anode and the appearance of the leader. In the interval the anode is surrounded by a uniform glow. It is also clear that each point of the leader track maintains luminosity throughout its growth, brightening and broadening with increasing overall length.

Figure 10 is a streak record of a discharge in a rod-rod gap. The general structure is similar to that of the rod-plane gap, but here there is also a negative leader from the grounded rod. The anode leader is found always to precede the cathode leader.

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standards and recommended practices

Approved American Standard

A new American Standard, PH22.124-1961, Screen Luminance for Indoor Theaters, was approved by the American Standards Association on May 5, 1961. This Standard is substantially as published in the April 1960 Journal. A copy of the Standard is available from the American Standards Association, Incorporated, 10 East 40th Street, New York 16, at a nominal cost.—*Alex E. Alden*, Staff Engineer

American Standard

Screen Luminance for Indoor Theaters

ASA Reg. U.S. Pat. Off.

PH22.124-1961

*UDC 778.2:725.824

Page 1 of 3 Pages

1. Scope

1.1 This standard specifies the luminance (brightness) of the projection screen—whether perfectly diffusing or directional—for indoor theaters equipped to project 35mm motion-picture film at a rate of 24 frames per second.

1.2 This standard specifies screen luminance levels at which the tone scale, contrast and pictorial quality of the projected image from release prints will be of the quality anticipated during their production, and is intended to provide for such quality throughout the audience area.

1.3 This standard describes criteria for evaluating the suitability of a screen — whether perfectly diffusing or directional — for a particular theater by establishing a luminance level and maximum luminance variations within the audience area.

2. Measurement

2.1 The measurement of screen luminance is made with the projector in complete operation but with no film in the aperture.

2.2 Screen luminance shall be measured with a photometer having the spectral sensitivity of a standard observer as specified by the International Commission on Illumination in 1931. The acceptance angle of the photometer shall be as small as is practical, and shall be so used that it accepts light from a screen area no larger than a circle whose diameter is 10 percent of the screen width.

3. Luminance Level

3.1 The luminance at the center of the screen shall be 16^{+4}_{-6} ft-L (55^{+14}_{-21} nits) as measured from a position on the longitudinal centerline of the auditorium and two thirds distance from the screen to the rearmost row of seats.

3.2 The luminance at a distance 5 percent of the screen width from the side edges of the screen, and on its horizontal axis, shall be between 65 and 85 percent of the center luminance as prescribed and measured in 3.1 above.

3.3 The luminance at all points on the horizontal axis of the screen, between points located at a distance 5 percent of the screen width from the sides of the screen, shall be between 5.5 and 20.0 ft-L (19 and 60 nits) and of no greater range than 3:1, as measured from any seat in the auditorium.

Approved May 5, 1961, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Printed in U.S.A.
ASA[illegible]

APPENDIX

(This Appendix is not a part of American Standard Screen Luminance for Indoor Theatres, PH22.124-1961, but is included to facilitate its use.)

A1. *Standard Luminance.* Possible luminance levels are limited by a minimum value below which the visual process becomes less efficient, and by a maximum value above which flicker becomes objectionable. Permissible luminance range is limited by the criterion that a good release print must provide acceptable quality when projected at any luminance within the range.

A2. *Other Variables.* In addition to the luminance distribution, the pictorial quality of projected pictures is influenced by the color of the projection light, the color and characteristics of the screen surface, the presence of stray light, the nature of the surround, and other factors not presently described by standards.

A3. *Preferred Screen Luminance.* This is considered to be that condition wherein (1) the luminance of the center of the screen is constant from every usable seat in the theater and is within the limits of 14–16 ft-L; (2) the luminance of the sides of the screen is approximately 85 percent of the luminance of the center; and (3) the luminance variation has axial symmetry around the center of the screen. The nominal value in 3.1 has been chosen to represent such preferred luminance. The tolerances have been selected to include viewing conditions which experience has shown to be acceptable and to exclude those known to be undesirable. As screen design permits more optimum control of luminance gain, it is expected that tolerances will be reduced and will become more symmetrical.

A4. *Indoor Theaters.* This standard is limited in scope to indoor theaters because it has been observed that optimum screen luminance for projected pictures depends upon the conditions of viewing. Under the conditions of the indoor theater with the screen subtending a large angle at the observer's position, with low stray-light levels, etc., these conditions have been found by experiment and experience to represent the best compromise among the many factors involved, but not necessarily the best situation for drive-in theaters and for auditoriums with high ambient light.

A5. *Directional Screens.* Matte white screens will show substantially constant luminance at any one specific area on the screen for measurements from any location within the theater. Directional screens in current use have been designed to produce specific reflection patterns which on goniometric measurements of luminance from various viewing angles show wide departures from the properties of a perfectly diffusing surface. By suitable choice of such patterns the attainable luminance may be increased considerably above that possible with a perfectly diffusing screen of the same size when measured near the axis of projection, although there may be a significant variation in luminance with viewing position in the theater.

A maximum permissible variation is given in 3.3; in a particular theater this condition can be met by several procedures, including one or more of the following: choice of a screen with a suitable reflection pattern; limitation of the seating area so that no patron views the picture from an angle at which the luminance is outside the tolerance of the standard; and curvature of the screen. (In practice the curvature of screens whose surface is continuous is limited to a radius equal to or somewhat greater than the projection throw to avoid excessive re-reflection and contrast loss.)

A6. *"Luminance gain"* is defined as the ratio of the luminance of a specified area of the screen to the luminance of a perfectly diffusing and perfectly reflecting surface, both measured under the same conditions of illumination and observation. For directional screens, luminance gain is a function both of the direction of illumination and of the direction of observation. With any given screen these two vectors may be chosen so that the luminance level obtainable is made a maximum, and this condition defines the "maximum luminance gain."

A7. *Limitation on Luminance Range.* Present directional screens show a large variation in gain with changes in the projection and viewing angles, necessitating the 3:1 luminance ranges prescribed in 3.3 when the more desirable screens are fitted into existing theaters. Even this range effectively limits the maximum luminance gain of the screen, and the wider the theater becomes, the lower the maximum luminance gain must be to meet luminance specifications with most existing directional screens. When screen design permits a smaller luminance range, it is intended that this standard be revised accordingly.

A8. *Maximum Screen Size.* Projection light output and screen luminance gain together determine the maximum screen size that can be illuminated to produce standard luminance.

A9. *Meter Acceptance Angle.* The maximum permissible acceptance angle of the luminance photometer will depend upon the instrument design and method of use, the size of the screen and other factors. The acceptance angle of a suitable instrument must be such that a reduction in this angle (followed by necessary recalibration) does not change the magnitude of any reading specified in 2 by more than ± 5 percent. The limiting conditions for the reliable use of such meters should be included in the manufacturer's specifications.

A10. *Conversion of Units.* Screen luminance in the U.S. is customarily measured in foot-Lamberts, although in international usage the nit is the preferred unit. 1 nit = 0.2919 ft-L; 1 ft-L = 3.426 nits.

A11. *Image Luminance.* Note that this standard specifies screen luminance with no film in the projector aperture. When films are projected, the average image luminance will be considerably below this level.