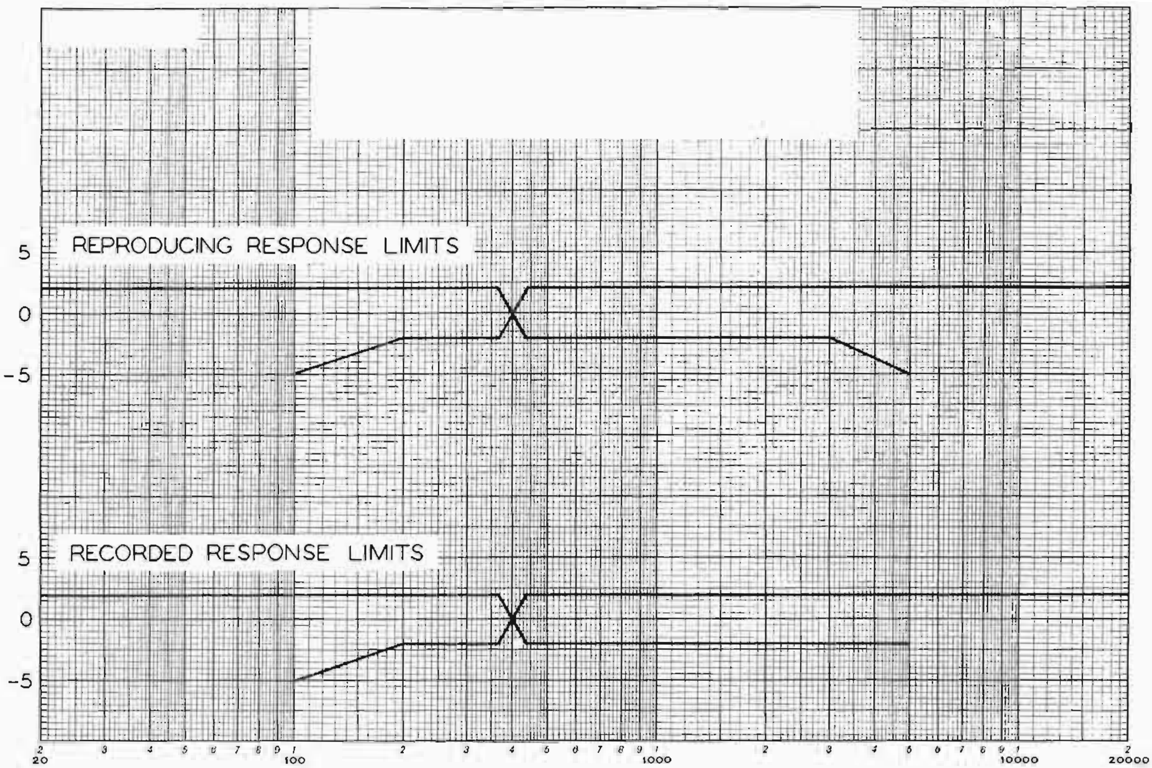

Fig. 9. NAB reproducing system and recorded response limits. Special purpose limited performance systems applicable to 7-1/2, 3-3/4, and 1-7/8 ips.

deflection on a Standard Volume Indicator (ASA Standard C16.5-1961) as that produced by a 400 Hz sine wave signal recorded at the NAB Standard Reference Level.

Reproducing System Response[28]

3.04 It shall be standard that the Reproduce System Response from an appropriate NAB Test Tape shall be within the tolerance limits shown in Fig. 9.

3.04.01 This specification represents the minimum acceptable limits, and is not intended to restrict the frequency range of voice recording systems which have the inherent capability of wide-range recording, without distortion. It is, however, often considered desirable to limit the extreme low frequency response for improved speech intelligibility.

system and the level of program material as measured by a Standard Volume Indicator (ASA Standard C16.5-1961). These peak levels are believed to be approximately the maximum flux which can be recorded on presently available tapes without excessive distortion. This is also substantiated by practical experience.

At a speed of 1-7/8 ips, it may be advisable to record certain types of program material at a lower level to avoid distortion.

[28]Basic Reproducing Characteristics are defined in Annex B. The curves are shown in Fig. 6 and the values listed in Tables 4 and 5.

Recorded Response

3.05 It shall be standard that the Recorded Response shall be within the tolerance limits shown in Fig. 9.

3.05.01 The recorded response is defined as the difference between the overall record—reproduce response and the reproduce response from an NAB Standard Test Tape of the same speed.

3.05.02 The measurement of Recorded Response must be made at the same level as that on the Standard Test Tape. Normal operating bias shall be used.

3.05.03 It is recommended that the Recorded Response be attenuated below 100 Hz at the rate of approximately 6 dB per octave in order to improve speech intelligibility. A similar attenuation above 5 kHz is recommended in order to reduce the chance of high frequency tape overload at the lower tape speeds.

Signal-to-Noise Ratio

3.06 It shall be standard that the unweighted signal-to-noise ratio shall be not less than the following:

Full Track	46 dB
Two Track	43 dB
Four Track	40 dB

3.06.01 Unweighted noise shall be measured over the frequency range of 20 Hz to 20 kHz. The response of the measuring system shall be uniform ± 0.3 dB from 30 to 15,000 Hz. Response at 20,000 Hz shall be 3 dB below the 400 Hz value, falling at the rate of at least 12 dB per octave above 20 kHz. The noise measurement shall be made using a tape previously recorded with bias but with no signal. The reference signal level shall be the 400 Hz NAB Standard Reference Level and the indicating meter shall have the dynamics of the Standard Volume Indicator (ASA Standard C16.5-1961). The measuring system shall have a full-wave rectified average measurement law.

Standard Test Tapes

4.01 The NAB Standard Test Tapes for reel-to-reel equipment shall be designated as follows:

Speed	*Test Tape*
15 ips	15 NAB 65
7-1/2 ips	7-1/2 NAB 65
3-3/4 ips	3-3/4 NAB 65
1-7/8 ips	1-7/8 NAB 65

4.02 All test tapes shall be recorded across the full width of the tape.

4.03 Each NAB Standard Test Tape shall contain five parts as defined in the following sections.

4.03.01 An azimuth adjustment tone of 60 seconds duration at the following frequencies:[29]

Speed	*Frequency*
15 ips	15 kHz
7-1/2 ips	15 kHz
3-3/4 ips	10 kHz
1-7/8 ips	5 kHz

4.03.02 A 400 Hz sine wave signal of 20 seconds duration at the following level referred to the NAB Standard Reference Level:

Speed	*Level*
15 ips	0 dB
7-1/2 ips	– 10 dB
3-3/4 ips	– 15 dB
1-7/8 ips	– 15 dB

4.03.03 A frequency response test containing the following frequencies at the indicated recorded levels. Each tone shall be approximately 12 seconds in duration and preceded by a voice announcement. The signal frequencies are recorded on these tapes in such a manner that they would supply a constant output level when reproduced on an Ideal Reproducing System.[30] The relative levels are measured during manufacture of the tape on a reproducing system of known, defined characteristics which are determined by the method described in Annex C.

15 ips 0 dB (in kHz)	*7-1/2 ips – 10 dB (in kHz)*	*3-3/4 ips – 15 dB (in kHz)*	*1-7/8 ips – 15 dB (in kHz)*
15	15		
12	12		
10	10	10	
7.5	7.5	7.5	
5	5	5	5
2.5	2.5	2.5	2.5
1	1	1	1
(in Hz)	*(in Hz)*	*(in Hz)*	*(in Hz)*
750	750	750	750
500	500	500	500
250	250	250	250
100	100	100	100
75	75	75	75
50	50	50	50
30	30	30	30

4.03.04 A 400 Hz sine wave signal of 20 seconds duration at the NAB Standard Reference Level.[31]

4.03.05 A 1000 Hz sine wave signal of 60 seconds duration at the NAB Standard Recorded Program Level. (See Section 2.04)

[29]The recorded level shall be the same as that of the corresponding frequency in the Frequency Response portion of the tape. The recorded azimuth shall be at 90° + 1 minute with respect to the edge of the tape.

[30]See Annex B of this Standard for a definition of the Ideal Reproducing System and the equalization to be used. Note that the curves of Fig. 6 are frequency response curves of the Ideal Reproducer with constant flux in the core of the Ideal Head instead of the basic amplifier curve which was used in the 1953 NAB Standard. The concept of expressing a curve in terms of time constants remains unchanged and it is still necessary to modify the amplifier response to compensate for practical reproduce head losses in a Standard Reproducing System.

[31]The level on the NAB Primary Reference Tape is that of a 400 Hz tone at a tape speed of 7-1/2 ips, and thus represents a wavelength of 18.75 mils. Test Tapes for speeds other than 7-1/2 ips are recorded such that they would supply the same ideal head flux at the same wavelength as the Primary Reference Tape, when measured on an Ideal Reproducing System.

Annex A

Methods of Tape Speed Measurement

It shall be standard that tape speed be measured by applying the 1/4 in. wide circumference of a precision pulley mounted on precision low friction bearings to the surface of the tape between the capstan and head assembly. The rotational speed of the pulley when driven by the tape may be measured by the use of an ac tachometer generator or by a stroboscope disc mounted on the pulley's flat surface. Tests of tape speed shall be made relative to the power line frequency.

It must be recognized that tape speed depends to some extent on tape thickness and tension, and on room temperature and humidity. Therefore, speed checks should be made under normal operating conditions with the machine adjusted according to manufacturer's recommendations.

Measurements shall be made with a tape the thickness of which is 0.0019 in. ± 0.0002 in. which corresponds to the thickness of nominal 1.5 mil base tape.

A suggested design for a practical stroboscope disc consists of a pulley with a diameter of 1.4305 + 0.0002 — 0.0000 in. upon which is attached a printed disc having 72 and 36 equally spaced dots or solid lines. A neon lamp operating from the 60 Hz motor supply flashes at a 120 Hz rate. The stroboscope disc, when illuminated by this lamp, will indicate 7-1/2 and 15 ips tape speeds, respectively. For 3-3/4 ips operation, a diode in series with a neon lamp is required so that the lamp will flash at a 60 Hz rate.

It shall be standard that when using a stroboscope disc as recommended above, no more than 14 dots per minute shall drift past a fixed reference point in either direction for 7-1/2 or 15 ips operation. For 3-3/4 ips operation the drift per minute shall not exceed 7 dots on the 36 dot disc. These limits of drift correspond to the speed tolerance limits of ± 0.2%.

Annex B

Ideal Reproducing System

It shall be standard that the NAB Ideal Reproducing System is a theoretical reproducer system. It consists of an "ideal reproducing head[a] and an amplifier the output voltable of which shall conform to the voltage-frequency curve of Fig. 6, with constant flux versus frequency in the core of the head.[b]

The curve of voltage versus 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 expressions:

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

$\omega = 2\pi f$

f = frequency

And, t_1 and t_2 are as follows:

Tape Speed	t_1	t_2
15 ips	3180 μs	50 μs
7-1/2 ips	3180 μs	50 μs
3-3/4 ips	3180 μs	90 μs
1-7/8 ips	3180 μs	90 μs

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

[b]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.

Annex C

Primary Calibrated Reproducing System [a]

A Primary Calibrated Reproducing System used for the purpose of calibrating Standard Test Tapes shall meet the following specifications:

1. The system response shall not deviate more than ± 3 dB from the ideal over the frequency range of interest.

2. Electrical—Apparent core loss at the highest frequency of interest shall not exceed 3 dB undamped head resonance shall not exceed 3 dB and amplifier deviation from the Ideal Response shall not exceed ± 3 dB.

3. Magnetic—Head gap losses shall not exceed 3 dB at the highest frequency of interest and the head contour effect curve shall not deviate more than ± 2 dB from the average.

Electrical losses shall be determined from measurements of the amplifier frequency response characteristic and the reproduce system

[a]An NAB Standard Reproducing System need not fulfill the requirements for a Primary Calibrated Reproducting System as described in this Annex.

output voltage characteristic with constant flux versus frequency in the head core.

Magnetic losses shall be determined from calculations of gap loss and measurements of head contour effects.

The following paragraphs specify the methods by which these characteristics shall be measured and the reproduce system calibrated. The procedure is to determine the various losses independently and consider them as deviations from the theoretical "Ideal Reproducing System."

Electrical Measurements

Three response frequency curves shall be made. First, the amplifier response alone with voltage directly proportional to frequency (voltage doubles for each octave frequency increase) measured by conventional methods; second, the head and amplifier response measured by applying a small voltage proportional to frequency across a low resistance connected in series with the head, and finally, the head and amplifier response measured with a constant flux versus frequency induced into the core of the reproduce head. The third measurement can be made by placing a fine wire over the head gap, securing it firmly in place, and feeding constant current through the wire. Although the resultant flux distribution is not identical to that from a tape, it is considered to be satisfactory for the purposes of this measurement. Ideally the third curve would follow the Standard Reproducing Characteristic as shown in Fig. 6. However, in practice the curve may vary from the ideal because of head resonance effects, and apparent core losses. Resonance effects are determined by comparing curves 1 and 2 while apparent core losses are identified by comparing curves 2 and 3.

Magnetic Measurements

A curve of approximate gas loss versus frequency shall be calculated from the following expression:

$$\text{Gap loss} = -20 \log_{10} \frac{\sin [(180°)(d/\lambda)]}{\pi d/\lambda}$$

where d = null wavelength

λ = wavelength at which the gap loss is calculated.

The null wavelength is determined by finding the recorded wavelength at which the reproducing head output reaches a distinct minimum of at least 20 dB below maximum output. It is desirable to make this measurement at 1/2 or 1/4 normal speed and with a tuned voltmeter with no greater than a one-third octave band width. In order to reach the 20 dB null the head gap edges must be sharp, straight and parallel.

In order to determine that a gap meets these requirements visual examination of the gap at about 1000X magnification is necessary. This may be accomplished with a toolmaker's microscope or with suitable photomicrographs taken at several locations along the gap. It has been shown that the null wavelength will be 1.14 times the optical gap length for a perfectly constructed head.[b] In practice it is usually greater. However, it is recommended that the null wavelength not be greater than 1.25 times the optical gap length for this application.

A curve of the low frequency reproducing response shall be made using a constant current vs. frequency recording made with normal bias and the result compared to the curve of reproduce system response with constant flux vs. frequency induced into the head core (Curve 3 above), in order to determine contour effects. This reproducing response curve ideally should follow the Standard Reproducing Characteristic at frequencies below approximately 750 Hz at 7-1/2 in. per second. In practice it is known that all of the flux from a tape at long wavelengths does not enter the head core. The amount that does enter varies with wavelength depending upon the length of tape to head contact, the shields in and around the head and the shape of the pole pieces.

It is important to accurately measure frequency when making the recording so that slight frequency errors are not interpreted as response errors. It is recommended that the slope of the contour effects curve not exceed 10 dB per octave so that a frequency error of 1/2% will result in a response error of not more than 0.07 dB.

Calibrated System Response

Having determined the various losses or deviations from the Ideal System Response, a calibration of the actual system is obtained as follows: From the system response curve, Curve 3 under Electrical Measurements, subtract the gap loss curve at high frequencies and algebraically add the low frequency portion by the contour effect curve. The resulting curve is the reproducing system response for constant available flux from a tape. The difference between this curve and the Standard Reproducing System Characteristic represents the deviation from the ideal response.

Glossary of Magnetic Tape Recording and Reproducing Terms and Definitions

Azimuth Loss—The signal loss due to misalignment of the playback head gap and the recorded signal.

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[b]W. K. Westmijze, "Studies on Magnetic Recording" Philips Research Reports, Vol. 8, No. 3, pp. 161-183, 1953.

Bias—See Magnetic Biasing.

Capstan—The spindle or shaft which drives the pressure roller and tape.

Contour Effect—The alteration of the voltage output from a magnetic reproducing head at long wavelengths due to the shape of the pole pieces and the presence of magnetic shielding close to the tape.

Distortion, Harmonic—Distortion charazterized by the appearance in the output of harmonics of the fundamental frequency when the input wave is sinusoidal.

Distortion, Per Cent Harmonic—A measure of the Harmonic Distortion in a system or component, numerically equal to 100 times the ratio of a root-mean-square voltages (or currents) of each of the individual harmonic frequencies, to the root-mean-square voltage (or current) of the fundamental.

Equalization—Equalization is the process of modifying the amplitude-frequency response characteristics in a recording and reproducing system, for one or both of the following purposes:

1. To produce a flat overall frequency response.
2. To match the signal handling capabilities of the recording system to the frequency distribution of the signal to be recorded and/or to minimize the audible noise of the reproducer, in order to produce the maximum audible signal-to-noise ratio.

Equalizer—A device designed to modify the amplitude-frequency response of a system or component.

Flutter—In recording and reproducing, flutter is the deviation of frequency which results in general from non-uniform motion during recording, or reproduction. (*Note:* The term "wow" usually refers to flutter occurring at a relatively low rate as, for example, a once-per-revolution speed variation of a phonograph turntable.)

Frequency Response—The relative output versus frequency of a recording or reproducing system. A more specific term than "frequency range," and usually presented in the form of a curve plotted with frequency as the ordinate and the output in dB as the abscissa.

Gap Length, Physical—The physical distance between adjacent surfaces of the pole tips of a magnetic head measured in the direction of tape travel.

Gap Length, Effective—The recorded wavelength at which the output of a magnetic head goes through the first null point. (*Note:* The effective gap length is greater than the physical length for both theoretical and practical reasons.)

Head Alignment—Positioning of the record and reproduce heads on a tape recorder so that their gaps are mutually parallel and perpendicular to the path of travel of the tape.

Level, Recorded—The recorded level on a magnetic tape is the level measured by a standard reproducing system with respect to the NAB Standard Reference Level, expressed in decibels.

Magnetic Biasing—Magnetic biasing is the simultaneous conditioning of the magnetic recording medium during recording by superposing an additional magnetic field upon the signal magnetic field. (*Note:* In general, magnetic biasing is used to obtain a substantially linear relationship between the amplitude of the signal and the remanent flux density in the recording medium.)

Magnetic Biasing, AC—The ac magnetic biasing is magnetic biasing accomplished by the use of an alternating current usually well above the signal frequency range, in the recording head.

Magnetic Head—A transducer for converting electrical signal currents into magnetic signals for storage on magnetic media, for converting stored magnetic signals into electrical signals, or for erasing stored magnetic signals. (*Note:* A ferromagnetic head is one in which the permeability of the material is much greater than one, being most often several thousands.)

Magnetic Head Core—The high permeability structure which forms the head gap and supports the head winding.

Magnetic Recording Head—A magnetic head for transforming electric signals into magnetic signals for storage on magnetic tape.

Magnetic Reproducing Head—A transducer for converting magnetic signals on magnetic tape into electric signals.

Noise (audio frequency)—Any electrical disturbance including both hum and hiss introduced from sources extraneous to the signal.

Noise, Unweighted—The noise measured within the audio frequency pass band using a measuring instrument which is uniform in response with respect to frequency over some specified pass band.

Noise, Weighted—The noise measured within the audio frequency pass band using a measuring instrument which has a frequency selective characteristic. The sensitivity is usually greatest in the frequency range where the car is most sensitive.

Post-emphasis—That portion of the equalization which is applied in the reproducer.

Pre-emphasis (preequalization)—That portion of the equalization which is applied in the recorder.

Print-through—The undesired transfer of a recorded signal from one layer of magnetic tape to adjacent layers.

Ring Head—A magnetic head in which the magnetic core material forms an enclosure with one or more gaps. The magnetic tape bridges one of these gaps and is contacted by the pole pieces.

Surface Induction—The flux density at right angles to the surface of the tape in a medium of unity permeability and not in contact with a reproducing device.

Test Tape—A test tape is a recording of various known frequencies at known amplitudes, usually for the purpose of testing and measuring reproducing equipment.

Weighting Characteristic—The shaped response-frequency characteristic of a measuring device used to produce more realistic indications of the subjective effects than are obtained with unweighted (flat) measurements.

NAB MAGNETIC TAPE CARTRIDGE SYSTEM RECORDING AND REPRODUCING STANDARDS[1]

Mechanical Specifications

Cartridge Sizes

1.05 It shall be standard that there shall be three cartridge sizes physically identified and designated as NAB-A, NAB-B, and NAB-C. Pertinent dimensions are shown in Chart A, Table 1.

CHART A
NAB CARTRIDGE STANDARD

THE SPRING ACTION DEVICE MUST NOT PROTRUDE MORE THAN 1/4" INTO CUT-OUT FROM REFERENCE B-B, NOR MORE THAN 3/16" ABOVE DECK SURFACE C-C.

FORCE REQUIRED TO DEFLECT SPRING FULLY SHALL BE 4 TO 8 OZ. MEASURED ALONG A-A, PARALLEL TO BASE.

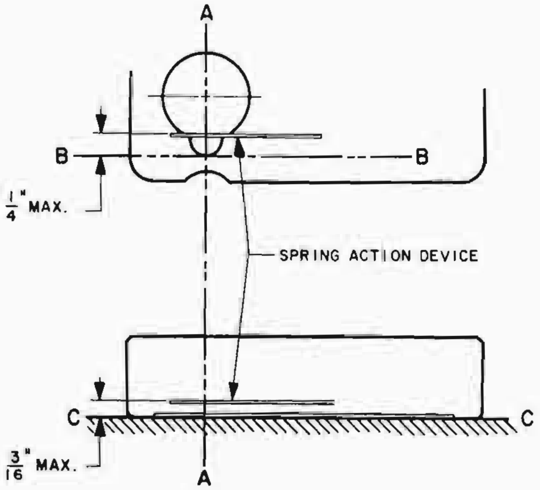

FIG. I REQUIRED SPRING ACTION DEVICE LIMITATIONS

TABLE I

CARTRIDGE NAB TYPE	WIDTH "W" ± 1/64"	LENGTH "L" MAX.	HEIGHT "H" MAX.
A	4"	5 1/4"	.9375
B	6"	7"	.9375
C	7 5/8"	8 1/2"	.9375

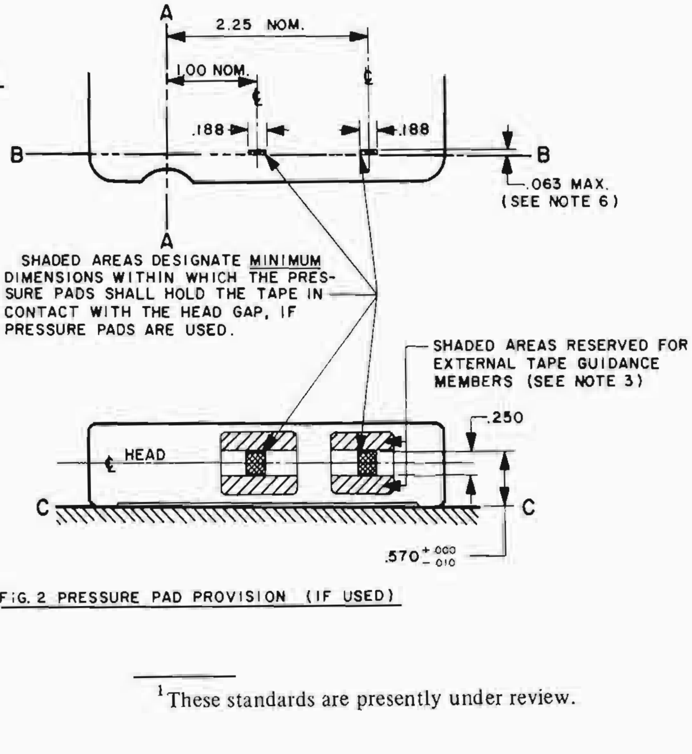

FIG. 2 PRESSURE PAD PROVISION (IF USED)

[1] These standards are presently under review.

CHART A NAB CARTRIDGE STANDARD (Continued)

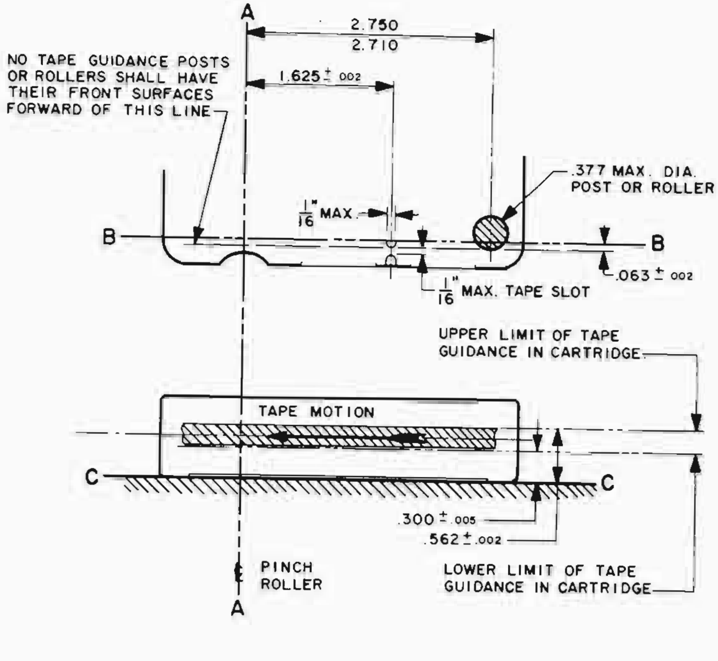

FIG. 4 TAPE GUIDANCE LIMITS

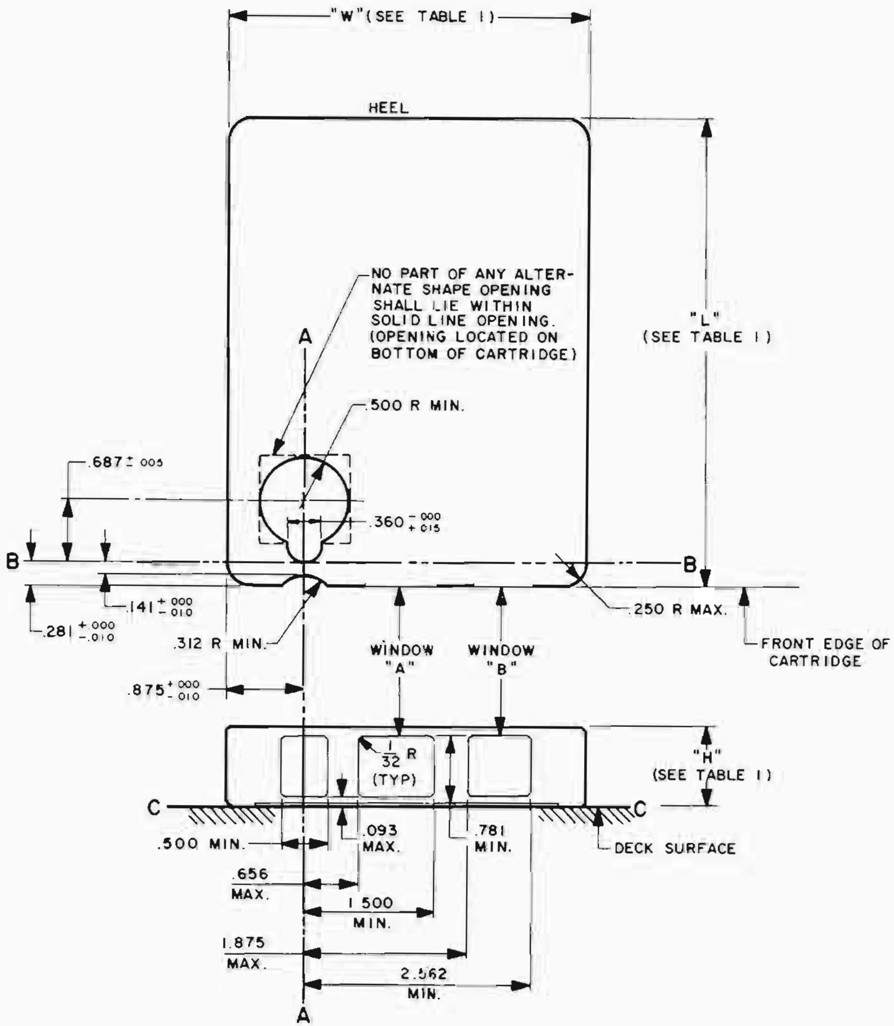

FIG. 3 CARTRIDGE DIMENSIONS

NOTES

1. DIMENSIONS
   ALL IMPORTANT OPERATING DIMENSIONS ARE REFERENCED FROM TWO IMAGINARY MUTUALLY PERPENDICULAR, VERTICAL PLANES MARKED A-A & B-B, AND A THIRD HORIZONTAL PLANE C-C, REPRESENTING THE DECK SURFACE OF THE CARTRIDGE TAPE PLAYER.

   WHERE APPLICABLE, DIMENSIONS INCLUDE DRAFT ALLOWANCES.

2. MATERIALS
   ALL MATERIALS USED IN THE CARTRIDGE CONSTRUCTION SHALL BE NON-MAGNETIC.

3. TAPE GUIDANCE
   PRECISE TAPE GUIDANCE SHALL BE PROVIDED BY TAPE GUIDE OR GUIDES EXTERNAL TO THE CARTRIDGE. INTERNAL GUIDANCE AS SPECIFIED IS TOLERANCED AND DIMENSIONED SO AS NOT TO INTERFERE WITH EXTERNAL HEAD GUIDES PROPERLY SET AND USING STD 1/4" TAPE (.246 ±.002).

   ROLLERS, POSTS, OR OTHER TAPE GUIDING SURFACES MUST BE SMOOTH AND PROVIDE A VERTICAL TAPE PLANE IN THAT PORTION OF TAPE WHICH PASSES ACROSS THE FRONT OF THE CARTRIDGE.

   THE MINIMUM WINDOW AREA, EXCEPT FOR THE AREA COVERED BY THE TAPE PATH, SHALL BE KEPT CLEAR FOR A DISTANCE OF .187 TO THE REAR OF B-B TO PROVIDE FOR EXTERNAL TAPE GUIDES.

4. TAPE TENSION
   TAPE TENSION SHALL NOT EXCEED 6 OZ AT CAPSTAN.

5. TAPE LENGTH
   TAPE LENGTH IN PLAYING TIME SHALL BE LEGIBLY MARKED ON THE HEEL OF CARTRIDGE BASE.

6. HEAD PENETRATION
   HEAD PENETRATION SHALL CONFORM TO CROSS-HATCHED AREA SHOWN IN FIG. 2.

Tape Thickness

1.10 It shall be standard that the thickness of magnetic tape for use in tape cartridges shall not exceed 0.0016 in.

Tape Width

1.15 It shall be standard that the width of magnetic tape be 0.246 in. ± 0.002 in.

Tape Speed

1.20 It shall be standard that the cartridge tape speed shall be 7-1/2 in. per second with a speed accuracy of ± 0.4% as measured over a 150 foot ± 1.0 in. loop of 1 mil (base film thickness) lubricated tape loaded in an NAB Type A cartridge.

Flutter[32]

1.25 It shall be standard that the flutter shall not exceed 0.2% RMS.

Machine Tape Pulling Force[33]

1.30 It shall be standard that the machine shall be capable of a minimum tape pulling force of one-and-one-half pounds (1-1/2) using clear (no-oxide) unlubricated 1/4 in. 1 mil (base film thickness) polyester tape.

Cartridge Loading

1.35 It shall be standard that a loaded NAB cartridge shall have the tape length in playing time clearly marked on the heel of the cartridge (see Chart A).

1.35.01 It shall be standard that a loaded cartridge shall contain no less tape than that required to provide the indicated playing time marked on the cartridge and that excess tape footage shall be in accordance with the following:

Length	*Excess Tape*
Up to 63 ft.	3 seconds maximum (22-1/2 in.)
Over 63 ft.	6 seconds maximum (45 in.)

Head and Track Configuration—Monophonic[34]

1.40 It shall be standard that: (a) The system shall be a two track system consisting of one program track and one cue track. (b) The upper track recorded by Head B shall be the program channel; the lower track recorded by Head B shall be the cue channel; the upper section of Head A shall be the program reproducing channel; the lower section of Head A shall be the cue reproducing channel. (c) The standard tape track dimensions shall conform to Chart B.

Head and Track Configuration—Stereophonic[34]

1.45 It shall be standard that: (a) The system shall be a three track system consisting of two program tracks and one cue track. (b) The upper track shall be the left program channel; the center track shall be the right program channel; the lower track shall be the cue channel. (c) The standard track dimensions shall conform to Chart C.

Electrical Specifications

Standard Reference Level[35]

2.05 It shall be standard that the NAB Standard Reference Level shall be that 400 Hz level which is equal to the recorded level on the NAB Primary Reference Tape.

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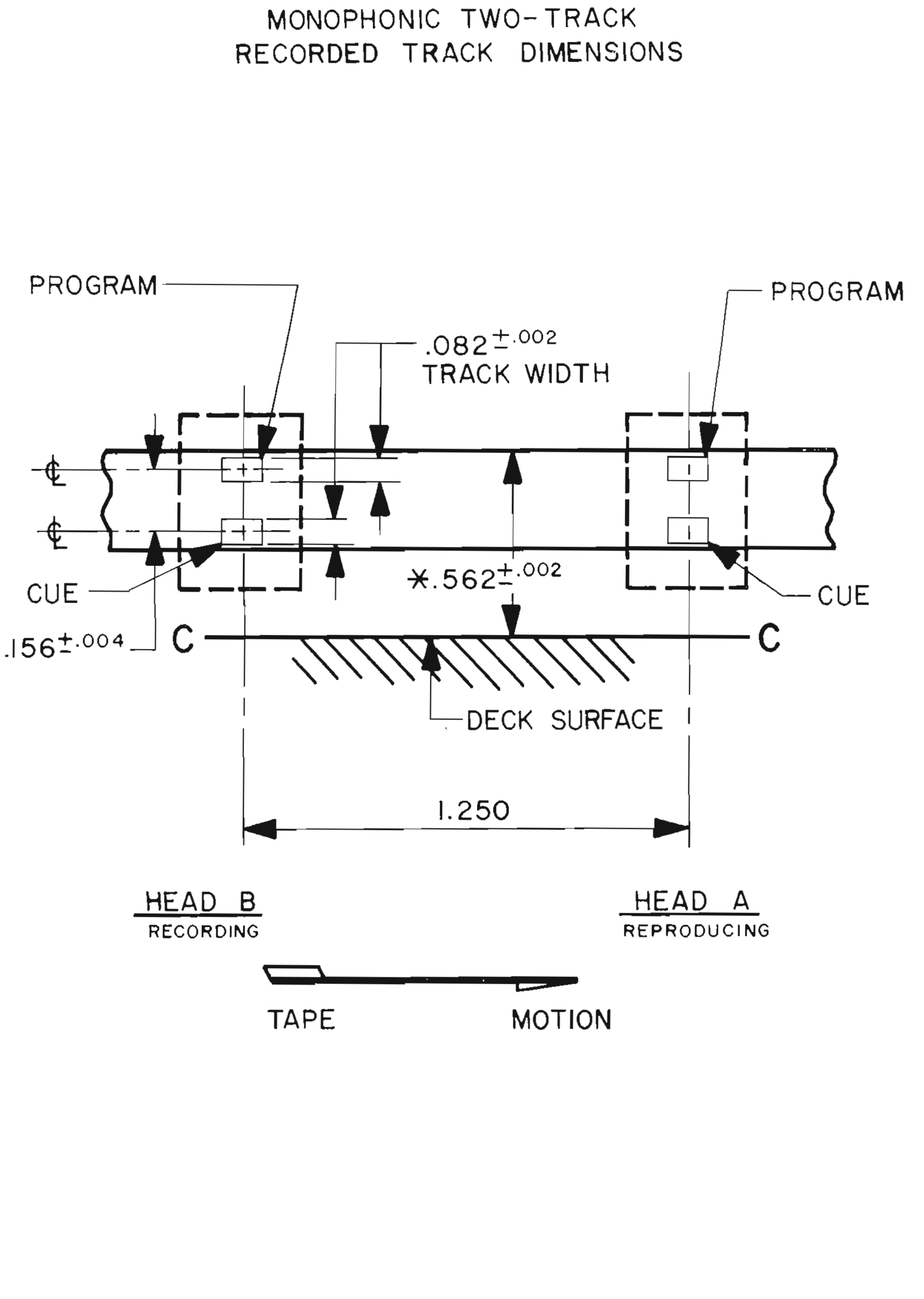
[32]The measurement shall be made within the band from 0.5 to 200 Hz by playing an NAB standard flutter tape containing a 3 kHz recording. The flutter meter shall have no frequency weighting. The meter shall have the dynamics of the Standard Volume Indicator (ASA C16.5-1961). When making flutter measurements it is recommended that the meter be read for 10 seconds, recording peak readings but excluding peaks which do not occur more often than three times in a 10-second period.

[33]This measurement shall be made by securing a length of 1/4 in. nonlubricated one mil polyester recording tape to a suitable tension scale. The tape is then threaded between the capstan and pressure roller and the machine set in motion. An indication of at least 1-1/2 lbs. on the scale should then be observed before tape slippage occurs.

[34]It is recognized that during the recording process there may be partial erasing of the cue tone and program material within the first 1/4 second of a recording. This possibility exists due to the arrangement of the recording and reproducing heads, the spacing between them and the fact that recording bias current may be present in the recording heads during the primary cue process after a recording has been completed. Some over-running of the tape is also to be expected at the stop (primary) cue. Audible degradation of the program material will usually not be noted in so short a period of time but to prevent this possibility it is recommended that the recording of program material be delayed by 1/4 second after the beginning of the primary cue tone.

[35]The NAB Primary Reference Tape is a tape of the normal general purpose type which has been selected for average characteristics of output, sensitivity, and distortion. The 400 Hz recording on it was made at 7-1/2 ips with bias adjusted for maximum output, at an output level 8 dB below that which produced 3% third harmonic distortion. This does not imply a failure to meet the 10 dB overload margin of Footnote 36. It is rather, an arbitrary but convenient method of specification and measurement which is consistent with this requirement for the magnetic recording process. Since neither the tape nor the measurement conditions can be duplicated exactly in the field, all NAB Standard Test Tapes contain a 400 Hz recording at the NAB Standard Reference Level within + 0.25 dB as a means for making this level available.

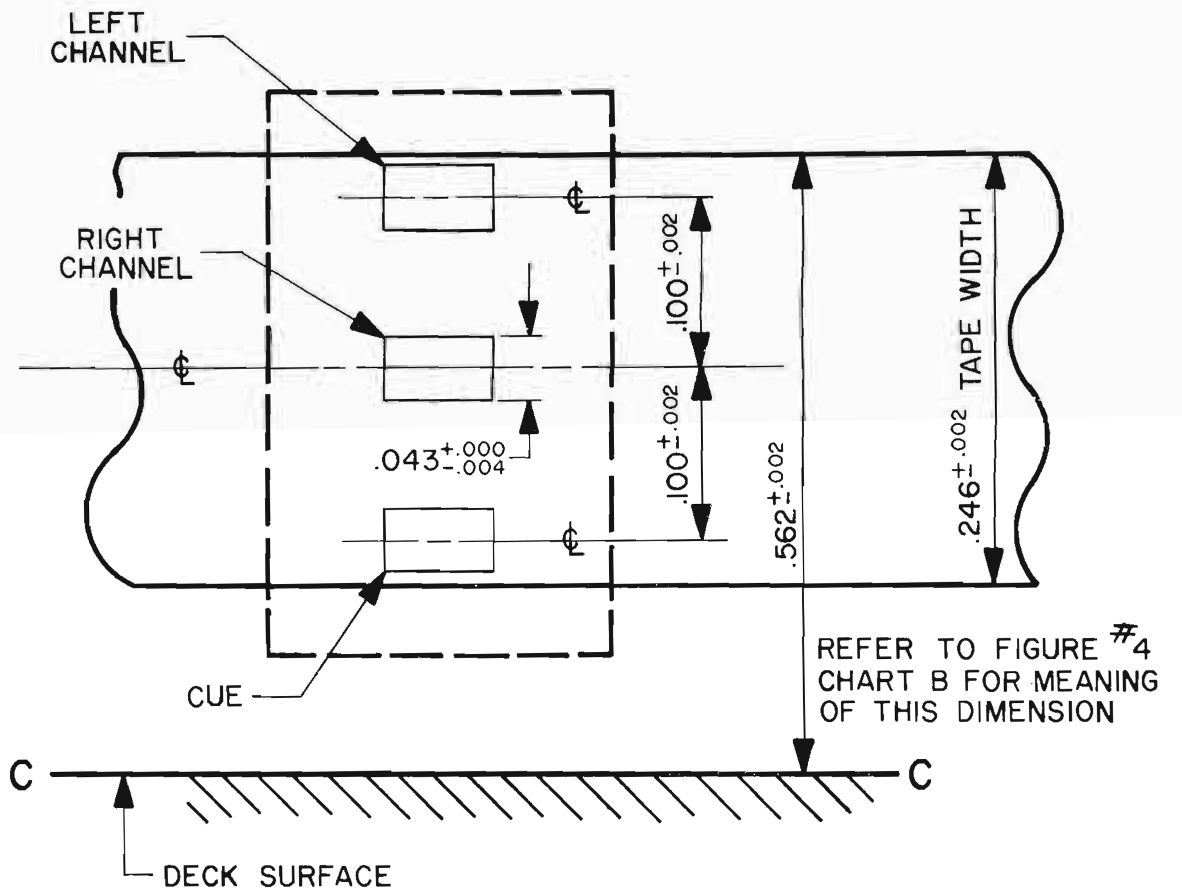
CHART B



* REFER TO FIG. 4, IN CHART A, FOR MEANING OF THIS DIMENSION

CHART C

STEREO 3-TRACK
RECORDED TPAE TRACK DIMENSIONS



NOTES:

1. IF SECOND STEREO HEAD IS USED IT SHOULD BE PLACED 1.250 FROM FIRST HEAD.
2. TRACK WIDTH: ALL TRACKS SHALL BE $.043^{+.000}_{-.004}$

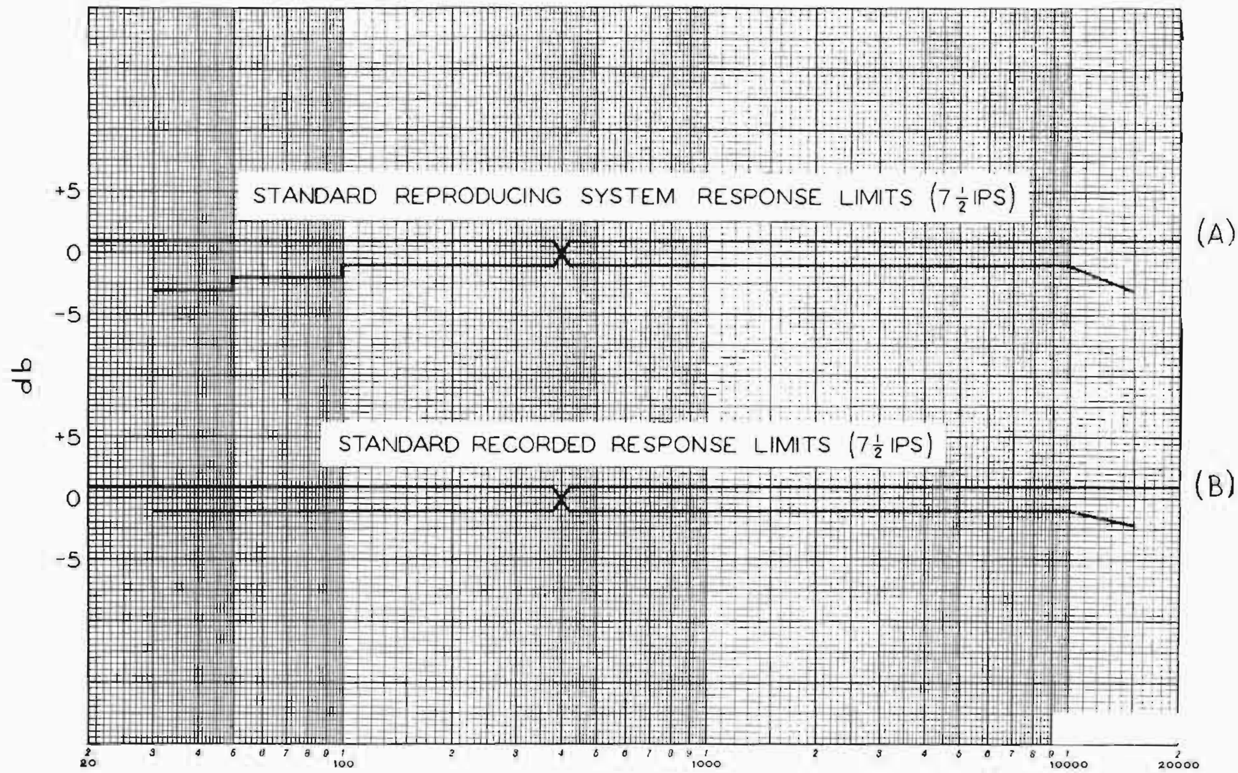


Fig. 10. Standard reproducing system response limits and standard recorded response limits.

Recorded Program Level[36]

2.10 It shall be standard that the recorded program level shall produce the same reference deflection on a Standard Volume Indicator (ASA Standard C16.5-1961) as that produced by a 400 Hz tone recorded at the Standard Reference Level.

Cue Tone Recorded Level

2.15 It shall be standard that primary and tertiary cue tones be recorded at a level that produces an output 8 dB, ± 3 dB, above that produced by the NAB Standard Reference Level at the open-circuit terminals of an ideal head. The secondary cue tone shall be recorded at a level that produces an output 2 dB, ± 3 dB, below that produced by the NAB Standard Reference Level at the open-circuit terminals of an ideal head. (See Annex C)

Frequency Response—Reproduce[37]

2.20 It shall be standard that the frequency response of a reproducing system, when reproducing an NAB cartridge frequency test tape, shall fall within the limits shown in Fig. 10, Part A, between the frequencies of 50 and 12,000 Hz.

Frequency Response—Record[38]

2.25 It shall be standard that the recorded response and level shall be the same as the NAB frequency test tape, within the limits shown in Fig. 10, Part B, when such recorded tape is reproduced through the same reproducing system.

[36]It is well established that at least a 10 dB margin is required between the sine wave load handling capacity of a system and the level of program material measured by a Standard Volume Indicator. This is believed to be approximately the maximum level which can be recorded on available tapes without excessive distortion. This specification of level is believed to represent the optimum compromise between distortion and signal-to-noise ratio for the magnetic recording process at audio bandwidths suitable for broadcasting.

[37]See Annex A, Part 2.

[38]The response measurement shall be made at the same recorded level as that of the NAB Test Tape.

System Distortion[39]

2.30 It shall be standard that the total record-reproduce system harmonic distortion shall be less than 3% for a 400 Hz tone recorded so as to produce a level 6 dB above the standard NAB Reference Level.

System Signal-to-Noise Ratio

2.35 It shall be standard that the unweighted signal-to-noise ratio shall be not less than the following:

Monophonic[40]	*Stereophonic*
45 dB	42 dB

2.35.01 Unweighted noise shall be measured over the frequency range of 20 Hz to 20 kHz. The noise measurement shall be made using a tape previously recorded with bias but with no signal. The reference signal level shall be the 400 Hz NAB Standard Reference Level and the indicating meter shall have the dynamics of the Standard Volume Indicator (ASA Standard C16.5-1961). The measuring system shall have the characteristics of a full-wave rectified average measurement law.

System Crosstalk—Monophonic

2.40 It shall be standard that the cue tone (normal level) to program channel system crosstalk at the NAB Standard Reference Level shall not be less than the following:

150 Hz	50 dB
1000 Hz	55 dB
8000 Hz	50 dB

System Crosstalk—Stereophonic

2.45 It shall be standard that the cue tone (normal level) to program channel system crosstalk shall not be less than 50 dB for stereophonic systems referenced to the NAB Standard Reference Level.

Channel Phasing—Stereophonic

2.50 It shall be standard that for stereophonic recordings the two program tracks shall be recorded with head gaps in line and phased for reproduction on equipment so connected that when a full track tape is reproduced it produces in phase signals in the two channel outputs.

Tape Erasure

2.55 It shall be standard that no erasing function shall be provided as a machine capability. Bulk erasing of tape cartridges is required.

Cue Tones

2.60 It shall be standard that the primary standard cue tone frequency shall be 1000 Hz ± 75 Hz.

2.60.01 The primary cue tone shall be the stop cue.

2.65 It shall be standard that the secondary cue tone shall be 150 Hz ± 30 Hz.

2.65.01 The secondary cue tone shall be the end of message cue.

2.70 It shall be standard that the tertiary cue tone shall be 8 kHz ± 1 kHz.

2.70.01 The tertiary cue tone shall be an auxiliary tone to be used as desired.

Cue Tone Burst Duration

2.75 It shall be standard that the cue tone burst duration shall be 500 milliseconds ± 250 milliseconds.

Test Tape Specifications

The NAB Test Tapes shall consist of four standard test tapes in NAB-A cartridges, each loaded with approximately 150 ft. of tape.

3.05 *Test Tape 1—Azimuth:* The azimuth adjustment tone shall be 15 kHz recorded full track 10 dB below the NAB Standard Reference Level and the recorded azimuth shall be 90°, ± 1 minute, with respect to the length of the tape. The tone shall be recorded over the full length of the tape.

3.10 *Test Tape 2—Flutter:* The flutter test tone shall be 3 kHz recorded full track at the NAB Standard Reference Level. The flutter content of the flutter test tape shall be no greater than 0.05%, measured in the same manner as described in Footnote 32. The test tone shall be recorded over the full length of the tape.

[39]The recording amplifier should not overload with high frequency input signals equal in level to the maximum expected 400 Hz level. In practice this means that the recording equalization places an additional demand on the undistorted amplifier output. Furthermore, bias leakage into the amplifier output may produce additional distortion. High frequency distortion products may not be detected by harmonic distortion measurements.

[40]This measurement is intended to give a measure of noise in terms of a fixed reference. In this way it becomes a measure of merit. It does not, however, take into account the program level which may be recorded on a particular tape nor the dynamic range of the program material. Heretofore, by common practice, the signal-to-noise ratio was determined by using peak recording level (3% THD) as a reference. When determined in this manner, the signal-to-noise ratio is improved by approximately 8 dB resulting in an effective signal-to-noise ratio of 53 dB. (Rev. 12/64)

3.15 *Test Tape 3—Frequency Response, Monophonic:* Test tones shall be recorded on the program track in accordance with the following table:

400 Hz	– 10 seconds	Standard Reference Level ± 0.25 dB
400 Hz	– 10 seconds	Calibration Level (10 dB below Standard Reference Level)
15 kHz	– 20 seconds	
12 kHz	– 5 seconds	
10 kHz	– 5 seconds	
8 kHz	– 5 seconds	
5 kHz	– 5 seconds	
2.5 kHz	– 5 seconds	
1 kHz	– 5 seconds	
600 Hz	– 5 seconds	
300 Hz	– 5 seconds	
150 Hz	– 5 seconds	
75 Hz	– 5 seconds	
50 Hz	– 5 seconds	
30 Hz	– 5 seconds	

Each test tone shall be identified by voice announcement preceding the tone. All test tones, with the exception of the Standard Reference Level Tone, shall be recorded so as to produce a uniform response ± 1/2 dB, when the test tape is reproduced through an ideal reproducing system (See Annexes A & B). The recording level shall be 10 dB below the NAB Standard Reference Level[41]

Test tones shall be recorded on the cue track in the following manner: 1000 Hz to coincide with the beginning of the program track test tones, 1000 Hz stop cue between the first and second 400 Hz tones, 150 Hz at the end of the program track test followed by 8000 Hz, with additional 150, 1000, and 8000 Hz tones of 4 seconds duration each added for calibration of cue circuitry. Unless otherwise specified, the cue test tones shall be recorded so as to comply with Sections 2.15 and 2.75 of these Standards.

3.20 *Test Tape 4—Frequency Response, Stereophonic:*[42] Test tones shall be recorded on the stereophonic program tracks in accordance with the following table:

400 Hz	– 10 seconds	Standard Reference Level ± 0.25 dB
400 Hz	– 10 seconds	Calibration Level (10 dB below Standard Reference Level)
15 kHz	– 20 seconds	
12 kHz	– 5 seconds	
10 kHz	– 5 seconds	
8 kHz	– 5 seconds	
5 kHz	– 5 seconds	
2.5 kHz	– 5 seconds	
1 kHz	– 5 seconds	
600 Hz	– 5 seconds	
300 Hz	– 5 seconds	
150 Hz	– 5 seconds	
75 Hz	– 5 seconds	
50 Hz	– 5 seconds	
30 Hz	– 5 seconds	

Each test tone shall be identified by voice announcement preceding the tone. All test tones, with the exception of the Standard Reference Level tone, shall be recorded so as to produce a uniform response ± 1/2 dB when the test tape is reproduced through an ideal reproducing system (See Annexes A & B). The recording level shall be 10 dB below the NAB Standard Reference Level.[43]

Test tones shall be recorded on the cue track in the following manner: 1000 Hz to coincide with the beginning of the program track test tones, 1000 Hz stop cue between the first and second 400 Hz tones, 150 Hz at the end of the program track test tones followed by 8000 Hz, with additional 150, 1000, and 8000 Hz tones of 4 seconds duration each added for calibration of cue circuitry. Unless otherwise specified, the cue test tones shall be recorded so as to comply with Sections 2.15 and 2.75 of the Standards.

Annex A

Ideal Reproducing System

It shall be standard that the NAB Ideal Reproducing System is a theoretical reproducing system. It consists of an "ideal" reproducing head[a] and an amplifier the output voltage of which shall conform to the voltage-frequency

[41]In lieu of the + 1/2 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.

[42]The test frequencies shall be recorded with a phase additive relationship. Channels shall be identified as "left" or "right" as applicable by voice announcement.

[43]In lieu of the + 1/2 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.

[a]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 wavelength flux paths are controlled so that no low frequency contour effects are present, and the losses in the head materials are negligibly small.

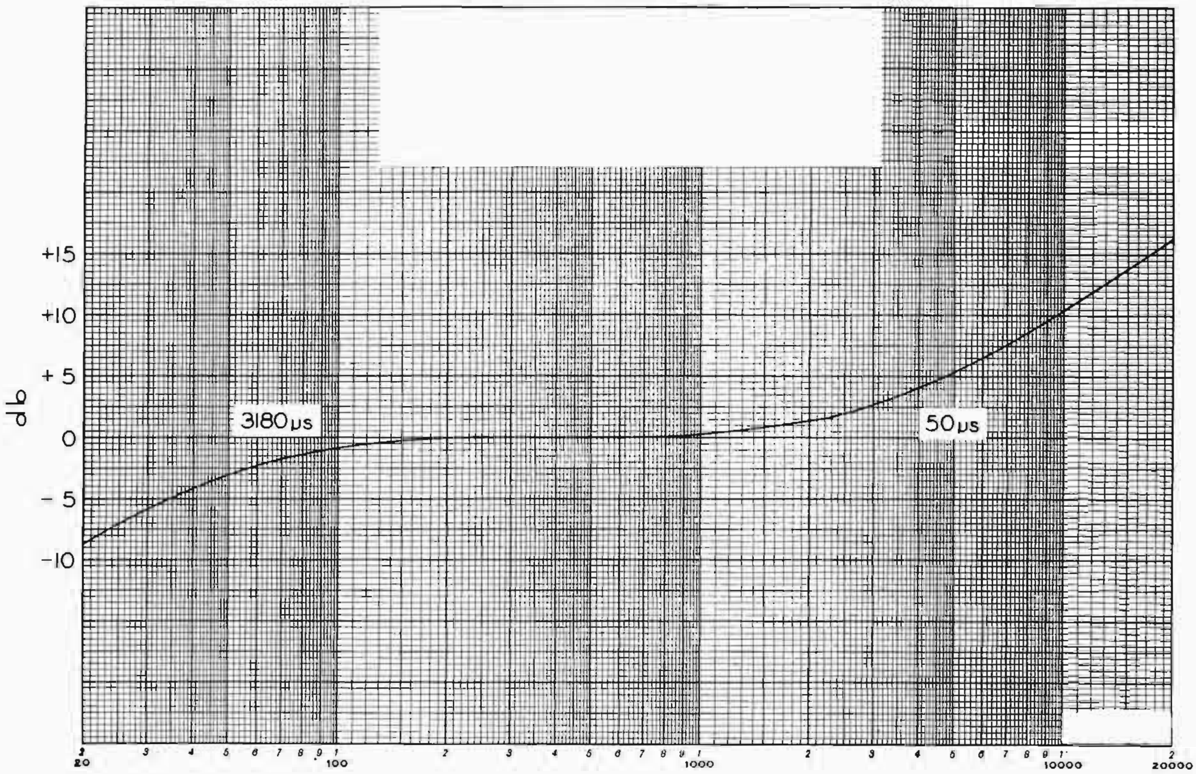


Fig. A. NAB standard reproducing charactertistic. Reproducing amplifier output for constant flux in the core of an ideal reproducing bead.

curve of Fig. A with constant flux versus frequency in the core of the head.[b]

The curve of voltage amplification versus 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:

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

$\omega = 2\pi$ times frequency

[b]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.

For 7-1/2 in. per second tape speed $t_1 = 3180$ microscends, and $t_2 = 50$ microseconds.

Standard Reproducing System[c]

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 Fig. 10. It shall also meet the specifications for distortion, signal-to-noise ratio and other applicable parts of this Standard.

[c]The practical method of measuring a reproduce system response characteristic is with an NAB Test Tape. More precise methods of measuring and calibrating a reproduce system are discussed in Annex B of this Standard. A reproducer calibrated by these methods and meeting the recommendations set forth in Annex B is considered suitable for measuring and calibrating test tapes.

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 Fig. 10.

Annex B

Primary Calibrated Reproducing System[a]

It shall be standard that a Primary Calibrated Reproducing System shall meet the following specifications:

a. The total net system response shall not deviate more than ± 3 dB from the ideal over the frequency range of interest.

b. *Electrical*—Eddy current loss at the highest frequency of interest shall not exceed 3 dB, undamped head resonance shall not exceed 3 dB and amplifier deviation from the ideal shall not exceed ± 3 dB.

c. *Magnetic*—Head gap losses shall not exceed 3 dB at the highest frequency of interest and the head contour effect curve shall not deviate more than ± 2 dB from the average.

Electrical losses shall be determined from measurements of the amplifier response frequency characteristic and the reproduce system output voltage characteristic with constant flux versus frequency in the head core.

Magnetic losses shall be determined from calculations of gap loss and measurements of head contour effects.

The following paragraphs specify the methods by which these characteristics shall be measured and the reproduce system calibrated. The procedure is to determine the various losses independently and apply them as corrections to the theoretical "Ideal Reproducing System."

Electrical Measurements

Three response frequency curves shall be made. First, the amplifier response alone with voltage proportional (voltage doubles for each octave frequency increase) to frequency, measured by conventional methods, second, the head and amplifier response measured by applying a small voltage proportional to frequency across a low resistance connected in series with the head, and finally the head and amplifier response measured with a constant flux versus frequency induced into the core of the reproduce head. The third measurement can be made by placing a fine wire over the head gap, securing it firmly in place, and feeding constant current through the wire. Although the resultant flux distribution is not identical to that from a tape, it is considered to be satisfactory for the purposes of this measurement. Ideally the third curve would follow the Ideal Reproducing Characteristic as shown in Fig. A. However, in practice the curve may vary from the ideal because of head resonance effects, and apparent core losses. Resonance effects are determined by comparing Curves 1 and 2 while eddy current losses are identified by comparing Curves 2 and 3.

Magnetic Measurements

A curve of approximate gap loss versus frequency shall be calculated from the following expression:

$$\text{Gap loss} = -20 \log_{10} \frac{\sin \frac{d}{\lambda} 180 \text{ degrees}}{\pi \frac{d}{\lambda}}$$

where d = null wavelength
λ = wavelength at which the gap loss is calculated.

The null wavelength is determined by finding the recorded wavelength at which the reproducing head output reaches a distinct minimum of at least 20 dB below maximum output. It is desirable to make this measurement at 1/2 or 1/4 normal speed and with a tuned voltmeter with no greater than one-third octave band width. In order to reach the 20 dB null the head gap edges must be sharp, straight, and parallel.

In order to determine that a gap meets these requirements visual examination of the gap at about 1000X magnification is necessary. This may be accomplished with a toolmaker's microscope or with suitable photomicrographs taken at several locations along the gap. It has been shown that the null wavelength will be 1.14 times the optical gap length for a perfectly constructed head.[b] In practice it is usually greater. However, it is recommended that the null wavelength not be greater than 1.25 times the optical gap length for this application.

A curve of the low frequency reproducing response shall be made using a constant current versus frequency recording made with normal bias and the result compared to the curve of reproduce system response with constant flux versus frequency induced into the head core (Curve 3 above), in order to determine contour effects. This reproducing response curve ideally should follow the Standard Reproducing Characteristic at frequencies below approximately 750 Hz at 7-1/2 in. per second. In practice it is known that all of the flux from a tape at long wavelengths does not enter the head core. The amount that does enter varies with wavelength depending upon the length of tape to head contact, the shields in and around the head and the shape of the pole pieces.

[a]It is recognized that commercial production recorders may deviate from the stated system losses and response, however, this does not invalidate the calibration procedure for such machines.

[b]W. K. Westmijze, "Studies on Magnetic Recording" Philips Research Reports, Vol. 8, No. 3, pp. 161-183, 1953.

TABLE A

Response of Ideal Reproducing System

Frequency (in Hz)	Response (in dB)	Frequency (in kHz)	Response (in dB)
20	– 8.6	1.5	+ 0.9
25	7.0	2	1.4
30	5.8	2.5	2.1
40	4.1	3	2.7
50	3.0	4	4.1
60	2.3	5	5.4
70	1.8	6	6.6
75	1.6	7	7.6
80	1.4	7.5	8.2
90	1.2	8	8.6
100	1.0	9	9.5
150	0.4	10	10.3
200	0.2	11	11.1
250	0.1	12	11.8
300	– 0.1	13	12.5
400	±0	14	13.1
500	+ 0.1	15	13.6
600	0.1	16	14.2
700	0.2	17	14.7
750	0.2	18	15.2
800	0.2	19	15.6
900	0.3	20	+ 16.1
1	+ 0.4		

It is important to accurately measure frequency when making the recording so that slight frequency errors are not interpreted as response errors. It is recommended that the slope of the contour effects curve not exceed 10 dB per octave so that a frequency error of 1/2% will result in a response error of not more than 0.07 dB.

Calibrated System Response

Having determined the various losses or deviations from the Ideal System Response a calibration of the actual system is obtained as follows: To the system response curve (Curve 3 under Electrical Measurements), subtract the gap loss curve at high frequencies and algebraically add the low frequency portion by the contour effect curve. The resulting curve is the reproducing system response for constant available flux from a tape. The difference between this curve and the Standard Reproducing System Characteristic represents the variation from the ideal response.

Annex C

Cue Tone Recorded Levels

1. The choice of the recorded level for the three cueing tones is based on two primary considerations. The first is the signal to noise ratio of the cue track. Maximum reliability of the cue system requires a high signal to noise ratio. Assuming that the cue system is well designed and is operating at a minimum noise level, it then remains that any improvement in the signal to noise ratio will be the result of recording the cueing tones at the highest practical level.

The second consideration is crosstalk of the cueing tones into the program channel. The crosstalk level can be kept to a minimum by recording the cueing tones at a low level. Since these two considerations aim in opposite directions, a compromise becomes necessary.

2. On the basis of experience, it was felt that the primary cueing tone (1000 Hz) could be recorded at the same level on the tape as the NAB Standard Reference Level, i.e., at normal program level. At 1000 Hz most systems exhibit good signal to noise and crosstalk ratios. Further, it was felt that the secondary cueing tone (150 Hz) should be recorded about 6 dB above program level in order to overcome possible interference from fundamental or harmonics of the power line frequency. The resulting slight increase in crosstalk should not be annoying because the ear is relatively insensitive to low level low frequency tones.

Finally, the tertiary cueing tone (8 kHz) posed a special problem because it may be recorded several times during a recording and the crosstalk could be annoying if at a high level. Accordingly, a level about 10 dB below program level was adopted. This level is still high enough for a good signal to noise ratio in the cue channel.

3. The recorded level of each of the three cueing tones is referenced to the NAB Standard Reference Level at 400 Hz. A direct comparison may then be made by means of an "ideal" head and a suitable voltmeter. Although the standard is written in terms of an "ideal" head, a practical head can be used if its losses are known.

The procedure for converting the original estimated tone levels from a "program level" reference to a voltage output of a head is as follows: the original tone levels are converted to relative flux by means of a correction factor. The correction factor is the inverse of the NAB equalization given in Table A, Annex B. These relative fluxes are converted into "ideal" head voltages by applying the response of an "ideal" head. Such a head has an output which rises 6 dB per octave with increasing frequency.

This procedure is shown in Table A, which converts to relative fluxes, and Table B, which converts to the output of the "ideal" head. The last column lists the adopted values, which are rounded off to whole numbers. The 8 kHz tone was rounded off to equal the 1000 Hz tone.

4. A practical method for measuring the recorded cue tone levels is to reproduce the recorded tape cue track through an NAB equalized playback channel. The output levels observed may then be compared with the Standard NAB

TABLE A

Converting from Program Level to Flux

Frequency (in Hz)	Recording level (ref. pgm level) (in dB)	Conversion factor (– NAB equalization) (in dB)	Relative flux (in dB)
400	0	0	0
1000	0	– 0.4	+ 0.4
150	+ 6	+ 0.4	+ 6.4
8 kHz	– 10	– 8.6	– 18.6

TABLE B

Converting from Flux to Ideal Head Output

Frequency (in Hz)	Relative flux (in dB)	Response of ideal head (in dB)	Output of ideal head (in dB)	Adopted level (in dB)
400	0	0	0	0
1000	– 0.4	+ 8.0	+ 7.6	+ 8
150	+ 6.4	– 8.5	– 2.1	– 2
8 kHz	– 18.6	+26.0	+ 7.4	+ 8

Reference Level. Table C shows the correct relationship of the various cueing tones to the standard levels when measured in this manner.

TABLE C

NAB Cue Tone Output Levels as Reproduced through an NAB Equalized Playback Channel

Frequency (in Hz)	Output (in dB)
400	0 (NAB Standard Reference Level)
1000	+ 0.4
150	+ 6.1
8 kHz	– 9.4

Glossary of Magnetic Cartridge Tape Recording and Reproducing Terms and Definitions

Azimuth Loss—The signal loss due to misalignment of the playback head with respect to the recorded signal.

Background Noise—Background noise is the total system noise independent of the signal. The signal is not included as part of the noise.

Bias—See Magnetic Biasing.

Capstan—The spindle or shaft—often the motor shaft itself—which drives the pressure roller and tape.

Cartridge—A plastic or metal enclosure containing an endless loop of lubricated magnetic tape, wound on a rotatable hub in such a fashion as to allow continuous tape motion.

Contour Effect—The alteration of the voltage output from a magnetic reproducing head at long wavelengths.

Crosstalk—The presence of an undesirable signal in a system channel from external sources.

Cue Tone—A recorded audio frequency of specified duration arranged in a physical fashion on the recorded tape so as to provide a signalling system available for positioning the tape at the start of message, end of same, and such auxiliary functions as may be necessary and desirable.

Cue Track—That portion of recorded tape which is used to actuate tape motion or auxiliary functions within or external to the recorder/playback device.

DBM—1 MW of power (usually 600 ohms). The standard reference level used in broadcast work.

Distortion—An undesired change in waveform.

Distortion, Harmonic—Nonlinear Distortion characterized by the appearance, in the output, of harmonics of the fundamental input frequency.

Distortion, Intermodulation—Nonlinear Distortion characterized by the appearance of frequencies in the output, equal to the sums and differences of the component frequencies present in the input wave.

Distortion, Nonlinear (Amplitude)—Distortion caused by a deviation from a linear relationship between the input and output of a system or component.

Distortion, Percent Harmonic—A measure of the Harmonic Distortion in a system or component, numerically equal to 100 times the ratio of the root-mean-square voltages (or currents) of each of the individual harmonic frequencies, to the root-mean-square voltage (or current) of the fundamental.

Equalization—The process of modifying the frequency response characteristics in a recording and reproducing system.

Equalizer—A device designed to modify the frequency response of a system or component.

Erasing Head—A device which is used to produce the magnetic field necessary for erasing a magnetic recording. (*Note:* AC erasing is achieved by subjecting the medium to a frequency modulated magnetic field of decreasing magnitude. The medium is then essentially left in a demagnetized condition.)

Erasure—Neutralizing the magnetic pattern on tape by placing it in a strong magnetic field, thereby removing any recorded signal from the tape. An "erase" head on a tape recorder does this automatically to any signal previously recorded on the tape just before the tape reaches the "record" head. A permanent magnet can also be used to erase magnetic tape, but with a resultant increase in background noise compared to ac erasure.

Flutter (*wow*) (*drift*)—The deviation of frequency which results in general from irregular motion during recording, or reproduction. (*Note:* The term "flutter" usually refers to cyclic deviations occurring at a relatively high rate, as for example, 10 Hz. The term "wow" usually refers to cyclic deviations occurring at a relatively low rate, as for example, a once-per-revolution speed variation of a phonograph turntable. The term "drift" usually refers to a gradual average variation over an extended period of time.)

Flutter Rate—The number of cyclical variations per second of the flutter.

Frequency Response—The relative output versus frequency of a recording or reproducing system usually presented in the form of a curve plotted with frequency as the ordinate and dB as the abscissa.

Frequency Tape—A recording of various test frequencies at known amplitudes, usually for the purposes of testing and measuring reproducing equipment.

Gap Length—The physical distance between adjacent surfaces of the pole tips or a magnetic head measured in the direction of tape travel. (*Note:* The effective gap length is usually greater than the physical length.

Gap Length, Effective—The recorded wavelength at which the output of a magnetic head goes through the first null point. (*Note:* The effective gap length is usually about 1.14 times the physical length.)

Head Alignment—Positioning of the record and reproduce head on a tape recorder so that their gaps are mutually parallel and perpendicular to the path of travel of the tape.

Level, Recorded—The level measured by a reproducing system with respect to the NAB Standard Level, expressed in decibels.

Magnetic Biasing—The simultaneous conditioning of the magnetic recording medium during recording by superposing an additional magnetic field upon the signal magnetic field. (*Note:* In general, magnetic biasing is used to obtain a substantially linear relationship between the amplitude of the signal and the remanent flux density in the recording medium.)

Magnetic Biasing, AC—Magnetic biasing accomplished by the use of an alternating current which is usually well above the highest signal frequency.

Magnetic Head—A transducer for converting electrical signal currents into magnetic signals for storage on magnetic media, for converting stored magnetic signals into electrical signals, or for erasing stored magnetic signals. (*Note:* A ferromagnetic head is one in which the permeability of the material is much greater than one (1) being most often several thousand.)

Magnetic Head Core—The high permeability (usually laminated) structure which forms the head gap and supports the head windings.

Magnetic Printing—The permanent transfer of a recorded signal from a section of a magnetic recording medium to another section of the same or a different medium when these sections are brought in proximity.

Magnetic Recorder—Equipment incorporating an electromagnetic transducer and means for moving a ferromagnetic recording medium relative to the transducer for recording electric signals as magnetic variations in the medium. (*Note:* The generic term "magnetic recorder" can also be applied to an instrument which has not only facilities for recording electric signals as magnetic variations, but also for converting such magnetic variations back into electric variations.)

Magnetic Recording Head—A magnetic head for transforming electric signals into magnetic signals for storage on magnetic media.

Magnetic Recording Medium—A magnetizable material used with a magnetic recorder for retaining the magnetic signals imparted during the recording process.

Magnetic Recording Reproducer—Equipment for converting magnetic signals on magnetic recording media into electric signals.

Magnetic Reproducing Head—A transducer for converting magnetic signals on magnetic media into electric signals.

Magnetic-coated Tape—A tape consisting of a coating of uniformly dispersed, ferromagnetic material on a nonmagnetic base.

Modulation Noise—The noise caused by the signal. The signal is not included as part of the noise.

Multitrack Magnetic Recording System—A recording system which provides, on a medium such as magnetic tape, two or more recording paths which are parallel to each other, and which may carry either related or unrelated program material in common time relationship.

Noise (audio frequency)—Any electrical disturbance introduced from a source extraneous to the signal.

Noise, Unweighted—The noise measured within the audio frequency pass band using a measuring instrument which is uniform in output with respect to frequency.

Noise, Weighted—The noise measured within the audio frequency pass band using a measuring instrument which has a frequency selective characteristic. The sensitivity is usually greatest in the frequency range where noise is most objectionable subjectively.

Playback—An expression used to denote reproduction of a recording.

Postemphasis—That portion of the equalization which is applied in the reproducer.

Preemphasis (preequalization)—That portion of the equalization which is applied in the recorder.

Pressure Roller—Also called "capstan idler" or "puck." A rubber-tired roller which holds the magnetic tape tightly against the capstan.

Recording Channel—The term "recording channel" refers to one of a number of independent recorders in a recording system or to independent recording tracks on a recording medium. (*Note:* Two or more channels are used at the same time for stereophonic recording or for multichannel monophonic recording.)

Recording Loss—The loss in recorded level whereby the amplitude of the wave in the recorded medium differs from the amplitude of the recording current.

Ring Head—A magnetic head in which the magnetic core material forms an enclosure with one or more gaps. The magnetic recording medium bridges one of these gaps and is contacted by the pole pieces on one side only.

Sound Recording System—A combination of transducing devices and associated equipment suitable for storing sound in a form capable of subsequent reproduction.

Sound Reproducing System—A combination of transducing devices and associated equipment for reproducing recorded sound.

Strobotron—A gas filled electron tube with a cold cathode used especially as a source of stroboscopic light.

Surface Induction—The flux density at right angles to the surface of the tape in a medium of unity permeability and not in contact with a reproducing device.

Tachometer—A device for measuring or indicating the rotational speed of a shaft or associated moving part.

Track Configuration—The relative position of the active recording area referenced to the entire cross-sectioned surface of the magnetic recording medium.

Weighting Characteristic—The response-frequency characteristic of a measuring device used to measure Weighted Noise.

NAB Audio Cassette Recording and Reproducing Standards

Mechanical Specifications

Cassette Size

1.05 It shall be standard that there be a co-planar magnetic tape cassette physically identified and designed as shown in Fig. 11, 12, 13, with a window area as specified in Fig. 13.

Tape Thickness

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

Tape Width

1.15 It shall be standard that the magnetic tape and leaders for use in an NAB Audio Cassette be 0.150 +0.000, — 0.002 in. (3.81 mm. + 0, — 50.8 μ) wide.

Standard Tape for Measurements

1.20 The standard measurement tape shall be equivalent to 3M Magnetic Tape Type 277. This is a 500 micro in. (12.7 μ) tensilized polyester backed tape with a 200 micro in. (5.1 μ) 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.)

Tape Wind

1.25 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 Fig. 14.

Tape Length within Cassette

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

Cassette Head Shield

1.35 It shall be standard that an NAB Audio Cassette contain a hum reducing magnetic shield behind the pressure pad as located in Fig. 14.

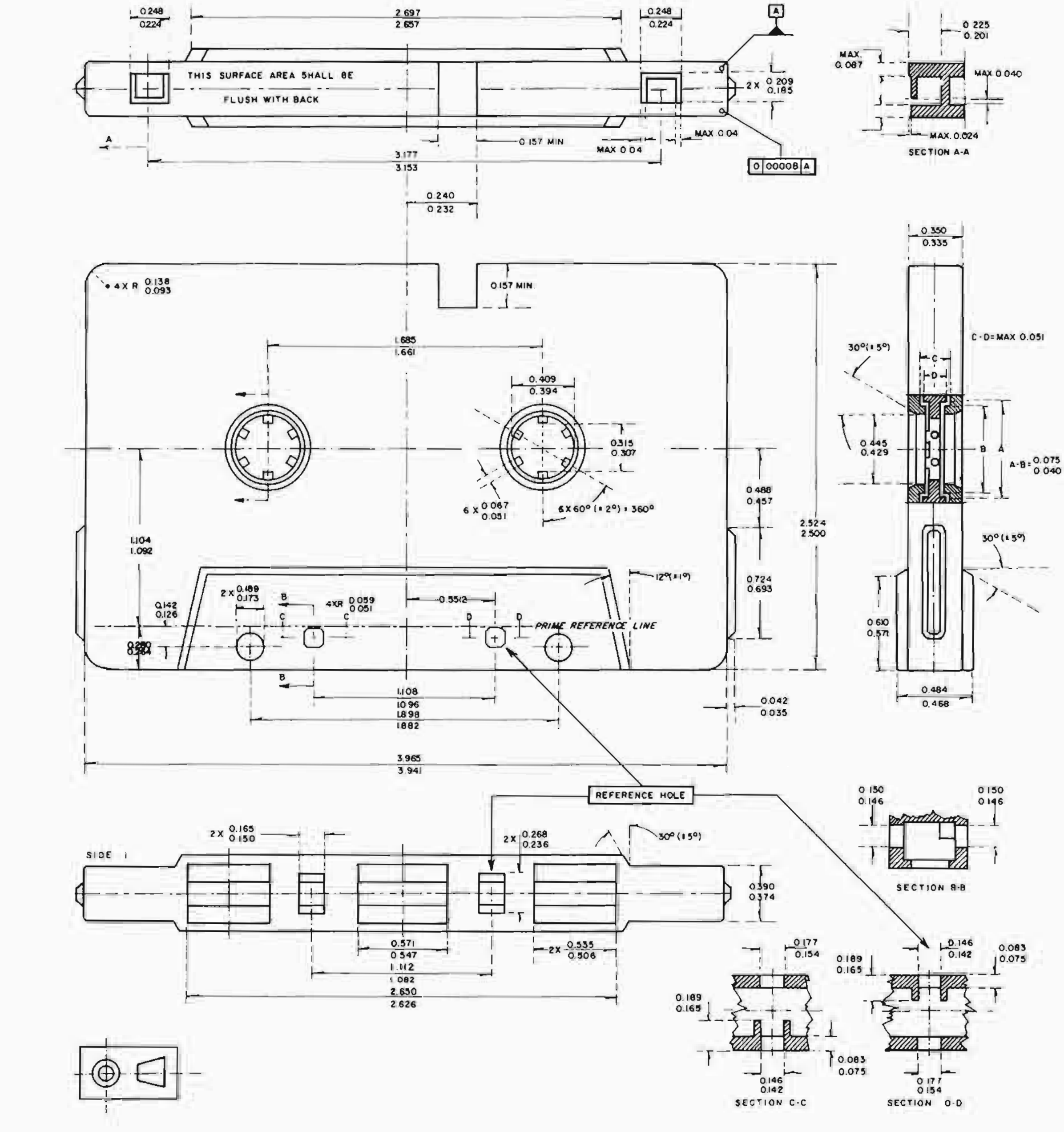
Pressure Pad[44]

1.40 It shall be standard that an NAB Audio Cassette have a pressure pad which is located and sized as described in Fig. 14. The pressure the pad exerts on the record/play head, when placed in the cassette in accordance with Fig. 15 shall be 11.4 to 34.1 oz./in.^{2} (0.5 to 1.5 gm./mm.^{2}).

Cassette Torque

1.45 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

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



DIMENSIONS IN INCHES

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

Fig. 11. External dimensions.

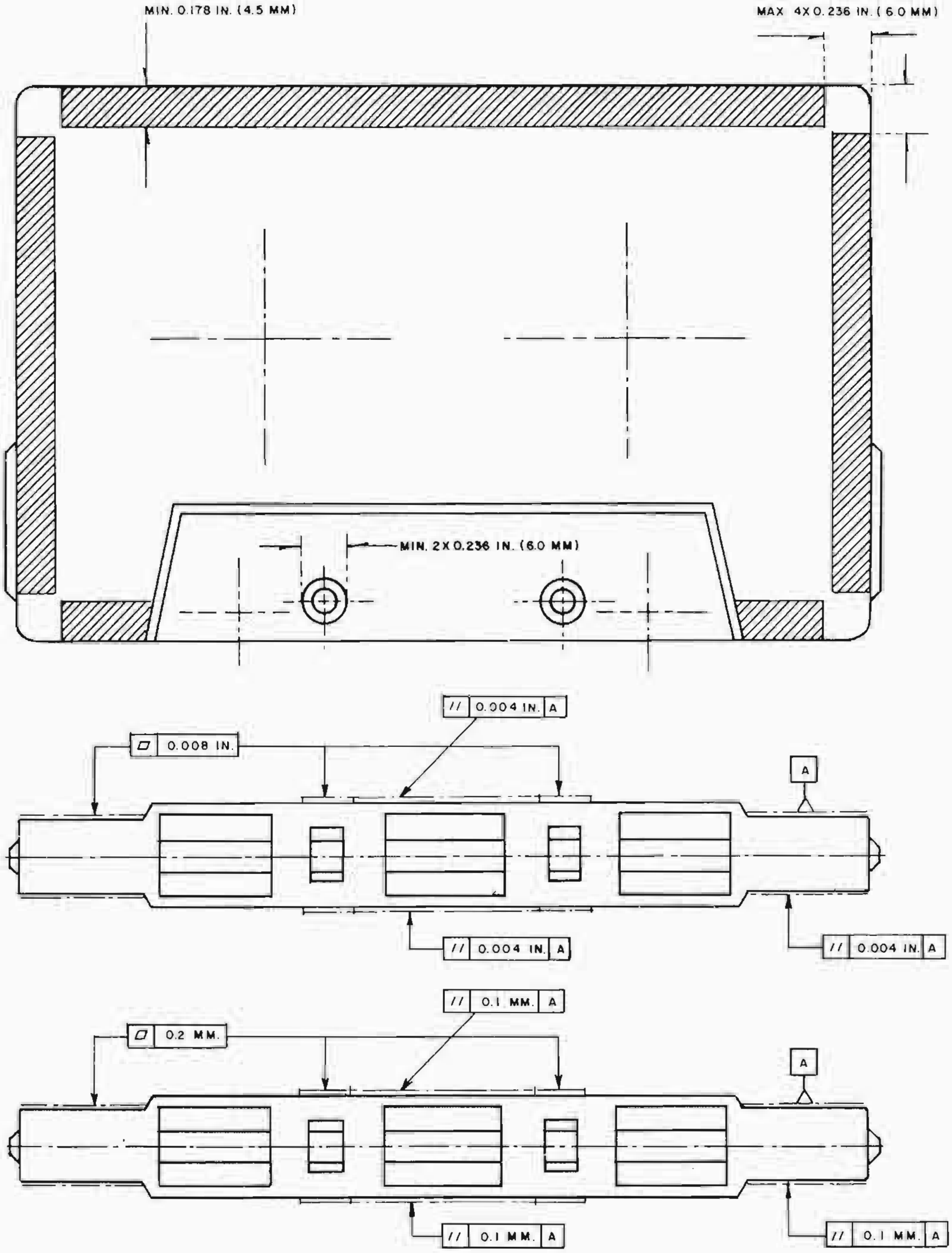
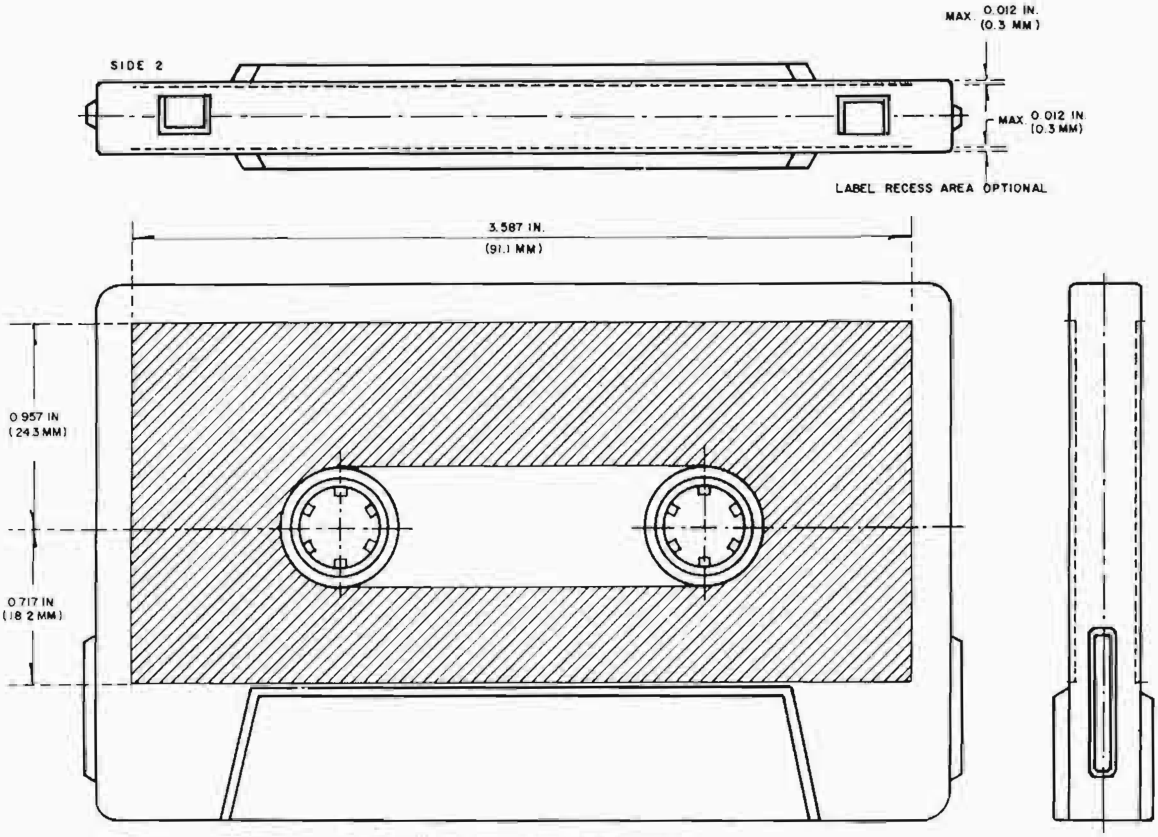
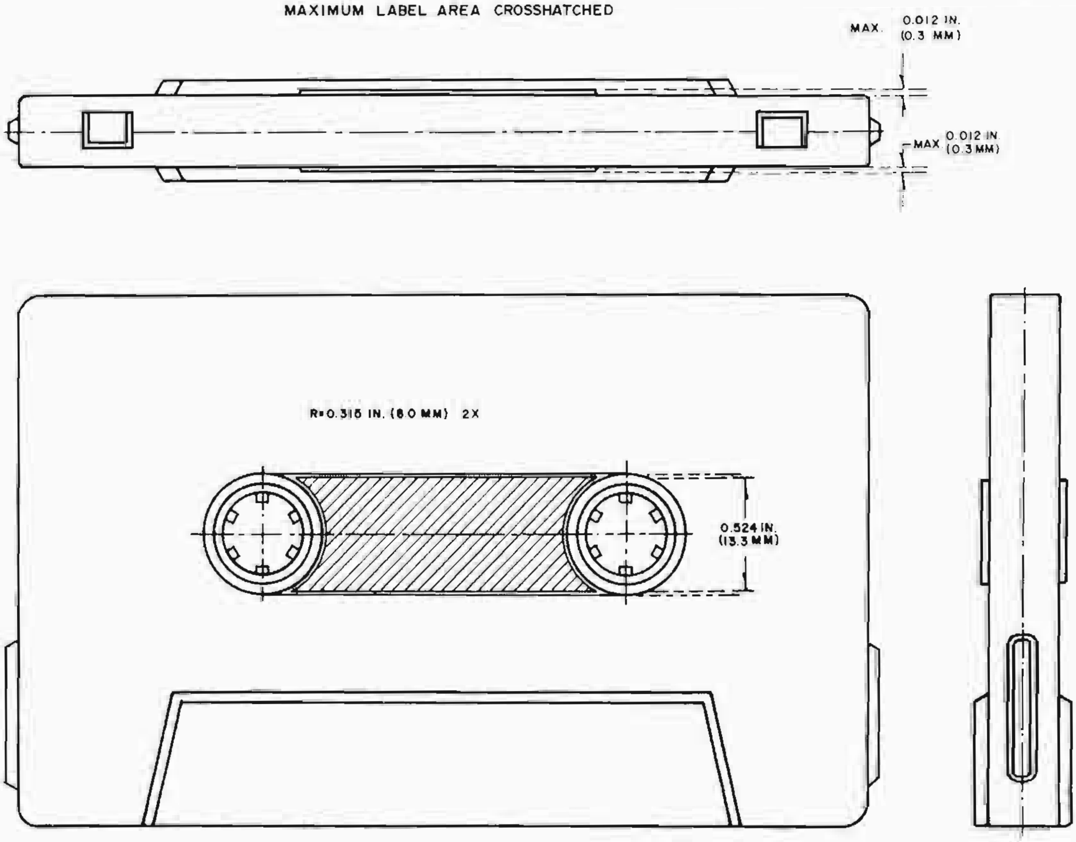


Fig. 12. Support planes.



MAXIMUM LABEL AREA CROSSHATCHED



MAXIMUM WINDOW AREA CROSSHATCHED

Fig. 13.

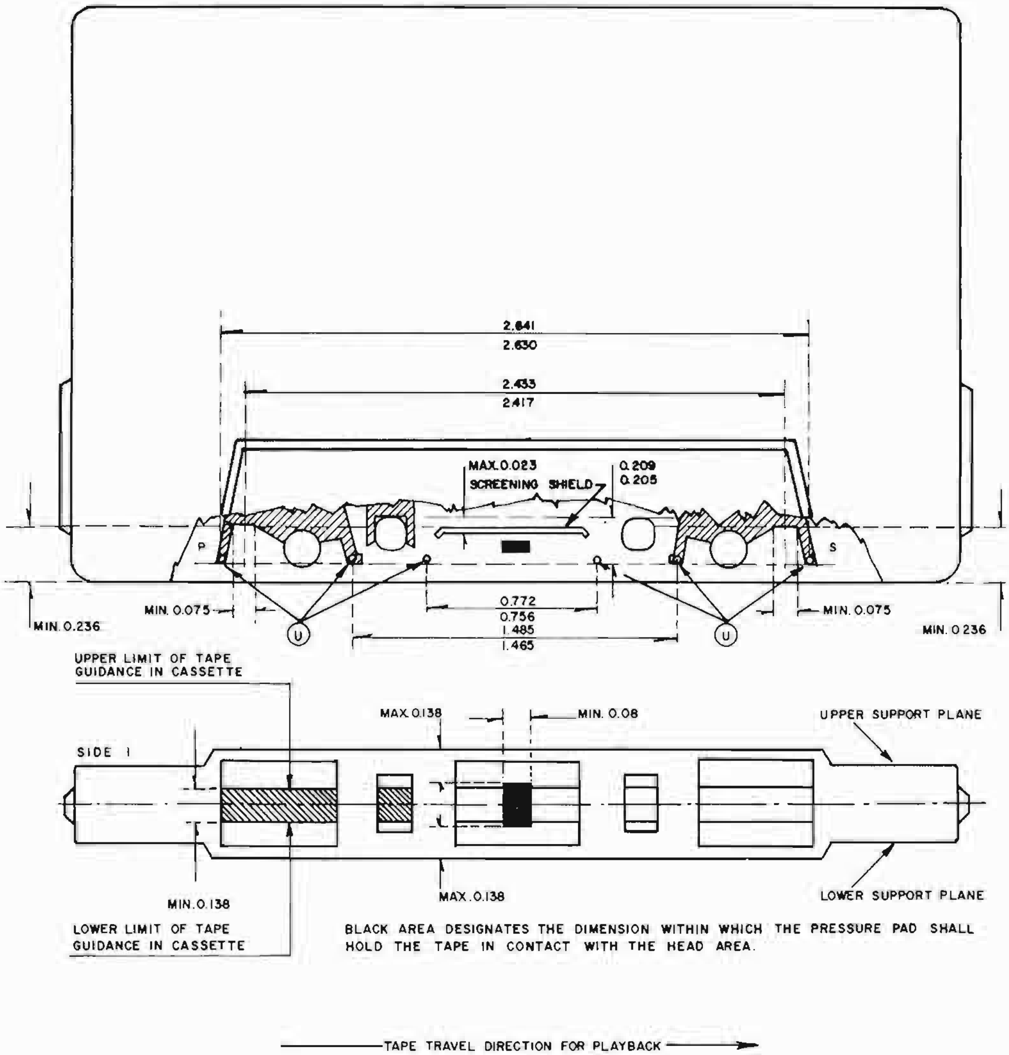


Fig. 14. Tape path dimensions and travel direction.

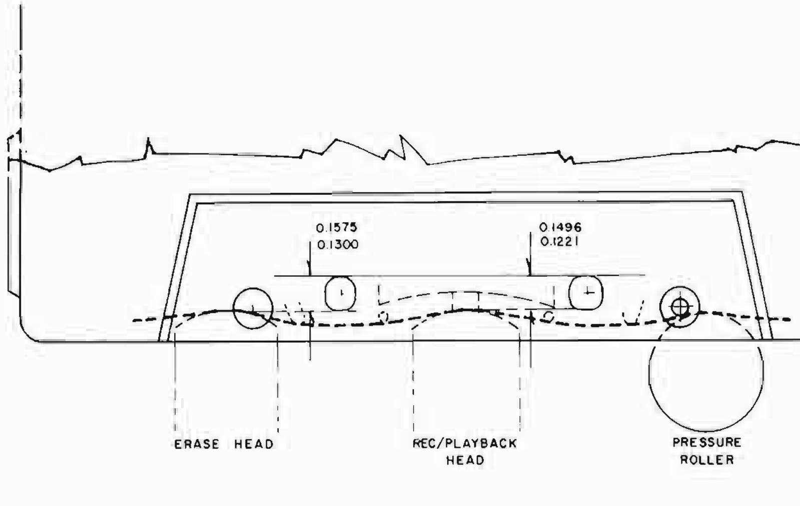


Fig. 15. Head penetration dimensions in record/play mode.

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. 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.).

Cassette Leaders

1.50.

1.50.01 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 ± 200 ° K and using a silicon phototransistor for detection.

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

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

Tape Position and Travel Direction

1.55 It shall be standard that the magnetic tape position and travel direction in the cassette head openings correspond to Fig. 14.

Cassette Breakage

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

Track Designation

1.65 It shall be standard that the track numbering be as shown in Fig. 16.

Cassette Support Planes

1.70 It shall be standard that the cassette be supported by the record/play instrument on only the cross hatched areas in Fig. 12 designated as support planes.

Label

1.75 It shall be standard that the label be located on side one only and shall fit within the area defined in Fig. 13.

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.

Cassette Environmental Conditions

1.80 Test environmental conditions are 70 ± 5° F. (21 ± 3° C.) and 50 ± 10% relative humidity. Operating environmental conditions shall be 20 to 125° F. (— 7 to + 52° C.) and 5 to 85% relative humidity noncondensing. Storage environmental conditions shall be a maximum of 125° F. minimum — 40° F. (+ 52°, — 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.

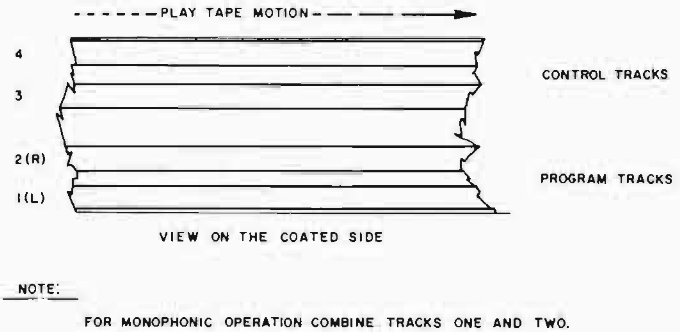


Fig. 16. Tape track designation.

Mechanical Specifications for Cassette Transport

Transport Cassette Acceptance

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

Tape Speeds

2.10 It shall be standard that the tape speeds be 1-7/8 and 3-3/4 ips ± 0.3% (4.76 cm./s & 9.53 cm./s ± 0.3%).

Flutter and Wow

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

Tape Guides

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

Head Configuration

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

Head Track Dimensions

2.30 It shall be standard that the track dimensions of the magnetic record/play head be in conformity with the track dimensions shown in Fig. 17. (Track width is the effective track defined as the region of the common interface on the abutting pole pieces).

Head Penetration

2.35 It shall be standard that the head penetration be in accordance with Fig. 15.

Head Phasing and Azimuth

2.40 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 1-7/8 ips (4.76 cm./s). The head may be adjusted for optimum within the phase and azimuth loss limits.

Head Zenith

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

Tape Wrap

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

Spindle Take Up Torque

2.55 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.).

Fast Wind Torque

2.60 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.).

Fast Wind Times

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

Maximum Tape Tension

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

Start-Stop Time

2.75 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.

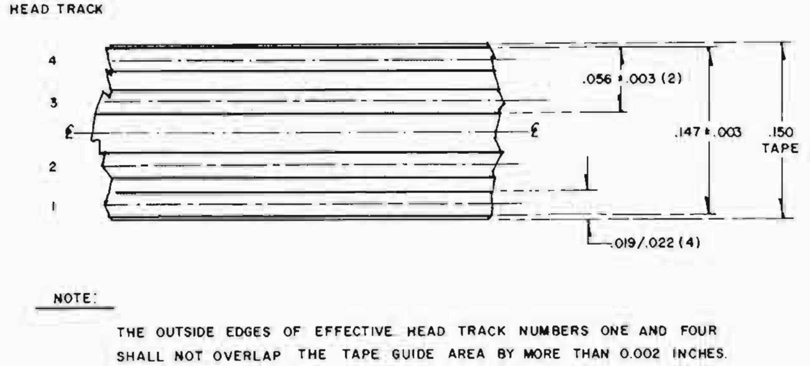


Fig. 17. Head track dimensions.

Cueing Accuracy

2.80 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.

System Electrical Specifications [45]

Standard Operating Reference Levels

3.05 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 1-7/8 and 3-3/4 ips (4.76 and 9.53 cm./s) speeds. (This is approximately 3 to 4 dB below 3% third harmonic tape distortion.)

Cue and Function Tone Recorded Level

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

Playback Equalization Time Constants

3.15 It shall be standard that the higher frequency equalization time constant at 3-3/4 ips (9.53 cm/s) be 90 microseconds. The lower frequency equalization time constant shall be 3180 microseconds.

At 1-7/8 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.

Signal-to-Noise Ratio (either audio channel)[46]

3.20 It shall be standard that at 3-3/4 ips (9.53 cm./s) the signal-to-noise ratio be not less than 48 cm./s) the signal-to-noise ratio be not less than 48 dB weighted (NAB) below standard operating level (Reference Fig. 18).

At 1-7/8 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.

[45]All recordings to be made on bulk erased tape.

[46]Weighted noise shall be measured using the weighting curve of Fig. 18 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.

Frequency Response[47]

3.25 It shall be standard that the system response be within the limits shown in Fig. 19.

Control Tones

3.30 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 ± 4%.

Primary Cue Tone[48]

3.35 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.

Secondary Cue Tone

3.40 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 programed event on the leading edge and drop the current even on the trailing edge.)

Tertiary Cue Tone

3.45 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.

Address Code

3.50 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).

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

[48]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.

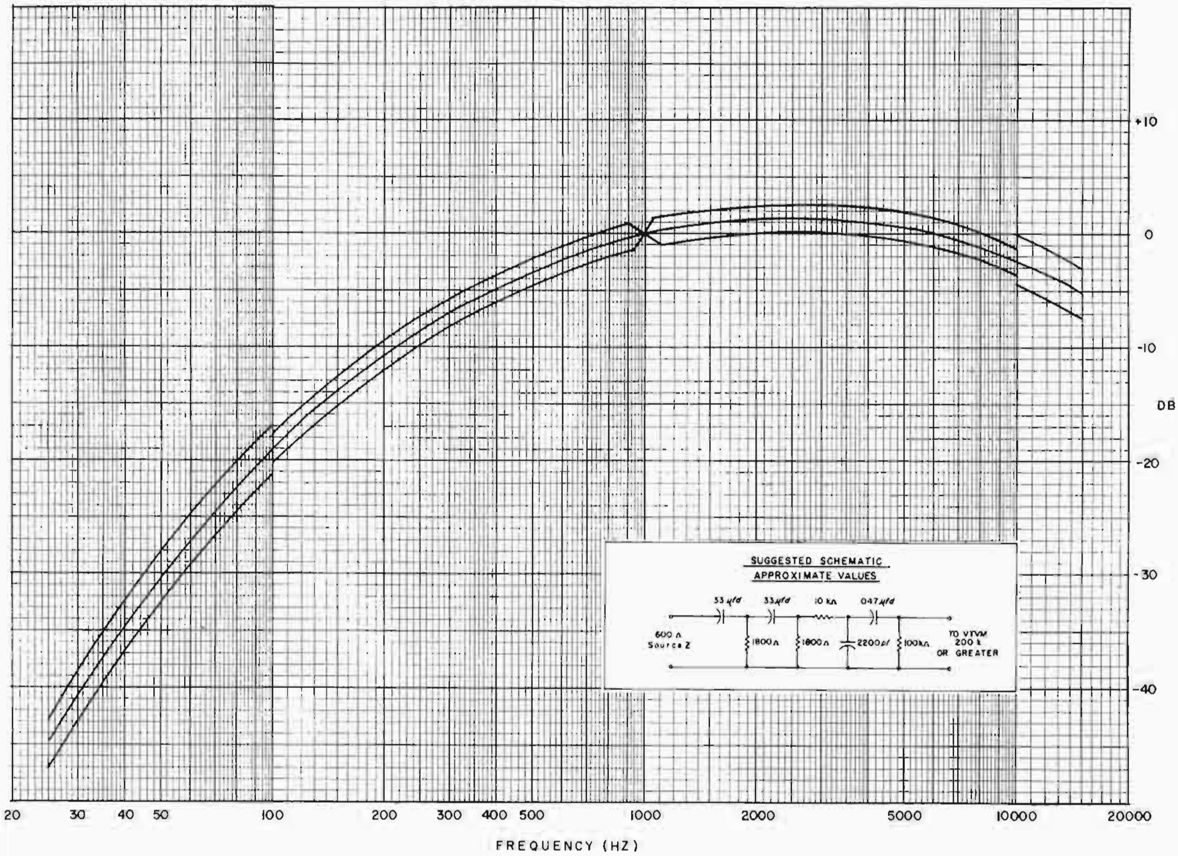


Fig. 18. Weighting curve for weighted noise measurements.

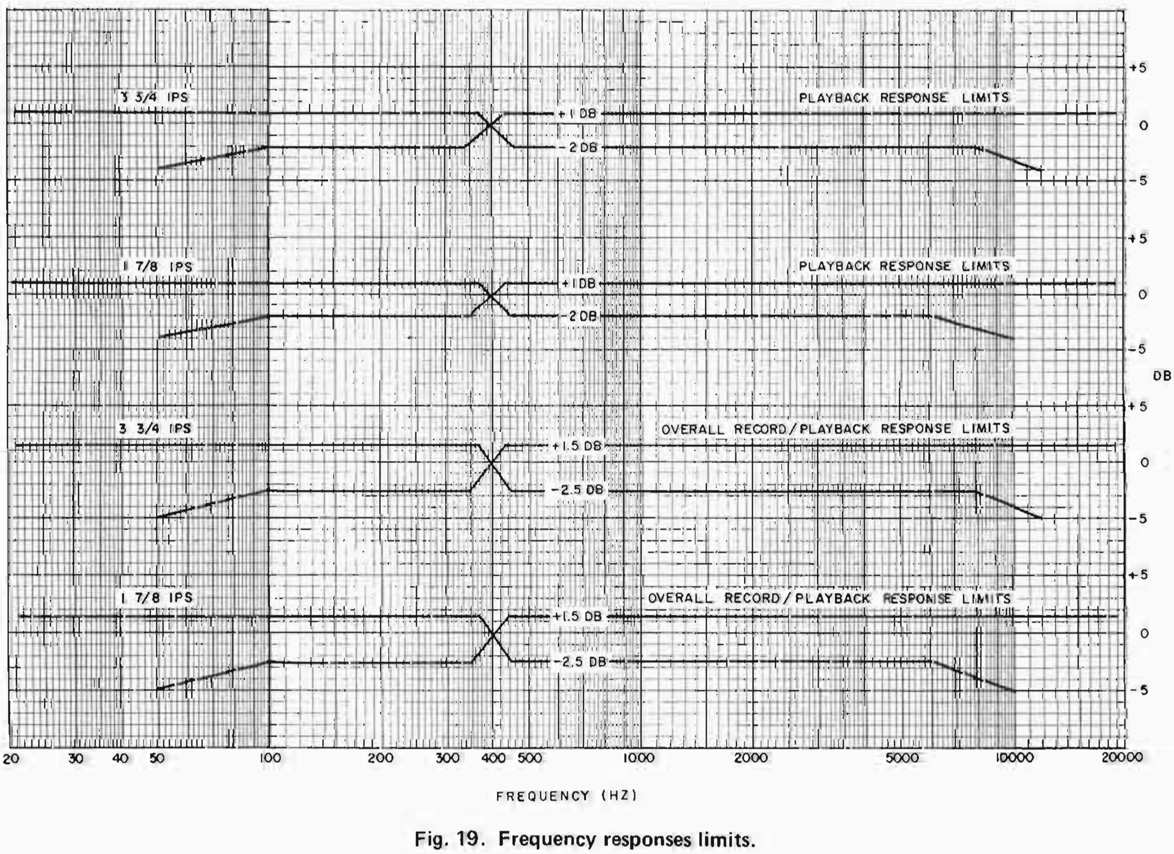


Fig. 19. Frequency responses limits.

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.[49]

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

Auxiliary Tones

3.55 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.)

Track Code

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

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

Crosstalk

3.65 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.[47]

Transient Noise

3.70 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.

[49]An example is shown in Fig. 20 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.

[50]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.

Test Tape Specifications

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

Cassette and Tape

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

Track Width

4.10 All recorded tones shall be full track.

Tone Spacing

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

Tape Erasure

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

Recorded Level

4.25 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.

Frequency Accuracy

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

Test Tape Format

4.35

Time (seconds)	*Frequency (Hz)*	*Level (dB)*	*Function*
0.5-1	639	−15	Stop tone to cue tape
10	400	0	Operating reference level
10	400	−20	Calibration level

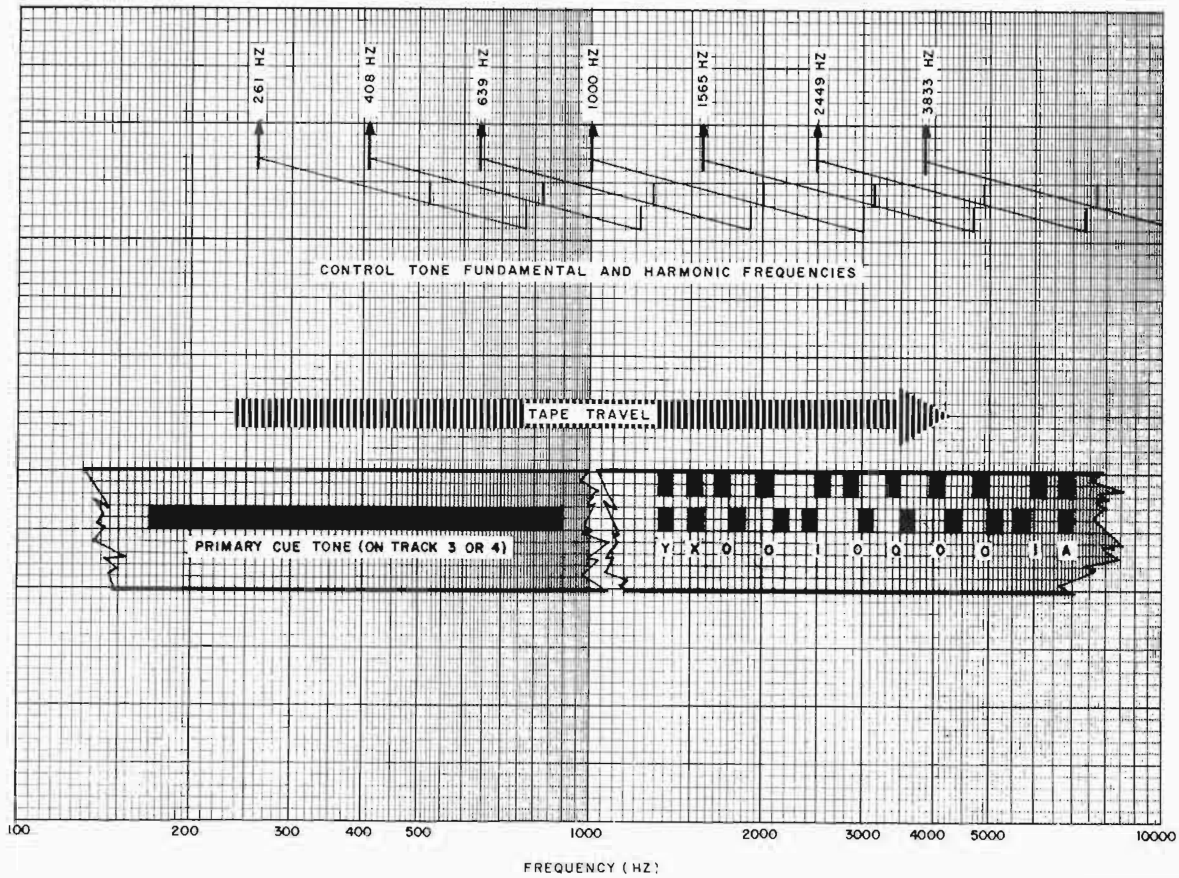


Fig. 20. Control tones and address codes.

(seconds)	*Frequency (Hz)*	*Level (dB)*	*Function*
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	3,833	−15	Tone bursts for cue tests
0.030	3,833	−15	Tone bursts for cue tests
0.030	3,833	−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

Annex A

Ideal Reproducing System

The standard NAB Ideal Reproducing System is a theoretical reproducing system. It consists of an "ideal" reproducing head[a] and an amplifier the output voltage of which shall conform to the voltage-frequency curve of Fig. A with constant flux versus frequency in the core of the head.[b]

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

---

[a]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 wavelength flux paths are controlled so that no low frequency contour effects are present, and the losses in the head materials are negligibly small.

[b]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.

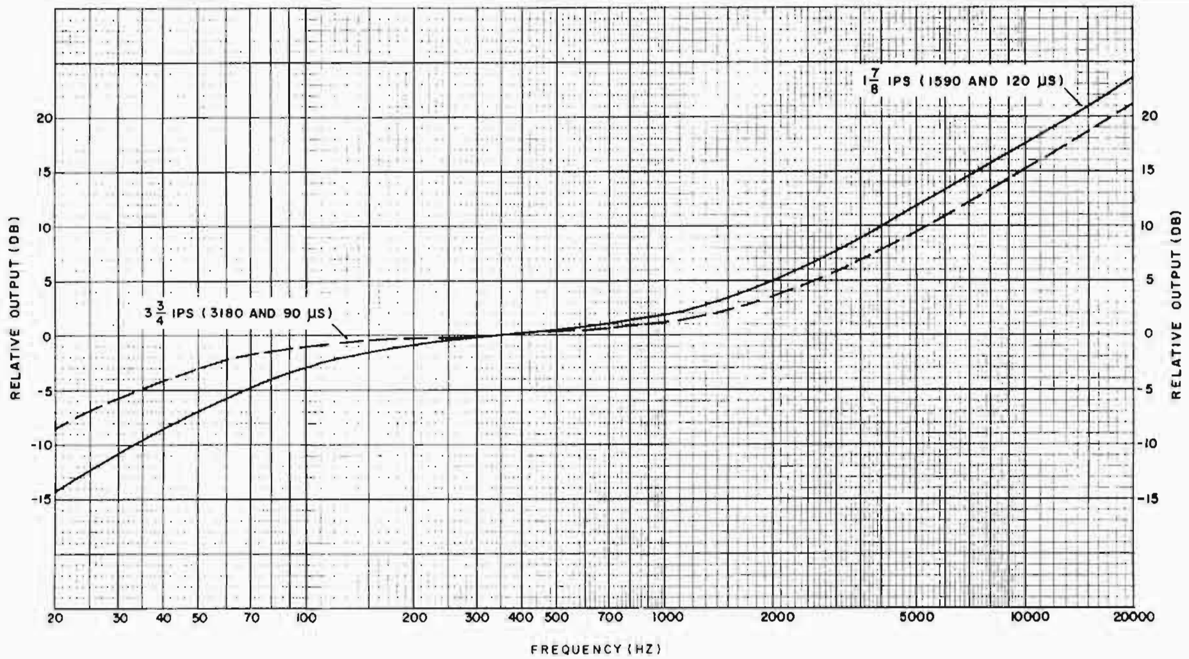


Fig. A. Reproducing characteristic reproducing amplifier output for constant flux in the core of an ideal reproducing head.

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:

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

$\omega = 2\pi$ times frequency

Standard Reproducing System[c]

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 Fig. 19. It shall also meet the specifications for distortion, signal-to-noise ratio and other applicable parts of this Standard.

[c]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 Fig. 19.

NAB STANDARD REPRODUCING CHARACTERISTIC
3-3/4 ips (3180 and 90 μs)

Reproducing amplifier output for constant flux in the core of an ideal reproducing head

Frequency (in Hz)	Response (in dB)	Frequency (in kHz)	Response (in dB)
20	− 8.6	1.5	+ 2.4
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 μs)

Reproducing amplifier output for constant flux in the core of an ideal reproducing head

Frequency (in Hz)	Response (in dB)	Frequency (in kHz)	Response (in dB)
20	− 14.2	1.5	+ 3.5
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		

Bibliography Of Organizations Promulgating Standards of Interest to the Broadcasting Industry

Arbeitsgemeinschaft der Rundfunkanstalten der Brundesrepublik Deutschland (Association of Radio Stations of the German Federal Republic, *ARD*).

British Standards Institution (BSI), British Standards House, 2 Park Street, London W.1, England.

Deutscher Normenausschus (German Standards Committee, DNA).

This organization formulates the Deutsche Industrie Normen (German Industrial Standards, DIN). Although the titles are given here in English, the original standards are, of course, all in German. Some of the Standards are also available in English translations, sometimes very literal, indicated by "E/DIN." These standards are sold by Beuth-Vertrieb GmbH, 1 Berlin 30, Burggrafenstrasse 4-7, West Germany. Standards in German, and the "E/DIN" translations, are available in the U.S.A. only from USASI.

Electronic Industries Association (EIA) Engineering Department, 2001 Eye Street, N.W., Washington, D.C. 20006.

Institute of Electrical and Electronics Engineers, Inc. (IEEE formerly AIEEE and IRE), 345 East 47th St., New York, N.Y. 10017.

These Standards are available from the IEEE, Order Department, and also from USASI.

International Broadcasting and Television Organization (IBTO or *OIRT*), Liebknechtova 15, Prague, 5 Czechoslovakia.

International Electrotechnical Commission (IEC), 1, rue de Varembe, Geneva, Switzerland.

International Radio Consultative Committee (CCIR), International Telecommunication Union, Place des Nations, Geneva, Switzerland.

Japanese Standards Association (JSA), 1-24 Akasaka 4, Minato-ku, Tokyo, Japan.

Magnetic Recording Industries Association (MRIA), Merged with EIA in 1965; no Standards issued.

National Association of Broadcasters (NAB) Engineering Department, 1771 N Street, N.W., Washington, D.C. 20036.

Philips Phonographic Industries, Baarn, The Netherlands.

Record Industry Association of America, Inc. (RIAA), One East 57th St., New York, N.Y. 10022.

Society of Motion Picture and Television Engineers (SMPTE), 9 East 41st St., New York, N.Y. 10017.

These Standards are published in the journal of the SMPTE in their draft and finally approved forms. The approved Standards are available from USASI.

Union Technique de l'Electricite, 20, rue Hamelin, Paris (16^{e}), France.

Available in the U.S.A. through USASI, in French only.

United States of America, Federal Specifications,

a) Bureau of Ships. Department of the Navy.

Standards can be ordered from Naval Ship Engineering Center, Code 6665.2M, Washington, D.C. 20360.

USA Standards Institute (USASI, formerly American Standards Association Inc.), 10 East 40th St., New York, N.Y. 10016.

USASI does not originate standards itself, but rather provides procedures for establishing national standards called "USA Standards" based on a consensus of those substantially concerned with the scope of the corresponding standards.

Standards sponsored by IEEE and approved by USASI are listed.

Standards sponsored by SMPTE and approved by USASI are listed.

Most foreign and international standards are distributed in the USA by the USASI.

Audio Cartridge Tape Recording and Reproducing Systems

1. General

1.1 *Scope*

The purpose of this standard is to describe and define the NAB Audio Cartridge Tape Recording and Reproducing System. This standard does not apply to special purpose tape cartridge systems which vary significantly from those described in this standard (tape speed, track configuration, noise reduction, etc.). This standard does not include any applicable safety requirements and supersedes the NAB Cartridge Standard dated October 1964.

1.2 *General Description of System and Applications*

This standard applies to an endless loop cartridge system for the recording and reproduction of audio broadcast programs on lubricated magnetic tape.

The NAB cartridge is an enclosure containing an endless loop of lubricated magnetic tape wound in such a fashion as to allow continuous tape motion.

The cartridge case has an opening in its lower side in order to accommodate a pressure roller, a corresponding cutout in the front side for a capstan, and two or more cutouts for insertion of magnetic head(s).

In the working position, the pressure roller pushes the tape against the capstan. At the same time, the pressure roller shaft may position the cartridge via a spring action device or other cartridge member.

The Standard requires either one program track and one cue track for monophonic programs; or two program tracks and one cue track for stereophonic programs.

A standard machine shall have the capability of accepting a single or multiplicity of NAB Size AA, Size AA and BB, or Size AA, BB, and CC cartridges.

A standard machine shall transport the tape, record and/or reproduce the signals recorded thereon in accordance with the requirements herein stated.

A standard cartridge shall maintain the tape in the position and condition shown in Fig. 1B. The cartridge shall permit the tape to be transported so as to meet the requirements herein stated.

1.3 *Description of Cue System*

This standard employs one track on the tape on which may be recorded four different signals, one each for (a) cueing the tape to a starting point, (b) providing an end of message signal, (c) a third signal, and (d) a fourth signal. Signals (b), (c), and (d) are used externally to the system. Refer to Section 3.4.

1.4 *Fast Wind (High Speed Cueing)*

High speed cueing is an optional feature and is intended for use in advancing the tape at a rate in excess of the normal (7.5 in/s, 190.5 mm/s) playing speed and stopping upon sensing the primary cue signal recorded on the cue track.

1.5 *Environment*

This standard applies when machines and NAB Type AA cartridges are operated in free air circulation under the following conditions:

1.5.1 *Relative Humidity*

Relative humidity not less than 25 percent or more than 80 percent.

1.5.2 *Ambient Temperature*

The ambient temperature shall not be less than 40 °F (4 °C) or more than 90 °F (32 °C).

1.5.3 *Power Source*

The line voltage is to be 117 v, ± 10 percent, 1ø, 60 Hz. Alternate voltages and frequencies may be used as specified on the equipment.

1.5.4 *Radio Frequency Interference (RFI)*

Cartridge tape equipment commonly operates in RF fields. The problem of determining a suitable test condition is under study.

2. Mechanical Requirements for Cartridges, Tape, Recording and Reproducing Equipment

2.1 *Mechanical Dimensions*

2.1.1 *Cartridges*

2.1.1.1 *Sizes and Dimensions*

Three cartridge sizes are standard; NAB Type AA, NAB Type BB, and NAB Type CC.[1]

The standard dimensions for NAB Type AA cartridge are shown in Fig. 1A and 1B.

Dimensions for NAB Type BB and Type CC are shown in Table 1. The dimensions for Type AA apply to Type BB and Type CC except for width and length.

TABLE 1

All Dimensions in Inches

Cartridge NAB type	Width	Length	Height
BB	6.010 5.990	7.025 6.975	.895 .865
CC	7.635 7.615	8.525 8.475	.895 .865

All Dimensions in Millimeters

Cartridge NAB type	Width	Length	Height
BB	152.65 152.15	178.44 177.17	22.73 21.97
CC	193.93 193.42	216.54 215.27	22.73 21.97

2.1.1.2 *Spring Action Device*

The cartridge spring action device when used, shall meet the requirements shown in Fig. 2.

2.1.1.3 *Form of the Cartridge Heel*

The cartridge heel shape is not standardized, but must fall within the outline shown in Fig. 1.

2.1.1.4 *Tape Path*[2]

The running path of the uppermost edge of the tape shall be parallel to the C plane (deck plane) at a distance perpendicular to said plane of 0.562 in. (14.275 mm). Tolerance is ± 0.002 in. (0.051 mm).

No member of the cartridge or playing mechanism shall prevent the tape from running within the prescribed limits. See Fig. 3.

2.1.1.5 *Tape Tension*

The tape tension measured with tape moving in the direction of normal travel, with heads and external guides eliminated, and any braking system defeated, shall not exceed 3 oz. (0.834 N).

2.1.1.6 *Tape Orientation*

The magnetic coating shall face the windows at the front of the cartridge, and shall move across the windows from right to left as the cartridge is held with the bottom down and the windows facing the observer. See Fig. 1B.

2.1.1.7 *Playing Time*

The playing time shall be clearly marked on the cartridge. Loaded cartridges shall contain no less tape than that required to provide the indicated playing time (at 7.5 in/s 190.5 mm/s). Excess tape shall not exceed 3 sec. playing time for playing times up to 100 sec., and not more than 6 sec. for playing times greater than 100 sec.

2.1.1.8 *Identification*

Cartridges conforming to this standard shall be

[1]The cartridges meeting this standard are similar to the former Type A, Type B and Type C, respectively. Certain differences in the Type AA, BB, and CC may prevent full compatibility with those described in the 1964 NAB Standard.

[2]Fig. 1B gives a dimension for the lower edge of the tape when it is in a relaxed static condition.

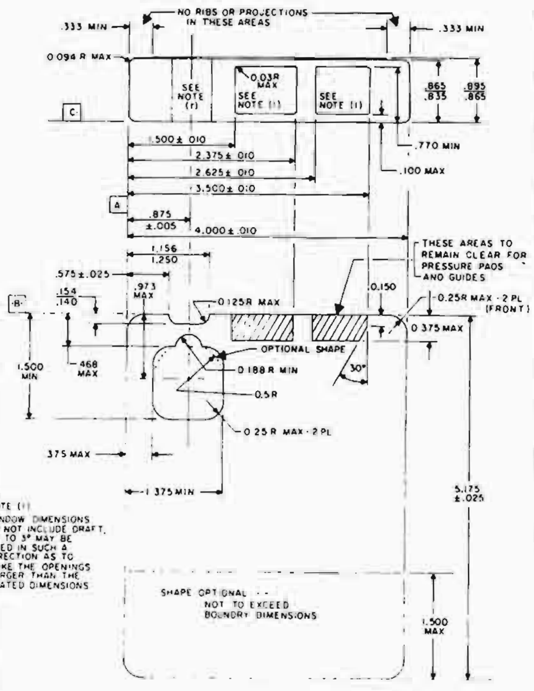


Fig. 1A. NAB "AA" cartridge.

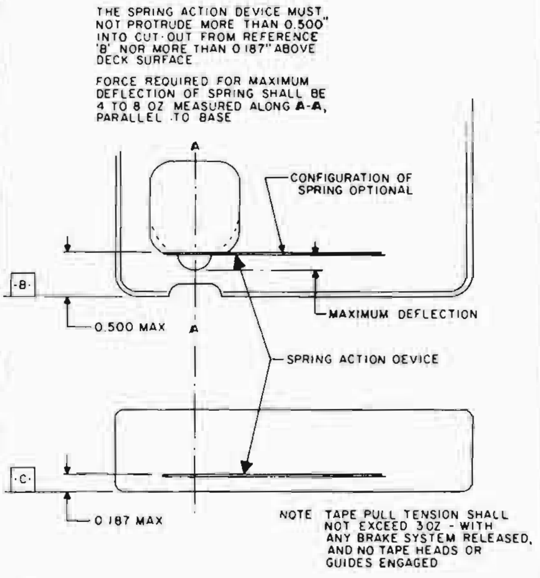


Fig. 2. NAB "AA" cartridge spring action device limitations.

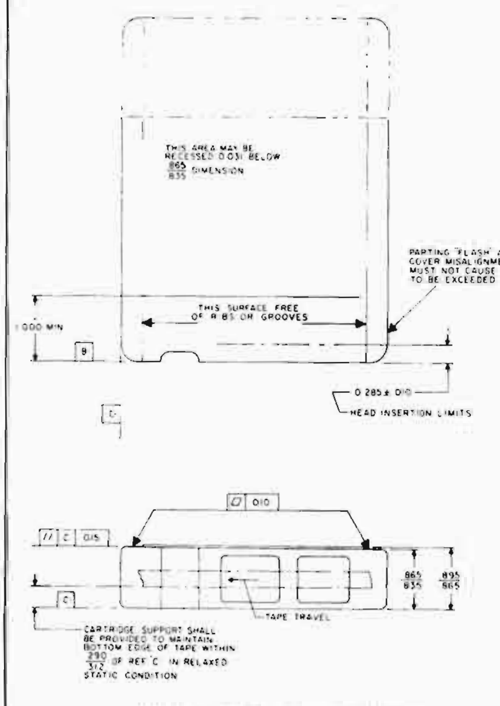


Fig. 1B. NAB "AA" cartridge.

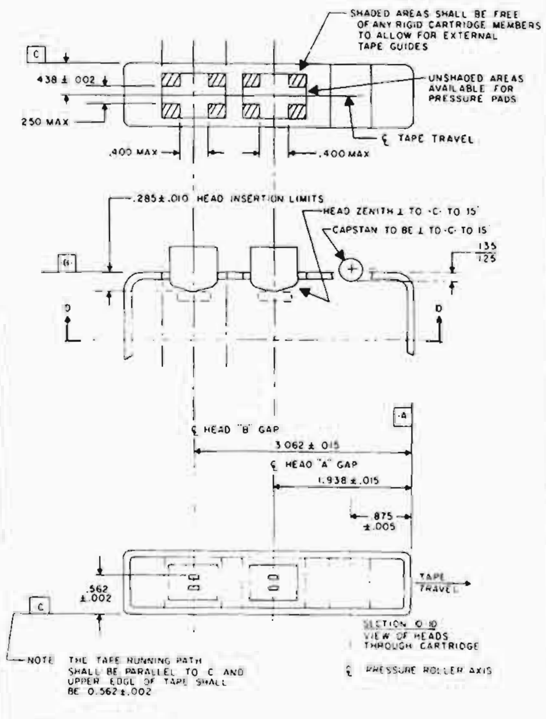


Fig. 3. Machine/cartridge interface dimensions.

clearly identified with the appropriate NAB Type (AA, BB, CC).

2.1.1.9 *Tape Stop Time*

The tape shall stop within 40 msec (maximum) of the transport release at 7.5 in/s (190.5 mm/s), or 80 msec (maximum) equivalent playing time from fastest speed.

2.1.2 *Tape*

2.1.2.1 *Tape Thickness*

Total thickness of tape (base film plus coatings) shall not exceed 1.6 mils (0.04 mm).

2.1.2.2 *Tape Width*

The tape width shall be 0.248 in. +0.000, -0.002. (6.30 mm +0.000, -0.05 mm.)

2.1.2.3 *Tape Lubrication*

Tape used in cartridges shall be lubricated on the side opposite the magnetic coating.

2.1.3 *Transport*

2.1.3.1 *Head Location*

The location of the center line of the gap of each head referenced to Plane A shall be as shown in Fig. 3.

2.1.3.2 *Head Insertion*

The tape contact surface of the head(s) relative to the B plane shall be as shown in Fig. 3.

2.1.3.3 *Head Zenith*

The tape contact surface of the head(s) shall be perpendicular to C plane within 15 min. of arc as shown in Fig. 3.

2.1.3.4 *Head/Tape Contact Area*

The tape-to-head contact area shall be within limits as shown in Fig. 3.

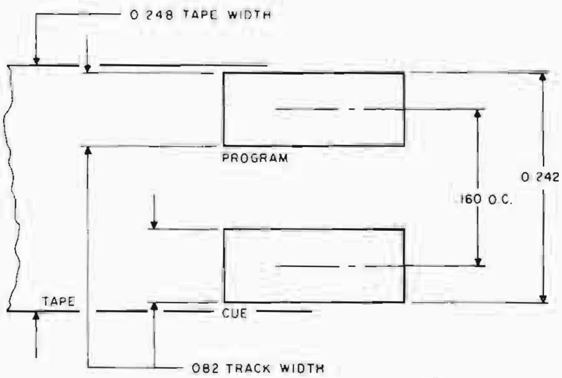


Fig. 4A. Mono track system reference dimensions.

2.1.3.5 *Track Reference Dimensions and Formats*

The monophonic track system reference dimensions are given in Fig. 4A. The stereophonic track system reference dimensions are given in Fig. 4B.

2.1.3.6 *Capstan Perpendicularity*

The capstan shall be perpendicular to Plane C (deck plane) within 15 min. of arc.

2.2 *Transport Performance*

2.2.1 *Tape Speed*

The standard tape speed shall be 7.5 in/s (190.5 mm/s) tolerance shall be ± 0.2 percent.

2.2.2 *Fast Wind (Optional)*

2.2.2.1 *Maximum Tape Speed*

The maximum tape speed shall be 30 in/s (762 mm/s) in fast wind mode (Me-

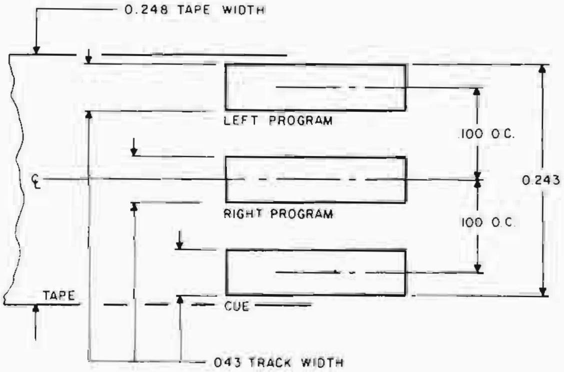


Fig. 4B. Stereo track system reference dimensions.

chanical considerations for tape and cartridge).

2.2.2.2 *Initiate Fast Wind Mode*

The fast wind mode shall be initiated by the trailing edge of the secondary cue tone (EOM) for automatic, or by actuation of a contact closure or equivalent for manual operation.

2.2.2.3 *Inhibit Start Command*

When stopping from the fast wind mode, the start command is to be inhibited for the maximum motor speed transition time (from fast to normal speed).

2.2.2.4 *Defeat Fast Wind Mode*

Machines with fast wind shall have a switch to allow the defeat of automatic fast wind mode. When in a recording mode, fast wind operation shall be defeated.

2.2.3 *Transport Stop Time*

The transport stop time shall be 80 msec. maximum at 7.5 in/s (190.5 mm/s); 120 msec. divided by the ratio of fast wind speed to 7.5 in/s (190.5 mm/s) when set in the recommended minimum time release adjustment or mode.

2.2.4 *Transport Start Time*

The transport start time from initiation of start command shall be 120 msec. maximum to first reach 7.5 in/s (190.5 mm/s).

2.2.5 *Maximum Temperature Rise*

The maximum temperature rise above ambient for any machine part in long-term contact with the tape or cartridge shall be 50°F (28°C).

2.2.6 *Flutter*

The weighted peak flutter of the reproducer shall be less than ± 0.15 percent measured according to ANSI S4.3, using a flutter test tape as described in Section 4.4 of this standard.

2.2.7 *Phase Difference (Stereo)*

The peak stereophonic phase difference shall not exceed 90° at 12.5 Hz.

3. Electrical Requirements for Recording and Reproducing Equipment

3.1 *Equalization*

3.1.1 *Recorded Tape Flux Characteristic*

The standard characteristic of the short circuit magnetic tape flux (and also the fluxivity) versus frequency shall fall with increasing frequency in conformity with the impedance of a parallel combination of a capacitance and a resistance having a time constant of 50 microseconds. Refer to Table 2 and Fig. 5.

3.2 *Standard Tape Reference and Operating Level*

3.2.1 *Reference Fluxivity*

For all measurements in this standard, the reference fluxivity shall be 160 nWb/m at 1 kHz as measured according to ANSI S4.6.

3.2.2 *Standard Operating Level*

The standard operating level is not specified.

160 nWb/m at 1 kHz is recommended if a VU Meter, or instrument of similar characteristics is used in the recording process with currently available magnetic tape.

3.3 *Program System Performance Requirements*

3.3.1 *Minimum Input Level*

3.3.1.1 *Reproducer Limit*

The maximum gain of the reproducer shall be such that a recorded fluxivity of

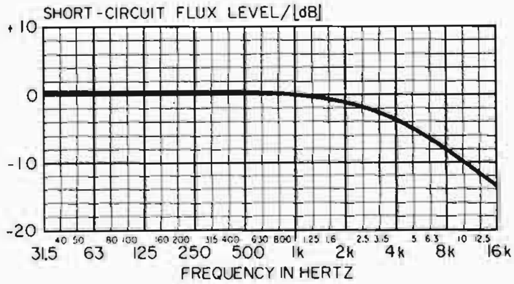


Fig. 5. Standard recorded tape short circuit flux characteristic.

50 nWb/m at 1 kHz (10 dB below reference fluxivity) will produce at least 0 dBm output level.

3.3.1.2 *Recorder Limit*

The recorder shall be capable of recording a 1 kHz signal at reference fluxivity from the following minimum input levels: -22 dBm (60 mv/600 ohms, or 30 mv/150 ohms) 600/150 ohm connection; -8 dBm (300 mv/600 ohms), -2 dBm (300 mv/150 ohms) bridging connection.

3.3.2 *Maximum Input Level*

3.3.2.1 *Reproducer Limit*

The reproducer shall be capable of reproducing no less than 1250 nWb/m equivalent input fluxivity at 1 kHz (18 dB above reference fluxivity).

3.3.2.2 *Recorder Limit*

The record amplifier shall be capable of accepting the following maximum levels: 0 dBm (780 mv/600 ohms or 390 mv/150 ohms) 600/150 ohm connection; +14 dBm (4.0 mv/600 ohms), +20 dBm (4.0 mv/150 ohms) bridging connection.

3.3.3 *Amplitude/Frequency Response*

3.3.3.1 *Reproducer Limit*

When reproducing a calibration tape meeting the requirements of paragraph 4, the output level of the reproducer shall be within a 2 dB window from 315 Hz to 10 kHz, 3 dB window from 150 to 314 Hz, 5 dB window from 50 to 149 Hz, and opening from 2 to 3 dB between 10 and 16 kHz, as shown in Fig. 6A, with the upper limit of the window to be flat from 20 Hz to 20 kHz.

3.3.3.2 *Recorder Limit*

When recording a tape and comparing its reproduced output with that of an NAB Standard test tape, the difference shall be within a 2 dB window from 50 Hz to 10 kHz, and opening from 2 to 3 dB between 10 kHz and 16 kHz, as shown in Fig. 6B.

3.3.3.3 *Level Difference (Stereo)*

The maximum level difference between stereo program channels shall be 1.5 dB for a reproducer, and 3.0 dB for a recorder/reproducer over the frequency range from 50 Hz to 16 kHz.

3.3.4 *Total Harmonic Distortion*

3.3.4.1 *Reproducer Limit*

The total harmonic distortion of the reproducer at +18 dBm output (from 50 Hz to 16 kHz) shall be less than 0.5 percent.

3.3.4.2 *Recorder Limit*

The total harmonic distortion of the record amplifier at 1 kHz, with a level 18 dB above that required to record 160 nWb/m on currently available magnetic tape, shall be less than 0.5 percent.

3.3.4.3 *System Limit*

The total harmonic distortion when recording and reproducing 160 nWb/m at 1 kHz, on currently available tape, shall be less than 2.0 percent.

With a 1 kHz tone recorded with peak bias on any lubricated tape at a level which produces 3.0 percent rms 3rd harmonic distortion, the distortion should result mainly from the tape nonlinearity and not from the recording or reproducing amplifiers.

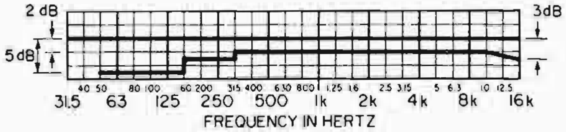


Fig. 6A. Reproduce characteristic tolerance.

3.3.5 *Signal/Noise Ratio*

3.3.5.1 *Reproducer Limit*

The reproducer signal-to-noise ratio shall be measured unweighted with a bandpass of 20 Hz to 20 kHz *without tape running,* but with an otherwise fully operating reproducer, from 160 nWb/m at 1 kHz reference level. The minimum signal-to-noise ratio shall be 50 dB for mono and 47 dB for stereo.

3.3.5.2 *System Limit*

The system signal-to-noise ratio shall be measured unweighted with a bandpass of 20 Hz to 20 kHz, using a tape recorded with bias but with no signal, from 160 nWb/m at 1 kHz reference level. The minimum system signal-to-noise ratio shall be 47 dB for mono and 44 dB for stereo.

3.3.6 *System Crosstalk*

3.3.6.1 *Stereo Program Crosstalk*

Stereo program crosstalk shall be measured at 50 Hz, 1 kHz, 10 kHz with 160 nWb/m and 50 nWb/m respective fluxivities, correct source and load impedances, and with normal gain control settings. The maximum stereo program crosstalk shall be -45 dB.

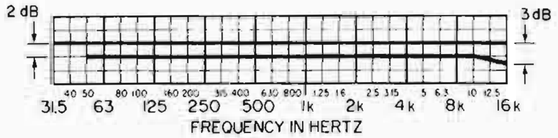


Fig. 6B. Record characteristic tolerance.

3.3.6.2 *Cue to Program Crosstalk*

Cue to program crosstalk shall be measured at 150 Hz, 1 kHz, 3.5 kHz and 8 kHz, with nominal levels, correct source and load impedances, and with normal gain control settings. The maximum cue to program crosstalk shall be -50 dB.

3.3.7 *Channel Phasing (Stereo)*

3.3.7.1 *Record Polarity*

In-phase stereo inputs to record amplifier input terminals shall produce in-phase magnetic signals on the tape (as from a full-track record head).

3.3.7.2 *Reproduce Polarity*

In-phase magnetic signals on the tape (as from full-track recording) shall be reproduced as in-phase stereo signals at the reproduce amplifier output terminals.

3.3.7.3 *Phase Difference*

The peak phase difference between stereo channels (record and subsequently reproduce) shall be less than 90° for all frequencies between 50 Hz and 12.5 kHz.

3.3.8 *Interface Impedances*

The recorder and/or reproducer shall be required to meet all of the specifications of this standard only when properly terminated in the rated source and load impedances.

3.3.8.1 *Reproducer Load Impedance*

The reproducer rated load impedances shall be 600 ohms on output connection *and* 150 ohms available on external connection or by internal wiring.

3.3.8.2 *Reproducer Output Impedance*

The reproducer output impedances shall not exceed 0.125 times the rated load impedance (75 ohms maximum for 600 ohms rated load, 18.8 ohms maximum for 150 ohms rated load), over the frequency range from 50 Hz to 16 kHz.

3.3.8.3 *Recorder Source Impedance*

The recorder source impedance shall be 150 ohms or less; on the 150 ohm connection, or 600 ohms or less on the 600 ohm connection.

3.3.8.4 *Recorder Input Impedance*

The recorder input impedances shall be 8 (minimum) times the rated source impedance (4,800 ohms minimum for 600 ohms rated source, 1,200 ohms minimum for 150 ohms rated source), and 10,000 ohm minimum bridging over the frequency range from 50 Hz to 16 kHz.

3.3.8.5 *Input/Output Connections*

The program record input and reproduce output connections shall be floating (ungrounded), capable of being connected to sources/loads with either side or centerpoint grounded while meeting all other specifications.

3.4 *Cue System Performance Requirements*

3.4.1 *Required and Optional Cue Facilities*[3]

There shall be a Primary cue system in NAB Standard Cartridge Tape Recorders and Reproducers. All other cue/logging facilities are optional. When used, the optional Secondary, Tertiary and Logging cue tones shall be as assigned in paragraph 3.4.2, the cue sensor limits shall be as specified in paragraph 3.4.6; and all other requirements listed in paragraph 3.4 for cue system performance must be met.

3.4.2 *Cue/Logging Generator Frequencies and Tolerances*

Primary cue: 1 kHz, ± 50 Hz.
Secondary cue: 150 Hz, ± 8 Hz.
Tertiary cue: 8 kHz, ± 400 Hz.
Logging signal: 3.5 kHz, ± 150 Hz for single-tone On/Off system.
3.3 kHz to 3.7 kHz maximum window for FSK logging system.

3.4.3 *Cue/Logging Tone Levels*

3.4.3.1 *Recorded Fluxivity*

Primary cue: 160 nWb/m, +20 nWb/m, -40 nWb/m.

Secondary cue: 360 nWb/m, +40 nWb/m, -110 nWb/m.

Tertiary cue: 20 nWb/m, +2 nWb/m, -6 nWb/m.

Logging signal: 35 nWb/m, +5 nWb/m, -10 nWb/m.

3.4.3.2 *Relative Output Levels*

When a tape with standard recorded cue tones is reproduced through an amplifier having the ideal NAB reproducing characteristic and compared to the NAB Standard Tape Reference Fluxivity (paragraph 4.2.1.2), the corresponding relative output levels are:

Primary cue: 0 dB standard, +1 dB maximum, -3 dB minimum (+1 -3 dB).

Secondary cue: +6 dB standard, +7 dB maxi-

[3]Recording of the Secondary cue, Tertiary cue and Logging signals shall be possible during the record and reproduce modes of the cartridge machines without causing any of the parameters to exceed the specified limits.

mum, +3 dB minimum (+1 -3 dB).

Tertiary cue: -10 dB standard, -9 dB maximum, -13 dB minimum (+1 -3 dB).

Logging signal: -10 dB standard, -9 dB maximum, -13 dB minimum (+1 -3 dB).

3.4.4 *Cue/Logging Tone Distortion*

The total harmonic distortion as recorded on the tape at the frequencies and levels listed above shall not exceed 5.0 percent.

3.4.5 *Cue/Logging Tone Duration*

Primary cue: 500 msec. minimum, 750 msec. maximum.
Secondary cue: 100 msec. minimum (15 cycles at 150 Hz), no maximum specified.
Tertiary cue: 2 msec. minimum (16 cycles at 8 kHz), no maximum specified.
Logging signal: No minimum or maximum specified. External logging encoding and decoding systems may have differing requirements.

3.4.6 *Cue Sensor Requirements*

3.4.6.1 *Cue Sensor Operation*[4]

The individual cue sensors shall operate satisfactorily with the levels listed in Section 3.4.3 for tones within the frequency tolerances listed below:

Primary cue: 1 kHz ± 100 Hz.
Secondary cue: 150 Hz ± 15 Hz.
Tertiary cue: 8 kHz ± 800 Hz.
Logging signal: No tolerance specified.

3.4.6.2 *Primary Cue Sensor Inhibitor*

A Primary cue sensor inhibit timer shall be incorporated to prevent the operation of the Primary cue sensor until after the Primary cue tone has initially passed the cue reproduce head. The duration of the inhibit or protect timer shall be 1.75 sec., ± 0.25 sec.

3.4.6.3 *Protection against False Cueing*

The Primary, Secondary and Tertiary cue sensors shall not respond to other standard cue or logging tones within the frequency tolerances listed in Section 3.4.2 (and with up to 6 dB above standard levels in 3.4.3 with no more than 5 percent distortion) when either in the normal speed or fast speed mode of operation.

3.4.7 *Cue Sensor External Switching Requirements*

The Secondary and Tertiary cue sensors shall have a ground switching output when the optional sensors are provided. The switching circuit shall be one-side grounded with a current sinking capability of at least 50 mA., voltage rating of at least +25 v when open and, with 50 mA. current, shall have 0.4 v maximum voltage drop across the switch when closed.

Protection shall be included to prevent damage of the switching circuit components with a reverse voltage of up to -25 v, and a reverse current of up to 100 ma. in the event the load switching supply is reversed in polarity.

3.4.8 *Logging Input/Output Requirements*

3.4.8.1 *Input Level*

The required input logging signal shall be 0.5 v., ± 0.25 v RMS level for a tape fluxivity of 35 nWb/m.

[4]The external logging system sensor must reject the Primary, Secondary and Tertiary cue signals at the maximum specified levels for error-free operation.

3.4.8.2 *Input Impedance*

The logging input impedance shall be 10,000 ohms minimum. The input may be one-side grounded.

3.4.8.3 *Output Level*

The required logging output level shall be 0.5 v, ± 0.25 v RMS from a logging signal of 35 nWb/m tape fluxivity.

3.4.8.4 *Load Impedance*

The logging load impedance shall be 10,000 ohms minimum. The output may be unbalanced.

3.4.8.5 *Protection From External Cue Tones*

The output circuit shall provide 40 dB minimum isolation for internal cue sensors from external cue signals appearing on the output connector from other machines connected in parallel with the output.

3.4.8.6 *Logging Output Distortion*

The total harmonic distortion for Primary, Secondary and Tertiary cue tones, and for Logging tones appearing at the logging output, recorded at maximum levels with up to 5.0 percent distortion on the tape shall be 7.0 percent maximum.

3.5 *Remote Input Switching Requirements*

3.5.1 *Reproducer Requirements*

Connections and circuitry for start and stop remote switching functions shall be provided in reproducers.

3.5.2 *Recorder Requirements*

Record set remote switching functions shall be provided in recorders. Connections and circuitry for Secondary and Tertiary cue remote record switching functions shall be provided when these optional facilities are provided in the recorder.

3.5.3 *Voltage and Current Requirements*

All circuits for remote switching shall be one-side grounded and capable of operation by the closure of an external normally open set of contacts, or equivalent. They shall operate from a positive supply voltage, with + 25 v maximum appearing on the switching terminals.

They shall require no more than 50 mA. current for operation, and shall operate when the switching voltage is pulled down to +0.4 v with respect to ground by the external switch.

Proteciton shall be included to prevent damage of the switching circuit components with a sustained reverse current of up to 100 mA. in the event an external supply is connected to the switching terminals.

3.5.4 *Response Time*

The switching circuits of 3.5.1 and 3.5.2 shall operate with a switch closure of 40 msec. or more.

4. Calibration/Test Tapes

4.1 *Label Information*

The cartridge shall be labeled. It shall state the test tape category, tape speed, NAB Standard and edition, the manufacturer and catalog number, and the track format.

4.2 *Spot Frequency Calibration Tape*

There is nothing at the present time for Section 4.2.

4.2.1 *General*

4.2.1.1 *Reference Frequency*

The reference frequency for calibration tapes shall be 1000 Hz.

4.2.1.2 *Reference Fluxivity*

The reference fluxivity for calibration tapes shall be an RMS short-circuit flux per unit track width of 160 nWb/m of track width at 1000 Hz, as measured according to ANSI S4.6-1973.

4.2.1.3 *Flux versus Frequency*

The recorded tape flux versus frequency shall be as given by the following equation:

$$(f) = 1/^2\ [1+(f/3180)^2]$$

where f is the frequency in Hz.

4.2.2 *Tolerances*

4.2.2.1 *Recorded Frequencies*

The recorded frequencies, when reproduced at the standard speed, shall be the specified values ± 1 percent.

4.2.2.2 *Reference Fluxivity*

The reference fluxivity shall be the specified value ± 3 percent.

4.2.2.3 *Flux versus Frequency*

The fluxivity versus frequency shall be the specified value in Table 2 ± 0.5 dB up to the frequency of 10 kHz, and ± 1.0 dB for frequencies above 10 kHz.

4.2.2.4 *Azimuth Angle*

The tape flux shall be parallel to the longitudinal axis of the tape with an azimuth alignment error across the entire track width not to exceed ± 0.2 milliradians (40 sec.).

4.2.3 *Recorded Tracks*

4.2.3.1 *Monophonic*

The recorded test signals may be recorded on the program track shown in Fig. 4A, or they may be recorded across the entire upper 0.16 in. (4 mm) of the tape.

4.2.3.2 *Stereophonic*

The recorded test signals may be recorded on the two program tracks shown in Fig. 4B, or they may be recorded (with fringing compensation) across the entire upper 0.16 in. (4 mm) of the tape.

4.2.4 *Test Tape Format*

4.2.4.1 *Announcements*

Each test tone shall be preceded by a voice announcement.

4.2.4.2 *Format*

The calibration tape shall contain at least the following frequencies, durations, and levels, preferably in the following sequence:

Frequency (Hz)	Duration (sec.)	Level (dB)	Function
1,000	5	- 0	Cue (Recorded on Cue Track)
1,000	20	0	Reference Fluxivity
1,000	10	-10	Response reference level
12,500	30	-10	Azimuth & phase calib.
50	5	-10	
63	5	-10	
125	5	-10	
250	5	-10	
500	5	-10	
1,000	5	-10	
2,000	5	-10	
4,000	5	-10	
8,000	5	-10	
10,000	5	-10	
12,500	5	-10	
16,000	5	-10	
1,000	20	0	Reference fluxivity

4.3 *Standard Speed/Timing Tape*

4.3.1 *Accuracy Requirement*

The speed timing error, when used within manufacturer's specified environmental conditions, traceable to a recognized timing standard such as the National Bureau of Standards, shall be less than 0.2 percent.

4.3.2 *Minimum Load Requirement*

The speed/timing cartridge shall contain no less than 2 min. of 1 mil base film lubricated tape, at standard operating speed of 7.5 in/s (190.5 mm/s), and shall be recorded on the top 0.082 in. track.

4.3.3 *Instructions for Use*

Instructions for use shall be stated in a concise and unambiguous way, since several differing types of test tapes are available. Instrumentation requirements and practical alternates shall be described, along with possible areas of error in their use.

4.4 *Flutter Test Tape*

4.4.1 *Frequency and Level*

The Flutter Test Tape shall be recorded at 3150 Hz ± 1.0 percent at 120 nWb/m ± 2 dB and to the requirements of ANSI S4.3.[5]

4.4.2 *Peak Flutter Content*

The weighted peak flutter content, when loaded in a cartridge shall not exceed ± 0.05 percent.

4.4.3 *Minimum Load Requirement.*

The Flutter Test Cartridge shall contain no less than 3½ min. of 1 mil base film lubricated tape at a standard operating speed of 7.5 in/s.

4.5 *Swept-Frequency Test Tape*

4.5.1 *General*

Two sweep modes are required: a rapid sweep followed by a slow sweep.

4.5.1.1 *Monophonic Test Tape*

The Monophonic Swept-Frequency Test Tape shall be recorded on the top 0.082 in. (2.08 mm) track.

4.5.1.2 *Stereophonic Test Tape*

The Stereophonic Swept-Frequency Test Tape shall be recorded in-phase ± 10° maximum. It shall be recorded either on the top and center 0.043 in. (1.09 mm) tracks or full track (cue track erased) provided fringing factor corrections are noted.

4.5.2 *Fast Sweep Test Tape*

4.5.2.1 *Voice Announcement*

No voice announcement is required.

4.5.2.2 *Cue Tones*

The tape shall be recorded without Primary cue tones and shall have 2 sec. of silence between sweeps.

4.5.2.3 *Format*

The fast sweep section shall start with 20 sec. of 1 kHz signal recorded at a -10 dB level ± 0.5 dB referenced to the 160 nWb/m Standard Reference Fluxivity. The 1 kHz Standard Reference Fluxivity shall be followed by 1 min. of the repetitive sweep frequency from 500 Hz to 16 kHz at the same level and at a 100 msec. sweep rate. The frequency shall change logarithmically in respect to time.

4.5.3 *Slow Sweep Section*

4.5.3.1 *Voice Announcements*

The frequencies shall be announced at a level low enough not to interfere with measurement accuracy.

4.5.3.2 *Cue Tones*

The Slow Frequency Sweep Calibration Tape shall include the Primary cue tone recorded one sec. before the beginning of each sweep.

4.5.3.3 *Format*

The slow sweep section shall follow the fast sweep section of the Sweep-Fre-

[5]American National Standard Institute.

quency Test Tape with three cycles of a repetitive sweep frequency recorded at a -10 dB level ± 0.5 dB referenced to the 160 nWb/m Standard Reference Fluxivity. The sweep frequency shall be 50 Hz to 16 kHz at a 25 sec. sweep rate. The frequency shall change logarithmically in respect to time.

4.6 *Cue/Logging Test Tape*

4.6.1 *Mono Test Tape*

The Mono Cue/Logging Test Tape shall be recorded on the bottom 0.082 in. (2.08 mm) cue track.

4.6.2 *Stereo Test Tape*

The Stereo Cue/Logging Test Tape shall be recorded on the bottom 0.043 in. (1.09 mm) cue track.

4.6.3 *Test Tape Format*

Using 160 nWb/m, ± 0.25 percent as 0 dB reference, the following tones shall be recorded within ± 0.5 percent of the nominal frequencies and within ± 0.5 dB of the specified levels, with a maximum total harmonic distortion of 5.0 percent. Each test tone is to be preceded by a voice announcement on the top track.

Freq.	Time	Level	Function
	THRESHOLD SENSITIVITY		
1 kHz	10 sec	— 7 dB	Primary threshold
150 Hz	10 sec	— 1 dB	Secondary threshold
8 kHz	10 sec	—17 dB	Tertiary threshold
	LOGGING TONE		
3.5 kHz	10 sec	—10 dB	Logging, nominal level
3.35 kHz[a]	10 ms[b]	—10 dB	
3.65 kHz[a]	10 ms	—10 dB	
	STANDARD LEVEL AND DURATION		
1 kHz[a]	500 ms	0 dB	Primary minimum time
150 Hz[a]	100 ms	+ 6 dB	Secondary minimum time
8 kHz	2 ms	—10 dB	Tertiary minimum time
	BANDWIDTH SELECTIVITY		
900 Hz	500 ms	— 3 dB	Primary limits
1100 Hz	500 ms	— 3 dB	
135 Hz	100 ms	+ 3 dB	Secondary limits
165 Hz	100 ms	+ 3 dB	
7200 Hz	2 ms	—13 dB	Tertiary limits
8800 Hz	2 ms	—13 dB	

[a]Repeat four times.
[b]ms = millisecond.

TABLE 2
Standard Recorded Tape Short Circuit Flux Characteristic (50 μsec)

Frequency (in Hz)	Flux Level (in dB)	Frequency (kHz)	Flux Level (in dB)
16	+.41	1	0
25	+.41	1.25	— .21
31.5	+.41	1.6	— .57
40	+.41	2	— 1.04
50	+.41	2.5	— 1.68
63	+.41	3.15	— 2.56
80	+.41	4	— 3.70
100	+.41	5	— 4.99
125	+.40	6.3	— 6.51
160	+.40	8	— 8.23
200	+.39	10	— 9.95
250	+.38	12.5	—11.74
315	+.37	16	—13.78
400	+.34	20	—15.66
500	+.30		
630	+.24		
800	+.14		

Relative flux level calculated by:

$$-10 \text{ Log} \left[1 + \left(\frac{f}{F}\right)^2\right]$$

where f is the frequency of interest and F is the transition frequency (3,183 Hz for 50 μsec.). The expression gives attenuation, with no attenuation for Zero Hz. The table is normalized for reference level at 1 kHz.

APPENDIX A

Glossary of Magnetic Cartridge Tape Recording and Reproducing Terms and Definitions

Azimuth Error, Mean (average)—The signal loss in each of two or more heads due to gap misalignment when adjusted for phase coincidence.

Cue Tones—Recorded audio frequencies of specified duration arranged in a physical fashion on the recorded tape so as to provide a signaling system available for positioning the tape at the start of message and/or such auxiliary functions as may be necessary and desirable.

Cue Track—That portion of the tape upon which the cue tones are recorded.

Flux (recorded)—A measure of the amplitude of the signal recorded on the magnetic tape.

Fluxivity—The name of short-circuit flux per unit track width. The usual multiple of the unit is nanoWebers per meter (nWb/m).

Gap Scatter—An expression for the horizontal displacement of two or more head gaps.

Logging Input—An external recording input connection to the cue track for the purpose of recording logging information.

Logging Output—An output connection from the cue channel for the purpose of reproducing logging information.

Logging Signal (tone)—Tones within an assigned frequency band used for the recording of logging information.

Motor Transition Time—The time in seconds for the tape drive motor to change from high to standard operating speed.

Primary Cue System—The tone and sensor used to cue the tape to the beginning of the recorded program.