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## Comparative lightfastness study of modern manufacturers' gouache colors used by SCA scribes

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### Executive Summary

If you don't want to read this paper and study tiny marks on paint tubes, you may want to buy all your gouache from DaVinci. Every one of their gouache colors is durable enough to last 50 or more years ([Hayes, 2012](#)), and the tubes are bigger and less expensive per ounce than many of their competitors ([Clemons, Parker, Saylor, et al., 2010](#); [Clemons, Parker, Saylor, et al., 2007](#); [Latham, Clemons, Parker, Saylor, et al., 2009](#)).

If you want more colors than the limited palette DaVinci offers or already have gouache by another manufacturer, please read on!

### Table of Contents

[Executive Summary](#)

[Introduction](#)

[The problem](#)

[Variations in colorfastness standards](#)

[ASTM D series: D4302 \(oils\), D4303 \(colorants\), D5067 \(watercolors\), D5724 \(gouache\),](#)

[D 5383 \(art technicians' assessments via Blue Wool\), and others](#)

[Blue Wool \(ISO 105-B01, 1994\)](#)

[The manufacturers' lightfastness scales](#)

[DaVinci: The one stop solution](#)

[Winsor and Newton: A good proprietary scale](#)

[Royal Talens: A bad proprietary scale](#)

[Schmincke: A middle of the road proprietary scale](#)

[Manufacturers without published colorfastness standards](#)

[Reeves Gouache](#)

[Colors that may be sufficiently lightfast if no further degradation occurs](#)

[Colors that are marginal](#)

[Colors that have already proven to be insufficiently lightfast](#)

[LeFranc & Bourgeois Gouache](#)

[Colors that may be sufficiently lightfast if no further degradation occurs](#)

[Colors that are marginal](#)  
[Colors that have already proven to be insufficiently lightfast](#)  
[Integrated chart of colorfastness standards across manufacturers](#)  
[Appendix A: My colorfastness testing methodology](#)  
[Appendix B: Bibliography and sources of manufacturers' colorfastness data](#)

## **Introduction**

Scrolls given as awards in the Middle Kingdom of the Society for Creative Anachronism are treasured and individually created works of art that are likely to be proudly displayed by their owners for years to come. However, most of the recipients are not library or museum conservation specialists - and most of the artists aren't conservation specialists either.

This paper is intended to help SCA illuminators understand how to select materials that will have the highest chances of surviving 25 years or more in the ordinary display circumstances likely to be used by their recipients, few of whom have access to museum quality storage and preservation conditions.

## **The problem**

Despite both the artists' and the recipients' best intentions, an award scroll proudly hung in an ordinary frame in an ordinary living room could be sun-bleached into illegibility within a few years of its giving -- or it may have been created with colors that erase themselves over the course of time.

My personal first encounter with this phenomenon involved looking back through my student art materials from 20 years ago; many of my theatrical costume renderings had changed, faded, or vanished completely. I hadn't intended these costume renderings to be permanent works of art, but the colors and pigments I was using are some of the same materials that SCA scribes and illuminators still use today.

Therefore, I decided to study the lightfastness qualities of different colors and different brands of gouache in order to come up with a list of paints that would be likely to give the artists the satisfaction of a long-lasting work of art that could be enjoyed by their recipients for years to come.

This paper won't address considerations like variations in paper or parchment surfaces beyond the general recommendation to look for acid-free archival-quality materials. Instead, it focuses on assessing the codes used by various manufacturers to indicate the level of archival endurance available across several of the media they produce, including watercolor, colored pencils, and gouache (with an emphasis on gouache since it's the preferred medium for many scribes).

## Variations in colorfastness standards

The definition of “colorfastness” varies widely depending on whom you ask. A scientist observing international standards will have a different definition than a manufacturer using their own proprietary standards, and manufacturers have a vested interest in making their paints and pigments sound as durable as possible. The standards also vary between manufacturers; some manufacturers’ version of “25 years of lightfastness” specifies details like storage under museum quality preservation conditions with glass that blocks ultraviolet light, which is a standard that most SCA-dian scroll recipients can’t adhere to.

There are two major internationally agreed upon standards for measurements of colorfastness, the ASTM D series and Blue Wool. Winsor and Newton’s color standards map fairly closely to these; other manufacturers’ standards vary more widely.

After introducing the lightfastness standards, I’ll compare them to various manufacturers’ proprietary standards, correlate them with my own testing results on pigments from manufacturers that don’t advertise their formulations’ colorfastness, and produce a list of recommendations for gouache to buy and gouache to avoid.

Since storage outside museum conditions will deteriorate art materials more quickly, I’m using the rough calculation that non-museum conditions (especially ultraviolet light) may halve the lifespan of a medium. Therefore, ASTM II’s 50 to 100 year museum rating may be 25 to 50 years in an average home with ordinary sunlight, and ASTM III’s 15 to 50 year museum rating may begin to fade in 7 years in a sunny home.

**ASTM D series: D4302 (oils), D4303 (colorants), D5067 (watercolors), D5724 (gouache), D 5383 (art technicians’ assessments via Blue Wool), and others**

The ASTM standards began as the “American Society for Testing and Materials” before becoming internationally recognized and changing to ASTM International. According to their website, “some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence.” ([About ASTM International](#), 2014)

The ASTM standards assign an I to V colorfastness ranking to various artists’ materials based on complex chemical assessments; I and II are recommended for artistic use and III through V are not recommended. The standards sell for \$42 apiece and require access to scientific tools to perform tests accurately.

While many of the standards developed by the D01.57 artists’ materials committees are highly technical and beyond the range of ordinary artists without access to chemistry labs, there are two somewhat simplified tests designed for art technicians and for artists themselves. I found it interesting that the ASTM standards referred art technicians to the Blue Wool testing system:

ASTM D 5383, "Standard Practice for the Visual Determination of the Lightfastness of Art Materials by Art Technologists"

A method for testing the lightfastness of art materials not covered by specifications D 4302, D 5067, D 5098, D 5724, D 6901 (markers, inks, pastels, and so on). The method uses the Blue Wool textile fading cards (BS 1006) and does not require sophisticated instrumentation (as in D 4303) to measure the results. Results can be communicated among other users of the standard with some degree of confidence that they have validity, but without the degree of confidence that instrumental evaluation provides.

([Gottsegen, 2010](#))

ASTM D 5398, the assessment for individual artists, is a further-simplified version of D 5383 that also refers artists to the Blue Wool lightfastness testing system.

### **Blue Wool ([ISO 105-B01](#), 1994)**

In the Blue Wool test system, cards are made with wool swatches that have been colored with different dyes that fade under known amounts of exposure to ultraviolet light. (It began as a textile industry lightfastness test, but the print community and artists' materials community have also adopted it.)

The eight wool pieces correspond to the 8 levels of colorfastness that the system recognizes. Each colorfastness level is two or three times as long as its predecessor: level 2 lasts longer than level 1, level 3 longer than level 2, and so forth. Items at levels 7 and 8 should be colorfast under ordinary conditions for many years, and under museum circumstances possibly hundreds.

To use a Blue Wool test in a museum setting, half of the color card is stored in the dark (to preserve the original unfaded colors) and the other half of the color card is mounted next to the museum item whose housing is being assessed. The amount of fading that the mounted Blue Wool card experiences will measure the amount of UV light the museum item is exposed to in its housing, so that the museum curators know if additional UV remediation is needed.

For art materials, a swatch of the tested color is often divided in half as well, with half stored in the dark and half deliberately mounted in an area exposed to sunlight and/or ultraviolet rays alongside the blue wool card. Both halves are compared on a regular basis, to determine how long the color swatch remains lightfast.

The "UV aging" process is sometimes accelerated with high intensity xenon lights, under the idea that a short period of high intensity exposure should compare to a longer period of ordinary exposure. (Light testing equipment such as the [ATI Xenon Light Fastness Tester](#) is sold on this principle.)

In contrast to the ASTM numbering system where a lower number is better, the Blue Wool numbering system considers a 1 as the worst result (a swatch that fades as quickly as the first Blue Wool dye) and an 8 as the best result (a swatch that lasts longer than the last Blue Wool dye).

The Golden Artist Colors company that sells Blue Wool test kits to artists for home use explains the correlation between the archival-art areas of ASTM and Blue Wool this way:

If "Blue Wool #6" fades before the material being tested, it would be analogous to an ASTM rating of II (Very Good) and the material would be considered durable enough for archival intentions. If the specimen continues to show no change by the time "Blue Wool #7" fades, it would be similar to an ASTM rating of I (Excellent).

...

Under conditions of museum exposure, ASTM Lightfastness II ( "Very Good"), materials should remain unchanged for approximately 100 years. Materials rated as worse than II (III and above) are not recommended for art that is intended to last.

[\(Golden Artist Colors, Inc., 1995\)](#)

Tony Johansen, the Director of the East Sydney Academy Of Art, gives the following caveat and his interpretation of the scales for reference:

Now to the contentious theme of putting an actual lifetime value on light fastness ratings. There is no easy answer here and most authorities try to dodge the issue. The reason being that pictures are shown in such a wide range of conditions. Even within one room one wall may get double (or more) the light of another wall, effectively doubling any effect that light will have on that work in a given time frame...

It is also easy to find differing interpretations of time for a given total of light (measured in lux) The following is a good rule of thumb and is based on MacEvoy's excellent 'The World's Finest Guide To Watercolor Painting' and that in turn was based on Gottsegen 'the Painters Handbook' and Colby 'A Suggested Exhibition Policy For Works On Paper (Journal of the International Institute For Conservation: Canadian Group 1992)'

**ASTM I** Excellent. Equivalent of Blue Woolscale 7 and 8. More than 100 years without change. (Probably more than 200 years in the case of Woolscale 8) (between 300 and 900 megalux)

**ASTM II** Very good. Blue Woolscale 6. Between 50 and 100 years without change (100 megalux)

**ASTM III** Fair. Blue Woolscale 4 and 5. Between 15 and 50 years without change. (10 to 32 megalux)

**ASTM IV** Poor. Blue Wooscale 2 and 3. Between 2 and 15 years without change. (1.3 to 3.6 megalux)

**ASTM V** Very poor. Blue Wooscale 1. Less than 2 years without change. (.4 megalux)  
([Johansen, 2006](#))

Derek R. Bates presents a third Blue Wool assessment estimating time, lux, and scale level at [DRB Materials Technology](#). This assessment largely agrees with Johansen's.

All of these assessments present Blue Wool 6 - 8 or ASTM I - II as materials likely to last a good portion of a SCA scroll recipient's lifetime, and ASTM III/Blue Wool 4-5 as marginal; the Mattech group qualifies Blue Wool 4-5 materials as "May be satisfactory when used full strength or with extra protection from exposure to light."

### **The manufacturers' lightfastness scales**

It would make an artist's life much easier if the manufacturers consistently used either of the scales above. However, because ASTM I and II / Blue Wool 6 - 8 can be difficult to achieve, the manufacturers tend to come up with their own lightfastness scales with different caveats and different coding.

The following information maps the manufacturers' scales to the ASTM and Blue Wool scales to the best of my ability, based on Johansen's mapping of years and lux to scale levels.

### **DaVinci: The one stop solution**

If you don't want to have to wonder whether your gouache will last, DaVinci is the one stop solution. They test all their gouache colors directly against ASTM D-5724 standards (with other media tested against the other ASTM standards) and everything they produce is either category I or II. Both lightfastness and toxicity information are available from the company's PDF and Excel files at <https://www.davincipaints.com/technical-info>. Vicki Hayes' color information in the 2012 Da Vinci Paint Catalog ([Hayes, 2012](#)) is enhanced by the material data and coding in the (undated and uncredited) Excel file from the same location.

In addition, several artists have good things to say about their value for money, since the tubes are larger than some other manufacturers' and the prices are lower per unit of volume. The major drawback cited to DaVinci seems to be in their limited 28 color palette. ([Clemons, Parker, Saylor, et al., 2010](#); [Clemons, Parker, Saylor, et al., 2007](#); [Latham, Clemons, Parker, Saylor, et al., 2009](#).)

### **Winsor and Newton: A good proprietary scale**

Winsor and Newton generally do a good job of presenting ASTM standards on their paints, pigments, and pencils. They also have a proprietary 'permanence' rating that assesses factors other than lightfastness.

However, not all their product lines have been ASTM assessed; gouache is one of the lines lacking the ASTM rating. In cases where their materials haven't been ASTM assessed, they present only their permanence rating.

Unlike some other manufacturers, Winsor and Newton's permanence ratings do **not** assume museum-quality preservation standards for artwork created with their materials. Their permanence ratings assume 'ordinary' conditions and include conditional modifiers:

The permanence of an artists' colour is defined as 'its durability when laid with a brush on paper or canvas, graded appropriately and displayed under a glass frame in a dry room freely exposed to ordinary daylight and an ordinary town atmosphere'. This definition reflects the manner in which we expect to find paintings displayed. However, for testing purposes we are also able to utilise accelerated tests for lightfastness and binder stability, in addition to the information issued by our pigment suppliers.

Winsor & Newton [permanence] ratings are therefore a combination of the natural passage of time, accelerated tests and pigment manufacturers' testing and development and are the most stringent in the industry.

- AA - Extremely Permanent
- A - Permanent
- B - Moderately Durable
- C - Fugitive

For further information on some colours, the rating may include one or more of the following additions:

- (i) 'A' rated in full strength may fade in thin washes
- (ii) Cannot be relied upon to withstand damp
- (iii) Bleached by acids, acidic atmospheres
- (iv) Fluctuating colour; fades in light, recovers in dark
- (v) Should not be prepared in pale tints with Flake White, as these will fade
- (vi) 'A' rated with a coating of fixative

[\(Winsor & Newton Inc., 2011.\)](#)

Winsor and Newton's specific durability ratings for gouache are presented on a related page [\(Winsor & Newton Inc., 2011-a.\)](#)

For the sake of mapping permanence ratings to durability for SCA purposes, I suggest:

- AA (Permanent) and A (Permanent) - treat as similar to ASTM I or II; considered archival quality
- B (Moderately durable) - treat as similar to ASTM III; considered marginal

## Royal Talens: A bad proprietary scale

If Winsor and Newton demonstrates what manufacturers should do with their proprietary scales, Royal Talens demonstrates what they shouldn't do.

Their marketing department clearly wants very much for people to think that their colors are ASTM compliant and that their color codes match to the ASTM I - V ratings. However, as always, the devil is in the details.

In their color chart, they use a 4-step color ranking and declare "The lightfastness of all these colours has been tested in accordance with ASTM Standards D4303." ([Royal Talens, 2011](#))

However, here are the catches:

First, they're measuring the pure colorants with ASTM D4303 -- but they aren't measuring the finished results, and the pigments and binders and drying agents make a big difference to a product's durability and lightfastness. ASTM D5724 (gouache) or D5383 (empirical assessment) would be better indicators of the finished product's real performance.

Second, their "+++, ++, +, 0" notations both invert the direction and don't provide a one to one correlation with the ASTM standards. A four-step scale where four is high doesn't provide the capacity to match the same interval set as a five-step scale where five is low.

Third, even if they had the right number of notations, they're not using the same interval set. ASTM I suggests at least a century of lightfastness in museum conditions. Royal Talens' "best" category (+++) claims to match ASTM I in offering a century -- but the steps stagger from there, as displayed in the table below.

ASTM ranking	Museum years estimated	Royal Talens ranking	Museum years estimated	Mismatch
I	100+	+++	100	None
II	50 - 100	++	25 - 100	Half as much durability on the low estimate
III	15 - 50	+	10 - 25	Half as much durability on the <i>high</i> estimate
IV	2 - 15	0	0 - 10	Three quarters as much



				durability on the high estimate
V	0 - 2	(0 presumed)	0 - 10	Talens' high estimate may be a factor of 5 too high

Note that in an earlier section, we determined that ASTM I and II were good for SCA use and III was marginal. Royal Talens' +++ matches at least the low end of ASTM I, but ++ falls between II and III in a way that means we can't determine which (if any) of their ++ colors are durable enough for scribal use.

### Schmincke: A middle of the road proprietary scale

Schmincke gouache comes highly recommended by THL Iohannes on the Midrealm Scribal Mailing List, particularly their metallic gouaches as a less expensive substitute for shell gold. Schmincke does a better job than Royal Talens of matching their assessments to existing standards, but they don't quite keep up with DaVinci's direct standard usage or Winsor and Newton's durability scale that includes lightfastness.

They use a 5 star ranking system which would be great if they were matching 5 step ASTM -- but instead they're matching the 8 step Blue Wool ([H. Schmincke & Co., 2008](#)).

Schmincke combines the bottom of the Blue Wool barrel at one star, which is fine for our purposes because scribes will know they won't want those. But in their three star rankings, they also combine the "middle" of the Blue Wool barrel awkwardly across the divider between ASTM II (good) and ASTM III (marginal) ([H. Schmincke & Co., 2004](#)).

(They also don't directly present the mapping between their stars and the Blue Wool rankings; I had to work that out across their PDFs.)

Schmincke has three lines of gouache and every color is ranked individually, which is great if you're detail-oriented. But it's harder to shop the range because their lightfastness is literally all over the scale; you'll need to look at every tube one at a time to determine whether it's durable enough, which means buying a starter kit is not a good idea.

Their Horadam line concentrates on individual pigments, which is good for people interested in authenticity. But with that higher authenticity comes higher exposure to some toxic substances including cobalt, cadmium, and nickel, and not all the authentic pigments are lightfast. Both lightfastness and toxicity data are in the Horadam Gouache PDF ([H. Schmincke & Co., 2008-a](#)).

The following table compares the the Blue Wool and Schmincke star rankings with the ASTM rankings and Johansen's year / lux estimates.

Blue Wool ranking	ASTM	Museum year / lux estimates	Schmincke stars
8	I	200+ (900 megalux)	***** (extremely lightfast)
7	I	100+ (300 megalux)	**** (good lightfastness)
6	II	50 - 100 (100 megalux)	*** (lightfast)
5	III	15 - 50 (32 megalux)	*** (lightfast)
4	III	15 - 50 (10 megalux)	** (limited lightfast)
3	IV	2 - 15 (3.6 megalux)	* (less lightfast)
2	IV	2 - 15 (1.3 megalux)	(not lightfast)
1	V	0 - 2 (.4 megalux)	(not lightfast)

So from this chart, anything ranked five-star or four-star should be more than fine for SCA purposes; both Blue Wool 8 and Blue Wool 7 correspond with ASTM I. The problem is with the three-stars.

In theory, three-star gouaches that map to Blue Wool 6 / ASTM 2 should also be fine -- but there's no way to distinguish the Blue Wool 6 (good) three-stars from the Blue Wool 5 (marginal) three stars. We're back to the problem of the mismatched scales, with one side playing an octave and the other pentatonic.

On the whole, I'd be inclined to give the three-star Schmincke gouaches the benefit of the doubt, because the rest of their scale skews a notch higher than the comparison scales. But short of repeating all of their Blue Wool testing to determine which break down at 32 megalux and which at 100, there's no way to be certain.

I'd be most wary of the three-star reds, oranges, and violets, based on my own cross-manufacturer test results (detailed below).

### **Manufacturers without published colorfastness standards**

Some of the scribes in my local group own gouache from manufacturers without published colorfastness standards, in part because they were inexpensive student-grade materials that were easy to buy as a set. However, I didn't want to invest in materials if I didn't know how colorfast they would be, so I embarked on an empirical colorfastness testing routine that's detailed in [Appendix A](#).

In this case, it's not as much a case of proving a positive as not-proving a negative. I can't prove that the ones that have lasted for 3.5 years of real-world light testing are colorsafe for 25 years or more. I can only prove that the ones that *haven't* lasted for 3.5 years *aren't* colorsafe. My results to date are noted below, though the tests are ongoing (the color swatches are still in my window).

## Reeves Gouache

### Colors that may be sufficiently lightfast if no further degradation occurs

- **Lemon yellow**
- **Medium yellow**
- **Blue lake**
- **Ultramarine**
- **Dark green**
- **Yellow ochre**
- **Burnt sienna**
- **Burnt umber**
- **Grey**
- **Black**

### Colors that are marginal

- **Leaf green** (The tint has faded but is still visible; the color hasn't shifted)
- **Emerald** (The tint has faded but is still visible; the color hasn't shifted)

### Colors that have already proven to be insufficiently lightfast

- **Flesh tone** has almost completely vanished.
- **Brilliant red** has lost about half its intensity and the paler tint has vanished entirely.
- **Crimson** has shaded toward purple-blue and the tint has nearly vanished.
- **Orange-red** has shaded toward brown and portions of the tint have vanished.
- **Violet** has lost all the red in the mixture and is now a solid blue instead of purple.

## LeFranc & Bourgeois Gouache

### Colors that may be sufficiently lightfast if no further degradation occurs

- **Primary yellow**
- **Violet** (This is a color that didn't pass in the Reeves set, but it's both maintained its intensity and its color in Lefranc & Bourgeois)
- **Ultramarine blue**
- **Emerald green**
- **Primary blue**
- **Burnt sienna**

- **Black**

Colors that are marginal

- **Leaf green** (This color has less noticeable fading than the Reeves set, but has faded)

Colors that have already proven to be insufficiently lightfast

- **Orange** has lost its tint section, though the solid section is still in place and color consistent.
- **Primary red** has lost its tint section, though the solid section is still in place and still color-consistent.
- While the **Lemon Yellow** was still passable in Sept. 2012, the additional year's time has sun bleached it notably more than the other survivors on its card. (I believe this would put it in the ASTM IV category, surviving more than two years but less than 10.)

**Integrated chart of colorfastness standards across manufacturers**

(Rows highlighted in yellow should be acceptable for SCA scribes to produce a scroll that will last at least 25 years in a recipient's frame, preferably not in direct sunlight. Rows colored green are marginal. DaVinci doesn't produce any colors that are ranked lower than ASTM II.)

Blue Wool ranking	ASTM	Museum year / lux estimates	DaVinci	Royal Talens (est.)	Schmincke stars (est.)	Winsor & Newton permanence rating (est.)
8	I	200+ (900 megalux)	I	+++	***** (extremely lightfast)	AA
7	I	100+ (300 megalux)	I	+++	**** (good lightfastness)	AA
6	II	50 - 100 (100 megalux)	II	++	*** (lightfast)	A
5	III	15 - 50 (32 megalux)		++ or +	*** (lightfast)	B
4	III	15 - 50 (10 megalux)		+	** (limited lightfast)	B
3	IV	2 - 15 (3.6 megalux)		+ or 0	* (less lightfast)	C

2	IV	2 - 15 (1.3 megalux)		+ or 0	(not lightfast)	C
1	V	0 - 2 (.4 megalux)		0	(not lightfast)	C

## Appendix A: My colorfastness testing methodology

I would've liked to have had some Blue Wool test strips for direct comparison & analysis purposes, but when I began this experiment in 2011 I hadn't been able to find any in packages smaller than "several hundred dollars of equipment and meant for official test lab" quantities. They are available in smaller quantities now, and I'm considering starting a second batch of testing alongside Blue Wool strips to see how they compare.

In the absence of official test strips, I went with the Unofficial but Very Empirical method.

- I painted gradients across divider lines and labeled every sample.
- One end of each gradient was solid pigment; the other was diluted with water to create as pale a wash as I could get, in order to determine whether pigments were more or less bleach-prone at specific concentrations.
- I cut my test strips in half. One half went into a dark spot; the other half got taped into my windows.
- I put my test strips in south-facing windows in my house in central Illinois. It has partial shade in the late afternoons, but gets pretty direct sunlight most of the morning and definitely at noon.
- Single-glazed windows from 1936 were pretty much guaranteed not to have any UV protection built into them.

The test strips were installed in my windows in August 2011. An image of my test results as of November 2013 is inserted below.

The leftmost column is the LeFranc and Bourgeois window panel with fading evident in some color swatches. The center two panels were stored in the dark. The rightmost panel is the Reeves window panel with fading evident in some color swatches.

LeFranc + Bourgeois  
Light April 1 2011

Lemon Yellow	
Primary Yellow	
Orange	
Primary Red	
Violet	
Ultramarine Blue	
Emerald Green	
Primary Blue	
Burnt Sienna	
Black	
Leaf Green	

LeFranc + Bourgeois  
Dark April 1 2011

Lemon Yellow	
Primary Yellow	
Orange	
Primary Red	
Violet	
Ultramarine Blue	
Emerald Green	
Primary Blue	
Burnt Sienna	
Black	
Leaf Green	

Reeves  
Dark

Lemon Yellow	
Primary Yellow	
Orange	
Primary Red	
Violet	
Ultramarine Blue	
Emerald Green	
Primary Blue	
Burnt Sienna	
Black	
Leaf Green	
Yellow Ochre	
Burnt Sienna	
Burnt Umber	
Grey	
Black	
Flake Pink	

Reeves  
Light

Lemon Yellow	
Primary Yellow	
Orange	
Primary Red	
Violet	
Ultramarine Blue	
Emerald Green	
Primary Blue	
Burnt Sienna	
Black	
Leaf Green	
Yellow Ochre	
Burnt Sienna	
Burnt Umber	
Grey	
Black	
Flake Pink	

## Appendix B: Bibliography and sources of manufacturers' colorfastness data

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