

Automotive Paint Color Characterizations, Comparisons and Make-Model-Year Searches

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1 INTRODUCTION

The FBI Laboratory uses an assortment of automotive paint resources to conduct make-model-year searches for investigative lead purposes. The color standard resources are received as physical or software-based color exemplars that represent original factory colors available on most imported and domestic vehicles marketed in North America. The physical samples can be received as manufacturer refinisher chips or painted color standards.

The color standards can also contain full layer systems and represent the color and chemical composition of the automotive paint formulations used at specified manufacturer plants that produce vehicles sold in North America. These painted standards are known as the National Automotive Paint File (NAPF). Each of these resources can be used as standalone color evaluators, or in conjunction with the Paint Data Query (PDQ) chemical database.

PDQ is an automotive paint database that contains information about the factory-applied topcoat and undercoat (primer) paints applied to most imported and domestic vehicles marketed in North America. It is reserved exclusively for law enforcement agencies involved in forensic investigations and is only available through a Memorandum of Understanding (MOU) with the Royal Canadian Mounted Police (RCMP) after training has been received in the use and limitations of PDQ.

2 SCOPE

This procedure applies to Chemistry Unit case working personnel who use automotive paint resources such as automotive manufacturer refinisher color chips, NAPF reference panels, and the PDQ database and reference samples for make-model-year searches.

3 EQUIPMENT

- Automotive paint manufacturer refinish color standards, (e.g., BASF, Axalta, PPG)
- Stereo microscope (~6X to ~100X) with two different lighting conditions (e.g., ring light oriented at ~180° and fiber optic light oriented ~45° from sample surface)
- PDQ software program (PDQi), current update, RCMP, PDQ Maintenance team, Edmonton, Alberta, Canada)
- Know-It-All spectral search software, current revision (Wiley and Sons, Inc)
- FBI Laboratory's NAPF physical collection
- NAPF software (Microsoft Access format)
- Munsell Book of Color, Matte and Glossy Collections (Macbeth Division of Kollmorgen Instruments Corporation, New Windsor, NY)

- Munsell Neutral Value Scale, Matte Edition (Macbeth Division of Kollmorgen Instruments Corporation, New Windsor, NY)
- Minolta CHROMA METER CR-241 Colorimeter, or equivalent
- Calibration Standard - White Calibration Plate (Currently Serial Number 11876001) (Konica Minolta or equivalent)
- PPG RapidMatch® spectrometer and software updates (PPG Industries)

4 STANDARDS AND CONTROLS

To ensure the PDQ database is installed and functioning properly, a “QA/QC test” query is supplied to each user annually with the database update. The completed query is returned to the RCMP prior to expiration of the previous version of the database.

The colorimeter and RapidMatch® spectrometer each has a color plate used to calibrate the instrument response with each day’s use.

5 PROCEDURE

5.1 General Approach

Determine if a paint specimen is a factory-applied, original equipment manufacturer (OEM) automotive finish using an appropriate Paints and Polymers (PP) technical procedure (e.g., PP-800, PP-300, PP-200).

For any automotive paint basecoat comparison or sourcing, physical exemplars or color search software can be used to assist with color code searches. If the automotive paint is an OEM, use PDQ for make-model-year searches.

5.2 Color Measurements

If appropriate, conduct color measurements on comparative items.

5.2.1 Colorimeter

- A. The tristimulus value of an exposed surface of a paint sample can be measured using the Minolta Colorimeter. Performance monitoring is conducted using the Yxy color space and samples are measured using the Munsell scale color space.

5.2.1.1 *Performance Monitoring*

The colorimeter must be calibrated prior to each use and when the measurement selector is changed.

- A. With the instrument on and ready for use, select the desired measurement area based on the sample size.

- B. Press the CALIBRATE button on the upper left side of the key pad. This will retrieve the previous settings, which will be shown in the display located in the upper right corner of the base.
- C. Ensure that the values are set in Yxy color space. If they are not, press the COLOR SPACE SELECT button until the proper setting is displayed.
- D. Place the white calibration plate on the specimen stage and focus the instrument until the dots on the plate and the white surface appear sharp through the viewfinder.
- E. Adjust the specimen stage so that the measurement area is centered between the two dots on the calibration plate.
- F. Press the MEASURE button. A series of three measurements will be taken. Once calibration is complete, the new values will appear in the display.
- G. Compare the displayed values with the values printed on the inside cover of the calibration plate.

1. Currently, calibration plate serial number 11876001 is in use and the values are:

C	Y 93.1	x 0.3126	y 0.3190
D65	Y 93.1	x 0.3151	y 0.3318

2. If the values are in agreement, the instrument is now ready for the analysis of samples. If the values are not in agreement, enter the standard (actual) values for the white calibration plate to correct the calibration. Record the correction, operator's name, date, and comments in the instrument's logbook.

- H. If any requirements fail, contact appropriate Unit personnel.

5.2.1.2 Sample Measurement

- A. The surface of the sample must be at least 0.3 mm in diameter.
- B. Samples should lay flat and possess little or no surface damage or contamination.
- C. Measurements obtained on samples being compared need to be collected using the same measurement area (0.3 mm or 1.8 mm diameter). Record which measurement area was used. When sample size permits, three readings are

recommended for the 1.8 mm diameter measurement area. A single measurement is recommended for the 0.3 mm diameter measurement area.

5.2.2 Munsell color resources

Alternatively, evaluate color designations using the Munsell color books or neutral scale.

5.2.3 PPG RapidMatch® spectrometer

- A. For automotive paint, the PPG RapidMatch® color matching spectrometer with accompanying Paint Manager® library can be used to determine automotive paint color codes if the sample is at least 3 cm x 2 cm in size.
- B. Calibrate the RapidMatch® spectrometry tool prior to each day's use by aligning it flat onto the white surface of the calibration plate and pressing the measurement button on the top of the tool. Once the reading is returned on the display window, align the orange-brown metallic surface (i.e., simulated automotive paint) with the spectrometer window, and again press the measurement button. The spectrometer will take a set of three measurements in rapid succession before indicating the tool is ready for use. Record use of the tool in its QA/QC logbook according to the procedures described in section 8.4 of the General Instrument Maintenance Protocol.
- C. For best results, ensure that the samples lay flat and possess little or no surface damage or contamination.
- D. Move the tool on the surface of the paint chip to collect five measurements. Once the measurements are recorded by the spectrometer, interface it to the Paint Manager® library in order to generate a hit list of manufacturer color codes that best align with the color measurements recorded by the spectrometer. Record the results of the library search.

5.3 PDQ

- A. Using the IR peak assignment charts as a guide, code the FTIR spectrum of each layer. In general, the RCMP recommends that the basecoat layer only be coded for binder information.
- B. If sample size permits, elemental analysis can also be conducted to further characterize the paint layers.
- C. (Optional): Assign Munsell color designations to the primer layer(s). For details, refer to PP-300.
- D. Conduct layer system queries through the PDQ database and/or search collected FTIR spectra using the PDQ spectral libraries.

E. For a layer system query search:

1. Evaluate the candidates acquired. Search criteria can be adjusted to broaden or narrow the search results. FTIR spectra of possible hits can be compared to further evaluate a candidate.
2. Once the search criteria are established, determine if a particular manufacturer and/or assembly plant is predominant.

F. For a spectral library search:

1. Compare each spectral candidate to the spectrum in question. If the spectra and color assignment compare favorably, that layer is considered a candidate.
2. Alternatively, conduct simultaneous multilayer spectral searches in order to target a particular plant more efficiently.

G. Record any trends in automotive manufacturer, assembly plant, and/or year(s) of production.

H. If a full layer system exemplar from the internal PDQ or NAPF collections is a good candidate, refer to PP analytical instrumentation procedures for chemical comparison (e.g., PP-200, PP-201, PP-202).

5.4 NAPF

- A. Assign a Munsell color designation to the color coat layer.
- B. Conduct a search through the NAPF database using a range for the Munsell color designation.
- C. The range for the Munsell hue, value, and chroma can be adjusted to narrow or broaden the search results.
- D. Additional search criteria can be selected (e.g., metallic/non-metallic, visual color, manufacturer) to further narrow the search results.
- E. Compare the color and appearance of the sample to the selected paint standards.
- F. Conduct color comparisons at low power magnification (~6X to ~100X) using two different lighting conditions.
- G. Record the results of the comparisons.

- H. A second PP examiner evaluates and records their results for any potential candidates.
- I. If a particular color is a candidate, the manufacturer can be contacted or searched online to obtain information regarding model and year information for the color.
- J. Record any trends in automotive manufacturer, assembly plant, and/or year(s) of production.
- K. If a full system panel is a good candidate, refer to PP analytical instrumentation procedures for chemical comparison (e.g., PP-200, PP-201, PP-202).

5.5 Manufacturer Color Refinish Resources

- A. If trends such as a particular manufacturer and/or production year exist, refer to the corresponding color refinisher pages for direct color comparisons.
- B. If no trends exist, search for color chips within the color refinisher pages for model years that coincide with the incident date(s), as well as relevant previous model years.
- C. Record potential color matches from the color standards in the color refinisher pages and compare the color and appearance of observed candidates to the sample using a stereo microscope. For details, refer to PP-300.
- D. Conduct color comparisons at low power magnification (~6X to ~100X) using two different lighting conditions.
- E. Record the results of the comparisons.
- F. A second qualified PP examiner evaluates and records their results for any possible candidates that compare favorably in color and appearance.
- G. If a particular color is considered a candidate, consider contacting the manufacturer to obtain or to verify model and year information printed on the refinisher pages for a given color.

6 LIMITATIONS

- Not all makes and/or years of vehicles produced by each manufacturer are present in these color resources.
- Sample size and condition can preclude conducting certain examinations, including color assessment and layer structure.
- Some data entry errors have been noted in these resources. Verify search results using independent resources when practicable.

- The paint formulation of the NAPF panel may not be representative of the chemistry used for a particular color or paint system. Chemistries may differ between manufacturing plants for paints being applied to different substrates.
- Paint color standards on paper or plastic substrates can differ slightly from the appearance of a specimen from an automobile.
- Automotive manufacturer color names can change for a given color between model years. Refer to the paint manufacturer codes to determine if colors issued in different model years are intended to be the same color.

7 REFERENCES

PP-200, Chemistry Unit, FBI Laboratory

PP-201, Chemistry Unit, FBI Laboratory

PP-202, Chemistry Unit, FBI Laboratory

PP-300, Chemistry Unit, FBI Laboratory

PP-800, Chemistry Unit, FBI Laboratory

8 REVISION HISTORY

Revision	Issued	Changes
06	09/01/2022	Added Colorimeter performance monitoring in order to archive Inst-601 technical procedure.
07	01/02/2025	Minor grammatical edits.