Fig. 6. The completely redesigned Photosonics camera system with the video monitor on the magazine side of the camera (r).

sure control was mounted on top of the rear lens-support, next to the zoom drive motor (Fig. 5). The video monitor was placed on the magazine side of the camera (Fig. 6). This completed the redesign.

Photosonics has recently developed a small, lightweight, high-speed camera with a quick-change magazine capability which will permit an 8-lb (3.6-kg) weight reduction and shorten the length of the camera assembly by several inches. Meanwhile, the unit has been reconfigured to accept a color video camera. Because of the larger size camera it was positioned alongside the lens with a cube beam splitter at the rear of the lens for taking the image to the film camera then through a relay lens and a 45° mirror to the video camera, with the video monitor positioned on top (Fig. 7).

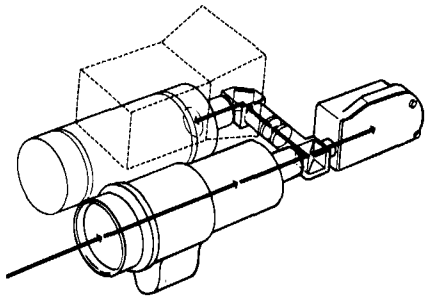


Fig. 7. Schematics of the reconfigured assembly with a color video camera alongside the zoom-and-Dynalens combination, showing the optical path with the video monitor on top indicated by dotted lines.

Conclusion

This system has since been used on tactical-weapons delivery tests and to provide battlefield surveillance for commanders and their staff during maneuvers by the U.S. Readiness Command and the U.S. Army. After over six years of continuous use, it is clear that, with the real-time video capability plus a high-speed film camera, this system brings the value of television and film together with a savings in personnel and equipment costs.

standards and recommended practices

Approved American National Standards

On 24 May 1974, the American National Standards Institute approved three new standards which are primarily editorial revisions including the combining of long and short pitch perforating dimensions into single standards: PH22.73-1974, Dimensions for 35mm Motion-Picture Film Perforated 32mm, 2R (revision and consolidation of PH22.73-1966 and PH22.138-1964); PH22.109-1974, Dimensions for 16mm Motion-Picture Film Perforated IR (revision and consolidation of PH22.109-1965 and PH22.12-1964); and PH22.110-1974, Dimensions for 16mm Motion-Picture Film Perforated 2R (revision and consolidation of PH22.110-1965 and PH22.5-1964).

Inasmuch as compliance with American National Standards is purely voluntary, these standards will become truly effective when broad publicity is given to their existence. ANSI and SMPTE would appreciate any personal influence to promote the use of these standards where such action is appropriate. Copies of the standards may be obtained for a nominal fee from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

Approved International Standards

The International Organization for Standardization (ISO) approved during May 1974 two International Standards, the technical content of which is published here for your information: ISO 486-1974, Cinematography — 16mm Motion-Picture Film Perforated 8 mm Type R-Cutting and Perforating Dimensions, and ISO 491-1974, Cinematography — 35 mm Motion-Picture Film-Cutting and Perforating Dimensions.

Reflecting no technical changes, the documents are transformations of earlier ISO Recommendations which are in complete agreement with American National Standards on film dimensions.

Complete copies of all International Standards are sold through the American National Standards Institute, 1430 Broadway, New York, NY 10018. — Alex E. Alden, *Staff Engineer*

ANSI PH22.73–1974
Revision and Consolidation of PH22.73-1966 and PH22.138-1964

American National Standard dimensions for 35 mm motion-picture film perforated 32 mm, 2R

Approved May 24, 1974 Secretariat: Society of Motion Picture and Television Engineers, Inc.

1. Scope

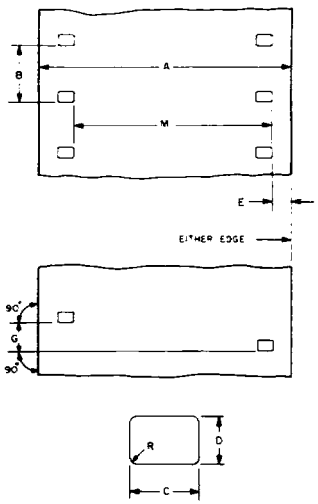
This standard specifies the cutting and perforating dimensions for 35 mm motion-picture film having two rows of 16 mm-type perforations, one row near each edge of the 35 mm film, and a perforation pitch of either 0.2994 or 0.3000 in (7.605 or 7.620 mm).

2. Dimensions

2.1 The dimensions shall be as given in the figure and table.

2.2 The dimensions pertain to a safety film as defined in American National Standard Specifications for Motion-Picture Safety Film, PH22.31-1967 (R1973).

2.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23 ± 1°C (nominally converted to 73 ± 2°F) and a relative humidity of 50 ± 2 percent. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.



Dimensions		Inches	Millimeters
A	Film width	1.377 ± 0.001	34.975 ± 0.025
B	Perforation pitch (long)	0.3000 ± 0.0004	7.620 ± 0.010
B′	Perforation pitch (short)	0.2994 ± 0.0004	7.605 ± 0.010
C	Perforation width	0.0720 ± 0.0004	1.829 ± 0.010
D	Perforation height	0.0500 ± 0.0004	1.270 ± 0.010
E	Edge to perforation	0.096 ± 0.002	2.44 ± 0.05
G	Perforation misalignment	0.001 max	0.03 max
L	100 consecutive perforation pitches	30.00 ± 0.03	762.0 ± 0.8
L′	100 consecutive perforation pitches	29.94 ± 0.03	760.5 ± 0.8
M	Lateral perforation displacement	1.113 ± 0.001	28.27 ± 0.03
R	Radius of perforation fillet	0.010 ± 0.001	0.25 ± 0.03

NOTE 1: The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, a code designation for the perforation shape (BH, KS, DH or CS) or the number of rows of perforations (1R, 2R, etc.), depending upon which is the significant factor, or the perforation pitch without the decimal point.

NOTE 2: The metric values in the table of dimensions are converted from the inch values in accordance with conversion principles outlined in American National Standard Metric Practice Guide, Z210.1-1973. The metric conversion of Dimension A is purposely chosen and shown to three decimal places to prevent the maximum width dimension from exceeding 35 mm.

Appendix

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

A1. The user is reminded that, as a plastic, film can change dimensions temporarily due to moisture or temperature, or permanently due to solvent loss or strain effect.

A2. Film for positive use has a longitudinal pitch 0.2 percent longer than its companion negative. Shrinkage of the negative during aging and processing prior to printing will generally not exceed 0.2 percent. Thus, the negative stock is expected to be 0.3 ± 0.1 percent shorter than the positive. This difference will minimize slippage between the two on the 12-inch (305-mm) circumference sprocket of the printer, assuming a film thickness of 0.0055 to 0.0065 in (0.140 to 0.165 mm).

A3. The uniformity of pitch, hole size and margin (Dimensions B, C, D and E) is an important variable affecting steadiness. Variations in these dimensions, from roll to roll, are of little significance compared to variations from one perforation to the next within any small group of consecutive perforations. As an example, the uniformity of the margin is uniquely critical for optical printing. During the printing process, the placement of the image on the film is usually with respect to successive lateral pairs of perforations at one-frame intervals. During subsequent projection, however, the portion of the image projected is usually located, not by these perforations, but by the edge of the film. The lateral steadiness of the projected image is, therefore, directly related to the frame-to-frame uniformity of the margin.

A4. For historical background on the development of this standard, refer to A. J. Miller and A. C. Robertson, "Motion-picture film — its size and dimensional characteristics," Jour. SMPTE, 74: 3-11, Jan. 1965.

American National Standard dimensions for 16 mm motion-picture film perforated 1R

Approved May 24, 1974

Secretariat: Society of Motion Picture and Television Engineers, Inc.

1. Scope

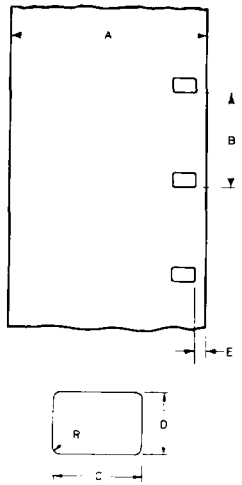
This standard specifies the cutting and perforating dimensions for 16 mm motion-picture film with perforations along one edge and a perforation pitch of either 0.2994 or 0.3000 in (7.605 or 7.620 mm).

2. Dimensions

2.1 The dimensions shall be as given in the figure and table.

2.2 The dimensions pertain to a safety film as defined in American National Standard Specifications for Motion-Picture Safety Film, PH22.31-1967 (R1973).

2.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23 ± 1°C (nominally converted to 73 ± 2°F) and a relative humidity of 50 ± 2 percent. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.



	Dimensions	Inches	Millimeters
A	Film width	0.628 ± 0.001	15.95 ± 0.03
B	Perforation pitch (long)	0.3000 ± 0.0004	7.620 ± 0.010
B'	Perforation pitch (short)	0.2994 ± 0.0004	7.605 ± 0.010
C	Perforation width	0.0720 ± 0.0004	1.829 ± 0.010
D	Perforation height	0.0500 ± 0.0004	1.270 ± 0.010
E	Edge to perforation	0.0355 ± 0.0020	0.902 ± 0.051
L	100 consecutive perforation pitches	30.00 ± 0.03	762.0 ± 0.8
L'	100 consecutive perforation pitches	29.94 ± 0.03	760.5 ± 0.8
R	Radius of perforation fillet	0.010 ± 0.001	0.25 ± 0.03

NOTE 1: The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, a code designation for the perforation shape (BH, KS, DH or CS) or the number of rows of perforations (1R, 2R, etc.), depending upon which is the significant factor, or the perforation pitch without the decimal point.

NOTE 2: The metric values in the table of dimensions are converted from the inch values in accordance with conversion principles outlined in American National Standard Metric Practice Guide, Z210.1-1973.

Appendix

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

A1. The user is reminded that, as a plastic, film can change dimensions temporarily due to moisture or temperature, or permanently due to solvent loss or strain effect.

A2. Film for positive use has a longitudinal pitch 0.2 percent longer than its companion negative. Shrinkage of the negative during aging and processing prior to printing will generally not exceed 0.2 percent. Thus, the negative stock is expected to be 0.3 ± 0.1 percent shorter than the positive. This difference will minimize slippage between the two on the 12-inch (305-mm) circumference sprocket of the printer, assuming a film thickness of 0.0055 to 0.0065 in (0.140 to 0.165 mm).

A3. The uniformity of pitch, hole size and margin (Dimensions B, C, D and E) is an important variable affecting steadiness. Variations in these dimensions, from roll to roll, are of little significance compared to variations from one perforation to the next within any small group of consecutive perforations. As an example, the uniformity of the margin is uniquely critical for optical printing. During the printing process, the placement of the image on the film is usually with respect to successive lateral pairs of perforations at one-frame intervals. During subsequent projection, however, the portion of the image projected is usually located, not by these perforations, but by the edge of the film. The lateral steadiness of the projected image is, therefore, directly related to the frame-to-frame uniformity of the margin.

A4. For historical background on the development of this standard, refer to A. J. Miller and A. C. Robertson, "Motion-picture film — its size and dimensional characteristics," Jour. SMPTE, 74: 3-11, Jan. 1965.

ANSI PH22.110–1974
Revision and Consolidation of PH22.110-1965 and PH22.5-1964

American National Standard dimensions for 16 mm motion-picture film perforated 2R

Approved May 24, 1974 Secretariat: Society of Motion Picture and Television Engineers, Inc.

1. Scope

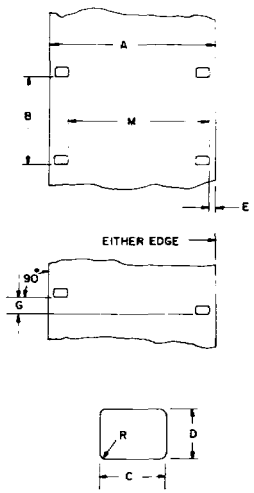
This standard specifies the cutting and perforating dimensions for 16 mm motion-picture film with perforations along both edges and a perforation pitch of either 0.2994 or 0.3000 in (7.605 or 7.620 mm).

2. Dimensions

2.1 The dimensions shall be as given in the figure and table.

2.2 The dimensions pertain to a safety film as defined in American National Standard Specifications for Motion-Picture Safety Film, PH22.31-1967 (R1973).

2.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23 ± 1°C (nominally converted to 73 ± 2°F) and a relative humidity of 50 ± 2 percent. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.



Dimensions		Inches	Millimeters
A	Film width	0.628 ± 0.001	15.95 ± 0.03
B	Perforation pitch (long)	0.3000 ± 0.0004	7.620 ± 0.010
B′	Perforation pitch (short)	0.2994 ± 0.0004	7.605 ± 0.010
C	Perforation width	0.0720 ± 0.0004	1.829 ± 0.010
D	Perforation height	0.0500 ± 0.0004	1.270 ± 0.010
E	Edge to perforation	0.0355 ± 0.0020	0.902 ± 0.051
G	Perforation misalignment	0.001 max	0.03 max
L	100 consecutive perforation pitches	30.00 ± 0.03	762.0 ± 0.8
L′	100 consecutive perforation pitches	29.94 ± 0.03	760.5 ± 0.8
M	Lateral perforation displacement	0.485 ± 0.001	12.32 ± 0.03
R	Radius of perforation fillet	0.010 ± 0.001	0.25 ± 0.03

NOTE 1: The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, a code designation for the perforation shape (BH, KS, DH or CS) or the number of rows of perforations (1R, 2R, etc.), depending upon which is the significant factor, or the perforation pitch without the decimal point.

NOTE 2: The metric values in the table of dimensions are converted from the inch values in accordance with conversion principles outlined in American National Standard Metric Practice Guide, Z210.1-1973.

Appendix

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

A1. The user is reminded that, as a plastic, film can change dimensions temporarily due to moisture or temperature, or permanently due to solvent loss or strain effect.

A2. Film for positive use has a longitudinal pitch 0.2 percent longer than its companion negative. Shrinkage of the negative during aging and processing prior to printing will generally not exceed 0.2 percent. Thus, the negative stock is expected to be 0.3 ± 0.1 percent shorter than the positive. This difference will minimize slippage between the two on the 12-inch (305-mm) circumference sprocket of the printer, assuming a film thickness of 0.0055 to 0.0065 in (0.140 to 0.165 mm).

A3. The uniformity of pitch, hole size and margin (Dimensions B, C, D and E) is an important variable affecting steadiness. Variations in these dimensions, from roll to roll, are of little significance compared to variations from one perforation to the next within any small group of consecutive perforations. As an example, the uniformity of the margin is uniquely critical for optical printing. During the printing process, the placement of the image on the film is usually with respect to successive lateral pairs of perforations at one-frame intervals. During subsequent projection, however, the portion of the image projected is usually located, not by these perforations, but by the edge of the film. The lateral steadiness of the projected image is, therefore, directly related to the frame-to-frame uniformity of the margin.

A4. For historical background on the development of this standard, refer to A. J. Miller and A. C. Robertson, "Motion-picture film — its size and dimensional characteristics," Jour. SMPTE, 74: 3-11, Jan. 1965.

Cinematography — 16 mm motion-picture film perforated 8 mm Type R — Cutting and perforating dimensions

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the cutting and perforating dimensions for 16 mm motion-picture film which is perforated 8 mm Type R.

NOTE – Film perforated in accordance with this International Standard is also referred to as "double 8 mm motion-picture film".

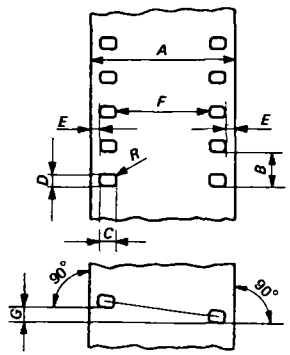
2 REFERENCES

ISO 543, *Cinematography – Motion-picture safety film – Definition, testing and marking.*

ISO 3042, *Cinematography – Labelling of containers for unexposed motion-picture and magnetic films – Minimum specifications.*[1)]

3 DIMENSIONS

The dimensions shall be as given in the figure and table.



Dimension	mm	in
A	15,95 ± 0,025	0.628 ± 0.001
B	3,81 ± 0,013	0.150 0 ± 0.000 5
C	1,83 ± 0,01	0.072 0 ± 0.000 4
D	1,27 ± 0,01	0.050 0 ± 0.000 4
E	0,90 ± 0,05	0.035 ± 0.002
F	10,49 ± 0,025	0.413 ± 0.001
G	0,025 max.	0.001 max.
L	381,00 ± 0,40	15.000 ± 0.016
R	0,25 ± 0,025	0.010 ± 0.001

NOTES

1 These dimensions and tolerances apply to safety motion-picture film as specified in ISO 490 immediately after cutting and perforating. If required by usage, the manufacturer shall indicate the atmospheric conditions applied to the dimensional control at the time of cutting and perforating.

2 Dimension *L* represents the length of any 100 consecutive perforation intervals.

3 The dimensions apply to low-shrunk film base, as defined in annex B. For film with higher shrinkage characteristics, dimension *A* shall be 15,98 ± 0,025 mm (0.629 ± 0.001 in) and *E* 0,91 ± 0,05 mm (0.036 ± 0.002 in).

4 In the slitting of double-width film after processing, the cut shall be made so that neither of the two 8 mm films has a width more than 8,03 mm (0.316 in). It is not practicable to state precisely the resulting widths after slitting since these will be affected not only by the tolerance on the width (dimension *A*) but also by the shrinkage of the film resulting from processing.

1) At present at the stage of draft.

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ANNEX A

UNIFORMITY OF PERFORATIONS

The dimensions given in this International Standard represent the practice of film manufacturers in that the dimensions and their tolerances are for film stock immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but since the film is a plastic material, the dimensions of the slit and perforated film stock never agree exactly with the dimensions of the slitter knives, punches and dies. Film can shrink or swell due to loss or gain in moisture content, or can shrink due to loss of solvent or plasticizer. These changes invariably result in changes in the dimensions during the life of the film. The change is generally uniform throughout a roll.

The uniformity of pitch, hole size and margin (dimensions *B*, *C*, *D* and *E*) is an important variable affecting steadiness. Variations in these dimensions from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group of consecutive perforations that is important.

ANNEX B

CHOICE OF WIDTH

In the early days of 16 mm film, the safety base used for this film had the characteristic of shrinking very rapidly by a certain fairly definite amount and then not shrinking much more. Although this film tended to swell at high humidities, nevertheless the shrinkage that occurred in the package before the user received the film was always at least as great as any swell that might occur due to high humidities at the time of use. This meant that the user never encountered film, even at high humidities, that had greater width than that specified in the standards. Therefore, camera manufacturers seldom ran into trouble so long as their film gates readily passed film at the upper limit of the slitting tolerance, namely 16,00 mm (0.630 in).

Within the past few years, however, a safety base with lower shrinkage characteristics began to be used. Although this film was less susceptible than the previous film to swelling at high humidities, nevertheless the shrinkage characteristics were so low that this shrinkage did not always compensate for the swell at high humidities. For this reason, film slit at the midpoint of the tolerance for width, namely 15,98 mm (0.629 in), would occasionally swell at high humidities to such an extent that it would bind in film gates designed to pass film with the width of 16,00 mm (0.630 in). The manufacturers, therefore, were compelled to slit at the lower edge of the tolerances permitted by national standards. Variations in their slitting width, however, sometimes produced film below the limits of the standard.

For this reason, the width dimension of 15,95 mm (0.628 in) has been adopted for this low-shrinkage film stock in order that the film manufacturers may slit within the standard tolerances and still produce film which does not exceed 16,00 mm (0.630 in), even at high humidities. It is therefore important that in no case should equipment fail to accommodate film of 16,00 mm (0.630 in) width.

For the purpose of choice of width, low-shrinkage film base is film base which, when coated with emulsion and any other normal coating treatment, perforated, kept in the manufacturer's normal commercial packings for 6 months at 18 to 24 °C (65 to 75 °F), exposed, processed and stored exposed to air for a period not to exceed 30 days at 18 to 24 °C (65 to 75 °F) and 50 to 60 % relative humidity, and then measured again in the same condition of temperature and humidity, has shrunk not more than 0,2 % from its original dimension at the time of perforating.

This definition of low-shrinkage film stock has been found by experience to be useful as a guide to film manufacturers in slitting their film stock. Departure from this definition should not be cause for rejection of the film stock.

Cinematography – 35 mm motion-picture film – Cutting and perforating dimensions

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the cutting and perforating dimensions for 35 mm motion-picture film and the types of perforations used.

2 REFERENCES

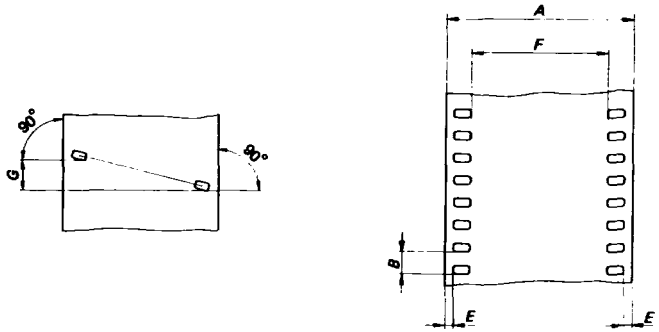
ISO 543, *Cinematography – Motion-picture safety film – Definition, testing and marking.*

ISO 3042, *Cinematography – Labelling of containers for unexposed motion-picture and magnetic films – Minimum specifications.*[1]

3 DIMENSIONS

The dimensions shall be as given in the figures and tables.

1) At present at the stage of draft.



Types of perforations

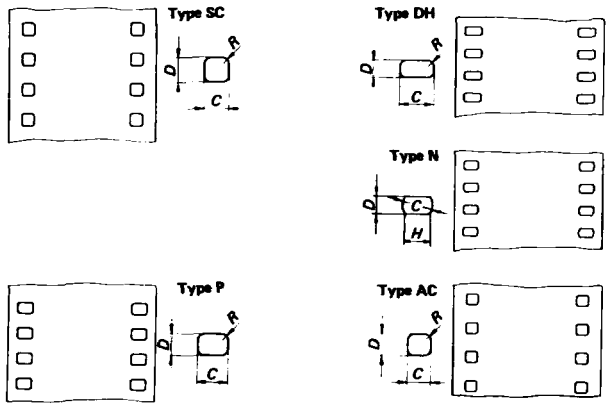


TABLE 1 – **Dimensions in millimetres**

Dimension	Type P	Type DH	Type N	Type SC	Type AC
A	34,975 ± 0,025	34,975 ± 0,025	34,975 ± 0,025	34,975 ± 0,025	34,975 ± 0,025
B	4,75 ± 0,01	4,75 ± 0,01	4,75 ± 0,01	4,75 ± 0,01	4,75 ± 0,01
B_1	4,74 ± 0,01	–	4,74 ± 0,01	–	–
C	$2{,}800\ ^{+0{,}005}_{-0{,}015}$	$2{,}800\ ^{+0{,}005}_{-0{,}015}$	$2{,}800\ ^{+0{,}005}_{-0{,}015}$	1,98 ± 0,01	1,98 ± 0,01
D	1,98 ± 0,01	$1{,}850\ ^{+0{,}015}_{-0{,}005}$	$1{,}850\ ^{+0{,}015}_{-0{,}005}$	1,98 ± 0,01	$1{,}850\ ^{+0{,}015}_{-0{,}005}$
E	2,01 ± 0,05	2,01 ± 0,05	2,01 ± 0,05	2,18 ± 0,05	2,18 ± 0,05
F	25,37 ± 0,05	25,37 ± 0,05	25,37 ± 0,05	26,65 ± 0,05	26,65 ± 0,05
G	0,025 max.	0,025 max.	0,025 max.	0,025 max.	0,025 max.
H	–	–	2,08 nominal	–	–
R	0,50 ± 0,025	0,33 ± 0,025	–	0,33 ± 0,025	0,33 ± 0,025
L	475,0 ± 0,4	475,0 ± 0,4	475,0 ± 0,4	475,0 ± 0,4	475,0 ± 0,4
L_1	474,0 ± 0,4	–	474,0 ± 0,4	–	–

TABLE 2 – **Dimensions in inches**

Dimension	Type P	Type DH	Type N	Type SC	Type AC
A	1.377 ± 0.001	1.377 ± 0.001	1.377 ± 0.001	1.377 ± 0.001	1.377 ± 0.001
B	0.187 0 ± 0.000 4	0.187 0 ± 0.000 4	0.187 0 ± 0.000 4	0.187 0 ± 0.000 4	0.187 0 ± 0.000 4
B_1	0.186 6 ± 0.000 4	–	0.186 6 ± 0.000 4	–	–
C	0.110 0 ± 0.000 4	0.110 0 ± 0.000 4	0.110 0 ± 0.000 4	0.078 0 ± 0.000 4	0.078 0 ± 0.000 4
D	0.078 0 ± 0.000 4	0.073 0 ± 0.000 4	0.073 0 ± 0.000 4	0.078 0 ± 0.000 4	0.073 0 ± 0.000 4
E	0.079 ± 0.002	0.079 ± 0.002	0.079 ± 0.002	0.086 ± 0.002	0.086 ± 0.002
F	0.999 ± 0.002	0.999 ± 0.002	0.999 ± 0.002	1.049 ± 0.002	1.049 ± 0.002
G	0.001 max.	0.001 max.	0.001 max.	0.001 max.	0.001 max.
H	–	–	0.082 nominal	–	–
R	0.020 ± 0.001	0.013 ± 0.001	–	0.013 ± 0.001	0.013 ± 0.001
L	18.70 ± 0.016	18.70 ± 0.016	18.70 ± 0.016	18.70 ± 0.016	18.70 ± 0.016
L_1	18.66 ± 0.016	–	18.66 ± 0.016	–	–

NOTES

1 These dimensions and tolerances apply to safety motion-picture film as specified in ISO 490, immediately after cutting and perforating. If required by usage, the manufacturer shall indicate the atmospheric conditions applied to the dimensional control at the time of cutting and perforating.

2 Dimensions *L* and L_1 represent the length of any 100 consecutive perforation intervals.

3 Dimensions B_1 and L_1 (short perforation pitch) are provided to fulfil the requirements of continuous sprocket contact printing.

ISO 491-1974 (E)

ANNEX A

UNIFORMITY OF PERFORATIONS

The dimensions given in this International Standard represent the practice of film manufacturers in that the dimensions and their tolerances are for film stock immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but since the film is a plastic material, the dimensions of the slit and perforated film stock never agree exactly with the dimensions of the slitter knives, punches and dies. Film can shrink or swell due to loss or gain in moisture content, or can shrink due to loss of solvent or plasticizer. These changes invariably result in changes in the dimensions during the life of the film. The change is generally uniform throughout a roll.

The uniformity of pitch, hole size and margin (dimensions *B*, *C*, *D* and *E*) is an important variable affecting steadiness. Variations in these dimensions from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group of consecutive perforations that is important.

ANNEX B

CHOICE OF LONGITUDINAL PITCH FOR NEGATIVE FILMS

The choice of pitch for negative motion-picture films depends, within certain limits, on the type of printer to be used. Where step-printers are used and the film is stationary when exposed, the choice of pitch is not strictly limited. Where the film moves continuously over a cylindrical surface at the time of printing (sprocket type printer), there are three major considerations involved in choosing the pitch. These considerations are

1) the sprocket diameter,

2) the film thickness,

3) the film shrinkage and the rate at which shrinking occurs.

Maximum steadiness and definition are secured on a sprocket type printer when the negative stock is somewhat shorter in pitch than the positive stock in the approximate proportion of the thickness of the film to the radius of curvature. For printing on a 64 tooth 35 mm sprocket, which is one with a circumference of about 30 cm (12 in), and with film 0,140 to 0,165 mm (0.005 5 to 0.006 5 in) thick, the optimum pitch differential is 0,3 %. The use of the ideal pitch differential for the negative film would minimize slippage between the positive and negative film during the printing operation, thus reducing the amount of blurring and jumping of horizontal lines in the picture or sound image that otherwise can take place. (This error should be differentiated from the jump caused by non-uniformity of successive pitchs *B*.) Experience has shown that the average pitch *L* of the negative film can vary ± 0,1 % from the ideal pitch, which is 0,3 % shorter than that of the positive film, without blurring of picture and sound being easily detected.

For many years, this difference in pitch was caused by the shrinkage of the negative film during processing and ageing. Current film bases shrink less thant the earlier ones and hence a shorter initial pitch becomes desirable. To satisfy this requirement for picture- or sound-negatives, it is common manufacturing practice to set the aim for the pitch at a value 0,2 % shorter than that of the positive films on which they will be printed. The additional shrinkage that occurs during processing and the ageing that takes place before the release prints are made then brings the pitch differential close to the optimum and desired value of 0,3 %. Accordingly, the pitch chosen is 4,74 mm (0.186 6 in).

The longitudinal pitch dimensions for the perforation for the types SC and N correspond to 0,2 % reduced pitch. Low-shrink negative stock to be perforated to these dimensions should not therefore shrink appreciably more than 0,2 % under normal conditions of use and for a reasonable life span,[1] so that the optimum pitch differential from the positive stock of 0,3 ± 0,1 % is maintained.

1) Measured after equilibrium with air at 23 °C (73 °F) nominal temperature and 50 % relative humidity or at the conditions prevailing at the time of perforating.