SMPTE RECOMMENDED PRACTICE — RP 41-1974

Evaluation of Color Films Intended for Television

Introduction

The television monitor and the home receiver present relatively small pictures and are usually viewed with other illuminated objects present. Television programming is usually a succession of separate segments presented contiguously. These differences from theatrical viewing and programming call for a different preview condition. The necessary conditions are a relatively small picture of a specified color and luminance, surrounded by a relatively large field of the same color at a lower luminance. The large, visible surround serves two important functions. It provides (1) a standard correlate of the ambient field of view of the television screen, which has a marked effect on the apparent contrast of the picture, and (2) a constant adaptation field against which to refer the color balance of the picture when making judgments of color balance.

The small picture simulates more closely the size and appearance of a television screen, and permits the use of a relatively large surround. This recommended practice differs from RP 41-1970 chiefly in that the concept of a visible surround, which in RP 41-1970 is noted only as an appendix item, becomes an integral part of the recommended practice. The screen luminance is also increased, so that the projected picture corresponds more closely to the luminance of television picture monitors.

This recommended practice conforms closely to practices in other countries. In Canada, CTP 1-1968, Viewing Rooms for Evaluation of 16 mm Color Film for Television, describes such a viewing room. Practices in the European Broadcasting Union are given in Tech 3091-E, Viewing Conditions for the Appraisal, by Means of Optical Projection, of Colour Films Intended for Television Presentation, First Edition, September 1970. Both documents appear in the February 1971 Journal of the SMPTE with examples of implementation.

1. *Scope*

This recommended practice is intended to define the necessary conditions for the color and luminance of open-gate screen illumination, the color and luminance of the surround illumination, the relative size of the surround and screen, and the level of ambient illumination to permit critical evaluation of color balance and contrast of films intended for television use. Such a viewing situation is particularly useful in the selection of the optimum color balance of prints. Because a relatively small screen is specified, such a projection room will not accommodate large audiences. A variation of this practice is recommended which will accommodate large audiences, but which is less critical for quality judgments.

2. *Color and Luminance of Open-Gate Screen*

2.1 Although it is recognized that ultimate reproduction of white in the television system will be at D_{6500}, a screen chromaticity and spectral distribution approximately that of a black body at 5400 ± 400 K shall be used.

2.2 This screen color results from chromatic distribution of the projector light and of the screen reflectance. (See Appendix A1.1)

2.3 To facilitate the illumination of a visual surround, it may be desirable to use a screen of low reflectance, or one with directional properties. (See Appendix A1.2.)

2.4 The luminance of the screen, measured according to American National Standard Screen Luminance and Viewing Conditions for 16 mm Review Rooms, PH22.100-1967, except that the acceptance angle of the photometer shall be 2° or less, shall be 40 ± 4 footlamberts (137 ± 13.7 candelas per square meter). This luminance will produce, with a film conforming to that specified in SMPTE Recommended Practice RP 46-1972, Density of Color Films and Slides for Television, in the gate, a white luminance of about 20 fL (68 cd/m²) which corresponds approximately to peak white luminance of color television monitors.

Revision of RP 41-1970
Approved July 1974

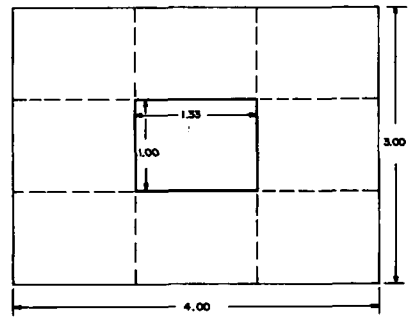
2.5 The luminance at a distance of 5 percent of the screen width from the side edges of the screen shall be 90 ± 10 percent of the center luminance.

2.6 If a directional screen is used, the viewing audience shall be restricted to that area from which the luminance tolerance is operative.

3. *Screen Dimensions*

3.1 The viewing screen shall be of such size that the viewing audience may be seated at a distance from the screen equal to 4 to 6 times the screen height. Its size shall be sufficiently small so that a visible surround area of approximately 8 times the screen area is possible (see figure).

3.2 The ratio of screen width to screen height shall be 1.33:1.



Relative Proportions of Screen and Surround

4. *Viewing Distance*

Observers preferably shall be placed so as to view the screen from a distance equal to 4 to 6 times the screen height.

5. *Light Surround*

5.1 Light surround is defined as the light, visible to the observer, which surrounds but does not include the central screen area.

5.2 The area of the light surround shall be preferably at least 8 times the screen area (see figure).

5.3 The luminance of the light surround shall be approximately 1/10 the open-gate screen illumination. (See Appendix A2.1.)

5.4 The color of the light surround shall match that of the open-gate screen illumination. (See Appendix A2.2.)

6. *Ambient Conditions*

6.1 The level of light other than screen illumination and surround shall be such as to be insignificant in comparison to them.

6.2 Light falling on the screen which is reflected to the viewing position shall be low enough so that the unlighted projection screen measures less than 1 fL (3.4 cd/m²). To achieve this, walls should be of low reflectance.

6.3 The viewing room decor preferably should give a generally neutral impression, without dominant colors being employed.

7. *Review Room for Large Audiences*

7.1 When the audience exceeds 10 to 15 persons, it becomes necessary to use a large screen. A large screen makes it impractical to obtain an illuminated surround having eight times the area of the screen. The following recommendations for viewing films in a darkened theater are given with the caution that elimination of the lighted surround reduces the viewer's sensitivity in making judgments of color balance and density, and also affects judgment of contrast. (See Appendix A3.1.)

7.2 Luminance level of the open screen for darkened room viewing shall be 16 ± 2 fL (55 ± 7 cd/m²), measured within the standard observing area with the projector operating with no film in the aperture. (See Appendix A3.2.)

7.3 Spectral distribution of the reflected light from the screen illuminated by the open-gate projector should approximate the spectral distribution of a black body at a color temperature of 5400 ± 400 K. (See Appendix A3.3.)

Appendix

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

A1. *Screen and Projector Characteristics*

A1.1 The desired color may be obtained using an arc source in the projector. The high intensity carbon arc usually operates at close to 5400 K. The xenon arc will operate closer to 6000 K when fresh, and may change toward 5000 K with age. Another method is to use a blue photometric filter such as the proper thickness of Corning Filter No. 5900 with a projector having a tungsten source, changing its nominal color of about 3500 K to 5400 K.

Color temperature may be verified most easily by comparison with a known reference of 5400 K (see SMPTE Recommended Practice RP 52-1974, Evaluation of Screen Luminance and Color in Review Rooms Used for Color Television Films) or by measurement using a spectroradiometer. Two- or three-color color temperature meters may not give reliable results with xenon illumination or other sources which depart from black-body spectral quality.

The luminance of the projection screen and the color and luminance of the surround and the open-gate screen may be evaluated by comparison with the reference illuminated screen specified in RP 52-1974.

A1.2 The choice of screen material will depend on projection illumination available and the method chosen to provide surround illumination. If the projection source is tungsten, filtered to 5400 K by a supplementary filter over the lens, only a directional, high-gain screen will provide sufficient open-gate screen luminance. If the source is a xenon arc capable of a beam output of the order of 100 lumens, a matte white screen can be used. If 500 lumens are available, a 20-percent reflection gray screen can be used. Both the 20-percent matte gray screen and the directional high-gain screen make it possible to achieve the desired black level on the unlighted screen, in the presence of some ambient light. This practice does not preclude the use of rear projection screens, provided uniformity of illumination can be achieved.

For aesthetic reasons, a screen mask may be desired. If used, it should preferably be black, and not more than three or four inches wide.

A2. *Light Surround*

A2.1 The level of surround luminance ideally should approximate average picture luminance. This is most frequently about ⅛ to ¼ the picture white luminance, although it can vary widely, so a value of 1/10 the open screen luminance is one valid compromise. This level (of about 4 fL [13.7 cd/m²]) may be measured directly, or it may be checked relative to screen luminance by placing a 1.0 density neutral, nonscattering filter over the projection lens. This attenuates the screen luminance by the factor of 10, allowing a visual match with the surround.

Alternatively, the low-level setting of the reference illuminated screen specified in SMPTE Recommended Practice RP 52-1974, can provide a visual reference for the surround.

The uniformity and shape of the surround field is not critical so long as the area surrounding the screen (8X screen area) is in the desired luminance range.

A2.2 It is important that the surround match the screen for color. The use of the 1.0-density filter over the projector, permitting a visual match of screen with surround, is the easiest and most accurate way to verify such a match. It is necessary, however, that the filter used introduce no color. A filter of evaporated metal, such as Inconel, can fill this requirement.

Surround illumination may be obtained in several ways. It can be a transilluminated panel. Front illumination can be used, providing the screen itself is not lighted. This can be achieved by placing the screen in a plane in front of the surround plane, with surround lights behind the screen. It can also be achieved by projecting surround light with specular optics, masking out the screen area. Or, it can be achieved if a directional, high-gain screen is used, by proper placement of overhead light, using readily available fluorescent tubes operating at 5500 K.

A2.3 When problems in room design prevent achievement of the full surround format and geometry, some compromise in uniformity of surround illumination and in centering of the screen in the surround area may still permit the essential performance of this review room.

A3. *Compatibility*

A3.1 Experiments have established that the same color balance and density for prints is preferred under the larger screen, darkened room condition as under the smaller screen, lighted-surround condition. However, it is possible, because of visual adaptation, for an observer in the darkened room to judge as acceptable some prints which would be recognized as less acceptable or unacceptable in the presence of the lighted surround.

A3.2 The luminance level of the review room for large audiences is the same as that previously specified for 16 mm and 35 mm review rooms (American National Standard Screen Luminance and Viewing Conditions for 16 mm Review Rooms, PH22.100-1967, and American National Standard Screen Luminance and Viewing Conditions for 35 mm Review Rooms, PH22.133-1963 (R1969)).

A3.3 This spectral distribution is the same as that specified for 35 mm review rooms (ANSI PH22.-133-1963). This ensures that the color balance of both 16 and 35 mm films intended for television shall be similar.

A3.4 Although these preview room recommendations are intended to enable a viewer to predict the suitability of a film for television use, these recommendations are not intended to simulate television display exactly.

A3.5 Use of a Subjective Reference Test Film as a visual reference is recommended (J. M. Waner and E. P. Ancona, Jr., "SMPTE Color Television Subjective Reference Test and Slides," Jour. SMPTE, 75: 218-220, March 1966 and "SMPTE Color Television Subjective Reference Test Films and Slides," Jour. SMPTE, 76: 686-688, July 1967). Since these films are color and density balanced for this recommended practice, they should provide a valid comparison reference.

SMPTE RECOMMENDED PRACTICE

RP 52–1974

Evaluation of Screen Luminance and Color in Review Rooms Used for Color Television Films

1. *Scope*

This recommended practice specifies a means for field evaluation of projection screen apparent color and luminance as specified in SMPTE Recommended Practice RP 41-1974, Evaluation of Color Films Intended for Television.

2. *Equipment*

2.1 The screen color and luminance shall be evaluated by comparison with a translucent rear-illuminated screen of the color designated in RP 41-1974.

2.2 The comparator shall be capable of being adjusted to three luminance levels without changing the color: 4, 16 and 40 footlamberts (14, 55 and 137 candelas per square meter).

2.3 The described instrument shall have a screen no smaller than 10 x 10 inches (25 x 25 cm). It shall have a voltmeter and a manually operated voltage control or shall be so constructed as to vary no more than 1 fL (3.4 cd/m²) with a 10-volt variation in the feed line.

2.4 A set of four viewing filters shall be part of the equipment. The filters are for the purpose of defining the limits of tolerance specified in RP 41-1974, and shall be so designed that one increases color temperature, one decreases color temperature, and the other two are of a color on the green-magenta axis, essentially perpendicular to the black body locus on the CIE Chromaticity Diagram, and of such density as to change the color coordinates by one half the amount of the first two named filters (see Appendix).

3. *Calibration*

The described comparator shall be calibrated against a laboratory standard source of 5400 K color temperature and spectral distribution. It shall match the standard within a tolerance limit of ± 10 mired and ± CC.025G.

4. *Operation*

4.1 In practice, the comparator is placed adjacent to the projection screen and compared while the projector is running with no film. For film review rooms, luminance is set at 16 or 40 fL (55 or 137 cd/m²), depending upon which screen condition is desired (see RP 41-1974).

If the screen does not match the comparator luminance, the projector luminance level shall be adjusted to match.

If the color still does not match, viewing the comparator screen through the yellow or blue filter held far enough from the eye to cover only the comparator field will give an evaluation as to the limits of tolerance of color temperature specified in RP 41-1974. Use of the green or magenta filters will give an evaluation as to the permissible deviation from the black body locus.

4.2 The 4 fL (14 cd/m²) luminance level may be used as a luminance and color reference for the surround illumination specified in RP 41-1974. It may also serve as an adaptive color reference during projection.

Approved July 1974