

Raymond Cheydleur
Global OEM Technical Manager, X-Rite Inc.
Kevin O'Connor, Color Consultant

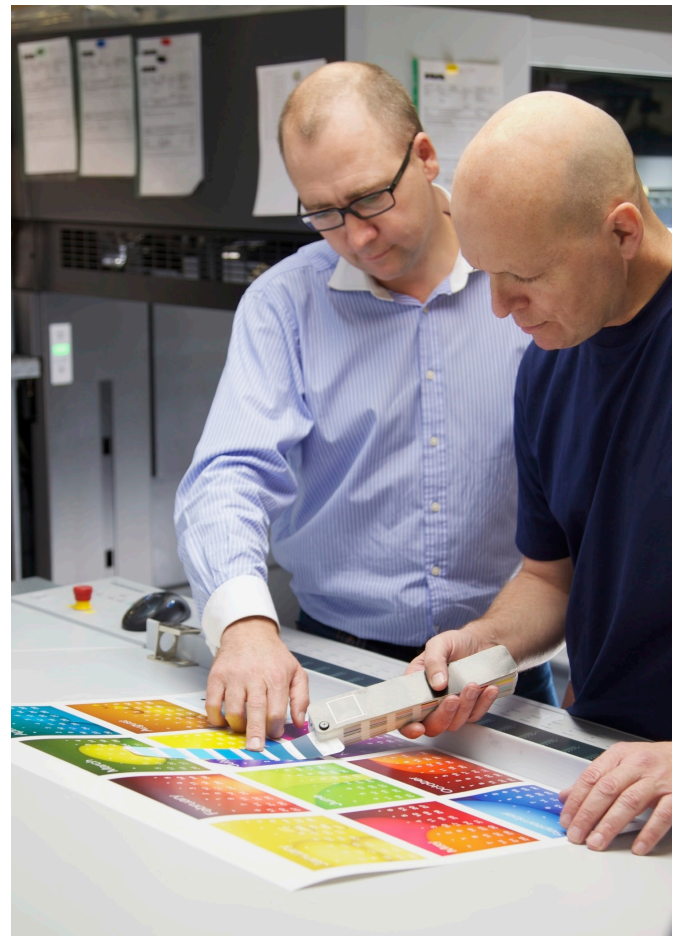
Return of the M Standards

Recent advances in technology have given companies in the graphic arts some effective new tools to accurately gauge how the addition of Optical Brightening Agents (OBAs) and Fluorescing agents to papers and inks will affect finished printed products. During the past decade, the paper industry embraced the use of OBAs to enhance the brightness of the papers and improve the appearance of their products, but color printing standards lagged behind providing simple and practical ways to verify these effects. With new standards now in place, the color measurement industry has responded to the challenge with instruments that offer appropriate solutions to meeting ISO13655, ISO 12647-2 and/or ISO/DIS 15339-1.2. standards, as well as an easy-to-use system to faithfully communicate color and appearance data called Color Exchange Format (CxF).

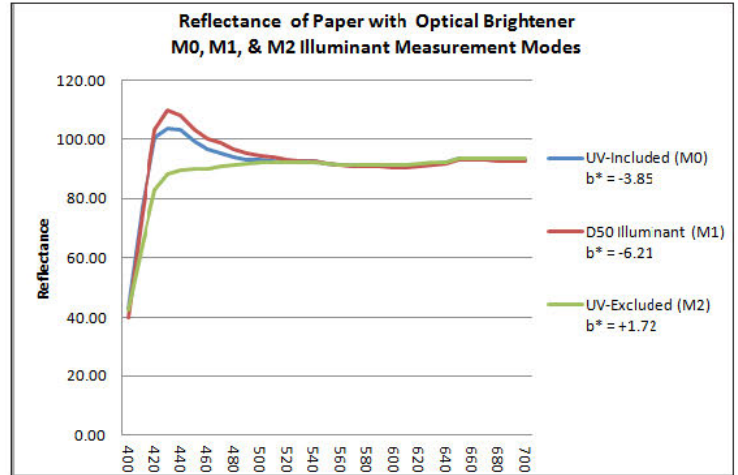
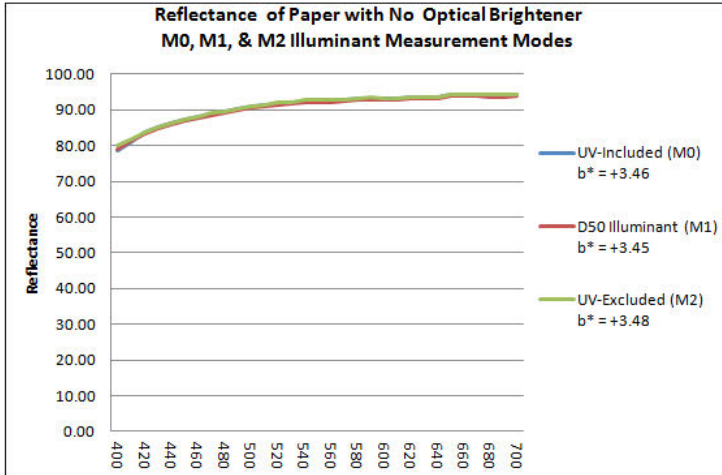
Introduction

OBAs operate through the process of fluorescence. They absorb invisible ultraviolet (UV) radiation at wavelengths below 400 nanometers (nm) and, through an electro-physical change, emit light mostly in the blue end of the visible spectrum at about 400 to 450 nm. When this light is emitted from papers using brightening agents, they are perceived as having a color that is "whiter than white," since the observed light from the paper will be the total of the reflected and emitted (due to fluorescence) light when illuminated by a source containing a large UV component. The effect is clearly evident when a paper containing brightening agents is illuminated with an ultraviolet light source, such as a "black" light.

The perceived color of a piece printed on a substrate containing OBAs will look different, depending on whether the light source used to view the print contains UV or not. Older graphic arts standards specified D50. Density standards required Illuminant A. To facilitate both use cases Illuminant A (incandescent light which does not contain much UV) was commonly used for both use cases. It was assumed that all substrates would measure the same because OBA content was not then a concern. In practice, colors viewed under real viewing conditions which contain more UV than Illuminant A sometimes were notably mismatched, and failed to meet expectations. These mismatches created serious challenges for people trying to measure and manage color consistency in a variety of workflows.



Effects of Illumination Conditions



New Technologies, New Papers and New Standards

New illumination sources, including light emitting diodes (LEDs), allow handheld color measurement instruments to measure with well-defined and controlled UV illumination components. To ensure consistency, new illumination sources and new substrates required new instrument and measurement standards for defining and measuring the relative UV content, and thus the degree of fluorescence of substrates containing OBAs. Further, companies found that they needed to apply standards to the UV component in the illumination of lighting systems that they used for the visual assessment of color to ensure correlation between printing facilities. For this reason the viewing standard, ISO 3664 was updated in 2009 to tighten the acceptable range of UV in the source, effectively increasing it. Defining and controlling the emitted UV component of the measuring device's illumination is essential to defining standard ways to measure and manage color printed on OBA-enhanced substrates.

X-Rite has always been at the forefront of advocating and helping to design standards for this evolving industry, and has continually advocated the concept of printing to standards. Factors driving this evolution include technology advancements, increasing distribution of information across different media, and the need to improve efficiency, productivity and profitability of print providers and their supply chain partners.

A New Series of Measurement Conditions Defined

As part of [ISO 13655-2009: Spectral Measurement and Colorimetric Computation for Graphic Arts Images](#), a new measurements standards "M" series of measurement illumination conditions has been defined by the International Organization for Standardization (ISO) to standardize illumination conditions appropriate for different applications when substrates contain brightening agents. The new M series allows color management of OBA-enhanced substrates to be further refined to a very high degree.

The need for the M series is driven by the color changes seen in materials containing OBAs when viewed with different light sources. The graphs above demonstrate the effects of three different illumination conditions on the same paper with and without optical brighteners. The amount of change between the three illuminants on papers with brightening agents, as shown in the second graph below, would result in an unacceptable match in many workflows and to many clients in the graphic arts.

In order to minimize this measurement variability, and to provide a way to communicate the illumination source used for measurement, a new notation of measurement illumination conditions was developed for inclusion in ISO 13655. It defines four distinct measurement illumination conditions. This notation also addresses other measurement parameters such as polarization.



The “M” standards, as they have been named, are designed to take into consideration the conditions listed below.

Measurement Illumination Condition M0

While it has historical significance as once being the most widely used standard, measurement condition M0 was superseded this year by measurement condition M1, which is now regarded as the preferred method of measuring OBA-enhanced substrates and imaging or proofing colorants. M0 was deprecated because it is limited in its definition and is not fully defined either the measurement illuminant condition or the UV content of the source. Thus, ISO 13655 specifies that M0 is not recommended for use when measured sheets exhibit fluorescence and there is a need to exchange measurement data between facilities. The standard notes that when instruments meeting M1 are not available, and relative data are sufficient for process control or other data exchange applications, M0 instruments of like manufacturer and model provide a viable alternative. This provision helps ensure that the existing population of instruments is not immediately called into question and can continue to be used in many workflows.

Measurement Illumination Condition M1

Starting this year, companies worldwide that use ISO 12647-2 and/or ISO/DIS 15339-1.2. as their standards for printing aims are required to use M1 as their first resource, and M0 is either not allowed or is considered the secondary option. Further, the widespread acceptance of M1 as the preferred standard has caused many companies to rethink their view of color measurement as discrete tasks in their processes and begin to embrace color measurement as a system. Measurement illumination condition M1 was defined to reduce variations in measurement results between instruments due to fluorescence, either by optical brighteners in paper or fluorescence of the imaging colorants or proving colorants. M1 (Part 1) specifies that the spectral power distribution of the light source used to measure the specimen should match CIE Illuminant D50. M1 also defines a second (Part 2) method for achieving M1 compliance that is valid for measuring optically brightened papers, but not for measuring inks or toners that fluoresce.

M1 Part 2 only requires that compensation method is used with a controlled adjustment of the amount of UV component (spectral region below 400 nm) used to measure. This is to provide correlation to the D50 illumination conditions as defined in ISO 3664:2009 viewing standard. Since M1 exists as part of a color measurement system, companies also need to be aware that their lighting systems for the visual assessment of color must be updated to reflect the new measurement condition, particularly if they want to produce valid comparisons with customers.

Measurement Illumination Condition M2

For the first time, an ISO standard defines what UV exclusion (variously known as UV-cut, No UV or UV filtered) should be in a measurement tool. M2 also provides a test to ensure compliance to the standard. Instrument manufacturers now have a defined way to provide agreement when customers require an instrument that does not contain UV, which improves consistency and precision in communicating color data. X-Rite developed its X-Rite Graphic Arts Standard (XRGA) to reduce differences in calibration standards and ensures that all new UV-cut products meet this definition.

Measurement Illumination Condition M3

M3 defines the effect of polarization. In essence, M3 requires the UV restricted properties of M2 and adds a definition of polarization. Polarization is used in certain measuring instruments to remove or minimize reflections. Polarization is usually accomplished by choosing a polarization function or adding an optional manufacturer specific polarizing filter. Through the use of XRGA, X-Rite helps ensure that its instruments offering M3 mode (polarization filter) provide a UV level that is compliant with the new standard.





Suggested Use Cases

	MO	M1 ₁	M1 ₂	M2	M3
Measure effect of OBAs		✓	✓		
Measure ink fluorescence		✓			
Measure non-OBA stock	✓	✓	✓	✓	
Cut the effect of OBAs				✓	✓
Cut first surface reflections					✓
Agree on M standard for use in exchanging data prior to measurement	When using any M standard to exchange data, it is essential to agree on a particular M standard measuring data.				

Application and use of M0, M1, M2 and M3

In theory, the cases where each of these measurement illumination conditions are used are relatively clear:

- M0 is for any use where neither substrate nor imaging colorants fluoresce.
- M1, Part 1, is intended for use when either substrate or imaging colorants, or both may fluoresce.
- M1, Part 2, is designed for use when a substrate may fluoresce, the fluorescing characteristic needs to be captured, and the user is confident that the imaging colorants do not fluoresce. (When in doubt, consulting with the ink manufacturer is recommended.)
- M2 is for use when the paper fluoresces, but there is a desire to eliminate this effect from the measurement data.
- M3 is for special use cases where first surface reflections should be minimized, including the use of polarization to do so.

The application of the measurement illumination conditions is more straightforward now than in past years, now that new standards and specifications clearly stipulate that M1 is to be used as the first choice.

Important Factors to Consider

Companies that are trying to hit standardized values, "print to the numbers," or meet customer supplied values need to understand the source of the values. Density values are less affected by illuminant conditions, but differences will result when measuring paper and other non-solid ink colors. Changes will be significant for different Status (T, E) responses and/or when a polarizer (M3) is added. When exchanging data, it will be just as important to note the measurement illumination condition (M0, M1, M2, M3) and the colorimetric computation method (e.g. D50/2, D65/10) as the density status.

X-Rite is working with ISO to define a more complete method to exchange measurement data using the Color Exchange Format (CxF) format, and the company is providing a path for customers to convert their legacy instruments to X-Rite devices.

These technologies are designed to help minimize X-Rite device portfolio variability as well as standardize the file format used to communicate digital color data. The products that X-Rite has delivered embody these technologies to help customers better utilize measurements made using the new ISO measurement illumination conditions (M0-M3).



X-Rite Graphic Arts Standard (XRGAs)

X-Rite and the former GretagMacBeth have taken great care over their histories to provide tools that meet their customers' requirements and conform to ISO standards. Since the merger between the two companies, X-Rite has responded to differences in the calibration standards used in the legacy product lines. Traditionally each company maintained its own traceable calibration standards and processes. Since these differences can represent issues for its customers that use multiple measurement instruments or need to exchange data, X-Rite developed XRGAs, a new corporate X-Rite factory calibration standard for graphic arts instruments. It includes new advances in color technology and changes required to meet ISO-13655. It is the goal of X-Rite to ensure that its portfolio is optimized so that all customers – regardless of their legacy affiliation – can enjoy high quality data exchange and workflows that use different instrumentation. The X-Rite Graphic Arts Standard (XRGAs):

- incorporates best in class methods for calibration
- maintains traceability to the National Institute of Standards and Technology (NIST)
- is compatible with respect to existing standard ISO 13655
- improves inter-model agreement for existing instruments
- preserves agreement among former X-Rite instruments and former GretagMacbeth instruments
- provides a single standard for all future graphic arts instruments to be delivered by X-Rite

New graphic arts instruments from X Rite ship in compliance with XRGAs, and existing graphic arts instruments will be compliant with XRGAs as soon as they have been returned to X-Rite for the recommended annual recertification.

For more information on XRGAs: http://www.xrite.com/product_overview.aspx?ID=1336

L7-462 XRGAs Whitepaper: http://www.xrite.com/documents/literature/en/l7-462_XRGAs_Whitepaper_FINAL_en.pdf

CxF3

CxF3 provides an XML -based color specification mechanism that is comprehensive, flexible and applicable to any industry where faithful communication of color and appearance data is critical.

CxF takes advantage of the openness and universal acceptance of XML (eXtensible Markup Language) and therefore can be seamlessly integrated into any workflow. Through the use of XML, CxF presents self-identifying color data and enables a flexible communication mechanism. CxF is able to integrate data from other color communication methods, including ICC color profiles, Density, CIE-Lab, XYZ, RGB, CMYK, PANTONE, RAL, NCS, Toyo, HKS, etc. The first ISO standard using CxF is about to be published: ISO 17972-1 Graphic technology — Colour data exchange format — Part 1: Relationship to CxF3 (CxF/X) This is the first of four ISO standards using CxF.

Conclusion

X Rite continues to support new standards for the graphic arts industry as they are defined and evolved. In doing so, the company helps its customers rise to new levels of quality and prosperity.

About the Authors

Ray Cheydleur is chairman of the Committee for Graphic Arts Technology Standards (CGATS) accredited by ANSI, as well as chair of CGATS SC3, Metrology and Process Control. Ray also participates in the US delegation to the ISO on Graphic Arts and Photographic Standards. He has worked in the field of photo, printing and process control for more than 30 years, currently serving as Global OEM Technical Manager at X-Rite.

Kevin O'Connor, a principal at Make Color Behave in San Luis Obispo, Calif., has wrestled with color for more than 40 years as a photographer, designer, product manager, speaker and educator. He brings his Irish wit and love of language to his passion – communicating complex color concepts in ways that can be understood.

Acronym List

CGATS: Committee for Graphic Arts Technologies Standards

CxF: Color Exchange Format

D50: Daylight, 5000°K

ISO: International Organization for Standardization

LED: Light emitting diodes

M: Measurement Mode

nm: Nanometers

UV: Ultraviolet

XML: Extensible Markup Language

XRGAs: X-Rite Graphic Arts Standard