A3.2 Line Repetition Rate. Initially, a tolerance was specified for this parameter, to serve as a fundamental tolerance on all system timing. This tolerance was moved to the Appendix to leave the standard untoleranced. The stated value, with tolerance, is:

Line repetition rate (derived) 33750.00 Hz $\pm$ 10 ppm

A3.3 Synchronizing Signal. The synchronizing signal specified in this standard is based on time durations, which are toleranced. For the purposes of this standard, counts of reference clock periods were chosen as the primary time specification, and time durations in microseconds are given as derived, quoting no tolerances. For information, the original tolerances on these parameters are:

a		0.593 $\pm$ 0.040 μsec
b		1.185 $\pm$ 0.040 μsec
c		0.593 $\pm$ 0.040 μsec
d		1.778 $\pm$ 0.040 μsec
e		2.586 $\pm$ 0.040 μsec
f	(sync rise time)	0.054 $\pm$ 0.020 μsec
S	sync pulse amplitude	300 $\pm$ 6 mV
	amplitude difference between positive and negative-going sync pulses	<6 mV

A4. Relationships Between Basic and Derived Parameters

Certain parameters have been determined as basic and fundamental system parameters. The values of all other system parameters can be derived from those chosen as basic. The purpose of this Appendix is to describe and define the derivations.

Line Repetition Rate (L):

$L = S \times F/2$

where

F = field repetition rate (Sec. 2),
and S = total scan lines per frame (Sec. 2).

Reference Clock Frequency (C):

$C = L \times R$

where

L = line repetition rate (Sec. 2, derived above), and R = reference clock periods in total line (Sec. 4).

Transformation Matrices Between Component Sets (Sec. 5):

The transformation matrices can be calculated from the chromaticity coordinates of the reproducer primaries and the chromaticity of reference white (i.e., the color reproduced when the reference reproducer is driven by equal primary signals), according to well-known methods.

Stated briefly, the equation for Y can be found as follows:

$Y = (G \times J_g \times y_g) + (B \times J_b \times y_b) + (R \times J_r \times y_r)$

where

J_g, J_b, and J_r are derived as follows:

$$\begin{bmatrix} J_r \\ J_g \\ J_b \end{bmatrix} = \begin{bmatrix} x_r & x_g & x_b \\ y_r & y_g & y_b \\ z_r & z_g & z_b \end{bmatrix}^{-1} \begin{bmatrix} x_w/y_w \\ 1 \\ z_w/y_w \end{bmatrix}$$

and

x_r, y_r, z_r are the chromaticity coordinates of the red primary,

x_g, y_g, z_g are the chromaticity coordinates of the green primary,

x_b, y_b, z_b are the chromaticity coordinates of the blue primary,

x_w, y_w, z_w are the chromaticity coordinates of reference white.

SMPTE RECOMMENDED PRACTICE

RP 61-1989

Specifications for Azimuth Test Film for 8-mm Type S Audio Reproducers, Magnetic Type

1. *Scope*

This practice specifies two test films for use in aligning the azimuth of magnetic head gaps in 8-mm Type S motion-picture audio reproducers, one operating at 20 ft (6.1 m) and another at 15 ft (4.6 m) per minute.

2. *Test Film Signal*

2.1 Recorded Frequency.

2.1.1 Type 24 Film. The audio record on the Type 24 film shall be an original recording which will reproduce at a frequency of 6300 $\pm$ 100 Hz when the linear velocity of the film is 24 frames per second or approximately 20 ft (6.1 m) per minute (4 in or 10.2 cm per second).

2.1.2 Type 18 Film. The audio record on Type 18 film shall be an original recording which will reproduce at a frequency of 5000 $\pm$ 100 Hz when the linear velocity of the film is 18 frames per second or approximately 15 ft (4.6 m) per minute (3 in or 7.6 cm per second).

2.2 Distortion. The total harmonic distortion of the recorded signal shall not exceed 1 percent.

2.3 Audio Record. The location and dimensions of the audio record shall be in accordance with American National Standard for Motion-Picture Film (8-mm Type S)—Magnetic Audio Record—Position, Dimensions and Reproducing Speed, ANSI/SMPTE 164-1988.

2.4 Recorded Level. The azimuth test tone shall be no less than 10 dB down from the equivalent reference level of 315 Hz at 185 nanowebers per meter after correct equilization of 90 μs. The signal level shall not fluctuate more than $\pm$ 0.5 dB within the test film length.

2.5 Flutter. The weighted peak flutter of the audio record shall not exceed 0.10 percent when measured in accordance with American National Standard Method for Measurement of Weighted Peak Flutter of Sound Recording and Reproducing Equipment, ANSI S4.3-1982.

2.6 Azimuth. The azimuth of the audio record shall be 90° $\pm$ 5′ to the reference edge of the film.

3. *Film Stock*

The film stock shall be magnetic full-coat, splice-free, of the low-shrinkage, safety type in compliance with American National Standard for Motion-Picture Film—Safety Film, ANSI/SMPTE 223M-1985; and cut and perforated in accordance with American National Standard for Motion-Picture Film (8-mm Type S)—Perforated 1R, ANSI/SMPTE 149-1988.

4. *Identification*

Each test film shall be identified by a suitable identification marking.

5. *Calibration*

5.1 Flux. The short circuit flux on the test film shall be determined by means of the calibrated short-gap ferromagnetic core reproducer technique. This technique is described in American National Standard Method of Measuring Recorded Flux of Magnetic Sound Records at Medium Wavelengths, ANSI S4.6-1982.

5.2 Level. The signal level measurements specified in 2.4 shall be measured with a standard volume indicator conforming to IEEE Std 152-1953, Volume Measurements of Electrical Speech and Program Waves.

NOTE: Test films made in accordance with this practice are available from the Society of Motion Picture and Television Engineers.

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SMPTE RECOMMENDED PRACTICE

RP 63-1989

Specifications for Sound-Focusing Test Film for 16-mm Audio Reproducers, Photographic Type

1. *Scope*

This practice specifies a test film for use in focusing the scanning beam of 16-mm motion-picture photographic audio reproducers operating at 36 ft (11 m) per minute.

2. *Test Film Signal*

2.1 Frequency. The audio record on the film shall reproduce at a frequency of 7000 ± 100 Hz (Type A) or 5000 ± 100 Hz (Type B) when the linear speed of the film is 24 perforations per second or approximately 36 ft per minute (7.2 in or 18.3 cm per second).

2.1.1 Type A. A film with a 7000-Hz record to be used by manufacturers and laboratories, for precise adjustment of the sound-focusing system.

2.1.2 Type B. A film with a 5000-Hz record to be used when simpler instruments are available or when lower quality is adequate, for quick adjustment of the sound-focusing system.

2.2 Audio Record. The location and dimensions of the recorded audio record shall be in accordance with American National Standard for Motion-Picture Film (16-mm) Prints—Photographic Sound Records, ANSI PH22.41-1983.

2.3 Recording. The film shall have an originally recorded, variable-density audio track. The track shall be heavily overmodulated and developed to high contrast so that it is essentially a square-wave track. The signal level shall not fluctuate more than ± 0.5 dB within the test film length.

2.4 Flutter. The weighted peak flutter of the audio record shall not exceed ± 0.1 percent when measured in accordance with American National Standard Method for Measurement of Weighted Peak Flutter of Sound Recording and Reproducing Equipment, ANSI S4.3-1982.

2.5 Azimuth. The azimuth of the audio record shall be 90° ± 3' to the reference edge of the film.

3. *Film Stock*

3.1 The film stock, preferably polyester, shall be splice-free, of the low-shrinkage, safety type in compliance with American National Standard for Motion-Picture Film—Safety Film, ANSI/SMPTE 223M-1985, and cut and perforated in accordance with long-pitch dimensions specified in American National Standard for Motion-Picture Film (16-mm)—Perforated 1R, ANSI/SMPTE 109-1986.

3.2 In the event that triacetate film stock is used, it shall be splice-free and shall have a maximum lengthwise shrinkage of 0.50 percent when tested as follows: At least 20 strips of film approximately 31 inches in length shall be cut for measurement of shrinkage. After normal development and drying (not over 80°F [27°C]), the strips shall be placed at least ¼ in apart in racks and kept for seven days in an oven maintained at 120°F (49°C) and a relative humidity of 20 percent. The strips shall then be removed, reconditioned thoroughly to 50 percent relative humidity at 70°F (21°C), and the shrinkage measured by a suitable method. The percent shrinkage shall then be calculated on the basis of deviation from the nominal dimension for the length of 100 consecutive perforation intervals given in ANSI/SMPTE 109-1986.

4. *Identification*

Each test film shall be identified by a suitable identification marking. This marking shall be printed lengthwise in the picture area and the spacing between consecutive titles shall be approximately 12 in (30 cm).

NOTE: Test films conforming to this practice are available from the Society of Motion Picture and Television Engineers.

Revision of RP 63-1983
Approved March 29, 1989

PROPOSED

SMPTE RECOMMENDED PRACTICE

RP 95
Revision of RP 95-1980

Installation of Gain Screens

1. *Scope*

This practice specifies the optimum installation parameters for gain screens used in motion-picture theaters.

2. *Considerations*

2.1 A gain screen is any screen surface with a gain of 1.1 or more. Gain determination of screens is specified in SMPTE Recommended Practice on Gain Determination of Front Projection Screens, RP 94-1980.

2.2 The effect of the screen gain is reduced when the angle of viewing is increased away from the major reflected rays. (See Appendix A4.)

2.3 When the light projection is perpendicular to the screen surface, the effect of gain diminishes in every direction away from the perpendicular condition to the screen center.

2.4 Specular screens follow the physical law; i.e., the angle of incidence equals the angle of reflection.

3. *Formulas*

3.1 Radius of Screen. The screen shall be curved when installed to a radius of:

$$\frac{\text{Projection distance} + \text{Distance between screen and audience center}}{2}$$

3.2 Degree of Tilt. To have maximum gain aimed at the center of the audience, the screen shall be tilted as follows:

$$\frac{\text{Projection angle to screen center}}{2}$$

Appendix

(This Appendix is not part of the SMPTE Recommended Practice, but is included for information only.)

A1. With gain screens, it is best to locate the audience inside the one-half maximum gain angles; good audience coverage can be attained if the audience boundaries are defined by the angles at which the gain is no less than that necessary to provide the recommended screen luminance (see American National Standard for Motion-Picture Film — Screen Luminance and Viewing Conditions —Indoor Theater Projection, ANSI/SMPTE 196M-1986).

A2. Retroflective or beaded-type screens shall be avoided unless the projector is in the center of the audience.

A3. Higher gain screens (1.5 and higher), and all "silver" screens should be installed in curved form to avoid the objectionable "hot-spot."

A4. Nearly all gain screens have a mirror effect, which causes the angle of projection reaching the sides of the screen to be reflected toward the walls unless the installation is in curved form.

A5. Where the audience seating is wider than the screen width, consideration should be given to a "ray-trace" of reflected light from the gain screen, so that the light properly reaches the side seats across the middle rows. Ray-tracing can be done by hand drawing or by computer and may differ from the formulas given in 3.1 and 3.2 above, especially with shorter focal length lenses, such as the range of 50- to 75-mm focal length for 35-mm anamorphic projection from a rear projection booth.

A6. Use of a curved screen with vertical projection angles greater than 8° requires consideration of curvilinear distortion, and may require adjustment of screen masking.

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PROPOSED

SMPTE RECOMMENDED PRACTICE

RP 105
Revision of RP 105-1981

Method for Determining the Degree of Jump and Weave in 70-, 35- and 16-mm Motion-Picture Projected Images

Introduction

Acceptability of undesirable image movement in a projection system depends upon several factors such as the purpose of projection, the critical nature of the image, the ratio of viewing distance to screen image size, and the frequency and direction of the motion. Projection performance can be determined by identifying these parameters and classifying the various degrees of steadiness.

1. *Scope*

This practice identifies image motion, classifies the practical limits of acceptability of film jump and weave, and recommends a method of measurement for projection of 70-, 35-, and 16-mm motion-picture prints.

2. *Definitions*

2.1 Jump is the undesirable vertical motion (in normal systems where the film travel is vertical) of the projected image. Called jump because of its rapid motion, it is usually at the same frequency as the motion-picture frame rate (24 frames/s, etc.).

2.2 Weave is the undesirable horizontal motion (in normal systems where the film travel is vertical) of the projected image. Weave is normally at a much slower rate than the frame rate, and usually less noticeable.

2.3 The viewer's impression of either jump or weave is related to the apparent size of the screen image. The apparent size of the screen image may be divided into three classifications:

Large: A large appearing screen image is one which is viewed from a distance of 3.7 screen heights or less (vertical field of vision is 15° or greater).

Medium: A medium appearing screen image is one which is viewed from a distance of 3.7 to 5.7 screen heights (vertical field of vision is 10x to 15x).

Small: A small appearing screen image is one which is viewed from a distance greater than 5.7 screen heights (vertical field of vision is 10x or less).

3. *Classification*

3.1 For each classification of apparent size of the screen image, the following percentages of jump and weave indicate the practical limit of acceptability in terms of the percentage of the image height:

Classification	Jump	Weave
Large appearing screen image (Review rooms, premier theaters)	0.12%	0.20%
Medium appearing screen image (*First-run theaters*)	0.20%	0.25%
Small appearing screen image	0.30%	0.30%

3.2 The values specified are achievable when using SMPTE test films. Higher values may be expected from normal release prints which may be produced to less exacting tolerances.

4. *Recommended Method of Measurement*

The recommended method of measurement is to project a test film made on a registration pin camera, such as the SMPTE 16-PA, as specified in SMPTE Recommended Practice on Specifications for 16-mm Projector Alignment and Screen Image Quality Test Film, RP 82-1985; the SMPTE 35-PA, as specified in SMPTE Recommended Practice on Specifications for 35-mm Projector Alignment and Screen Image Quality Test Film, RP 40-1971 (R1977); or the SMPTE 70-PA, as specified in SMPTE Recommended Practice on Specifications for 70-mm Projector Alignment and Screen Image Quality Test Film, RP 91-1987.

These films have the overall area covered with a checkerboard pattern as follows:

35-PA 170 vertical squares (see table below)

Aspect Ratio	Projected Image Area	One square = Percent Movement
1.37:1	0.602 x 0.825"	0.7%
1.66:1	0.497 x 0.825"	0.8%
1.75:1	0.471 x 0.825"	0.9%
1.85:1	0.446 x 0.825"	0.94%
2.4:1	0.700 x 0.838"	0.6%

200 horizontal squares (1 square = 0.5%)

70-PA 100 vertical squares (1 square = 1.0%)
220 horizontal squares (1 square = 0.46%)

16-PA 100 vertical squares (1 square = 1.0%)
134 horizontal squares (1 square = 0.75%)

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Project the appropriate test film under normal conditions. For 35-mm projection, jump should be measured with the format which uses the smallest film image height used in the theater, usually 1.85:1, and weave should be measured with the format which uses the largest film image width used in the theater, usually 2.4:1 anamorphic.

Place an appropriate device, such as a microphone stand, near the screen to provide a sharp shadow. Position the shadow to be adjacent to any background square and observe the amount of movement. As an example, using the 35-PA test film, if the vertical movement averages a quarter square and projection is at a 1.85:1 ratio, the jump is 0.94% divided by 4, or 0.235%.

Appendix

(This Appendix is not part of the SMPTE Recommended Practice, but is included for information only.)

A1. This practice assumes that jump is the undesirable vertical motion that functions at frame-rate frequency, while weave is much slower, and perhaps slower than 1/4 of frame-rate frequency. Of course, random motion from splices or film damage might be more noticeable.

A2. For convenience, the table below shows the practical limit of acceptability in terms of fractions of a block on the appropriate test film for each film size and projection format:

Apparent Image Size		35-mm Format 2.4	1.85	1.75	1.66	1.37	70-mm	16-mm
Large	Jump	1/5	1/8	1/8	1/7	1/6	1/8	1/8
	Weave	2/5	2/5	2/5	2/5	2/5	2/5	1/4
Medium	Jump	1/3	1/5	1/5	1/4	1/3	1/5	1/5
	Weave	1/2	1/2	1/2	1/2	1/2	1/2	1/3
Small	Jump	1/3	1/3	3/8	1/2	1/2	1/3	1/2
	Weave	3/5	3/5	3/5	3/5	3/5	2/3	1/2

A3. This practice assumes that other parameters, including equipment maintenance and test film perforation condition, are noted.