Applications Note

Insight on Color **Vol. 7, No. 3**

45°/0° Perfect Reflecting Diffuser Standards

Some customers have noticed differences in measurements made on the HunterLab D25 series of colorimeters versus those made on HunterLab 45°/0° or 0°/45° spectrophotometers such as the ColorQuests, LabScans, and MiniScan 45/0s. Readings from different models of instruments will always vary slightly due to differences in internal dimensions, light sources, etc., but the major contributor to the differences between HunterLab colorimeter and spectrophotometer measurements is due to the different calibration bases for the two types of instruments.

HunterLab has updated the calibration of its reflectance standards for spectrophotometers in order to utilize the Spectrophotometric calibration accuracy improvements established by the National Bureau of Standards (now the National Institute of Standards and Technology) in 1981 ("NBS 45°/normal reflectometer for absolute reflectance factors," J.J. Hsia and V.R. Weidner, *Metrologia*, **17**, 97-102 [1981].) The accuracy of instrument working standards has benefited from the Bureau's progress and from the change in HunterLab calibration transfer procedures. The values of the HunterLab master set of porcelain enamel tiles, calibration at NBS (our transfer standards) are now documented and used in terms of Spectral Reflectance Factors at 10-nm intervals over the visible wavelength range. These spectral values are transferred to Laboratory and Instrument Working Tiles by means of a 0°/45° spectrophotometer. This is a significant change from past practice, when calibrations were transferred in tristimulus terms only, by means of filter colorimeters.

This change is applicable to the calibrations of all HunterLab spectrophotometers built during 1981 and later. No changes have been made, however, in the reference basis for D25 (including D25LT) and ColorTrend HT colorimeter 45°/0° instrument working standards. The HunterLab 1972 Perfect Diffuser (recorded as CIE Illuminant C, 1931 2° Observer values) will continue as the reference for these instruments in order to reduce the impact on users who have multiple colorimeters.

The effect of the change from HunterLab 1972 to NBS 1981 references on HunterLab white tile calibrations is to increase the tristimulus values for spectrophotometers by approximately 2% in relation to colorimeters. All colors have correspondingly higher reflectance and lightness values. However, the direction and magnitude of changes in a and b values for nonwhite colors cannot be generalized and will not be the same for all colors. White tile conversion factors are given below for Illuminant C and the 2° observer.

FACTORS BY WHICH HUNTERLAB 1972 (COLORIMETER) VALUES ARE MULTIPLIED TO OBTAIN NBS 1981 (SPECTROPHOTOMETER) REFERENCED VALUES:

X	Y	Z
1.018	1.019	1.012

These values were confirmed by measuring a single white tile using a D25A colorimeter (C/2°) and a ColorQuest 45/0 spectrophotometer (also C/2°). Values obtained for a single reading are provided below.

Instrument	X	Y	Z
D25A	81.03	83.13	98.22
ColorQuest 45/0	82.70	84.85	99.48
Multiplication Factor	1.021	1.021	1.013

The actual values obtained for the multiplication factors are very close to those expected.

We know that these statements are true for HunterLab colorimeters and spectrophotometers. (If you have further questions concerning your particular model, refer to the Certificate of Traceability shipped with the instrument.) However, the calibration bases for other brands of instruments is unknown. If attempting to compare measurements made on instruments produced by other manufacturers, be sure to establish what calibration procedures are being used.

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