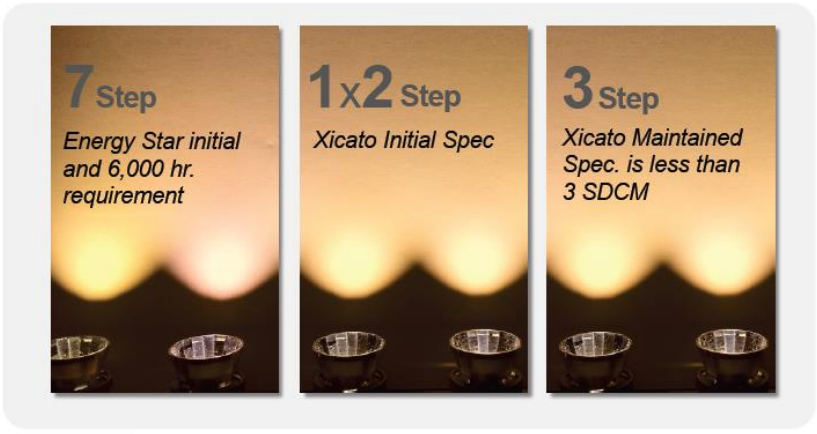
XICATO

"C": A Metric For Maintained Color Consistency

As lighting professionals have discovered in recent years, the emergence of LED technology has triggered higher awareness and expectations from customers. In particular, light that was once considered acceptable in quality is no longer tolerated as expectations for quality have risen in importance. A key element of lighting quality that is receiving increased attention is color maintenance. The US Department of Energy (DOE) recently issued an update of their position on color maintenance in LED Luminaire Lifetime: Recommendations for Testing and Reporting[1], and for the first time referenced a "C" metric for maintained color consistency. A "C" metric was proposed by Xicato in 2013 and now appears on all product data sheets.

Let's start with some background: The "L" notation, as in "L_{70}" is familiar to most and stands for lumen, and the following two characters for the percentage of light output that remains at a point of time in the future. For the last decade it has been used as a proxy for useful life. However, for many applications useful life is not well represented by lumen maintenance. Instead, *color* maintenance provides the better indicator of useful lifetime. Unfortunately, color maintenance specifications for any light source can be difficult if not impossible to find. Even when provided, the format and clarity of the information is not consistent as different approaches are used.

The "C" notation Xicato proposes stands for a light source's color point at a point in time, in the future, compared to its original color point at the date of manufacture, as measured in CIE 1976 color space. In layperson terms, it's a specification for color maintenance. For example, "C_3 50,000hrs" is .003 Δ u',v', or a distance of .003 as measured on the CIE 1976 color space, compared to its original color point, at 50,000 hrs. The CIE 1976 color space is used because it has the big advantage that the distance between points on the diagram are proportional to the perceived color difference. The USA Environmental Protection Agency's "Energy Star" program also uses CIE 1976 and most lighting academics worldwide agree that it is the most appropriate color space to use for measuring color change.



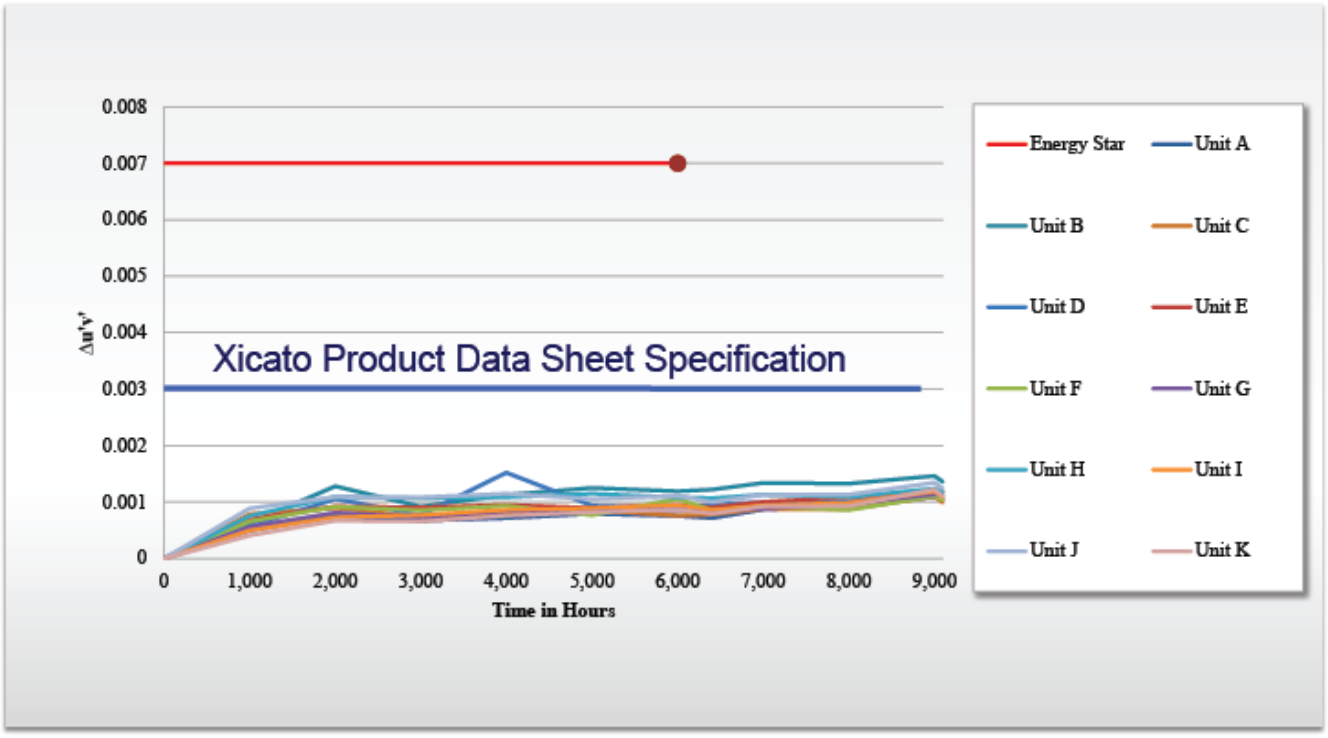
Basis for the "3" as in .003 Δ u',v'
< 3 is recognized to be "just noticeably different"

Similar to the metric that enables customers to compare two source's lumen life- for example one at L_{70}, 35,000 hrs. vs. another of L_{90} at 25,000 hrs., adoption of the "C" metric provides a common yardstick to enable them to compare source's specification for color maintenance over time.

[1] http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_luminaire_lifetime_guide_sept2014.pdf

But as savvy lighting consumers know, stating a specification is not the same as realizing the performance. As the saying goes, “trust and verify”; manufacturers can make claims on data sheets, but those claims are only as good as the reliability data that backs them up. Thanks to the IES, we have tools like LM-80 and TM-21 to use to back up data sheet lumen maintenance claims. For color consistency, one can also use LM-80 outputs. Currently no industry-accepted projection standards akin to TM-21 exist. Individual light source manufacturers may have their own projection methodologies. In the absence of being provided color maintenance projection methodology and, of course, results, the best way for a customer to value the ability of a source to maintain color over time is to see if it is addressed via a warranty.

Xicato Corrected Cold Phosphor Reliability Data



By adopting the “C” notation and communicating to customers, the industry can better move forward to educate customers on basic aspects of light quality. It’s a simple device, grounded in science, and enables one to compare products’ light quality.