SMPTE RECOMMENDED PRACTICE — RP 111-1989

Dimensions for 70-mm, 65-mm and 35-mm Motion-Picture Film Splices

1. *Scope*

1.1 This practice specifies the significant dimensions of splices for 70-mm, 65-mm and 35-mm motion-picture film intended for projection and exhibition or for laboratory printing.

1.2 There are a number of methods for splicing triacetate or polyester motion-picture film that have found practical and commercial acceptance and that meet the operational requirements for the physical strength of the bond. This practice is not intended to recommend one method over another, but rather to emphasize the requirements common to all splices.

2. *Applications*

2.1 Within the motion-picture technology, splices are employed in two different contexts with correspondingly different permissible tolerances:

2.1.1 Projection Applications. The film is usually a print and the primary objective is for the splice to be unobtrusive in the projected image and the reproduced sound. Film guiding and positioning are usually achieved through the film seeking an equilibrium position within a system that introduces high tolerance edge guiding for lateral positioning, and perforation reference against a loose-fitting tooth or claw for vertical positioning. The splice used in projection applications will have slightly broader dimensional tolerances than the splice used in laboratory applications.

2.1.2 Laboratory Applications. The film may be negative or positive, camera original or intermediate, etc. The primary objective is for the splice to be unobtrusive in the end product achieved through contact or optical printing, special effects, etc. The dimensional tolerances on splices are more readily controlled and the permissible tolerances are tighter than for the projection application in Sec. 2.1.1.

3. *Dimensions*

3.1 The dimensions shall be as given in the figures and tables and apply to processed films and leaders which contain nominal shrinkage up to 0.2%.

3.2 The film width at the splice shall not exceed

1.379 in (35.03 mm) for 35-mm films
2.561 in (65.05 mm) for 65-mm films
2.758 in (70.05 mm) for 70-mm films

3.3 The angle between the respective edges of the spliced films shall be 180° ± 3'. Thus, the spliced film shall be aligned to the extent that when one portion of the film is placed against a straight edge, the other portion will not deviate more than 0.004 in (0.10 mm) in 5 in (127 mm).

3.4 Dimensions of the butt splices shall conform to Dimensions B, E, G, and H, as specified in the tables.

3.5 Butt splices shall be made centrally on the frameline.

3.6 The dimensions of the tape applied to secure a butt splice shall not interfere with the film dimensions specified for the particular film type.

3.7 The tape shall be wide enough to cover at least half a frame on each side of the splice.

3.8 Tape splices shall be made with an optically clear, transparent tape resulting in a splice capable of withstanding tension at least 50% greater than projector gate tension for that film width.

3.9 The tape shall adhere uniformly to the film without corrugations or entrapped air bubbles.

3.10 The width of the tape used shall encompass the full width of the film on one side, and exclude the perforation area and the area of the magnetic records and balance stripes on the opposite side. Splices with tape on one side only are not functional in projection and are unacceptable. Splices made with tape wrapped around the film interfere with guiding and are unacceptable.

3.11 Butt splices shall be made so that the film ends are touching as closely as possible to prevent white light from showing through.

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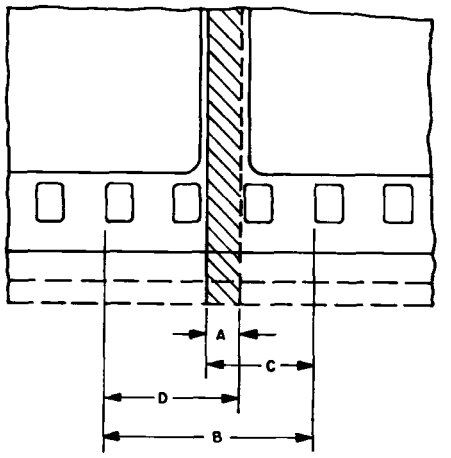

Fig. 1
Splices on 70-mm, 65-mm and 35-mm Films

Table 1
Dimensions of Cement Overlap Splices for 35-mm Motion-Picture Film

Dimensions	Laboratory		Projection Nonanamorphic Prints		Projection Anamorphic Prints*	
	in	mm	in	mm	in	mm
A†	0.049 nom	1.24 nom	0.073 nom	1.85 nom	0.048 nom	1.22 nom
B	0.560 ± 0.002	14.22 ± 0.05	0.561 ± 0.002	14.25 ± 0.05	0.561 ± 0.002	14.25 ± 0.05
C	0.268 ± 0.002	6.81 ± 0.05	0.278 ± 0.004	7.06 ± 0.10	0.268 ± 0.002	6.81 ± 0.05
D	0.341 ± 0.002	8.66 ± 0.05	0.356 ± 0.004	9.04 ± 0.10	0.341 ± 0.002	8.66 ± 0.05

*Notice that the splices on anamorphic films will fall within the projected area, and extra care must be taken in making a clean splice.
†To minimize projection of splices, the width of the laboratory splice should be no greater than 0.040 in (1.02 mm).

Table 2
Dimensions of Cement Overlap Splices for 70-mm and 65-mm Motion-Picture Films for Laboratory and Projection

Dimensions	Inches	Millimeters
A	0.067 ref	1.70 ref
B	0.561 ± 0.002	14.25 ± 0.05
C	0.275 ± 0.002	6.98 ± 0.05
D	0.353 ± 0.002	8.97 ± 0.05

Table 3
Dimensions of Weld Overlap Splices on 35-mm Polyester Motion-Picture Film

Dimensions	KS Perforation		CS Perforation	
	in	mm	in	mm
A	0.020 nom	0.51 nom	0.020 nom	0.51 nom
B	0.561 ± 0.002	14.25 ± 0.05	0.561 ± 0.002	14.25 ± 0.05
C	0.252 ± 0.002	6.40 ± 0.05	0.254 ± 0.002	6.45 ± 0.05
D	0.329 ± 0.002	8.36 ± 0.05	0.327 ± 0.002	8.31 ± 0.05

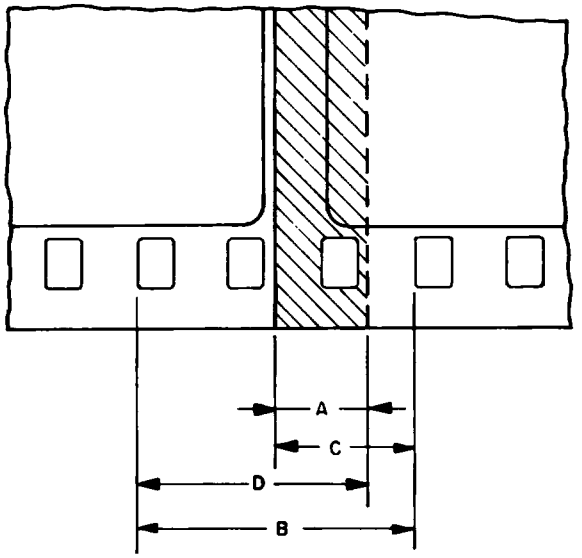

Fig. 2
Full Projection Cement Splices on 35-mm Projection Prints

Table 4
Dimensions of Full Perforation Overlap Splices on 35-mm Motion-Picture Projection Prints

Dimensions	Inches	Millimeters
A	0.156 nom	3.96 nom
B	0.561 ± 0.002	14.25 ± 0.05
C	0.241 ± 0.002	6.12 ± 0.05
D	0.476 ± 0.002	12.09 ± 0.05

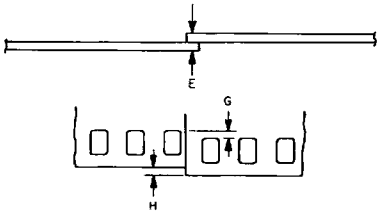

Fig. 3
Dimensions for All Film Widths

Table 5
Dimensions for All Splices

Dimensions	Laboratory		Projection	
	in	mm	in	mm
E (see A4)	0.013 max	0.33 max	0.019 max	0.48 max
G (see A3)	0.002 max	0.05 max	0.002 max	0.05 max
H (see A2)	0.002 max	0.05 max	0.002 max	0.05 max

Appendix

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

A1. Maintaining continuity of pitch across the splice requires that the perforation interval within which the splice lies be equal to the perforation intervals in the unspliced portions. This may be difficult to measure, however, inasmuch as the act of forming the bond may slightly distort perforation walls in those perforations nearest the bond (because of solvent, thermal, or mechanical action) and, therefore, introduce uncertainty into the measurement. Consequently, it is not customary to measure the primary dimension, but to measure over two or more perforation intervals.

A2. The lateral alignment that is most significant for the projection and exhibition mode of film use is the avoidance of any large offset of the film edges before and after the splice, Dimension H. Therefore, for projection applications, this is the most convenient control parameter.

A3. The lateral alignment that is most significant for the printing mode of film use is the maintenance of perforation alignment across the splice. Therefore, for laboratory applications, the most convenient control parameter is Dimension G.

A4. The splice joint for triacetate film may be made as an overlap splice using either film cement, thermal fusion, or transparent pressure-sensitive (adhesive) tape applied to both sides. In some cases, the tape is applied for reinforcement during projection to either one or both sides of a cement splice. A butt splice may also be made using thermal fusion or tape. The splice joint for polyester films is usually made as an overlap splice that is physically molecularly welded together by an ultrasonic splicer. Either an overlap splice or a butt splice may be made by applying transparent pressure-sensitive (adhesive) tape to both sides of the polyester film.

There are several methods of forming the film overlap or joint for splices used by laboratories and film exchanges. The most common methods are usually referred to as negative splices, positive splices, full-hole positive splices, and butt splices. In addition, transparent pressure-sensitive (adhesive) tape splices are currently employed on 35-mm films for theatrical projection applications utilizing automated equipment with large reels or horizontal platters. CinemaScope splices can be made with an overlap of as little as 0.030 in (0.76 mm).

If moisture is used to remove the emulsion on triacetate film, the film ends must be dry before applying cement and making the splice.

A5. Tape used to reinforce a cement splice on any film size should preferably be placed on the base side, except that for the reinforcement of a cement splice on magnetic striped film, the tape should be applied to the emulsion side of the film to avoid masking the magnetic sound tracks.

If a splice consists of tape material only, however, the tape should be applied to both sides of the film to prevent collapse or hinging during projection, but must not cover magnetic stripes if present.

For optimum results, the reinforcing material (splicing tape) should extend to both edges of the film to include the perforation area, except in the case of magnetic striped prints as noted above. Although tape width is not considered critical, it has been determined that tape 0.750 in (19.05 mm) wide, which includes two perforations on each side of the splice, may adequately reinforce splices. Consideration should be given to the sudden changes in apparent film stiffness at the edges of the splicing tape if tapes on the two sides of the film are exactly superimposed, and to the possible visibility of the tape edges if they appear in the projected image.

When a butt splice is made with tape only, care should be taken to tightly butt the two pieces of film with minimal separation with the tape placed on both sides of the film. The spliced film should flex evenly, with no tendency to collapse or hinge.

A6. When overlap splices are made on film which will travel over magnetic heads, the splice should be made so that the trailing film drops onto the scanning head rather than bumps up onto it.

A7. When tape splices are used, care should be taken to keep perforations clear of foreign matter. This requires careful alignment of pre-perforated tape, or clean, precise perforating of the tape by the splicer.

A8. Splices should be inspected frequently for defects including dirt, discoloration, edge lifting, etc. With tape splices, it is important to inspect for stretching, hinging, oozing of adhesive, and width-wise expansion which can cause a hangup in projection.

A9. If the splice consists of a tape material or if tape material is used to reinforce cement splices, it is recommended that consideration be given to the transparency characteristics. All air bubbles should be removed and the edges of the tape should make firm contact. Currently available pre- or post-perforated transparent polyester tape with pressure-sensitive adhesive is recommended.

SMPTE RECOMMENDED PRACTICE — RP 151-1989

Lubrication of 35-mm Motion-Picture Prints for Projection

1. *Scope*

This practice recognizes that proper lubrication of 35-mm motion-picture prints is needed to promote good projection performance. Proper lubrication will result in improved steadiness, reduction of noise in the projector gate, reduced perforation damage, and increased projection life.

2. *Referenced Document*

This practice has similar use and intent to SMPTE Recommended Practice on Lubrication of 16 and 8-mm Motion-Picture Prints, RP 48-1984.

3. *Definitions*

3.1 Edge Waxing. The application of wax or other lubricant to the area of the processed print film that is outside the picture and sound track area. On 35-mm film, lubrication is usually applied to each edge, including the perforation area and margin, using a suitable applicator wheel. The high level of lubrication required by 35-mm prints usually requires edge-waxing.

3.2 Full-Width Lubrication. The lubrication of the entire surface of the film, including picture and sound track area. Usually the film is dipped in a solvent solution of the lubricant, buffed, and allowed to dry. Full-width lubrication is recommended for 16- and 8-mm motion-picture prints, as noted in SMPTE RP 48-1984. The amount of lubricant that can be applied to the film as a full-width application is limited because of problems with mottle, visibility, and roll slipperiness, and is usually insufficient for optimum projection life of 35-mm prints.

4. *Lubricants*

4.1 Recommended Lubricant. A solution of a hard wax dissolved in a suitable solvent is the recommended lubricant. No other wax or lubricant was found in the literature to be as safe, effective, or inexpensive as paraffin wax. The most commonly used solvent for dissolving and applying the wax is inhibited methyl chloroform (1,1,1-trichloroethane), a solvent often used for cleaning motion-picture film. Proper care should be exercised in handling this solvent, to minimize exposure of personnel or environment to the solvent or its vapor. An inhibited grade of solvent should be used to minimize the possibility of solvent decomposition and the release of toxic fumes.

4.2 Unsuitable Lubricants. The lubricant and solvent used should have no adverse effect on the film, and should be effective in prolonging the projection life of the print. Mineral oils (motor oil, projector oil) may dissolve and leach out the oil-soluble dyes in the film, and should not be used. Nonvolatile oils (mineral or silicone) may cause mottle or undesirable sticking together of the film surfaces, which may cause dirt particles to adhere to the film. Some materials may attack the film base or emulsion, or have an adverse effect on image stability or projection life. Avoid using solvents that are flammable or explosive, or that pose a health or environmental hazard (e.g., benzene or carbon tetrachloride).

5. *Film Cleaning*

The lubricant should be removable by normal film-cleaning operations, such as solvent cleaning. After cleaning, the film should be relubricated prior to the next projection.

6. *Edge-Waxer Design*

The edge-wax is usually applied to the film at a point near the end of the processing operation, using an applicator wheel rotating in a reservoir of edge-wax solution. The applicator wheel applies the wax solution only to the perforation and margin area of the film. The wax solution is usually applied only to the emulsion side of the film, with some transfer of the wax to the base side of the film expected when the film is wound up into a roll. The wax solution is allowed to partially dry on the film prior to wind-up, so it will not migrate into the picture or sound track area.

Many laboratories apply edge-wax to the film just prior to the film wind-up on the processing machine. Equipment is available from several suppliers, or may be custom built. Care should be taken to monitor and control the application of the edge-wax.

Edge-wax may also be applied to the processed film as a separate operation, using equipment that is currently available.

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7. *Edge-Wax Application*

The amount of wax applied to the film is a function of the concentration of the edge-wax solution, the applicator wheel speed, the film transport speed, and the surface properties of the applicator wheel. Concentrations of up to 50 grams of wax per liter of solvent may be used with the optimum concentration dependent on applicator design, machine speed, and effectiveness of the final result as described in Sections 8 and 9.

Edge-wax should not be applied to prints which will later have magnetic striping or protective overcoats applied, as the wax will prevent proper adhesion of these materials. Edge-wax should not be applied to 35-mm film which will be slit for 16- or 8-mm use. These films should be lubricated in accordance with SMPTE RP 48-1984. Edge-waxing is not necessary for prints intended only for use on continuous motion telecines.

8. *Properties of Properly Edge-Waxed Film*

The dried wax deposit should be just visible as a haze on both the emulsion and base side of the film. The wax deposit should be only in the perforation and margin area, and should not bleed into the picture or sound track area. When wound with normal tension, large rolls of film should not dish when handled, and there should be no excessive build up of wax during projection.

The effectiveness of the lubrication in prolonging projection life should be evaluated by using the Film Projection Life Test (see Section 9). Properly lubricated prints should have at least twice the projection life of unlubricated prints. Insufficient wax application will give less than optimum performance. Excessive wax application may intrude into the picture or sound track area, or result in wax flaking or buildup in the projector.

9. *Test Methods*

The Film Projection Life Test is the most reliable method for determining the effectiveness of the lubrication in improving projection life. Simple measurements of the coefficient of friction of the emulsion and base side of the film (e.g., paper-clip friction or sled friction) may not accurately measure the effectiveness of the film lubrication in actual use, although they may be of use in monitoring wax application.

The Film Projection Life Test is fully described in the reference given in Section 10.

10. *Reference*

Many technical papers have been published on the subject of film lubrication. One of the most recent, which also surveys previous work, is "Lubrication of 35-mm Release Prints for Extended Projection Print Life" by Edward Mino and Rodney S. Perry, in the October 1983 SMPTE Journal, pp 1051-1057.