Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

A1. Dimension B (or B_1)

Dimension B (or B_1) controls the longitudinal registration of the two films being spliced. It is measured to the perforations that are most commonly used for registration on splicing blocks, and to the nearer edges of these perforations, which are generally used for registration.

A2. Dimensions C, C_1, D, and D_1

Dimensions C, C_1, D, and D_1 were chosen to give a splice which has one edge along the frameline. This provides the so-called invisible splice when printing A and B rolls of original photography.

A3. Orienting the Films

It is desirable to orient the films in splicing so that a magnetic head scanning the film would, at a splice, drop down onto the trailing film rather than bump up onto it.

A4. Preventing White Line

In order to prevent the appearance of a white line on the screen, the scraped area should be 0.001 to 0.003 in (0.03 to 0.08 mm) narrower than the area covered by the overlapping film. Presence of this narrow uncemented area will not shorten the life of the splice.

A5. Striped Film

If the film being spliced contains a stripe, the stripe must be removed from the base of the film falling on top of the mating piece.

A6. Splicing Technique

Emulsion and binder must be completely removed by scraping in order to ensure a strong, long-lasting cement bond. The surface on the base side of the film to be joined must also be thoroughly cleaned. Sometimes it may be helpful to roughen the base surface slightly when certain films resist satisfactory splicing.

PROPOSED

SMPTE RECOMMENDED PRACTICE RP 106

Film Tension in 35-mm Motion-Picture Systems Operating Under 0.9 m/s (180 ft/min)

Introduction

This practice was developed by the Committee on Theatrical Projection Technology to guide equipment manufacturers, projectionists, and service personnel in making designs for and adjustments to new or current equipment for 35-mm motion-picture projectors and film-handling devices. Current film and sprocket-tooth combinations have a tension limit of 66.7 N (15 lbf) before rupture occurs. Therefore, all film handling equipment must maintain a film tension that is only a small fraction of this rupture limit. Film tension in excess of 4.4 N (16 ozf) is unnecessary and only increases film wear, while tension as low as 1.7 N (6 ozf) appears to be sufficient to provide a steady screen image.

1. *Scope*

1.1 This practice specifies the film tension needed to transport 35-mm motion-picture film through a film-handling system operating under 0.9 m/s (180 ft/min) while minimizing conditions that contribute to film damage.

1.2 This practice also recommends methods for testing film tension.

2. *Film Tension*

Film tension under normal operating conditions shall be 1.7 to 4.4 N (6 to 16 ozf).

3. *Measurement Methods*

3.1 A feed or take-up system shall be measured with the equipment in normal operating mode after placing 0.9 to 1.8 m (3 to 6 ft) of film around the hub of the reel and attaching the other end to a dynamometer. Tension shall be plotted against winding diameter and shall be as specified in Sec. 2.

3.2 To measure the film tension necessary to move the film through the projector gate, a short length of normal print material shall be placed in the projector gate and the gate closed. The film shall be attached to a dynamometer that pulls it through the gate.

NOTE: Gate tension should be adjusted to avoid picture image jump of more than 15 percent of the image height.

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PROPOSED

SMPTE RECOMMENDED PRACTICE RP 104

Cross-Modulation Tests for Variable-Area Photographic Sound Tracks

1. *Scope and Purpose*

1.1 This practice describes the cross-modulation method of measuring high-frequency distortion introduced during the production of variable-area sound motion-picture release prints. Through measurements of distortion at various negative densities, it is possible to choose negative densities that will produce sound prints having minimum distortion and optimum quality under the particular method of processing employed.

1.2 Cross-modulation tests are used extensively in establishing and maintaining photographic control of variable-area sound tracks. In consideration of waveform, output level, and noise reduction, it is necessary for variable-area prints to have high density contrast. At satisfactorily high track densities, an appreciable amount of image spread occurs, producing partial rectification of high frequencies. To compensate for this, an equal and opposite amount of image spread is introduced into the negative. Therefore, to establish the correct negative- and print-density combination, amplitude-modulated high frequencies are recorded and printed over a suitable density range. By measuring the rectified component from the prints, the correct density combinations are indicated.

2. *Test Method*

2.1 The test track described in Sec. 3 is recorded and developed under standard conditions for the process being checked. A series of recordings is made at different lamp currents to give a range of negative densities above and below the expected optimum density. A print is then made of the negative series under standard conditions of exposing and printing for the print film under test. There should be sufficient unspliced film ahead of the test track to permit stabilization of printer speed. Alternatively, a single negative can be made and a series of prints made from that negative. A third and more comprehensive test method involves exposing a negative series and printing it at a series of print densities.

The distortion content of the test track print is then measured. In making the measurements, the test track print is threaded through the sound head of the film reproducing device in the proper manner according to the position of the sound track. The distortion of each section of the print is then measured using one of the methods described in Sec. 4.5.

The negative density that results in the least amount of distortion in the print is considered the optimum negative density for the set of conditions used.

2.2 Since the method described here measures the overall distortion for a process involving numerous variables, each of which may affect the total distortion, it is necessary that all such variables (except the negative density, which is purposely varied to find the optimum) in the recording and processing of the test track be maintained at the same values as they are normally in the process to be checked. The variables include film stock (both sound negative and print), printer exposure, negative and print gamma, color temperature of printer light, and type of printer.

3. *Test Track*

3.1 The test track consists of three sections recorded in sequence at the same negative recorder lamp-current setting.

3.1.1 Section 1. 400 ± 10 Hz constant amplitude sinusoidal signal at 80 ± 5% of full modulation (or 2.0 ± 0.5 dB below full modulation).

3.1.2 Section 2. A high-frequency sinusoidal signal amplitude modulated to 80± 5% of full modulation (2.0 ± 0.5 dB below full modulation) at 400 ± 10 Hz. The peak amplitude of this modulated signal will be 80 ± 5% of that required for full modulation of the sound track (or 2.0 ± 0.5 dB below full modulation). The high frequency will be 6000, 7000, 8000, or 9000 ± 100 Hz for formats 16-mm and larger. The modulated high frequency will be 4000 ± 100 Hz for formats 8-mm and smaller.

3.1.3 Section 3. Track fully modulated at 30 Hz or less, or forward and reverse bias applied with no modulation present, suitable for density measurement of both clear and opaque areas.

3.2 Sections 1 and 2 should have a running time of 10 seconds, and Section 3 at least 1 second. Neither the 400-Hz nor the high-frequency modulated signal shall contain more than 5% total harmonic distortion. The modulated wave of Section 2 shall not contain a 400-Hz component greater than 50 dB below a 400-Hz signal with the same peak-to-peak amplitude. The recorder should be adjusted correctly for slit azimuth, track location, and focus.

4. *Reproducing and Measurement Methods*

4.1 *Reproducing Equipment.* The reproducing equipment shall consist of a sound film reproducer, an amplifier, an attenuator, a 400-Hz band-pass filter, and an AC voltmeter. A typical equipment arrangement is shown in Fig. 1. The attenuator is optional in some measuring system setups. (See Appendix A1.)

4.2 *Signal-to-Noise Ratio.* The signal-to-noise ratio of the entire system shall be at least 55 dB.

4.3 *Filter.* The 400-Hz band-pass filter should have uniform transmission ± 0.5 dB from 370 to 430 Hz. The filter shall have an attenuation at 4000 Hz of at least 45 dB greater than pass-band attenuation and an attenuation at frequencies of 6000 Hz and above of at least 55 dB greater than pass-band attenuation. No specification of attenuation within the pass-band is required other than the condition of uniform transmission.

4.4 *Distortion.* Care should be taken that the photocell or photodiode and its associated coupling circuit to the amplifier input stage do not introduce a significant amount of cross-modulation distortion. The complete reproducing system should be checked for indications of distortion by use of a suitable test film.

4.5 *Measurement and Calculation of Distortion.* The amount of cross-modulation distortion may be expressed either in decibels of cancellation (also known as cross-modulation product) or in percent distortion.

4.5.1 *Cross-Modulation Product.* The cross-modulation product is determined by the following equation:

$$\text{Cross-modulation product} = 20 \log_{10} (V_{ref}/V_{xm})$$

where V_{ref} = voltage at output of filter for Section 1 of test track, and V_{xm} = voltage at output of filter for Section 2 of test track.

4.5.2 *Percent Cross-Modulation Distortion.* Percent cross-modulation distortion is determined by the following equation:

$$\text{Percent cross-modulation distortion} = V_{xm}/V_{ref} \times 100\%$$

where V_{ref} and V_{xm} are defined as in Sec. 4.5.1.

5. *References*

5.1 BAKER, J. O., and ROBINSON, D. H. Modulated high-frequency recording as a means of determining conditions for optimal processing. *J. SMPE*, vol 30, no. 1, Jan 1938, pp 3-17.

5.2 UHLIG, R. E. The optimum carrier frequency for cross-modulation tests. *SMPTE J.*, vol 85, no. 8, Aug 1976, pp 623-626.

5.3 WILLIAMS, G., and STRONG, M. Quality control of 16mm variable-area soundtracks for small studios. *J. SMPTE*, vol 73, no. 9, Sept 1964, pp 792-796.

*See Sec. 4.1.

Fig. 1
Reproducing Equipment

Appendix

(The Appendix is not a part of this SMPTE Recommended Practice, but is included for information purposes only.)

A1. There are a number of techniques that can be used to measure cross-modulation distortion. The following methods are typical:

A1.1 For this method, the attenuator of Fig. 1 is omitted and the AC voltmeter is calibrated in decibels and has range-changing facilities. The voltages corresponding to Sections 1 and 2 of the test track are measured in decibels and the difference taken, thus obtaining the cross-modulation product in accordance with Sec. 4.5.1.

A1.2 For this method, the attenuator of Fig. 1 is omitted and the AC voltmeter is calibrated in volts and has range-changing facilities. The voltages corresponding to Sections 1 and 2 of the test track are measured in volts and the percent cross-modulation distortion calculated according to Sec. 4.5.2.

A1.3 For this method, the attenuator of Fig. 1 is uncalibrated and the AC voltmeter is calibrated in decibels and has range-changing facilities. While Section 1 of the test track is being reproduced, the attenuator is adjusted for a reading of 0 dB on the meter. Then, when Section 2 of the test track is being reproduced, the cross-modulation product, in decibels, can be read directly from the meter.

A1.4 For this method, the attenuator of Fig. 1 is uncalibrated and the AC voltmeter is calibrated in volts and has range-changing facilities. While Section 1 of the test track is being reproduced, the attenuator is adjusted for a reading of 1.0 volts (which is interpreted as 100%). Then, when Section 2 of the test track is being reproduced, the percent cross-modulation distortion can be read directly from the meter.

A1.5 For this method, the attenuator of Fig. 1 is calibrated in decibels and the AC voltmeter may be just a single-range instrument. While Section 1 of the test track is being reproduced, the attenuator is adjusted so that the meter reads at a reference mark on the meter. The attenuator setting is noted. Then, when Section 2 of the test track is being reproduced, the attenuator is readjusted so that the meter reads at the same reference mark. The difference between the two attenuator settings is the cross-modulation product.

A2. The equation in Sec. 4.5.1 will always yield a positive number for the cross-modulation product. The greater this number, the greater the amount of cancellation of distortion or the lesser the amount of distortion in the print. Nonetheless, cross-modulation product is normally plotted with the magnitude increasing downward, as shown in Fig. 2. The optimum negative is determined by visually estimating the position of the center of the cusp.

A3. The equation in Sec. 4.5.2 will always yield a positive number for the percent distortion, since AC voltages are always positive. It is customary, however, to plot the percent distortion as negative for negative densities greater than the optimum density. (For negative densities less than the optimum density, the print may be considered to be overexposed for the negative used, and thus the percent distortion in the print is "over" or positive. Conversely, for negative densities greater than the optimum negative density, the print is underexposed, and thus the percent distortion is "under" or negative.) A sample plot is shown in Fig. 3. The optimum negative density is that density at which the plotted line crosses the zero percent distortion line.

A4. The specification of the high frequency (i.e., the carrier frequency) of the modulated signal of Section 2 of the test track covers a fairly broad range. Characteristics of the recorder, especially the amount of film-loss equalization as well as the characteristics of the sibilant speech sounds, affect the choice of optimum frequency for a given system. The range of carrier frequencies was specifically chosen to inclue 9000 Hz, a frequency which has been widely used for cross-modulation tests on 35-mm sound tracks for a number of years. In addition, it is recognized that 4000 Hz is being used by some laboratories as a carrier frequency for 16-mm sound tracks with apparently satisfactory results. The most important characteristic of the cross-modulation signal, in terms of its use for measuring distortion on various kinds of test equipment in different laboratories, is the modulating frequency, which is set at 400 Hz.

A5. The amplitude modulated signal of Sec. 3.1.2 may be produced by either of two methods. The first method is to actually amplitude-modulate a high-frequency carrier by the 400-Hz modulating signal. This is actually a multiplicative process as indicated by the following equation:

$$V_{am} = (1 + m \sin \omega_{400}\, t) \sin \omega_{hf}\, t$$

where ω_{400} = modulating frequency and ω_{hf} = carrier frequency.

The other method is to combine, in a suitable electrical summing process, two high frequencies whose difference frequency is the modulating frequency, and whose average frequency is the carrier frequency. It is noted that although the average frequency of the two high-frequency signals is subject to the same tolerance as the carrier frequency, the difference between the two frequencies is subject to the tighter tolerance of the modulating frequency.

A6. The amplifiers of the recorder should not add a significant quantity of distortion to cross-modulation signal during recording. One way to ensure this is to feed the signals into the recording circuit as close to the light-modulating device as possible and still provide sufficient gain to produce 80% modulated signals. It is also desirable to remove all high- and low-pass filters, film loss equalization, compressors, and limiters from the circuit when recording cross-modulation signals.

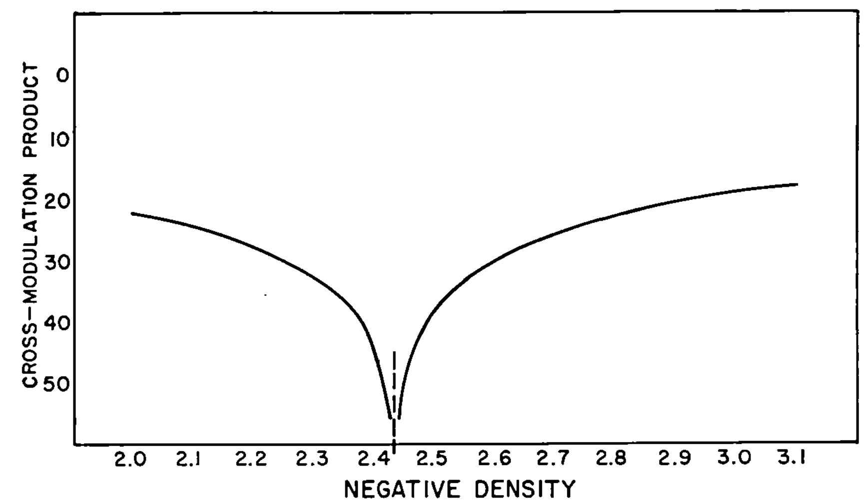

Fig. 2
Cross-Modulation Product

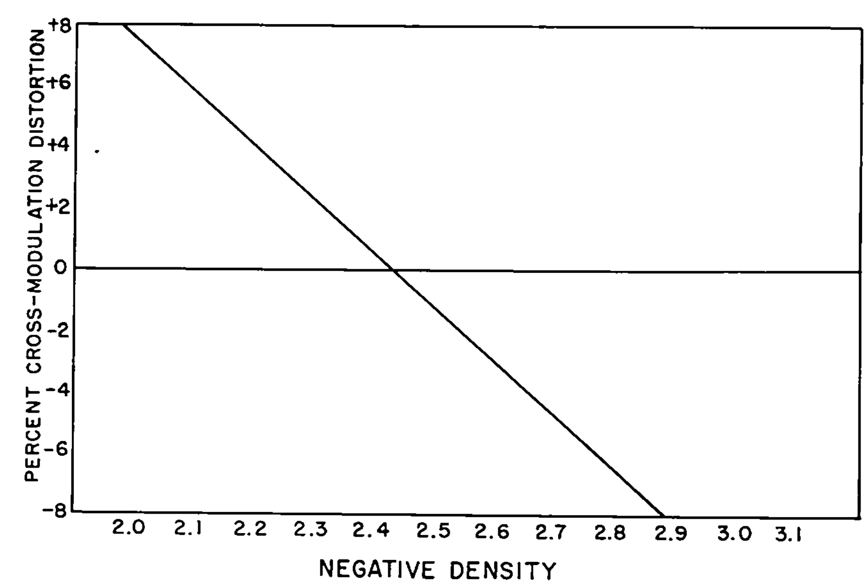

Fig. 3
Negative Cross-Modulation Distortion

PROPOSED

SMPTE RECOMMENDED PRACTICE — RP 105

Method for Determining the Degree of Jump and Weave in 70-mm, 35-mm 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, recommends a method of measurement, and classifies the practical limits of acceptability of film jump and weave during projection of 70-, 35-, and 16-mm motion-picture prints.

2. *Definitions*

2.1 Jump is the verical motion of the projected image. In normal systems where the film is moving in the vertical direction, this movement is usually related to the rate of projection, such as 24 frames per second.

2.1 Weave is the horizonal motion of the projected image. In normal systems where the film is moving in the vertical direction, this motion is at times related to the rate of projection, but is usually at a much slower rate.

2.3 The apparent screen image size specified in Section 3 is the ratio of the screen height to the viewing distance from the rear of the seating area:

(a) Large-appearing screen image assumes a viewing distance 2½ to 3½ screen heights.

(b) Medium-Large appearing screen image assumes a viewing distance 3½ to 5½ screen heights.

(c) Medium-appearing screen image assumes a viewing distance 5½ to 8 screen heights.

(d) Small-appearing screen image assumes a viewing distance over 8 screen heights.

3. *Classification*

3.1 Classification of types of presentation in degree of image movement, as measured in terms of a percentage of the image width or height, shall be as follows:

Class	*Type of Presentation*	*Jump*	*Weave*
A	Review room, premier showing, and large-appearing screen image	0.12%	0.20%
B	First-run and medium-large appearing screen image	0.20%	0.25%
C	Medium- and small-appearing screen image, sub-run, drive-in	0.30%	0.30%
F	Subacceptable (which can lead to unsatisfactory viewing and complaint)	0.40%	0.40%

3.2 The values specified under Class A are achievable when using SMPTE test films. Higher values can be expected from normal release prints which are manufactured to less exacting tolerances.

3.3 In a drive-in theater, the back seating row would be the middle of the back ramp for car parking.

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Appendix

(The Appendix is not a part of this SMPTE Recommended Practice, but is included for information purposes only.)

A1. This practice assumes that the jump or weave frequency is nearly the same as the 24 frames/s rate. Infrequent or random screen image motion from splices and film damage can be more noticeable.

A2. This practice assumes that a weave frequency of less than 16 frames/s might be less noticeable; however, high-frequency motion of more than 24 frames/s and some double-motion would be more fatiguing to the eye.

A3. The recommended method of measurement is to run a test film made on a registration pin camera, such as the SMPTE 16-PA, 35-PA, or 70-PA, as specified in SMPTE Recommended Practice on Specifications for 16-mm Projector Alignment and Screen Image Quality Test Film, RP 82-1978; SMPTE Recommended Practice on Specifications for 35-mm Projector Alignment and Screen Image Quality Test Film, RP 40-1971 (R1977); and SMPTE Recommended Practice on Specifications for 70-mm Projector Alignment and Screen Image Quality Test Film, RP 91. These films have the overall area covered with a checkerboard pattern which appears as follows:

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

35-PA 170 vertical squares (see table below)

Aspect Ratio	Aperture Plate	Percent Movement (One Square)
1.37:1	0.660 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%
2.35:1	0.700 x 0.839"	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%)

Project the test film under normal conditions. Place an appropriate device, such as a mike 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. If the movement averages a quarter square, for example, and projection is at a 1.85:1 ratio, the unsteadiness is 0.94% divided by 4, or 0.235%.