

ESTA



ANSI E1.55 - 2016
Standard for Theatrical Makeup Mirror Lighting

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Table of Contents

1 Introduction (informative).....	1
2 Scope (normative).....	1
3 Definitions.....	1
4 General description (informative).....	2
4.1 The task.....	2
4.2 The conventional solution.....	2
4.3 Leaving the conventional solution.....	3
5 Requirements (normative).....	3
5.1 Level of illumination.....	3
5.2 Maximum luminance.....	3
5.2 CCT.....	3
5.3 Color rendering.....	3
5.4 Topology of the system.....	3
5.4.1 Inverted U.....	4
5.4.2 Double horizontal row.....	4
5.4.3 Double vertical row.....	4
5.5 Distribution of illumination.....	4
5.6 Uniformity.....	4
6 Explanation (informative).....	5
6.1 Level of illumination.....	5
6.2 Maximum luminance.....	5
6.2 CCT.....	5
6.3 Color rendering.....	5
6.4 Topology of the system.....	6
6.4.1 Apparent size of sources.....	6
6.4.2 Distribution of illumination.....	7
6.5 Uniformity.....	7

1 Introduction (informative)

For many decades, the illumination for makeup mirrors in theatres and other performance venue dressing rooms has been provided by a vertical row of lamps on each side of the mirror, with an additional horizontal row along the top. It is a simple system of illumination, difficult to get wrong, and when there are errors (e.g., no lamps on one side, lamps too dim, lamps too bright), the errors are usually obvious and easy to correct. However, the development of non-incandescent sources has increased the number of possible variables in a makeup mirror lighting system. It is now possible to have a makeup mirror lighting system that seems to be like any other with rows of lamps, but that, in fact, does not provide light sufficient to allow a performer or makeup artist to apply makeup quickly and accurately.

The many subtle ways modern makeup mirror lighting can fail to meet the needs of a performer has prompted representatives from Actors' Equity Association to ask ESTA for a guidance document on makeup mirror lighting systems. This standard is that document. It is intended to describe the illumination levels produced on the performer's face, the distribution of light sources and the light from those sources, apparent source size, maximum luminance, color rendering, and correlated color temperature of lighting for makeup mirrors with the goal of helping performers and makeup artists apply makeup quickly and accurately.

This standard does not make recommendations for the efficacy of the light sources used for makeup mirror lighting. However, it defines the minimally acceptable properties for the light to be produced. With that information, a person can select sources that have good efficacy and that will provide adequate lighting.

2 Scope (normative)

This standard applies to lighting systems for makeup mirrors and makeup stations used by performers and makeup artists for applying makeup to performers in theatres and other performance venues. It describes the topology of the makeup mirror lighting system, the quantity of light, the distribution of light from those sources, apparent source size, brightness, color rendering, and correlated color temperature.

This standard does not prohibit the development and use of other makeup mirror lighting systems, but makeup mirror lighting systems not meeting the minimum requirements of this standard shall not be said to comply with this standard. This is not intended to be used as a regulatory document.

This standard does not address the electrical or mechanical safety of makeup mirror lighting systems. Those matters are addressed in standards published by other organizations.

3 Definitions

CCT: Correlated Color Temperature. The temperature expressed in Kelvin (K) of a Planckian black body radiator at which the hue of it and a target illumination source appear to match. The calculation of CCT from the spectral power distribution of a source is defined in CIE 15:2004, Colorimetry.

Continuous Spectrum: For the purposes of this standard, a Continuous Spectrum is a lamp output in which visible light is produced at all wavelengths from 400 to 700 nm, and no wavelength in the range from 450 to 700 nm is less than 10% of the lumen output of the highest lumen wavelength.

CRI R_a: General Color Rendering Index. CRI R_a is a method of expressing in a single number the ability of a light source to reveal the colors of various objects faithfully, using a set of eight test color samples designated TCS01 – TCS08. It is defined in CIE 13.3-1995, Method of measuring and specifying colour rendering properties of light sources.

CQS Q_a : General Color Quality Scale. CQS Q_a is a method of expressing in a single number the ability of a light source to reveal the colors of various objects faithfully. CQS Q_a is defined in Davis, W. & Ohno, Y., "The Color Quality Scale," *Optical Engineering*, 49(3):033602 (March 2010).

Face plane: An imaginary plane of the performer's face defined by the supraorbital foramen above the eyes (the eyebrow ridges) and the tip of the chin.

Makeup artist: A person applying makeup to a performer. The makeup artist and performer could be the same person, if the performer is applying makeup to the performer's own face.

Makeup station: A place for applying makeup on a performer, consisting of a mirror with a makeup mirror lighting system and a desk or shelf below the mirror or close by it for holding makeup supplies and tools.

Performer: The person on whom the makeup is being applied at a makeup station.

TM-30-15 R_f : Fidelity Index. TM-30-15 R_f is a method of expressing in a single number the ability of a light source to reveal the colors of various objects faithfully. R_f is defined in IES TM-30-15, *IES Method for Evaluating Light Source Color Rendition*.

4 General description (informative)

4.1 The task

A makeup artist applying makeup to a performer's face needs uniform illumination on the front planes of the performer's face and also to the sides of the face, around the ears, above the face at the hairline, under the chin, and around the neck. "Uniform illumination" does not mean dead flat, but it does mean without significant shadows and with only gradual changes of illumination around curved surfaces. The level of illumination should not change significantly as the performer leans forward toward and back away from the makeup mirror; that is, the space through which a performer might lean toward or away from the mirror must be near-field space, one in which the inverse square law does not apply.

An adequate level of illumination is important, but the luminance of the sources should be limited. It is impossible to light the face around the performer's eyes without also shining light into the eyes. This direct light from the sources into the eyes must not be blinding or an uncomfortable glare, particularly if the performer is also the makeup artist and is applying his own makeup.

Color rendering also is important. It is not important that the makeup being applied at the makeup station appear as it will on stage, but it is important that the different colors of makeup can be easily distinguished from each other at the makeup station. Most makeup colors are pastels, but some are intense colors that may be difficult to distinguish if the illuminating light source has significant gaps in its spectrum.

4.2 The conventional solution

A conventional makeup mirror lighting system usually consists of a vertical row of incandescent lamps on each side of the makeup mirror and a row horizontally along the top. In some venues, the system consists of two horizontal rows: one above and one below a large makeup mirror spanning several makeup stations, and occasionally in systems with two vertical rows and none across the top. In both cases, the numerous lamps effectively make a large source that almost encircles the performer's face, thus providing light to the sides of the head, top of the forehead, and under the chin. The large source provides a lot of light but with limited source luminance. The large source size and the close proximity of the performer's face to the source largely nullifies the inverse square law; the performer's face, 300 to 500 mm in front of the mirror, is effectively in the near field of the makeup mirror lighting system.

Conventional incandescent lamps also provide excellent color rendering for the purpose. Operated at their nominal voltage, they have a CRI R_a rating of almost 100. Their CCT of about 2700 K gives a light that looks normal to most performers and makeup artists. The use of lamps on a voltage lower than their rating to increase lamp life (e.g., 130 V lamps operated at 115 V) will result in a lower CCT and reduced shorter-wavelength output, but color rendering is usually acceptable, although seeing blues is more difficult.

4.3 Leaving the conventional solution

The topology of a conventional makeup mirror lighting system works; there is no compelling reason to abandon it. However, the efficacy of conventional incandescent lamps, only about 14 lumens per watt, is a problem. This low efficacy means that some conventional incandescent lamps are no longer available on the market because of energy efficiency regulations. When they are available, many people would prefer not to use them to reduce energy costs, to reduce heat in dressing rooms, and to reduce the negative impact on the environment from powering lighting.

There are many reasons why people would prefer to use more efficacious sources or might be required to use them. However, once a cook-book approach (e.g., "Use rows of 60 W A-lamps, and it will be fine.") of a conventional solution must be abandoned, it becomes important to consider what the lighting system must or should do.

5 Requirements (normative)

5.1 Level of illumination

The level of illumination produced on the performer's face plane must not be less than 500 lux throughout the range of 200 mm to 600 mm from the performer's face to the mirror.

The level of illumination produced on the performer's face plane at distances from 200 to 600 mm from the mirror should not be less than 1000 lux, as this is a better value.

5.2 Maximum luminance

The luminance of the visible parts of the system shall not create uncomfortable or debilitating glare for the performer or makeup artist.

The luminance of the lighting system seen by the performer or makeup artist should not be higher than 30,000 cd/m².

5.2 CCT

The CCT of the sources shall be between 2700 and 3500 K.

5.3 Color rendering

The sources shall provide good color rendering. Good color rendering will be provided if one or more of the following criteria are met:

- (a) The source is an incandescent or tungsten-halogen lamp with slight or no filtering of the output.
- (b) The source produces a Continuous Spectrum.
- (c) The source has a CRI R_a , CQS Q_a , or TM-30-15 R_f rating of 85 or higher. This requirement will be met if any of these ratings are 85 or higher; it is not necessary that two or all of the ratings be 85 or higher.

5.4 Topology of the system

The topologies described in the subclauses of 5.4 comply with this standard. Other topologies, such as a single horizontal line of lamps, do not.

5.4.1 Inverted U

An inverted U lighting system shall consist of a vertical line of lamps or a continuous source on each side of the mirror and one horizontal line of lamps or a continuous source across the top. If discrete lamps are used, there shall be at least two lamps used in the vertical rows and at least two lamps across the top, with no more than 500 mm between adjacent lamps in a row. Lamps at the end of the top horizontal row in line with the vertical rows shall not be considered part of the horizontal row but shall be considered part of the vertical rows.

The vertical row of lamps or continuous source on each side of the mirror shall be long enough that, when the performer is sitting or standing at the makeup station, whichever is considered the normal position, the bottom and top of the vertical row of lamps/continuous source shall be 280 mm or more below and above the height of the performer's nose. The vertical row of lamps or continuous sources shall be at least 560 mm long.

The spacing between the vertical rows of lamps or continuous sources shall not be less than 600 mm nor more than 1200 mm.

5.4.2 Double horizontal row

A double horizontal row system shall consist of two horizontal lines of lamps or a continuous sources, with one row or line across the top above the mirror and one below the mirror. If discrete lamps are used, there shall be no more than 500 mm between adjacent lamps in a row.

The horizontal rows of lamps or continuous source above and below the mirror shall be spaced far enough apart that, when the performer is sitting or standing at the makeup station, whichever is considered the normal position, the bottom and top rows shall be 280 mm or more below and above the height of the performer's nose. The horizontal rows of lamps or continuous sources above and below the mirror shall be at least 560 mm apart.

5.4.3 Double vertical row

A double vertical row system shall consist of two vertical lines of lamps or continuous sources, with one row or line on each side of the mirror. If discrete lamps are used, there shall be no more than 500 mm between adjacent lamps in a row.

The vertical row of lamps or continuous source on each side of the mirror shall be long enough that, when the performer is sitting or standing at the makeup station, whichever is considered the normal position, the bottom and top of of the vertical row of lamps/continuous source shall be 280 mm or more below and above the height of the performer's nose. The vertical row of lamps or continuous sources shall be at least 560 mm long.

5.5 Distribution of illumination

The sources shall project light toward the performer's face when seated or standing (as required) at the makeup station throughout a distance range from the mirror of 200 mm to 1200 mm. The sources also shall project light across the mirror surface so that a performer leaning in closer than 200 mm will be illuminated.

5.6 Uniformity

The sources used for a makeup mirror lighting system shall be uniform. That is, the sources used on the left and right sides of the mirror and above the mirror shall have the same CCT, the same color rendering ability, and the same lumen output per lamp or per linear meter of source, if the sources are continuous.

6 Explanation (informative)

6.1 Level of illumination

The IESNA's *The Lighting Handbook, Tenth Edition: Reference and Application*, Table 28.2, recommends 500 lux on table-height horizontal surfaces in theatre dressing rooms and 400 lux for vertical surfaces 4 feet [*sic*] above the floor (face height for a person sitting), when the dressing rooms are used by a population that is mostly between the ages of 25 and 65 years of age. It recommends double those levels for populations over 65. The requirement and recommendation in this E1.55 standard for makeup mirror lighting is founded on the ideas that the actor's face is just as critical a task surface as the makeup station table top and that performers may be over 65. Performers 65 years old and younger will not be disadvantaged by light levels appropriate for older performers.

6.2 Maximum luminance

Experience has shown that the luminance of a bare, frosted 60 W incandescent A-lamp is tolerable. The 30,000 cd/m² maximum recommendation is based on measured luminances of 60 W A-lamps and output-equivalent LED replacements.

6.2 CCT

This CCT recommendation is for vanity lighting in clause 22.2.13, "Toilets/Locker Rooms," of *The Lighting Handbook, Tenth Edition: Reference and Application*. It is a range that will be perceived as normal by most people.

6.3 Color rendering

(a) Incandescent lamps and tungsten-halogen lamps inherently produce a full-spectrum light. The slight doping of neodymium added to some lamp envelopes provides only slight filtering and does not compromise the full-spectrum nature of the light.

(b) Many lamps are not marketed with CRI R_a , CQS Q_a , or TM-30-15 R_f ratings. However, an inexpensive spectroscope sold for school use (under \$15 US) will let a person see the spectrum of a lamp by breaking the light into a rainbow of colors.

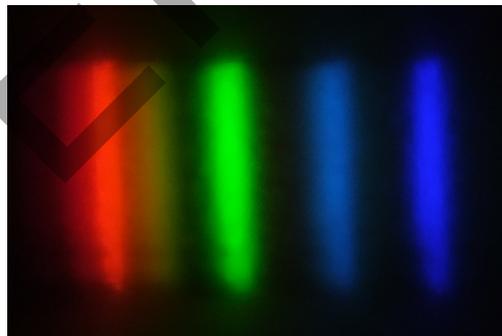


Figure A

Figure A is a photograph of the spectrum of a compact fluorescent lamp viewed with an inexpensive spectroscope. The color rendering for this lamp is nominally 82 CRI R_a , but some colors are missing from the spectrum, so there will be color perception errors.

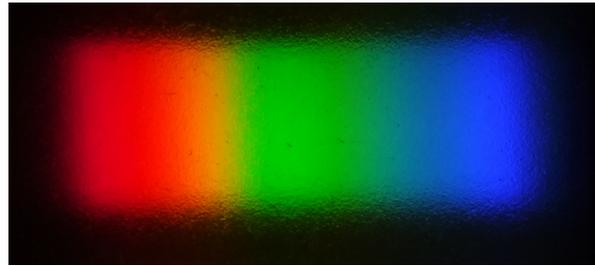


Figure B

Figure B is a photograph of the spectrum of a phosphor-converted white LED lamp viewed with the same photometer used with Figure A. There are dim spots in the cyan and yellow, but there are no black bands. Color perception with this lamp is better and easier than perception with the lamp shown in Figure A. Of course, an incandescent lamp will show a full spectrum with no dim spots.

This is a simple empirical method of evaluating an unrated lamp or source. It should not be used if a CRI R_a , CQS, or TM-30-15 rating for the lamp or source is known.

(c) The minimum 85 CRI R_a recommendation given here is higher than the 82 CRI recommended as a minimum for vanity lighting in clause 22.2.13, "Toilets/Locker Rooms," of *The Lighting Handbook, Tenth Edition: Reference and Application*. Eighty-two CRI is a reasonable minimum for general applications, such as toilets and locker rooms, but it is marginal for theatrical makeup station use. Lamps rated at 85 CRI would be better and are available. Of course, lamps with higher ratings would be even better, but may not be readily available.

6.4 Topology of the system

6.4.1 Apparent size of sources

The vertical rows of lamps on each side of the mirror should be large to help nullify the inverse square law to help provide uniform illumination as the performer leans toward or away from the makeup mirror.

The minimum distances above and below the performer's nose given in this standard are selected so that the light from below and above will be 35 degrees from the horizontal when the performer is positioned at the makeup station, and the performer's face is 500 mm away from the mirror. This will provide uniform, shadowless light to the top of the head, the neck, and under the chin.

If the makeup station is to be used by a performer who might be standing or sitting, the makeup mirror and the vertical sources at the sides of the mirror will have to be longer to accommodate the variation in the performer's face height from the floor. As alternative, the whole makeup mirror and lighting system could be raised and lowered to accommodate the performer. Whether the mirror and lighting system should move or simply be larger is outside the scope of this standard. It is also possible to simply designate the makeup station as being designed to be used by a sitting performer or by a standing performer, and that it is not designed to be suitable for both performer positions.

Most makeup mirror lighting systems use rows of discrete lamps, but these lamps could be turned into a continuous source by the use of a diffuser over the row. A continuous linear source also could be provided by a tubular fluorescent lamp, a tubular white LED lamp, or some other means.

The spacing specified between the vertical lines of lamps or sources in an inverted U system is meant to frame the mirror but not be too much wider than any practical makeup station width. If an entire makeup counter several meters long in a dressing room is served by only two vertical rows at the ends, there will

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be very little side-light for the performer working in the middle of the counter, and very little light for under the chin and under the nose.

6.4.2 Distribution of illumination

The sources traditionally used for a makeup mirror lighting systems are practically omnidirectional. More directional sources might be more efficient—there is no need for the top horizontal row to light the dressing room ceiling—but increased directionality might compromise the uniformity of distribution that is needed.

6.5 Uniformity

The sources used a makeup mirror lighting system need to be uniform so the makeup artist has no worries about the left side of the performer's face perhaps looking different from the right side, not because the makeup is different, but because the makeup mirror lighting is different left to right.