# COLOR CLASSIFICATION SYSTEMS
## for Figure Painters and Model Builders

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**Notes:**

The purpose of this paper is to give model makers and figure painters a peek into how color operates, and to take some of the mystery out of esoteric paint codes and color designations. The study of color as it applies to artistic endeavors can be a lifelong quest, or a just passing phase of familiarization. Knowing the secrets of color manipulation means having better tools to paint more life-like figures, and to build more convincing models.

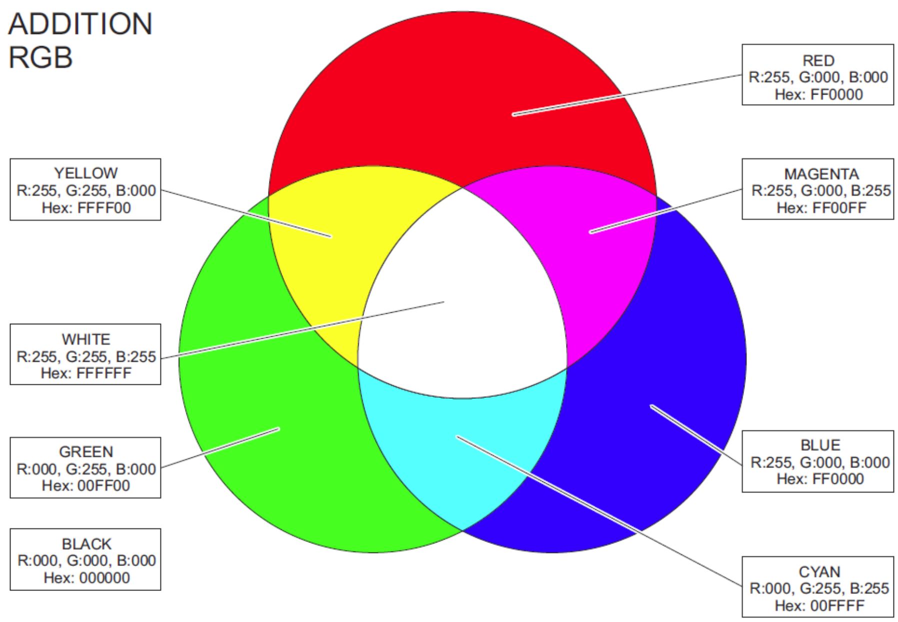
The information presented here is generally obtained from the internet. For any subject, there can be numerous sources. Those presented here seem to present the best information, and/or the consensus opinion.

There are numerous systems for classifying colors. The ones given here are those most likely to be encountered by builders of military models. For systems used by other nationalities, an internet search is the best first research tool. Be sure to examine interesting webpages for the location of original source documents.

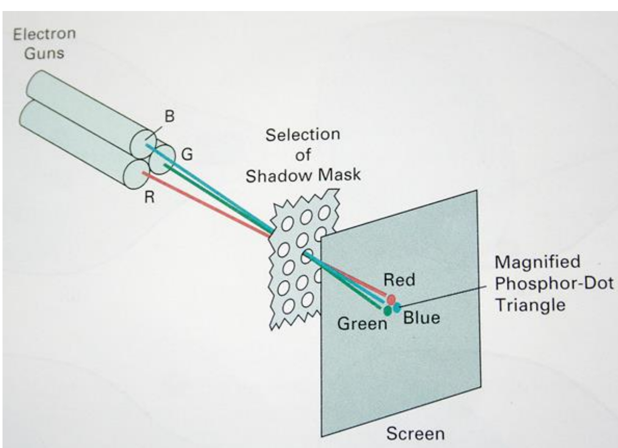
C. P. Schenfeld – editor/researcher

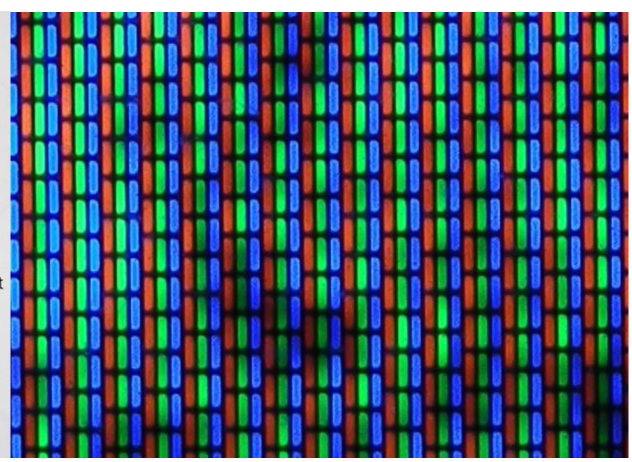
## I. RGB (for Red, Green and Blue)

RGB is the description of systems that create color by adding and combining light. Each of the three components is described by a number from 0 to 255, usually in its hexadecimal form.




For years, color television was produced by shining carefully modulated electron beams through masks designed such the beam for, say, the “red” signal would strike only the section of the screen with the red-tinted filter, the “blue” signal would strike only the blue-tinted section, and so on. Now, the same scheme is carried out using LEDs.

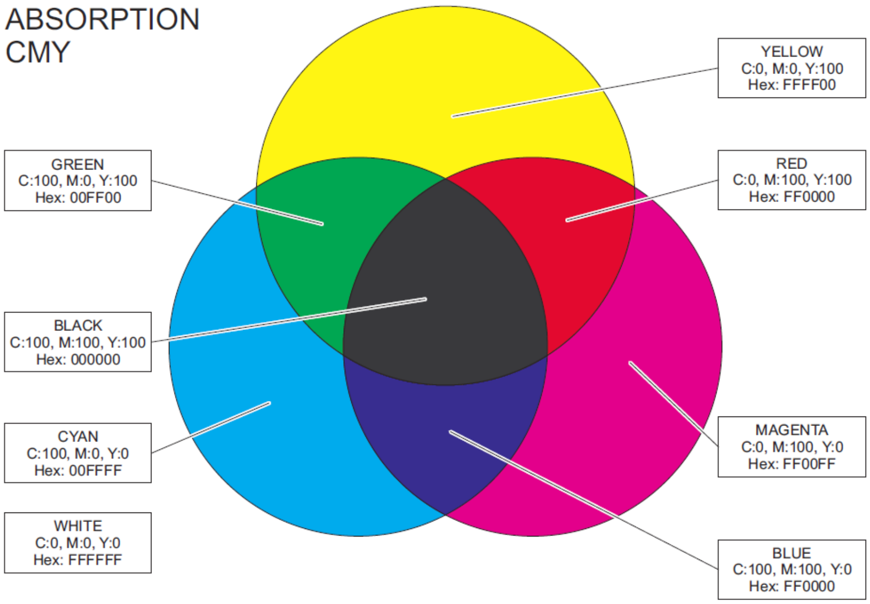


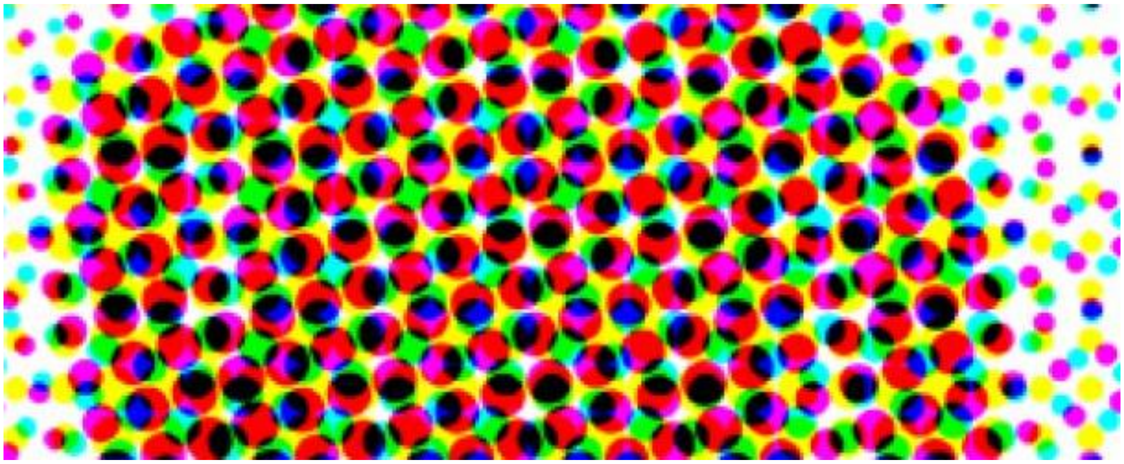
Three signals, each with 256 possible intensities equals 16,777,216 possible colors. On the internet, the intensity is limited to 16 for each signal, meaning that there are only 4,096 “internet-safe” colors.

## II. CMY (for *C*yan, *M*agenta, *Y*ellow) or CMYK (for *C*yan, *M*agenta, *Y*ellow, blac*K*)

CMY and CMYK is the description of systems that create color by absorbing light frequencies from white. Each of the three or four components is described by a number from 0 to 100, or the percentage of that color present. This is the system used in lithographic printing, where the inks absorb light, reflecting only specific frequencies. In most instances, a fourth “kobalt” (black) layer is used to add depth and contrast to the colors. The white is provided by the media upon which the item is printed



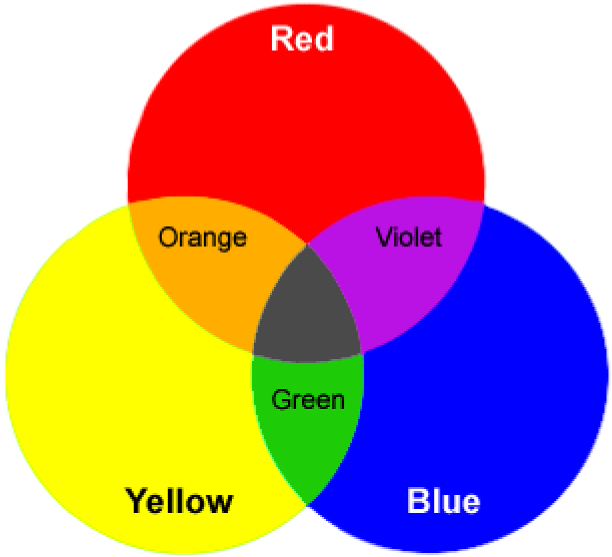

In printed form, images are usually formed by dots of one of the CMYK colors. The relative size of the dots is determined by the percentage value of that particular color.



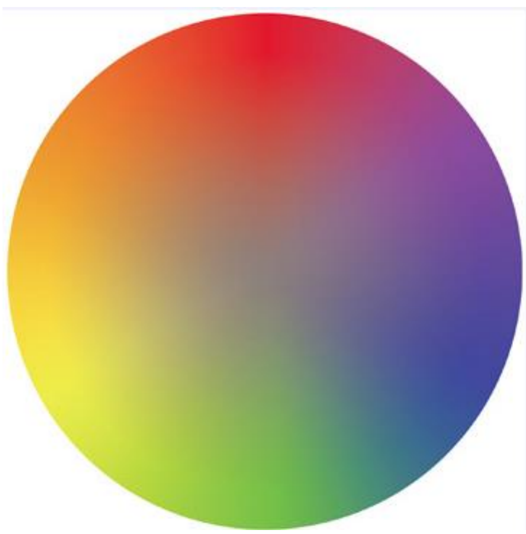
The colors cyan, magenta and yellow were chosen because of their ability to simulate the colors most closely associated with the rod cells of the retina. As an example, pure yellow combined with pure magenta absorb most color frequencies, reflecting only red. (As review, the other two rod cell types are green and blue.) When all three C, M and Y are combined in equal proportions, they produce a shade of gray.

## III. Primary Colors

Primary colors are considered to be Red, Yellow and Blue. While not a formal system of color classification, and in spite of being a bit skewed from the “scientific” CYM system, primary colors form the best intuitive tool for thinking about colors. Primary colors are, in fact, the foundation of the color wheel, and of the Munsell color system.



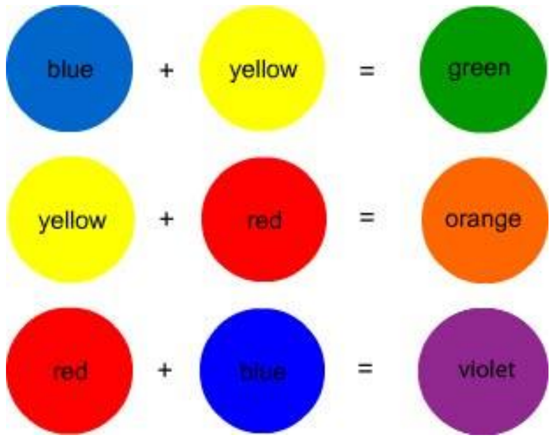

Paint is a light absorbing material, and when mixed according to the color wheel, will generally yield predictable results.

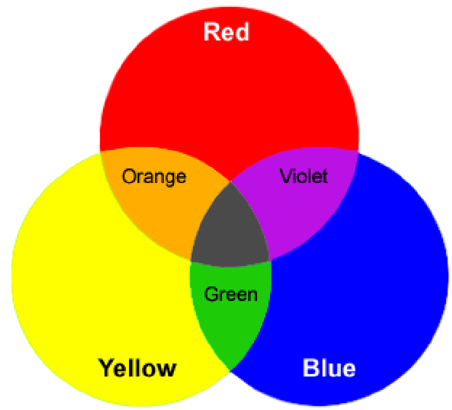


The disadvantage of using a “pure” primary color approach is the difficulty in accounting for the intensity (or value) of the various hues. This is addressed in the Munsell system of color notation, as described in section IV.

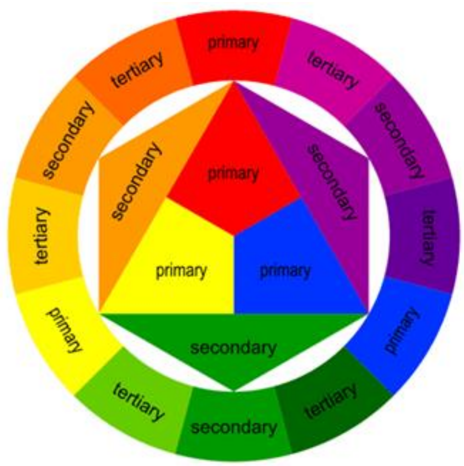
## III. Primary Colors (continued)

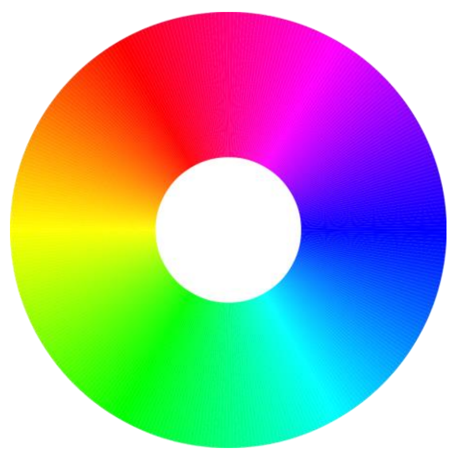
Combining equal portions of two primary colors produces secondary colors.



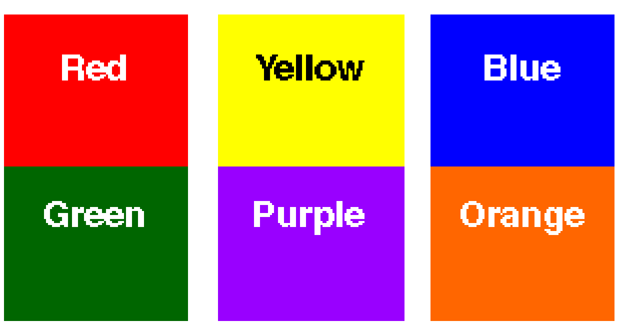



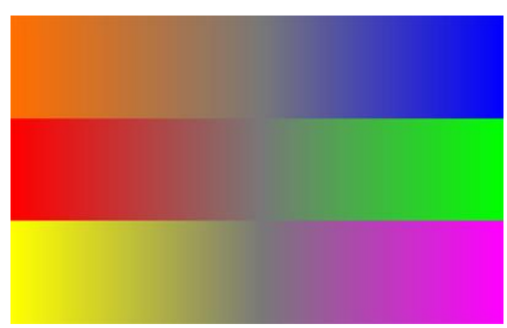

Combining equal portions of two adjacent colors (for example yellow and green) yields tertiary colors (in this case, yellow green). Continuing this process yields all of the visible hues.



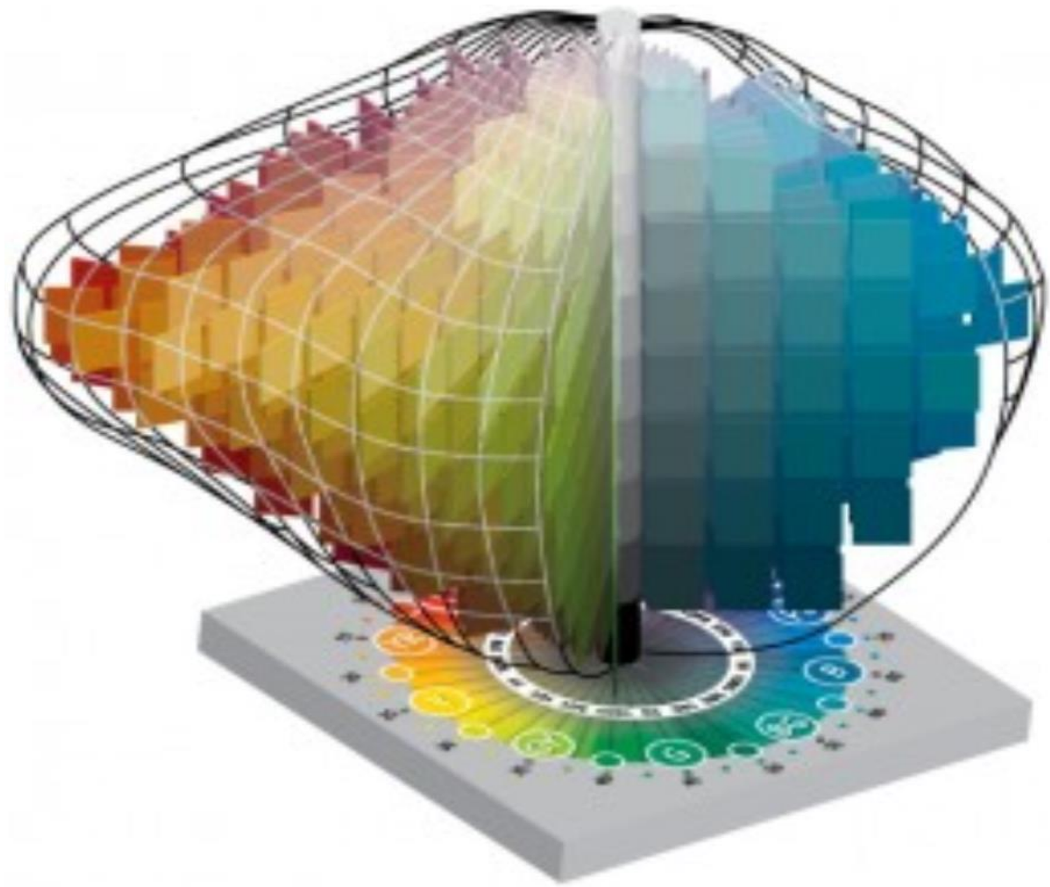
Colors directly across from each other on the color wheel are called complimentary colors. Mixing a color with its compliment reduces its purity, or chroma. Mixing equal portions of two complimentary colors produces a shade of gray.



## IV. Munsell Color Notation

Munsell Color Space: Munsell hue, value and chroma can be varied independently so that all colors can be arranged according to the three attributes in a three-dimensional space. The neutral colors are placed along a vertical line, called the “neutral axis,” with black at the bottom, white at the top, and all grays in between. The different hues are displayed at various angles around the neutral axis. The chroma scale is perpendicular to the axis, increasing outward. This three-dimensional arrangement of colors is called the “Munsell color space.” All colors lie within a specific region of Munsell color space called the “Munsell color solid.” Hue is limited to one turn around the circle. The scale of value is limited on the lower end by pure black, which is as dark as a color can be, and on the top by pure white, which is as light as a color can be. For a given value, there is a limit to the chroma that is possible, even with theoretically ideal coloring agents. Real coloring agents, with less than ideal characteristics, impose further limitations on physical representations of the color solid. The Munsell Color Order System itself is applicable to all possible colors. The highest chroma yellow colors have rather high values, while the highest chroma blue colors have lower values.

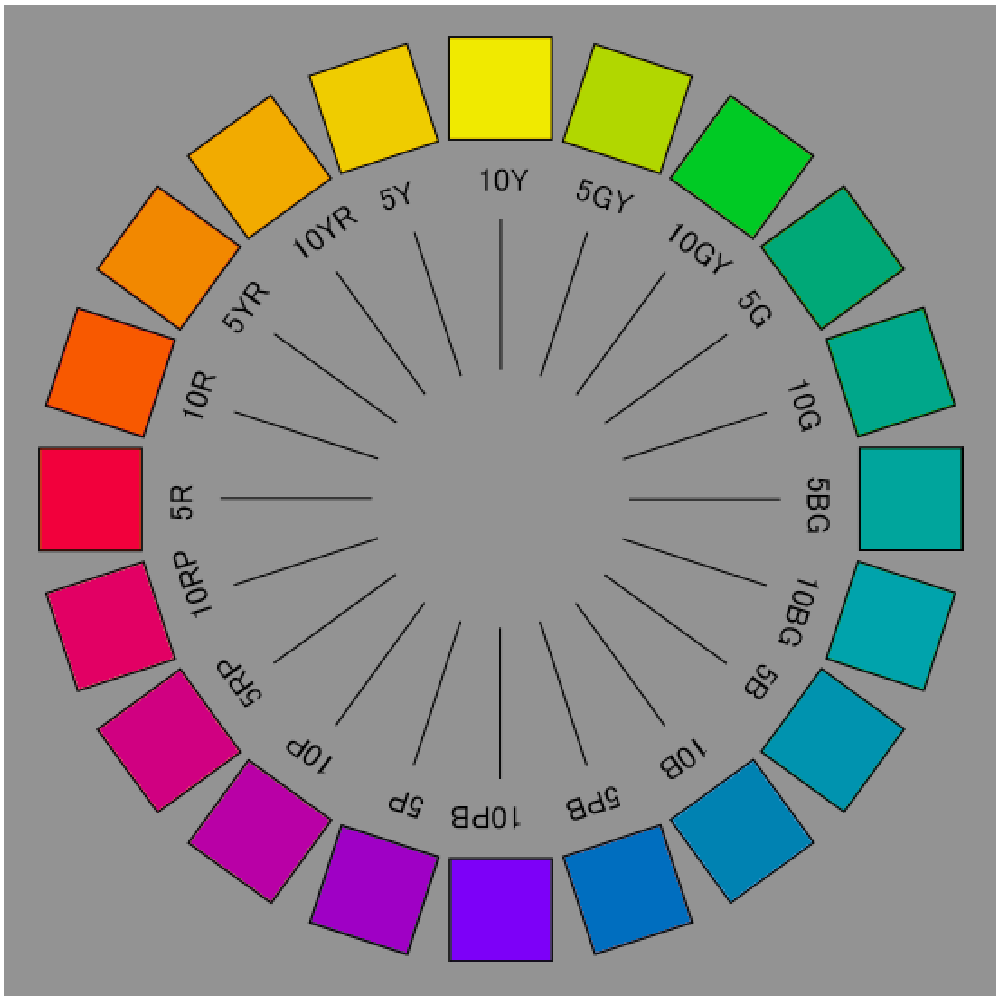


## IV. Munsell Color Notation (continued)

Munsell color order system is based on a three-dimensional model depicted in the Munsell color tree. Each color has three qualities or attributes:

1. Hue – color such as red, orange, yellow, etc.

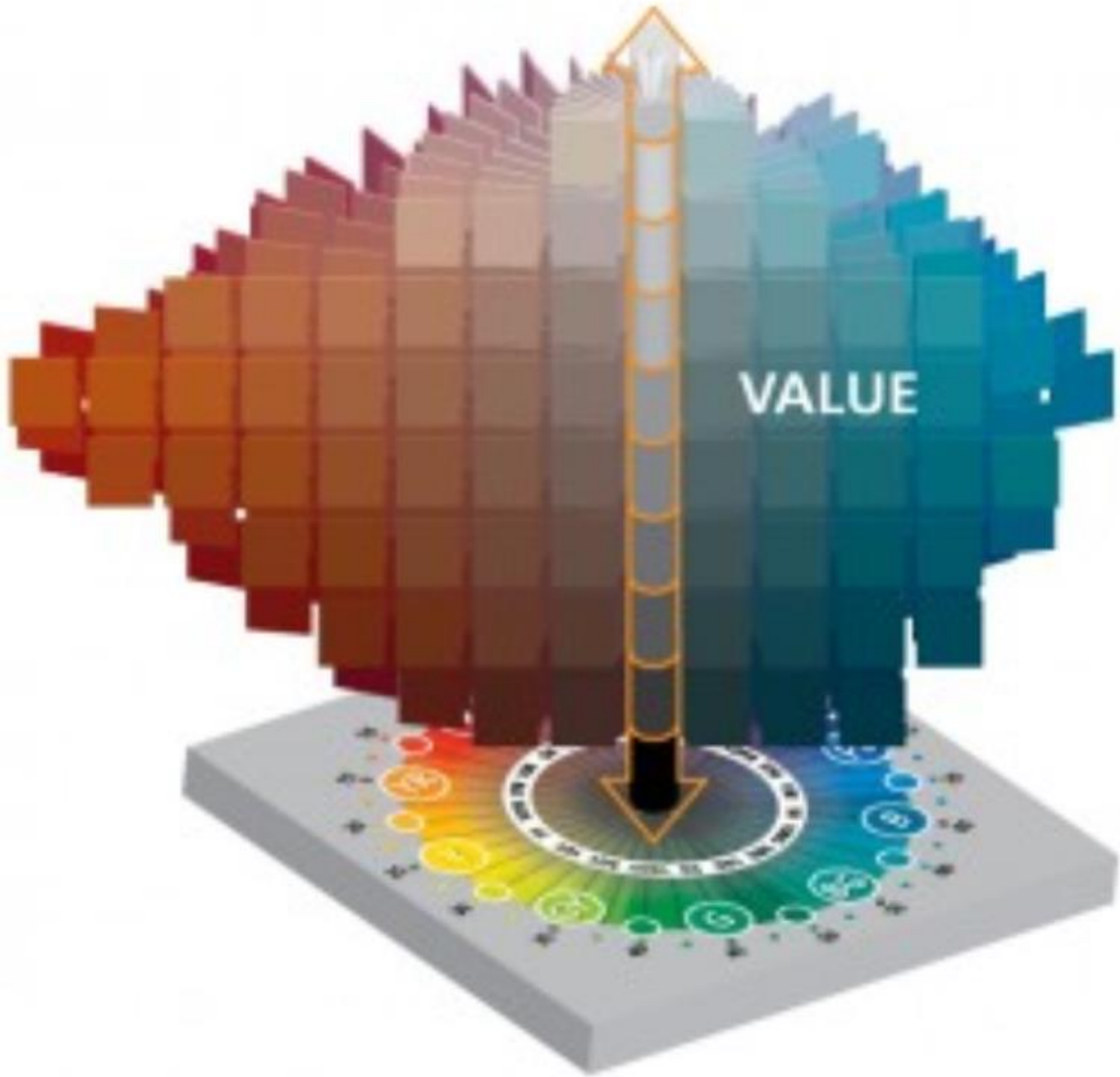
   Munsell arbitrarily divided the hue circle into 100 steps of equal visual change in hue, with the zero point at the beginning of the red sector, as shown in Figure 1. Hue may be identified by the number from 0 to 100, as shown in the outer circle. This may be useful for statistical records, cataloging and computer programming. However, the meaning is more obvious if the hue is identified by the hue sector and the step, on a scale of ten, within that sector. For example, the hue in the middle of the red sector is called “five red”, and is written “5R.” (The zero step is not used, so there is a 10R hue, but no 0 YR.) This method of identifying hue is shown on the figure below.




## IV. Munsell Color Notation (continued)

2. Value – the lightness or darkness of a color

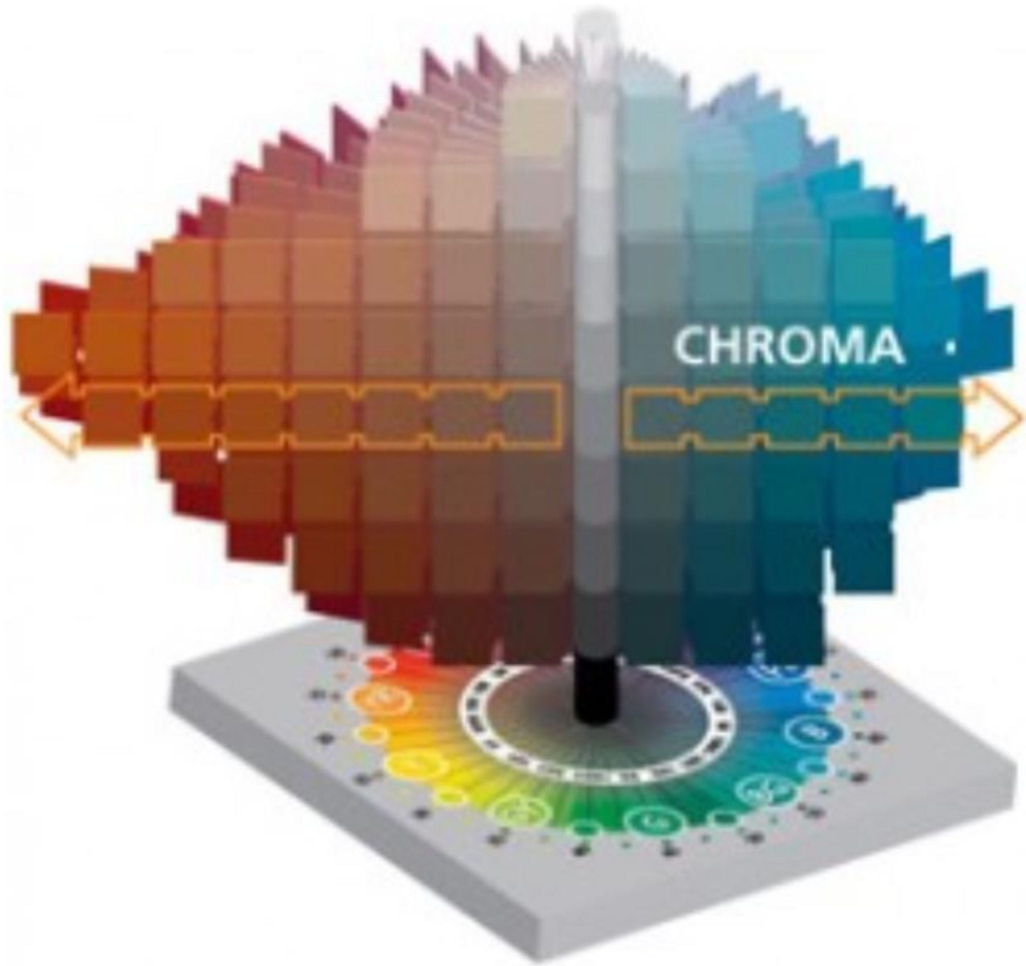
Value indicates the lightness of a color. The scale of value ranges from 0 for pure black to 10 for pure white. Black, white and the grays (as shown in the illustration) between them are called “neutral colors”. They have no hue. Colors that have a hue are called “chromatic colors.” The value scale applies to chromatic as well as neutral colors.



## IV. Munsell Color Notation (continued)

3. Chroma – the saturation or brilliance of a color

Chroma is the departure degree of a color from the neutral color of the same value. Colors of low chroma are sometimes called “weak,” while those of high chroma (as shown in figure 3) are said to be “highly saturated,” “strong,” or “vivid.” Imagine mixing a vivid red paint, a little at a time, with a gray paint of the same value. If you started with gray and gradually added red until the vivid red color was obtained, the series of gradually changing colors would exhibit increasing chroma. The scaling of chroma is intended to be visually uniform and is very nearly so. The units are constant. The scale starts at zero, for neutral colors, but there is no arbitrary end to the scale. As new pigments have become available, Munsell color chips of higher chroma have been made for many hues and values. The chroma scale for normal reflecting materials extends beyond 20 in some cases. Fluorescent materials may have chromas as high as 30.




Source: http://munsell.com/

## V. ANA (Army/Navy Aeronautical) Color System

The ANA system of color classification was the result of combining and justifying the numerous different color systems used by United States Military Aviation in 1939. The colors for aeronautical use were described by a three-digit number in the 5xx or 6xx range, and included approximately 44 colors. Lustre was not addressed by the color number.

The list was revised in 1943, and included only 28 colors.

Charts of ANA colors are available at:

Pre-1943 http://www.cybermodeler.com/color/ana_matrix.shtml

1943 and Later http://www.cybermodeler.com/color/ana_table2.shtml

*Sources: http://www.cybermodeler.com/*

ANA was strictly for aeronautical use. Several other standards were in effect, with all being aimed at bringing some form of order to the military procurement system. QM-31 is only one.

QM-31 Pre-war: http://www.cybermodeler.com/color/qm_matrix.shtml

## VI. Federal Standard FS-595a, FS-595b, (etc.)

Federal Standard 595 was first issued in March 1956 to provide a reference for "Colors Used in Government Procurement." The colors in the Federal Standard set have no official names, just five-digit numbers. Any names given below are generic.

The first figure can be 1,2 or 3 and indicates the level of specularity (sheen):

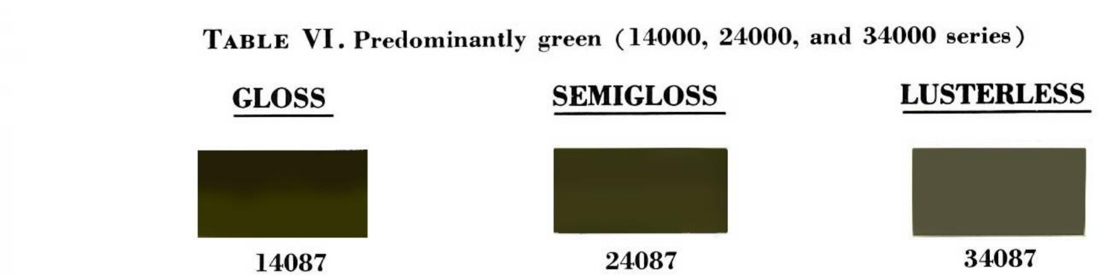
- 1 = gloss    2 = semi gloss    3 = matt

The second figure indicates a general color classification group;

| | |
|---|---|
| 0 = Brown | 5 = Blue |
| 1 = Red | 6 = Grey |
| 2 = Orange | 7 = Other (white, black, violet, metallic) |
| 3 = Yellow | 8 = Fluorescent |
| 4 = Green | |

The remaining figures (third to fifth) combined into a number indicate the intensity. Lower value indicates a darker color, higher value - a lighter color, with no other significance. The numbers have been assigned with gaps to allow addition of new colors. Fed-Std-595 is a color collection, not a complete color system, and this has the following implications:

- The existence of a color chip 1xxxx in the FS Fan Deck doesn't imply that there is a color chip for 3xxxx. However, references to such "virtual" chips built on the principle "same color, but different sheen" is a widespread practice.
- The FS in not extensible, i.e. it does not allow to derive new colors form the existing ones. Thus, if you compare i.e. RLM colors to FS codes, you can only refer to the nearest existing FS color, which most often isn't a perfect match. In practice, the FS set is extensive enough to find a good-enough match for almost any color.




| | ILLUMINANT C | | | ILLUMINANT A | | | ILLUMINANT F | | |
|---|---|---|---|---|---|---|---|---|---|
| Color Number | X | Y | Z | X | Y | Z | X | Y | Z |
| 14087 | 2.02 | 2.11 | 1.25 | 2.48 | 2.21 | 0.39 | 2.13 | 2.20 | 0.75 |
| 24087 | 2.98 | 3.09 | 2.09 | 3.64 | 3.21 | 0.66 | 3.14 | 3.21 | 1.18 |
| 34087 | 5.16 | 5.26 | 4.41 | 6.15 | 5.43 | 1.35 | 5.34 | 5.40 | 2.52 |

Example of FS-595a specification (color chips and tristimulus values)

## VI. Federal Standard FS-595a (continued)

Color Cross Reference. The following colors meet the special requirements for safety, highway and camouflage colors.

| Safety Colors (OSHA) | | | Highway Colors (DOT) | | | Camouflage Colors (NATO) | | |
|---|---|---|---|---|---|---|---|---|
| Red | -- | 11105 | Brown | -- | 10055 | International Orange | -- | 12197 |
| | -- | 11120 | Red | -- | 11086 | Silver/Aluminum | -- | 17178 |
| | -- | 11140 | | -- | 11105 | Brown 383 | -- | 30051 |
| Orange | -- | 12300 | Orange | -- | 12243 | Mid Brown | -- | 30117 |
| | -- | 12246 | Yellow | -- | 13507 | Brown | -- | 30140 |
| Yellow | -- | 13591 | | -- | 13538 | Red | -- | 31136 |
| | -- | 13655 | Green | -- | 14066 | Light Red | -- | 31158 |
| Green | -- | 14120 | | -- | 14109 | Field Drab | -- | 33105 |
| | -- | 14260 | Blue | -- | 15065 | Earth Yellow | -- | 33245 |
| Blue | -- | 15092 | | -- | 15090 | Tan 686 | -- | 33446 |
| | -- | 15102 | School Bus Yellow | -- | 13415 | Sand | -- | 33303 |
| Purple | -- | 17142 | | | | Dark Sandstone | -- | 33510 |
| | -- | 17155 | | | | Yellow | -- | 33538 |
| | | | | | | Aircraft Green | -- | 34031 |
| | | | | | | Dark Green | -- | 34082 |
| | | | | | | Green 383 | -- | 34094 |
| | | | | | | Dark Green | -- | 34108 |
| | | | | | | Light Green | -- | 34558 |
| | | | | | | Light Green | -- | 34449 |
| | | | | | | Light Blue | -- | 35109 |
| | | | | | | Gray | -- | 36231 |
| | | | | | | Aircraft Gray | -- | 36300 |
| | | | | | | Black | -- | 37030 |
| | | | | | | Interior Aircraft Black | -- | 37031 |
| | | | | | | Black | -- | 37038 |
| | | | | | | Violet | -- | 37100 |
| | | | | | | White | -- | 37875 |

Note: The chips for camouflage colors shall be used for general color matching purposes only. The specifications for camouflage coatings contain requirements for infrared reflectance which must be met in addition to color. The color cards (chips) for the camouflage colors will contain pigments chosen for their stability and compatibility with the color card coating and, therefore, have different infrared reflectance characteristics than those required for camouflage coatings. Merely matching the color chip for color will not be sufficient to assure product acceptance by the contracting activity.

Note: FS595 color standards (fan decks, binders, etc.) available for purchase here:
http://www.estore.fed-std-595.com/

FS595a is based upon the following ASTM (American Society for Testing and Materials) Standards:

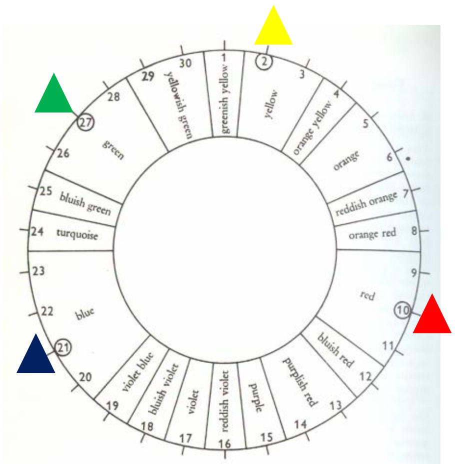
- D 523 -- Specular Gloss.
- D 1729 -- Visual Evaluation of Color Differences of Opaque Materials.
- D 2244 -- Calculation of Color Differences from instrumentally measured color coordinates.
- E 308 -- Spectrophotometry and Description of Color in CIE 1931 System.

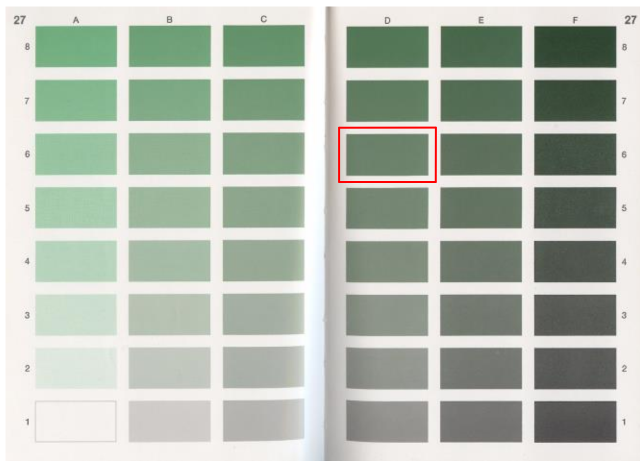
Sources:
*Federal Standard 595 Paint Spec* from Fed-Specs.com
FastPoint Technologies, Inc. 8381 Katella Ave, Suite J Stanton, CA 90680

## VII. *Methuen Handbook of Colour* by Andreas Kornerup and Johan Henrik Wanscher


*The Methuen Handbook of Colour* was published by Eyre Methuen, London in 1963 as a guide for botanists (mainly) and other scientists that need to describe colors. It covers the essentials of color practice and includes an international dictionary of colors with British Standard equivalents.

It is laid out as a series of color plates, each of a specific hue, derived by dividing the color wheel into 30 segments. Each plate is divided into six densities or saturation levels (A/low thru F/high), and each of those divided into eight intensities or levels of chroma (1/low thru 8/high) for a total of 1440 colors. Thus, a color described as 27D6 would be found to be an intermediate chroma, moderately saturated blue-green.




The handbook has been published in at least three editions, but because the images are printed as opposed to being true paint chips, there are noticeable variations between same color in each of the editions (and, indeed, between copies of the same edition.) Copies are also rare and expensive.

Scarcity and color variation make this a problematic standard to use as a reliable reference. This is of interest to modelers mainly because of its use by Ray Rimmel (among others) to describe the colors of World War I aircraft. So, sometimes, this is the only reference available. Given the uncertainty involved in early aviation, it may just be good enough.

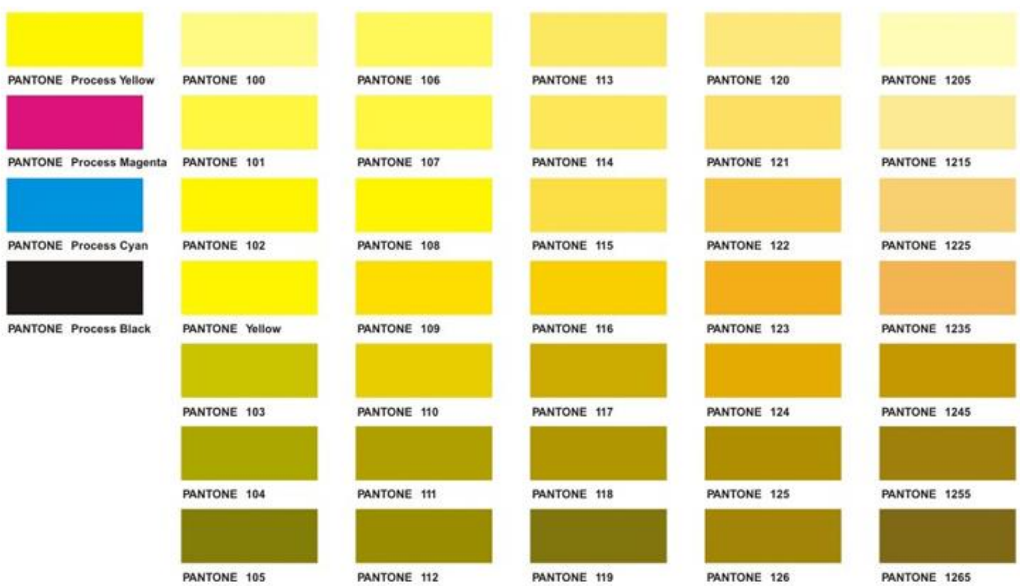
Additional information can be found here:
http://artquill.blogspot.com/2012/12/methuen-color-index-and-classification.html

## VIII. Pantone Color Matching System

The Pantone Color Matching System is largely a standardized color reproduction system (i.e. used in printing). By standardizing the colors, different manufacturers in different locations can all refer to the Pantone system to make sure colors match without direct contact with one another.

One such use is standardizing colors in the CMYK process. The CMYK process is a method of printing color by using four inks—cyan, magenta, yellow, and black. A majority of the world's printed material is produced using the CMYK process, and there is a special subset of Pantone colors that can be reproduced using CMYK. Those that are possible to simulate through the CMYK process are "process colors" as such within the company's guides.

However, most of the Pantone system's 1,114 spot colors cannot be simulated with CMYK but with 13 base pigments (14 including black) mixed in specified amounts. The Pantone system also allows for many special colors to be produced, such as metallics and fluorescents. Pantone colors are described by their allocated number (typically referred to as, for example, "PMS 130"). PMS colors are almost always used in branding and have even found their way into government legislation and military standards (to describe the colors of flags and seals.)




Example of a Pantone™ color chart page. The complete system involves several books, some containing over 100 such pages.

Pantone color matching tools available for purchase at:
http://www.pantone.com/graphics/pantone-matching-system

*Source: https://en.wikipedia.org/wiki/Pantone*

## IX. RAL Standard Colors (Reichs-Ausschuß für Lieferbedingungen und Gütesicherung 840, 840-R, etc.)

In 1927 the German *Reichs-Ausschuß für Lieferbedingungen und Gütesicherung* (State Commission for Delivery Terms and Quality Assurance) invented a collection of 40 colours under the name of "RAL 840". Prior to that date manufacturers and customers had to exchange samples to describe a tint, whereas from then on they would rely on numbers.

In the 1930s the numbers were changed uniformly to four digits and the collection was renamed to "RAL 840 R" (R for revised). With tints constantly added to the collection, it was revised again in 1961 and changed to "RAL 840-HR", which consists of 210 colors and is in use to this day. In the 1960s the colors were given supplemental names to avoid confusion in case of transposed digits.

As "RAL 840-HR" covered only matte paint the 1980s saw the invention of "RAL 841-GL" for glossy surfaces, limited to 193 colors. A main criterion for colors in the RAL Classic collection is to be of "paramount interest". Therefore most of the colors in it are used on warning and traffic signs or are dedicated to government agencies and public services (for example: RAL 1004 - Swiss Postal Service, RAL 1021 - Austrian Postal Service, RAL 1032 - German Postal Service). The first digit relates to the shade of the color:

| Range | Range Name | First | Last | QTY |
|---|---|---|---|---|
| RAL 1xxx | Yellow | RAL 1000 Green Beige | RAL 1037 Sun Yellow | 40 |
| RAL 2xxx | Orange | RAL 2000 Yellow Orange | RAL 2013 Pearl Orange | 14 |
| RAL 3xxx | Red | RAL 3000 Fire Red | RAL 3033 Pearl Pink | 34 |
| RAL 4xxx | Violet | RAL 4001 Red Purple | RAL 4012 Pearl Black Berry | 12 |
| RAL 5xxx | Blue | RAL 5000 Violet Blue | RAL 5026 Pearl Night Blue | 25 |
| RAL 6xxx | Green | RAL 6000 Patina Green | RAL 6038 Luminous Green | 36 |
| RAL 7xxx | Grey | RAL 7000 Squirrel Grey | RAL 7048 Pearl Mouse Grey | 38 |
| RAL 8xxx | Brown | RAL 8000 Green Brown | RAL 8029 Pearl Copper | 20 |
| RAL 9xxx | White/Black | RAL 9001 Cream | RAL 9023 Pearl Dark Grey | 14 |

**RAL F9**

This collection, which follows the naming of RAL Classic, was invented in 1984. It is made up of only 3 colors (RAL 6031 - green bronze, RAL 8027 - leather, RAL 9021 - tar), used by the *Bundeswehr* for military camouflage coating.

A .pdf rendition of RAL color chips is available at:
http://sweets.construction.com/swts_content_files/153167/600149.pdf

*Source: https://en.wikipedia.org/wiki/RAL_colour_standard*

## X. RLM Standard Colors L.Dv. 521

The colors used by the Luftwaffe were defined by the State Ministry of Aviation (*Reichsluftfahrt Ministerium*), which established a standard for color shades, their production and application. These directives were promulgated through a series of service regulations (*Luftwaffen Dienstvorschriften*) designated L.Dv. 521. The earliest edition to survive (L.Dv. 521/1) is dated March 1938 and included a color table (*Farbtontafel*) that was to be matched by manufacturers, aircraft repair depots, and front-line units. Other regulations, some of which had been established before the formation of the RLM itself in 1933, limited the number of colors and encouraged production from pigments that could be obtained in Germany. At a time of limited hard currency, such policies simplified purchase and storage, and minimized dependence on imported raw materials. Paints were supplied by different companies and, although aircraft manufacturers could choose which commercial products to purchase, they all were to adhere to these uniform standards, as represented by the *Farbtontafel* and later by individual paint chips.

There is no official description of RLM 81/82/83 nor any surviving paint samples. Dornier referred to both RLM 81 and 82 as *Dunkelgrün*; Messerschmitt and Blohm & Voss described them as *Braunviolett* and *Hellgrün*, respectively. Lacking sufficient documentation, RLM 83 is more enigmatic. Although aircraft samples show considerable variation in shade, it seems likely that these colors were reissues of the nearly identical RLM 61/62/64 that had appeared in the *Farbtontafel* of 1936 but been withdrawn from service by the beginning of the war.

After the war, the reconstituted Luftwaffe used RAL colors.

More information at:
http://www.rlm.at/download/rlmpdf_e.pdf
http://www.cybermodeler.com/color/rlm.shtml
Color Chart of RLM Colors available at:
http://www.cybermodeler.com/color/rlm_matrix.shtml

Not usually depicted on color charts are:
RLM00 (Clear Lacquer or Varnish)
RLM01 Silber (used extensively on pre-war aircraft)
RLM99, which meant no coloration, such as for bare metal panels or putty

Source:
http://penelope.uchicago.edu/~grout/encyclopaedia_romana/luftwaffe/colors.html