SMPTE STANDARD

Reference Viewing Environment for Evaluation of HDTV Images

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Approved
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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE ST 2080-3 was prepared by Technology Committee 10E.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

The creation of television images that are intended to follow a standard of consistency in reproduction requires definition of a reference display, of a controlled viewing environment, and of a set of measurement procedures to enable consistent calibration of both display and environment. This document specifies a controlled viewing environment referred to as the Reference Viewing Environment.

1 Scope

This standard specifies the reference viewing environment for picture quality evaluation of HDTV images.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3 Normative References

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

SMPTE ST 2080-1:2014, Reference White Luminance Level and Chromaticity for HDTV

ISO/CIE 11664-1 (2007), Colorimetry — Part 1: CIE standard colorimetric observers

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 diffuse reflection

reflection of light in many directions.

Note 1 to entry: Light reflected from an illuminated surface that produces a perfectly diffuse reflection will have the same luminance from all viewed directions

4.2 information display

display not performing the function of a reference display.

Note 1 to entry: Examples include computer displays for edit or color grading systems and continuity monitors.

4.3 reference display

display intended for use in making critical aesthetic decisions concerning the image parameters of the signal being evaluated or corrected.

Note 1 to entry: Specification of a reference display is outside the scope of this document.

4.4 reference viewing environment

room or a portion thereof that is designed for critical viewing of images on a reference display.

Note 1 to entry: When used with a calibrated reference display, images can be consistently evaluated between environments and over time.

4.5 surround

the area visible to the observer from or behind a plane coincident with and surrounding but not including the reference display(s)

Note 1 to entry: A surround of defined luminance/illuminance is necessary for the correct perception of contrast in the displayed image. The surround provides a fixed neutral visual reference that prevents the eye from changing adaptation level.

5 Viewing characteristics

5.1 Adaptation Time

The observer shall be visually adapted to the viewing environment. The time allowed for the observer's adaptation should be at least 10 minutes.

Note: At the operating levels specified for HDTV displays, including the surround illumination level specified in Section 6.5 below, the eye is in photopic response (cone cells). Ten minutes is sufficient time for human cone cells to adapt. Refer to Kalloniatis and Luu.

5.2 Viewing Distance

The observer's nominal distance from the center of the reference display should be 3 to 3.2 picture heights.

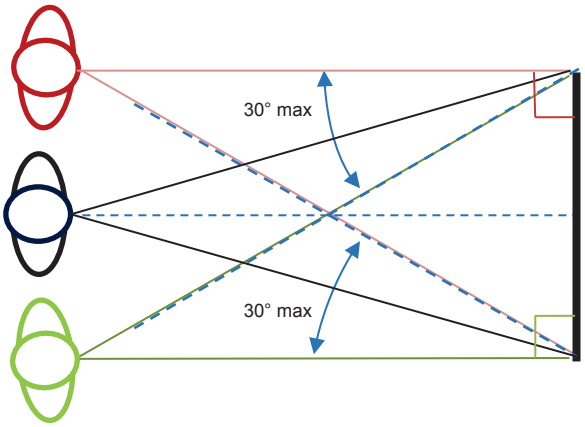
5.3 Viewing Angle

The observer position shall be within a horizontal angle of 30 degrees and within a vertical angle of 15 degrees from a line normal to the image plane of the reference display. (See Figure 1 and Figure 2.)

Note 1: There are displays that can reproduce images accurately over a wider range of viewing angles. Users can take this into account when determining size and placement of the display within the reference viewing environment. Specification of display performance is outside the scope of this document.

Note 2: In order to accommodate all viewer positions, it can be desirable to mount the display so that it can be tilted. The design of lighting in the room needs to take this into account.

Note 3: The width of a typical armchair is 0.67 m (26 inches) as shown in Figure 1. For armchairs of this width, the distance and screen dimensions given in Figure 1 are the minimum sizes that permit viewer placement within the horizontal viewing angles specified.



Width of seat: w = 0.67m
Max horizontal angle to screen: 30 degrees
Distance to 1.33m wide screen: 2.32m
Height of 1.33m wide screen: .75m (60" diagonal)
Optimal distance to .75m screen (3.0x-3.2x): 2.25m-2.4m
Dashed lines show 3.0x – 3.2x screen height

Figure 1 – Example Horizontal Viewing Angles, Primary (Central) and Secondary Viewers

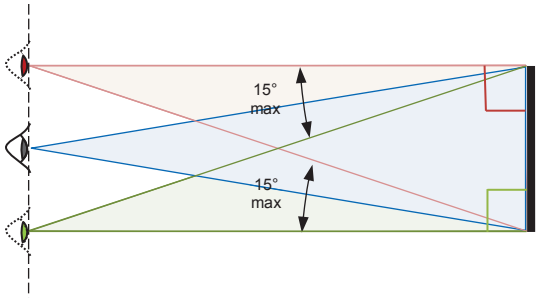


Figure 2 – Vertical Viewing Angle, Limits on Observer Eye Height

6 Surround Characteristics

6.1 Surround Illumination

The surround may be either self-illuminated or reflective (externally illuminated).

6.2 Surround Color

If used, a reflective surround should be a visually neutral surface (preferably gray).

6.3 Surround Chromaticity

The surround should be illuminated with a light of a characteristic such that the light emitted or reflected matches the display chromaticity of the reference white in use (see SMPTE ST 2080-1).

Note: The spectral power distribution of the light emitted or reflected from the surround is unlikely to match that of the display's illuminants. Further research would be needed to determine the importance of such a match.

6.4 Surround Luminance Value

The reflected light from the surround or background in the field of view shall have a luminance of 5.0 ± 0.5 candelas per square meter. Surround luminance shall be measured with a spot photometer or spectroradiometer having the spectral luminance response of the standard observer (photopic vision), as defined in ISO/CIE 11664-1. The acceptance angle of the measuring device shall be 2° or less. The measuring device shall have an accuracy of ± 3% of reading or better and a range whose minimum shall include 0.40 cd/m^2. The measuring device's response to luminance variation over time shall be to properly integrate any such variation occurring at frequencies at or above 24 Hz and display the arithmetic mean value.

Note: This surround luminance level is significantly different than the value specified in earlier documents. Refer to Annex A for further information on this change.

6.5 Surround Area Extent

The outer extent of the surround should occupy no less than 90 degrees horizontal field of view and no less than 60 degrees vertical field of view. (See Figure 3.)

6.6 Display Physical Mounting (Informative)

A good practical approach is to have a reference display placed in a free-standing environment 7 cm to 2.5 screen heights in front of the wall providing the visual surround. The surround receives its illumination from directly controlled and ambient lighting in the room.

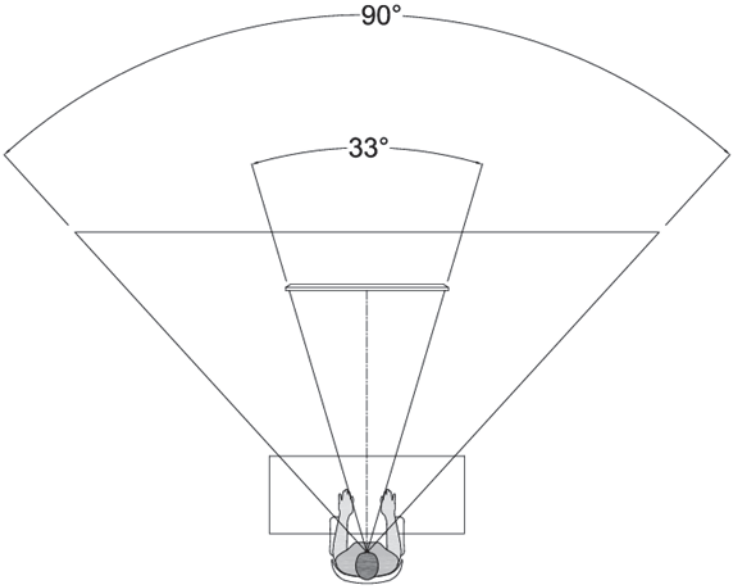


Figure 3 – Horizontal Field of View for Reference Display Surround Area

7 General Conditions — Viewing Area Decor

7.1 Decor

The viewing area decor and any surfaces should be matte, without dominant colors. Areas in the field of view shall be devoid of vivid colors.

7.2 Surface Reflections

Reflections from all surfaces normally visible to the viewer from the operating position, except the viewing surface of the reference display, should be diffuse and should not exceed the luminance value of the surround.

Reflections from all surfaces that might be visible as reflections in the reference display should have a diffuse surface reflectance of less than 50% of the luminance value of the surround.

Note: This value assumes that the reference display's surface has a low reflectance. Any reflections from the reference display that are visible to the viewer can interfere with the displayed image.

7.3 Loudspeakers

Loudspeakers placed in the front of the room may be mounted in front of the surround, provided they are small with respect to the size of the reference display and are a neutral color, preferably medium to dark grey or black.

8 Viewing Room Lighting Characteristics

8.1 Light Sources

All light sources in use during picture assessment or adjustment should closely match the chromaticity of the reference white in use (see SMPTE ST 2080-1).

8.2 Lighting Reflections

Reflections from light sources onto the reference display shall not cause a perceptible impairment to the displayed image from the normal viewing position.

8.3 Working Lights

The production desk and control consoles where a script is read should be illuminated to produce a reflected light level of about 100 lx (10 fc). The illumination on the general working surfaces of the production desks and consoles should be a maximum of 40 lx (4 fc).

Note: This level of illumination is chosen to minimize the possibility of visible reflections from the viewing surface of the reference display, while still providing sufficient illumination for operations.

8.4 Secondary Displays

The luminous surface areas of secondary displays such as information displays and touch screen control panels should produce a maximum luminance level of 100 cd/m^2.

The average chromaticity of the emitted light, integrated over time, should approximate the reference white in use (see SMPTE ST 2080-1), and areas of high color saturation should be limited in size, luminance, and time held on the panel.

Annex A Surround Luminance Level (Informative)

Predecessor documents on the display environment, specifically SMPTE RP 167:1995, cite a surround level that is 10% of reference white. However, this level is rarely if ever used; the surround is usually set at a far lower level. The question that then arises is where the 10% level comes from, and by what means was it determined?

A review of the literature, particularly in the SMPTE Journal, reveals that it can be traced to work done at the CBC and CRC in Canada in the 1960s and 70s, and was greatly influenced by the characteristics and limitations of monochrome and early color CRTs. Indeed, significant effort was expended to reduce the effective contrast range of the CRTs to at most 100:1, and the surround level was set at the center of the contrast range in order to achieve a satisfactory subjective black.

The industry no longer uses CRT-based displays, and we go to significant effort to minimize or eliminate ambient illumination of the display's face. We expect our HDTV reference displays to be able to reproduce a black level of .05 nits or less, which when combined with the reference white level of 100 nits gives a contrast range of 2,000:1. The center of this range is sqrt(100 x .05) or approximately 2.24 nits. This is not necessarily the optimum setting for the surround level, however.

There is consensus in the industry that 10 nits is too high, as evidenced by the fact that this level is rarely if ever used. Research has revealed that surround levels below 2 nits have minimal effect on the perception of black. This implies that a suitable surround level will be somewhere below 10 nits but not lower than 2 nits. The geometric mean of these two values is 4.5 nits, so a value close to this would seem to be a reasonable compromise.

While science can confirm what would happen in average observer responses across different surround levels and in well-defined use cases, this does not answer the question of what the level should be. The conclusion is that there probably is no single optimal surround level that science can give us; the best we can expect is a range. However, there is agreement that we need to specify a surround level that is consistent and repeatable from facility to facility, given the influence of the surround on the perception of black and (to a lesser extent) on the appearance of color.

A survey of user organizations also wrestling with this issue revealed that the industry was independently converging on a consensus of 5 cd/m^2 for the luminance level of the surround. Given this, and the factors already cited, it was agreed to adopt this as the standard luminance level for the surround in the reference viewing environment for HDTV.

Bibliography (Informative)

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SMPTE ST 274:2008, Television – 1920 × 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

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Kalloniatis, Michael and Charles Luu, Light and Dark Adaptation, http://webvision.med.utah.edu/book/part-viii-gabac-receptors/light-and-dark-adaptation/, accessed 2017-04-18