SMPTE 196M-2003
Revision of
ANSI/SMPTE 196M-1995

SMPTE STANDARD

for Motion-Picture Film — Indoor Theater and Review Room Projection — Screen Luminance and Viewing Conditions

1 Scope

This standard specifies the screen luminance level, luminance distribution, and spectral distribution (color temperature) of the projection light for theatrical, review-room, and non-theatrical presentation of 16-, 35-, and 70-mm motion-picture prints intended for projection at 24 frames per second. This standard also specifies review-room viewing conditions. It is the purpose of these specifications to achieve the tone scale, contrast, and pictorial quality of the projected print that will be of the quality intended during its production.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE RP 27.4-1994, Specifications for an Operational Test Pattern for Checking Jitter, Weave and Travel Ghost in Television Projectors

SMPTE RP 95-20034, Installation of Gain Screens

SMPTE RP 98-1995, Measurement of Screen Luminance in Theaters

ISO/CIE 10527:1991, Colorimetric Observers

3 Projector operating conditions

Measurement of screen luminance shall be made with the projector in normal operation (with shutter running), with its lens set at focus position, but with no film in the aperture. The measurement of spectral distribution (color temperature) of the projection light is best made with the shutter momentarily stopped and held open, and with no film in the aperture.

4 Photometer type

Screen luminance shall be measured with a spot photometer having the spectral luminance response of the standard observer (photopic vision), as defined in ISO/CIE 10527 (see annex A.4). The acceptance angle of the photometer shall be 2° or less. The photometer response to the alternation of light and dark on the screen shall be to integrate over the range of 24 Hz to 72 Hz and display the arithmetic mean value.

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5 Luminance level

5.1 Measurement location

To simulate audience viewing, screen luminance measurements shall be taken from the center of the seating area at a height of approximately 1 m (39 in) above the floor. To ensure reasonable luminance at other seating locations, measurements shall also be taken from the center and each end of the middle row, and shall be within the limits given in 5.3 or 5.4.

5.2 Theater nominal luminance

Theater screen luminance shall be nominally 55 cd/m^2 (16 fL) measured at the screen center. The luminance of the screen sides and corners shall be measured at a distance of 5% of the screen width from the screen edges. The readings shall be taken from each location specified in 5.1.

5.3 Theater luminance limits

Theater screen luminance at the screen center shall be between 41 cd/m^2 (12 fL) and 75 cd/m^2 (22 fL). Luminance at the screen sides shall be 75% to 90% of the screen center luminance, but not less than 34 cd/m^2 (10 fL).

5.4 Review room luminance and limits

Review room screen luminance shall be 55 cd/m^2 ± 7 cd/m2 (16 fL ± 2 fL) at the screen center. The luminance of the screen sides and corners, measured as described in 5.2, shall be at least 80% of the screen center reading.

6 Luminance distribution

The screen luminance shall be symmetrically distributed about the geometric center of the screen. The luminance of any point on the screen between the center and the edges, as measured from any seat in the middle row, shall not exceed the screen center reading (see annex A.2). For screens with a gain factor of 1.1 or more, the screen shall be curved for light uniformity as described in SMPTE RP 95. A more complete measurement of screen luminance distribution is described in SMPTE RP 98 and is recommended for new or revised installations.

7 Spectral distribution

7.1 For 35- and 70-mm prints, the light reflected from the screen in theaters shall have a spectral distribution approximating that of a blackbody at a color temperature of 5400 K + 600 K -- 200 K, the use of short-arc xenon light sources being assumed. For review rooms, where color matching is more critical, projectors shall have a chromaticity match, for the same film format, of x = ± 0.002 and y = ± 0.004. For laboratory use in color timing, projectors shall have a chromaticity match of x = ± 0.001 and y = ± 0.002. Typical chromaticity readings would be D5500: x = 0.332 and y = 0.347. Chromaticity measurement
requires a precision chromaticity meter, not a color temperature meter.

7.2 16-mm prints are made for projection with either arc or tungsten illuminant. When the intended illuminant cannot be specified uniquely, 16-mm prints should be evaluated at 5400 K.

8 Multiple projector adjustment

8.1 Same format

The resultant luminance from all projectors intended for use in the continuous sequential viewing of material of the same format shall not vary by more than 7 cd/m^2 (2 fL).

8.2 Different formats

The resultant luminance from projectors intended for use in a sequential system of viewing material of different formats shall not vary by more than 14 cd/m^2 (4 fL) (see annex A.5).

8.3 Temperature

The apparent color temperature of the projection light from projectors intended for continuous sequential operation shall be consistent within a total range of 400 K. For 16-mm projection with light sources with a color temperature of less than 3500 K, the range shall be limited to 7% or 200 K.

9 Review room viewing conditions

All observers in a review room shall be located within a standard observing area which shall be:

a) within the limits of a 15° angle on either side of a perpendicular to the center of the screen, in both the horizontal and vertical planes; and

b) at a distance of 3 picture heights ± 1 picture height from the screen.

10 Stray light and contrast

10.1 No stray light or illuminated area with luminance greater than 3.4 cd/m^2 (1.0 fL) shall be visible from the normal observing area of theaters or review rooms.

10.2 Screen luminance due to stray light shall be less than 0.16% (600:1 theater screen contrast ratio) for review rooms and primary theaters. For all other theaters, the luminance due to stray light shall be less than 0.25% (400:1 theater screen contrast ratio).

Annex A (informative)
Additional data

A.1 Luminance level limits

Acceptable luminance levels are limited by a minimum value below which the visual process becomes less efficient and by a maximum value above which (assuming a shutter frequency of 48 flashes/s) flicker becomes objectionable. The permissible luminance range is limited by the criterion that a good release print must provide acceptable quality when projected at any luminance within the specified range. Users are reminded that screen luminance may decrease as a function of bulb age, dirt on optics, dirt on screen, etc. Projection equipment should be chosen to have more than sufficient light output to meet the specifications in this standard over a period of time. Usually, arc current is adjusted to compensate for changes in light output.

A.2 Light incident on the screen

Misadjustment of the projector light source optical system may cause luminance readings taken at various locations in the seating area and on various areas of the screen to exceed the screen center reading taken as described in clause 5 (hot spots). To avoid this possibility, it is desirable to measure directly the light from the projector falling on the screen. This may be done by measuring the incident light across the screen surface with a footcandle meter and adjusting the light source optics to ensure that no area on the screen receives incident light greater than the screen center.

A.3 Normal print

To provide interchangeability in motion-picture projection, it is desirable that print quality conforms to that of a normal print so that theaters can operate at known projection conditions and will, thereby, be able to exhibit projected pictures of good pictorial quality. It has not been possible to specify this normal print in terms of its optical density and other objective measurements because of the difficulties of specifying artistic quality in scientific terms. Accordingly, the normal print is

defined as that print which conveys the desired artistic impression when projected under review room conditions as described by this standard.

A.4 Meter acceptance angle and response

A photometer with a photopic spectral response allows use of a well known standard response for all photometer manufacturers. A mesopic (partially dark-adapted) response might be better, but no standard has been set for the mesopic observer under typical screen viewing conditions. When entering a theater from daylight, we find it difficult to see others in the audience although they see us because they are partially dark-adapted. The degree of adaption varies with the film subject matter. A typical film reduces the average screen luminance from 55 cd/m2 to 5.5 cd/m^2 (16 fL to 1.6 fL). The rest of the theater is much darker. Because of increased blue sensitivity of the eyes (Purkinje effect) as one becomes somewhat dark-adapted, a photometer with a photopic response may give readings on a xenon illuminated screen and a carbon-arc illuminated screen that are the same, although many observers see the xenon illuminated screen as the brighter. The xenon-arc spectrum has a peak in the blue region where, because of the Purkinje shift, there is increased sensitivity. A representative mesopic curve may be developed and adopted in the future.

A.5 Matching luminance of different formats

It may be necessary to adjust projector light output to compensate for the different aperture sizes and magnifications used when projecting different formats. The projector light source should be capable of achieving the specified screen luminance for the format with the least light efficiency (usually non-anamorphic wide screen). Adjustment may be made by changing arc current or by the use of attenuators in the light beam to reduce the screen luminance to the recommended value when projecting more light-efficient formats.

A.6 Other applications

Specifications for drive-in threater screen luminance are covered in SMPTE RP 12.

Annex B (informative)
Bibliography

SMPTE RP 12-1997, Screen Luminance for Drive-In Theaters

SMPTE RP 94-2000, Gain Determination of Front Projection Screens

SMPTE RP 153-1999, Method for Measuring 35- and 70-mm Shutter Efficiency