**ASTM Report to CIE Division 8 - April 2000**

## 1. ASTM

Organised in 1898, ASTM (the American Society for Testing Materials), is one of the largest voluntary standards development organisations in the world. More than 10,000 ASTM Standards are published each year in the 73 volumes of the *Annual Book of ASTM Standards*. ASTM develops six principle types of full-consensus standards:

- Standard Test Method - a definitive procedure for the identification, measurement and evaluation of one or more properties of a material, product, system, or service that produces a test result.
- Standard Specification - a precise statement of a set of requirements to be satisfied by a material, product, system or service that also indicates the procedure determining whether each of the requirements is satisfied.
- Standard Practice - a definitive procedure for performing one or more specific operations or functions that does not produce a test result.
- Standard Terminology - a document composed of terms, definitions of terms, descriptions of terms, explanations of symbols, abbreviations, or acronyms.
- Standard Guide - a series of options or instructions that do not recommend a specific course of action.
- Standard Classification - a systematic arrangement or division of materials, products, systems, or services into groups based on similar characteristics such as origin, composition, properties, etc.

The work of ASTM is currently carried out by 32,000 volunteer members, from more than 100 countries, who serve on 129 technical committees that are devoted to specific areas of interest.

## 2. ASTM COMMITTEE E12 – COLOR AND APPEARANCE

### 2.1 SCOPE

To promote knowledge of appearance properties and characteristics, and to encourage the improvement and development of standards for describing and evaluating the appearance properties (such as color gloss opacity, and texture) of engineering materials by:

a. The stimulation and sponsoring of research into appearance problems.
b. Formulating terms, nomenclature, and definitions generally applicable for describing the appearance of engineering materials.
c. Developing, or coordinating with technical committees, standards methods, recommended practices for measurement of fundamental and genera! appearance properties.
d. Assisting the technical committees to improve appearance standards by advice, suggestions, and dissemination of information.
e. Reviewing and recommending approval or revision of ASTM standards, existing or proposed, involving appearance factors.
f. Serving, with the approval of the ASTM Board of Directors, as liaison agent between the Society and other organizations in matters concerned with factors of appearance.

2.2 OFFICERS 1999-2000

| | | |
|---|---|---|
| Chairman | Robert Marcus | (Datacolor International) |
| Vice-Chairman | Richard Harold | (Graphic Arts Technical Foundation) |
| Recording Secretary | Robert Austin | (Quikset) |
| Membership Secretary | Kenneth Uding | (Stimsonite) |
| Staff Manager | Bode Buckley | (ASTM) |
| Administrative Assistant | Lisa Drennen | (ASTM) |

2.3 E12 SUB-COMMITTEES

There follows a list of the E12 sub-committees together with their chairmen and affiliations: I am a member of those sub-committees marked with an asterisk(*).

| | | | |
|---|---|---|---|
| E12.01* | Terminology | John Setchell | Eastman Kodak |
| E12.02* | Spectrophotometry and Colorimetry | Jack Ladson | Estee Lauder |
| E12.03* | Geometry | Cal McCamy | |
| E12.04* | Color and Appearance | Danny Rich | Sun Chemical |
| E12.05 | Fluorescence | David Burns | 3M |
| E12.06* | Appearance of Displays | Jonathan Hardis | NIST |
| E12.07 | Color Order Systems | Robert Marcus | Datacolor International |
| E12.08 | High Visibility Materials | Gary Lesley | |
| E12.10 | Retroreflection | Al Heenan | |
| E12.11* | Visual Methods | Nick Hale | Hale Color Consultants |
| E12.12* | Measurement of Metallic and Pearlescent Colors | Allan Rodrigues | DuPont |
| E12.13 | Photoluminescent Safety Markings | Marina Batzke | |
| E12.14* | Multidimensional Characteristics of Appearance | Paul Tannenbaum | DuPont |

## 3. E12 SUB-COMMITTEE REPORTS

Each sub-committee has a number of test methods, practices and guides assigned to it. In the section below work in progress is reported (in italics), based on attendance at, and/or the minutes of, the most recent meeting. It is not possible to attend all sub-committee meetings because of parallel sessions. In particular those concerned with retroreflectors, high visibility materials and fluorescence and are held in parallel with the more traditional subjects.

### E12.01 Terminology

John Setchell (Eastman Kodak)

Scope: The development of terminology and definitions of terms and symbols; and the insurance of uniformity of usage in these matters and conformance with Society recommendations.

E0284 1999 Terminology of Appearance John Setchell

WG1 Terms relating to perception Nick Hale

WG2 Terms relating to gonioappearance Allan Rodriguez
WG3 Terms relating to calibration John Setchell
WG5 Terms relating to precision and bias Jack Ladson
WG6 New terms John Setchell
*Terms from ISO 3664 (Viewing conditions) are to be considered. Aspecular angle and anormal angle are to be proposed for measurement angles relative to the specular and the normal respectively. The definitions will include a direction (±) for the angle.*
WG7 Terms relating to fluorescence David Burns
*New terms relating to measurement will be coming from E12.05. The appearance of fluorescent materials is lacking from the terminology document. It may be too soon, however, to define suitable terms.*
WG on revision of CIE Document 17.4 John Setchell
*The CIE Division 1 contribution to the revision of the ILV has now been passed to CIE Division 2 for comment, and circulated to all national committees for voting: cut-off date 15-Dec-99.*
WG on reference to other standards in E284 Ellen Carter
*On going work - liaison with ISO, CIE, ASTM, IEC, ANSI and TAPPI required.*

New Business
*There are problems with the terms phosphorescence and photoluminescence in the E12.13 standards. The terms spectrocolorimeter and spectrophotometer need revising because of the advent of new instrument types. The problem is that some instruments measure regularly-based spectral data and then calculate colorimetry - spectrophotometers. Others measure the spectral data, but only report the subsequently calculated colorimetry - spectrocolorimeters. There is now a third type of instrument that samples the spectrum, interpolates the data to be regularly spaced and then calculates colorimetry. A name is required for these latter instruments. There was also some discussion on using the term spectrometer instead of spectrophotometer. The former better describes the actual measurements made because no recourse is made to the visual response function.*

**E12.02 Spectrophotometry and Colorimetry**

Jack Ladson (Estee Lauder)

Scope: The development of methods of test and practices for spectral characteristics of color.

| | | | |
|---|---|---|---|
| E0259 | 1997 | Standard Practice for Preparation of Pressed Powder White Reflectance Factor Transfer Standards for Hemispherical Geometry | Danny Rich |
| E1164 | 1994 | Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation | Danny Rich |
| E1331 | 1996 | Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry | Hugh Fairman |
| E1347 | 1997 | Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry | John Setchell |
| E1348 | 1990 | Standard Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry | Yvonne Barnes |
| E1349 | 1990 | Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry | Norbert Johnson |

| | | | |
|---|---|---|---|
| E1477 | 1998 | Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating Sphere Reflectometers | Bill Beakes |
| E1651 | 1994 | Standard Test Method for Total Luminous Reflectance Factor by use of 30/T Integrating Sphere Geometry | Jerry Popson |
| Draft | | Guide for Reflectance and Transmittance of Translucent Materials | Nick Hale |

*There was much discussion about the sub-committee's documents in that many are standard methods but should, perhaps, take on the form of more generic standard practices. A major difference is that methods, being application specific, require a statement on the precision and bias of the measurements whereas practices do not. It was argued that the job of E12 was to provide users with documents describing good practice. It was then up to the user to take the practice guides and write their own application specific standard methods. As a result of the discussion it was agreed that Standard Methods E1331, E1348 and E1349 should be withdrawn and replaced by a revised Standard Practice E1164 for measuring colour by spectrophotometry.*

**E12.03 Geometry**

C S McCamy

Scope: The study and description of the geometry of appearance, including gloss, luster, haze, texture, turbidity, and directionality, and the development of methods of test and practices for analyzing geometric properties and appearance attributes of objects and materials.

| | | | |
|---|---|---|---|
| E0167 | 1996 | Standard Practice for Goniophotometry of Objects and Materials | Paul Tannenbaum |
| E0179 | 1996 | Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials | Hugh Fairman |
| E0312 | 1996 | Standard Practice for Description and Selection of Conditions for Photographing Specimens | Cal McCamy |
| E0429 | 1991 | Standard Test Method for Measurement and Calculation of Reflecting Characteristics of Metallic Surfaces Using Integrating Sphere Instruments | |
| E0430 | 1997 | Standard Test Method for Measurement of Gloss of High Gloss Surfaces by Goniophotometry | Richard Harold |
| E1767 | 1995 | Standard Practice for Specifying the Geometry of Observations and Measurements to Characterize the Appearance of Materials | Cal McCamy |

*E1767 Being revised by Cal McCamy.*
*E0167 Requires minor amendments before balloting next year.*
*E0312 Requires minor amendments before balloting next year.*
*E0430 It was suggested that this document be moved to a Practice when next revised.*

*Nick Hale is looking into writing, or have written, a guide to reflection and transmission measurements of translucent materials.*

*Cal McCamy tabled a draft standard practice for specifying the geometry of multi-angle spectro-photometers. This includes the GretagMacbeth, the X-Rite and the Minolta geometries. The document is complete and will now move to voting.*

**E12.04 Color and Appearance Analysis**

Danny C. Rich (Sun Chemical)

Scope: To develop and maintain standards leading to the numerical description of color and appearance including general procedures for appearance analysis, computational methods, color specification, color difference, data handling and issues of uncertainties.

| | | | |
|---|---|---|---|
| E0308 | 1999 | Standard Practice for Computing the Colors of Objects by Using the CIE System | Danny Rich |
| E0313 | 1997 | Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates | Richard Harold |
| E0805 | 1994 | Standard Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials | Ellen Carter |
| E1345 | 1990 | Standard Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements | Danny Rich |
| E1708 | 1995 | Standard Practice for Electronic Interchange of Color and Appearance Data | Hugh Fairman |
| E2022 | 1999 | Standard Practice for Calculation of Weighting Factors for Tristimulus Colorimetry | Danny Rich |
| Z6899Z | | Standard Practice for Specifying and Verifying the Performance of Colorimeters, Spectrocolorimeters and Goniospectrocolorimeters | Danny Rich |

TG1 ?

TG2 Interpolation of illuminant data James Lelant

*This issue is difficult to resolve. The suggestion has been made that it would be better to use 1nm data for the illuminant and the observer, and then interpolate the reflectance data for calculation. This should minimise the error.*

*E0308 A new version is now available.*

*E0313 Contains errors and therefore needs revision.*

*E0805 Needs some revision, including a title change.*

*E1708 Needs some revision.*

*Z6899Z There was much discussion on terminology - some of it already covered in the report for Sub-Committee 12.01. It was agreed that comparison between instruments of the same type would be known as inter-instrument, and comparison between different models as inter-model. This will be added to the document Z6889Z which should now pass ballot.*

## E12.05 Fluorescence

David M. Burns (3M)

Scope: To develop standards describing the measurement, terminology, calibration and instrument procedures for measuring materials exhibiting fluorescence.

| | | | |
|---|---|---|---|
| E0991 | 1998 | Standard Practice for Color Measurement of Fluorescent Specimens | David Burns |
| E1247 | 1992 | Standard Test Method for Identifying Fluorescence in Object-Color Specimens by Spectrophotometry | David Burns |

TG 1 Two monochromator methods
TG 2 Guide to fluorescence
TG 3 Assessing daylight simulators Cal McCamy
*Concerned that the current CIE method is for use in assessing the light sources used to simulate daylight spectral power distributions. What is required is a method of assessing the effect of the actual light source used on the spectral irradiance of a test of test colours where the excitation may come from the ultra-violet and/or the visible part of the spectral. The major difficulty is the provision of suitable stable, fluorescent, standards for making the evaluations. It is important that any proposed method should handle coloured samples as well as whiteness.*

## E12.06 Appearance of Displays

Jonathan Hardis (NIST)

Scope: The development of standard measurement methods, practices, and terminology pertaining to the appearance, performance modeling, and special characteristics of display devices (such as cathode ray tubes, flat panel displays, and photographic imaging systems) and coordinating such activities with other organizations having similar interests.

| | | | |
|---|---|---|---|
| E1336 | 1996 | Standard Test Method for Obtaining Colorimetric Data from a Visual Display Unit by Spectroradiometry | |
| E1341 | 1996 | Standard Practice for Obtaining Spectroradiometric Data from Radiant Sources for Colorimetry | |
| E1455 | 1997 | Standard Practice for Obtaining Colorimetric Data from a Visual Display Unit using Tristimulus Colorimeters | Jonathan Hardis |
| E1682 | 1996 | Guide for Modelling the Colorimetric Properties of a Visual Display Unit | |

*This sub-committee had not met for some years and the chairman started a discussion on the immediate needs of those who require measurements from visual displays. It transpired that one of the requirements was a test method to enable those in the reproduction industries to make accurate and precise colour measurements from visual displays (CRTs and those using more recent technologies, for example, LCD and gas plasma) for use in generating profiles for colour management systems. This will be pursued.*

## E12.07 Color Order Systems US TAG TC 187

Robert I Marcus (Datacolour International)

Scope: To develop and maintain test methods, practices and guides relating to the use of color order systems and determining the notations of colors in respect to various color order systems To serve as an advisory group to other organizations with an interest in color order systems.

| | | | |
|---|---|---|---|
| D1535 | 1997 | Standard Practice for Specifying Color by the Munsell System | Robert Marcus |
| E1360 | 1995 | Standard Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System | Robert Marcus |
| E1541 | 1998 | Standard Practice for Specifying and Matching Color Using the Colorcurve System | Robert Marcus |

*D1535 No action required.*
*E1360 Requires reapproval. Requires some editorial changes. Also a possibility of adding a mention of software available to interpolate OSA colour parameters.*
*E1541 No action required.*

*It is anticipated that ISO TC187 will be disbanded.*

**E12.08 High Visibility Materials for Individual Safety**

Gary M Lesley

Scope: The promotion of knowledge, stimulation of research, and development of standard definitions, durability and visibility test methods, recommended practices, and user classification, and performance specifications for non self luminous high-visibility apparel and accessories used to improve the conspicuity and resultant safety of people and animals.

| | | | |
|---|---|---|---|
| E1501 | 1992 | Specification for Nighttime Photometric Performance of Reflective Pedestrian Markings for Visibility Enhancement | David Engler |
| E1896 | 1997 | Specification for Daytime Pedestrian Visibility Enhancement | David Engler |
| F0923 | 1994 | Guide to Properties of High Visibility Materials Used to Improve Individual Safety | Fred Billmeyer |

TG 1 High visibility

**E12.10 Retroreflection**

Al Heenan

Scope: The study and description of the geometric and spectral properties of retroreflection and the development of methods of tests and practices for analysis of retroreflection properties.

| | | | |
|---|---|---|---|
| D4061 | 1994 | Standard Test Method for Retroreflectance of Horizontal Coatings | |

| | | | |
|---|---|---|---|
| E0808 | 1999 | Standard Practice for Describing Retroreflection | Dennis Couzin |
| E0809 | 1994 | Standard Practice for Measuring Photometric Characteristics of Retroreflectors | Fred Billmeyer |
| E0810 | 1994 | Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting | |
| E0811 | 1995 | Standard Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions | Fred Billmeyer |
| E1696 | 1995 | Standard Test Method for Field Measurement of Raised Retroreflective Pavement Markers Using a Portable Retroreflectometer | Allan Heenan |
| E1709 | 1995 | Standard Test Method for Measurement of Retro-reflective Signs Using a Portable Retro-reflectometer | Dennis Couzin |
| E1710 | 1997 | Standard Test Method for the Measurement of Retro-reflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retro-reflectometer | Dennis Couzin |
| E1743 | 1996 | Standard Practice and Use of Portable Reflectometers for the Measurement of Pavement Marking Materials | Allan Heenan |
| E1809 | 1996 | Standard Test Method for Measurement of High Visibility Retroreflective Clothing Marking Material Using a Portable Retroreflectometer | David Engler |

TG 1 Retroreflective pavement markings
TG 2 Retroreflective sheeting measurements

**E12.11 Visual Methods**

William N Hale (Hale Color Consultants)

Scope: The scope of the subcommittee shall be to examine appearance attributes of materials which do not currently lend themselves to instrumental evaluation, and to derive visual methods by which these characteristics can be objectively described.

Included in this scope shall be the development of standards related to characteristics of observers, specification of light sources not elsewhere specified, illuminating and viewing geometry and other conditions concerned with visual evaluation of materials.

| | | | |
|---|---|---|---|
| D1729 | 1989 | Standard Practice for Visual Evaluation of Color Differences of Opaque Materials | Cal McCamy |
| D2616 | 1996 | Standard Test Method for Evaluation of Visual Color Difference With a Gray Scale | |
| D3134 | 1997 | Standard Practice for Establishing Color and Gloss Tolerances | Jack Ladson |

| | | | |
|---|---|---|---|
| D4086 | 1997 | Standard Practice for Visual Evaluation of Metamerism | Fred Billmeyer |
| E1478 | 1997 | Standard Practice for Visual Color Evaluation of Transparent Sheet Materials | Murrey Stewart |
| E1499 | 1997 | Guide to the Selection, Evaluation and Training of Observers | Fred Billmeyer |
| E1808 | 1996 | Guide to the Designing and Conducting of Visual Experiments | Fred Billmeyer |
| Z6606Z | | Standard Practice for Selecting and Calibrating Sources for the Visual Assessment of Object Colors | |
| Z6607Z | | Standard Test Method for Assessing the Quality of Sources for the Visual Assessment of Object Colors | |

*James Worthey presented some new ideas on the derivation of a colour rendering index. Cal MaCamy described progress towards a method for grading illuminants in viewing booths. This involved the derivation of metamers for CIE Illuminants A and F2 (Cool white fluorescent). Bill Thornton described progress on the derivation of a new set of colour matching functions. This work has been carried out to overcome apparent problems with the CIE colour matching functions whereby a lamp which is perceived as white and whose spectral power distribution contains only peaks at approximately 550 and 650 nanometres computes to be a green, relative to daylight. Refer to the work published in Color research & Application, and the distributed papers, for more details. Richard Harrold gave a progress report on the round-robin being conducted of the use of the Japanese colour apptitude test. Results are expected by the next meeting.*

### E12.12 Measurement of Metallic and Pearlescent Colors

Allan Rodrigues (DuPont)

Scope: Not stated

| | | |
|---|---|---|
| Draft 7 | Standard Test Method for Multiangle Measurement of Metal Flake Pigmented Materials | Jack Ladson |

*Gerhard Rosler reviewed the progress with draft standard DIN FNF 24, part of DIN 6175-2, 'Colour tolerance for car paints' which should be published by March 2000. 25, 45, 75, 110 degree measurement is included but 15 degree (favoured in the US) is not. Angle of incidence is always 45 degree. Tolerances are given for both measured and calculated colour values. Tolerances are for lightness, chroma (with a lightness dependence), hue( with a lighness, chroma dependence). Tolerances are also a function of the aspecular angle. These tolerances utilise a new colour difference formula to allow for the angular dependence.*

*Mike Pointer: Running a project at NPL to start reviewing the measurement of appearance: the project has 9 industrial/academic partners. Writing a state-of-the-art review of multi-angle spectrophotometry and gloss measurement. The report will include a comparison of results from X-Rite, GretagMacbeth, Minolta, Perkin Elmer Lambda 19 + Labsphere, Murakami made using a set of 39 samples. These include car panels, knitted fabrics, plastics, and fabrics. Gloss meters and distinctness of image meters may also be included. Work is also be carried out at the University of Leeds to investigate optimum viewing conditions for viewing colour difference between car panels and comparing visual results*

*with measurements.*

*Mary McKnight, Maria Nadel: NIST project on colour and appearance looking at links between micro-structure of materials, reflection (BRDF) properties and appearance properties. Work is majoring on modelling the physics, and applications to computer imaging.*

*Status of committee work - Cal McCamy*
*Draft of standard practice for specifying geometry of multi-angle spectrocolorimeters - work carried out in E12.03.*

*Pearlescence - What to do? Two presentations.*
*John Book (Flex Products Inc. - Chromaflair), Colour Measurement of Interference Pigments.*
*Paul Hofman (EM C&P Division - Automotive Products, Division of Merck KGaA, Darmstadt, Germany) Afflair Range of Pigments.*

*The measurement problems were obvious from these two presentations. Call for proposal to do work to settle this issue and define the measurement problem and potential solutions.*

*Draft 8 - Standard Test Method for Multi-Angle Color Measurement of Metal Flake Pigmented Materials - Jack Ladson*

E12.13 Photoluminescent Safety Markings

Marina Batzke

Scope: Not stated

| | | |
|---|---|---|
| Z6374Z | Specification for Photoluminescent (Phosphorescent) Safety Markings | Marina Batzke |
| Z6816Z | Guide for Recommended Uses of Photoluminescent Safety Markings | Marina Batzke |

E12.14 Multidimensional Characteristics of Appearance

Paul Tannenbaum

Scope: Not stated

*Paul described a round-robin experiment where different groups were asked to use instruments available to them for the measurement of surfaces. The samples are the ACT Technologies set of varying orange peal. Instruments used include the BYK-Gardner glossmeter, the BYK-Gardner wavemeter, and others. Visual assessment was carried out by Edgar Chambers of Kansas State University using a panel of skilled observers and a second panel of 100 non-skilled, but trained, observers. Correlation was found between some scaled variables and some measured parameters. Distinction of image (DOI) is coming out as a good correlate of some visual scales.*

*A second set of panels was suggested that consist of sprayed black metal, coated with an overcoat containing various amounts of a scatterer. The committee is not concerned with the use of pigment types, e.g. metallic or pearlescent, and not concerned, at least for the time being, with colour; hence the choice of black. It was suggested that white might make a suitable choice for future work.*

*Funding must be found In order to progress this work. Mention was made of the Optical Properties of Materials Group at NIST who are interested in this type of work and have industrial collaborators.*

*It was hoped in the future to extend the work beyond car panels to skin, carpets, textiles etc.*