



# Metamerism and Illuminants



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## Introduction

Apparel production is a complex process, where the finished product is a mixture of various materials. Colour matching all these materials is important to meet the needs of the final consumer.

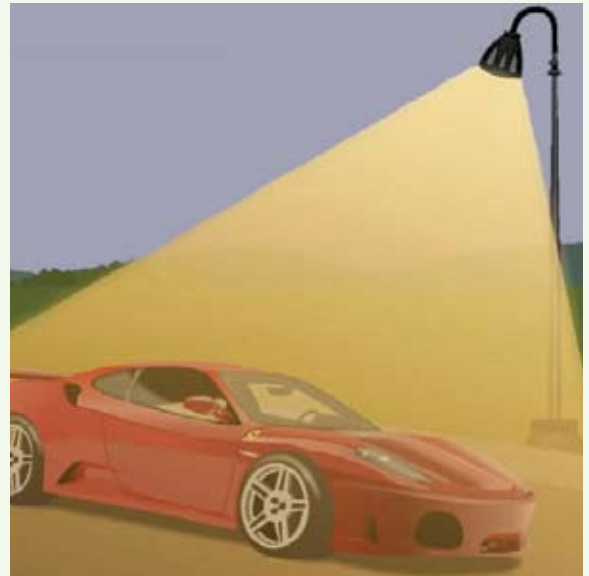
The supply chain consists of many different stages and whilst a garment may pass colour matching at one stage of the distribution, there might be a difference in shade observed at another stage. This is because of the condition of metamerism.

This technical bulletin will explain how you can reduce the effects of metamerism by adopting standard illuminants and colour matching cabinets to assess colour.

## What is Metamerism?

Metamerism is a scientific description of a common colour phenomenon where two colour samples which appear to match under one light source, no longer match when viewed under a different light source.

The colour of an object will appear to vary depending on the light source which is used to illuminate it. For example, you park your bright red car at the roadside in daylight. Darkness falls and although you would still say you have a red car it may well appear to be brown under sodium lighting. This phenomenon is known as metamerism.



## Kinds of Metamerism

Metamerism changes from one viewing condition to other. Several kinds of metamerism exist:

- **Illuminant Metamerism** means an object may match under a certain illuminant to a certain observer, but appear as a different colour under a different illuminant
- **Observer Metamerism** is caused by a difference in colour vision between observers; it is highly subjective and cannot always be avoided. However by proper selection and training of colourists the risk can be reduced
- **Geometric Metamerism** can be controlled by viewing the samples at the same distance from the observer and at the same (45 degree) angle to the light source

The next few sections will describe illuminants.

## Importance of Light in Metamerism

The energy of the light source used by the observer to view a product is the most important factor affecting its appearance and in metamerism. The two major factors that influence what we see are:

- The amount and quality of light illuminating an object
- Colour of the background against which an object is viewed

Accurate visual perception depends on the light source being a 'controlled' source, where the colour properties and quality is defined such as in a standard matching cabinet.

## What are Illuminants?

An illuminant is a theoretical source of visible light with a profile which is published. In general, the illuminant values are a measurement of the spectral energy distribution of an artificial temperature radiator that radiates heat with a specific colour at the defined temperatures of the light source, unit [K].

## What is the difference between a light source and an illuminant?

- Illuminants have standard values which never vary, while the energy of a light source can vary
- A light source is a physical emitter of radiation, such as a candle, a tungsten bulb and natural daylight, while an illuminant is the theoretical representation of the light source
- All light sources can be specified as an illuminant, but not all illuminants can be physically realised as a light source

## Different Industrial Illuminants

| Illuminant Designation                  | Lamp Type                       | Operating Temperature | CRI (Colour Rendering Index) | Usage / Kind of Illumination  |
|---|---------------------------------|-----------------------|------------------------------|---|
| CIE Standard Illuminant A (INCA-A)      | Tungsten halogen                | 2856°K                | 100                          | Incandescent or tungsten light, generally seen in home environments   |
| CIE Standard Illuminant D65             | 7 Phosphor daylight fluorescent | 6500°K                | 93                           | Cool white fluorescent light, generally seen in office environments   |
| Fluorescent Illuminant TL84             | European commercial fluorescent | 4100°K                | 85                           | Most commonly used illuminant resembling noon daylight  |
| Illuminant CWF (Cool White Fluorescent) | USA commercial fluorescent      | 4150°K                | 62                           | Common wide band fluorescent which simulates office or store lighting; generally used by most merchandisers and retailers; disadvantage is that it is very poor for rendering colours as it accents blues, yellows and greens, suppressing all red and makes skin tones look greyed and unnatural |
| Illuminant UV                           | Daylight fluorescent            | 6500°K                | 93                           | Reveals the presence of fluorescent dyes and bleaches, resembles daylight   |
| Illuminant D50                          | 7 Phosphor daylight fluorescent | 5000°K                | 92                           | Used to evaluate colour quantity and uniformity, resembles noon sky daylight  |
| Illuminant D75                          | 7 Phosphor daylight fluorescent | 7500°K                | 94                           | Used to evaluate opaque materials, resembles north sky daylight   |
| Illuminant U30                          | USA commercial fluorescent      | 3000°K                | 85                           | Commercial narrow band fluorescent light  |
| Mercury Vapour                          | High intensity                  | 4100°K                | 70                           | Generally used in stores and factories  |
| High Pressure Sodium                    | High intensity                  | 2100°K                | 50                           | Generally used in streets and factories   |

**Note:** CRI (Colour Rendering Index) is defined as the ability of the illuminant to render colours as they would appear under true daylight. An index of 100 represents a perfect simulation of daylight.

**Fluorescent Lamp Variants:**

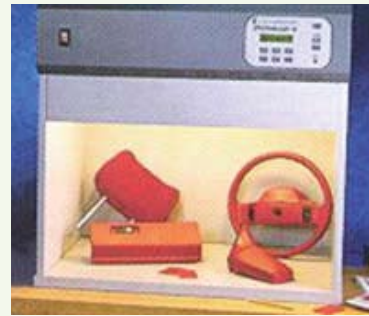
- CW - Standard Cool White
- WW - Standard Warm White
- CWX - Deluxe Cool White
- WWX - Deluxe Warm White
- ES - Energy Saving
- HO - High Output



**D65** Artificial daylight



**TL84** Store lighting



**A** Domestic tungsten lighting

**Colour Temperature**

Colour temperature is a method for describing certain colour characteristics of light sources. It is a reference number that quantifies the appearance of light. The terms 'warm' and 'cool' in lighting refer to subjective experiences, such as a warm flame or a cool winter sky.

**Cool and Warm Light Sources**

Light sources that have higher colour temperatures are 'cool' light sources, while those that have lower colour temperatures are 'warm' light sources.

**Applications of Colour Temperature**

| Colour Temperature | Kelvin Range           | Associated | Effects & Moods                   | Appropriate Location | Applications   |
|--------------------|------------------------|------------|-----------------------------------|----------------------|--|
| Warm               | 3,000K                 | Friendly   | Intimate<br>Personal<br>exclusive | Restaurants          | Hotel Lobbies, Boutiques,<br>Office Areas, Libraries   |
| Neutral            | 3,500K                 | Friendly   | Inviting<br>Non-threatening       | Public<br>Reception  | Office Areas, Showrooms,<br>Book Stores  |
| Cool               | 4,100K                 | Neat       | Clean<br>Efficient                | Office Areas         | Conference Rooms,<br>Classrooms, Mass<br>Merchandisers, Hospitals  |
| Daylight           | 5,000K<br>to<br>6,500K | Bright     | Alert<br>Exacting<br>colouration  | Galleries            | Museums, Colour<br>Matching Booths,<br>Jewellery Shops, Medical<br>Examination Areas,<br>Textile Industry, Printing<br>Companies |

**Impact of Brightness and Position of the Light Source**

The brightness of illumination affects the apparent purity of colours and the amount of detail visible in shadows. In general, the brighter the illumination, the more saturated colours appear and the greater the amount of detail that may be seen in shadow. The geometry of the illumination also affects the parent colour and contrasts of a product. Whether the illumination is coming from a small source or a large diffused one, the angle at which the light strikes the objects and angle of view all affect appearance.



**Use of Matching Cabinets**

A matching cabinet is the standard equipment for the visual assessment of colour and they are best used for colour appraisal with the below parameters:



**Dimensions**

|                       | Width    | Height | Depth  |
|-----------------------|----------|--------|--------|
| <b>Overall Area</b>   | 1,560 mm | 780 mm | 620 mm |
| <b>Viewing Cavity</b> | 1,520 mm | 560 mm | 590 mm |

**Cabinet Interior**

- The cabinet interior should be coloured with Munsell Grey N5
- For best results, glare, extraneous lights and anything which will mal-adapt the visual response must be avoided
- Any windows near the cabinet should be fitted with grey blinds
- No direct lights should be in the field of view and the general lighting in the vicinity should be 'Artificial Daylight' to a level of 200 to 300 lux
- The wall area behind the cabinet should be finished in light grey emulsion BS 00A01

**Viewing Backgrounds**

- The shade matching cabinet utilises neutral grey surroundings to accommodate the widest range of colours

**Viewing Distance**

- The distance of the Colour Matcher to the samples being viewed should also be constant regardless of the colour of the samples. The samples should ideally be viewed at a 45° angle of incidence to the light source



## Reducing the Effects of Metamerism

We have seen that metamerism and illuminants are important considerations in controlling and assessing colour in the manufacturing process of any coloured object. In textiles it is therefore important to use consistent quality dyestuff and to consider and use the appropriate illuminants and conditions in matching colour.

Please **contact** your local Sales Office to find out more about metamerism and illuminants.