



Technical & Applications Information on the
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WHAT IS THE COLOR RENDERING INDEX (CRI) OF A LIGHT SOURCE?

The Answers To Some Frequently Asked Questions On The CRI

Generally speaking, the Color Rendering Index is a method of categorizing light sources as to how effectively they might illuminate colors. Unfortunately, there is a great deal of misunderstanding about the CRI, and what it actually means.

As stated in IES Publication RP-16-96, the CRI is a measure of the degree of color shift objects undergo when illuminated by a light source, as compared with the color of those same objects when illuminated by a reference illuminant of comparable (within 100 Kelvins) color temperature.

Q. Is it true that the higher its CRI value, the closer a light source matches the color rendering qualities of “natural daylight?”

A. No. “Natural daylight,” can actually cover a very wide variation in color composition and correlated color temperature (CCT). A deep blue overcast north sky, for example, can have a CCT as high as 8000 Kelvins, while an orange western sky at sunset can have a CCT lower than 2600 Kelvins. Again, the Color Rendering Index simply rates the color rendering properties of a test source to a C.I.E.* - defined reference illuminant of the same chromaticity.

Q. But, isn't the Color Rendering Index an absolute value...don't two light sources having the same CRI look the same and render color identically?

A. No. The CRI is a relative value, used to compare two lamps of the same type to each other. In fact, several light sources can have the same CRI rating, yet differ dramatically in color appearance and color rendering properties. A 6500 Kelvin fluorescent lamp has a blue-white appearance; a Cool-White Deluxe (CWX) fluorescent lamp appears reddish-yellow; and an Incandescent-Fluorescent (IF) lamp has an orange cast - **yet all three can have an identical CRI rating of 90.**

Q. Can a lamp with a Correlated Color Temperature of 5500 Kelvins be tested for its Color Rendering Index versus a standard reference of 5000 Kelvin?

A. No. The Color Rendering Index determination must be made between a test lamp and reference source that are within 100 Kelvins of each other. Therefore, the claim of a 98 CRI for a test lamp with a CCT of 5500 Kelvins versus a reference source of 5000K is not valid.

Q. If one 5000K light source has a CRI of 94 and another of similar spectral quality has a CRI of 91, what will be the type and degree of appearance difference between them?

A. None. As stated in C.I.E. Publication 13.2 on the Color Rendering Index, the color differences between sources that differ by three CRI units is not perceptible.

Q. If fluorescent lamps with a claimed CRI of 98 are installed into a transparency viewer or viewing station, can the light output of those viewers be claimed to have a CRI of 98?

A. No. The CRI must be determined on the output of the viewer itself. In fact, the modifying effects of the reflector, baffles, diffuser, and operating conditions in a standard viewer can reduce the lamp's CRI rating by five CRI units or more.

*Commission Internationale de l'éclairage (International Commission on Illumination)

LIMITATIONS & SHORTCOMINGS OF CRI

According to the procedures specified in ISO Standard 3664:2000, the Color Rendering Indices for graphic arts and photographic industry color viewing light sources are determined by using CIE Standard Procedure 13.2., "Method of Measuring and Specifying Colour Rendering Properties of Light Sources." This Standard describes a procedure for comparing the color rendering properties of a test 5000 Kelvin light source to those of CIE Standard Illuminant D5000, using 8 specified test colors. If the color rendering properties of the test source equal those of the Standard Illuminant, theoretically the CRI of the test source would be 100.

It is interesting to note that most 5000 Kelvin light sources used in viewing color are fluorescent sources, whose spectra include mercury lines or "spikes" at approximately 405nm, 436nm, 546nm and 578nm. The D5000 Illuminant, however, has a smooth spectrum, uninterrupted by any lines or spikes. So to speak then, spectrally, we are not comparing "apples to apples".

People involved in color measurement and color matching learn quickly that there are, essentially, two types of color matches: spectral or non-spectral, sometimes referred to as iso-meric or metameric matches. If the spectrum of the test color matches the spectrum of the standard, or "target" color, therefore, it is a perfect spectral color match. This type of spectral color match can never be achieved when comparing a 5000K fluorescent source to a D5000 Illuminant, due to the spectral mercury lines.

It is actually possible, utilizing the CRI formulas and manipulating the fluorescent phosphor combinations, to make 5000 Kelvin lamps (which are very spectrally dissimilar to the D5000 Illuminant) yield an apparently high CRI. For example, Figure 1 below depicts a test lamp, designated "B", which emits (excluding the mercury spikes) a spectrum which closely follows that of the D5000 Illuminant. Figure 2 shows test lamp "C" having a highly inflective spectrum, compared to the D5000 Illuminant. While both test lamps have a CRI above 90, test lamp "C" actually has a higher CRI than test lamp "B". This should not be so!

