This document has been sent to **ASTM International** for development as an ASTM Standard. For information about ASTM and their process please refer to astm.org. This document is being made available at this stage of the process so that the forensic science community and interested stakeholders can be more fully aware of the efforts and work products of the Organization of Scientific Area Committees for Forensic Science (OSAC). The documents were prepared with input from OSAC Legal Resource Committee, Quality Infrastructure Committee, and Human Factors Committees, as well as the relevant Scientific Area Committee. The content of the documents listed below is subject to change during the standards development process within ASTM and may not represent the contents of the final published standard. All stakeholder groups or individuals are strongly encouraged to submit technical comments on this draft document during the ASTM balloting process. Technical comments will not be accepted if submitted to the OSAC Scientific Area Committee or Subcommittees.

Standard Practice for a Forensic Paint Analysis Training Program

Date: August 2018

To: Subcommittee E30.01 members

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Work Item #: WK64632

Ballot Action: Proposed new standard

Rationale: The OSAC Materials (Trace) Subcommittee has developed a training document for the forensic analysis of paint. This document was created through a consensus process. It is anticipated that the standard will be used by practitioners and laboratories to develop a training program for the forensic analysis of paint. Legal or scientific terms that are generally understood or defined adequately in other readily available sources may not be included in this standard. This is the first time this item has been balloted at the subcommittee level.

Standard Practice for a Forensic Paint Analysis Training Program

1. Scope

1.1. This document is intended as a practice for use by laboratory personnel responsible for training examiners to perform forensic examinations and comparisons of paint.

1.1.1. This standard cannot replace knowledge, skills, or abilities acquired through education, training, and experience and is to be used in conjunction with professional judgement by individuals with such discipline-specific knowledge, skills, and abilities.

1.2. It contains a list of training objectives with recommended methods of instruction, reading assignments and structured exercises to provide practical experience for the trainee.

1.2.1. Additional training could be required for a particular method or instrument referred to herein. The application of analytical techniques to paint analysis assumes the trainee is already competent in the use of each particular analytical technique or instrumental method.

1.2.2. Other sources of information on forensic paint examination not specifically mentioned in this document can be considered and added.

1.2.3. Additional paint training beyond that which is listed here should be made available to the trainee. Such training could include off-site courses, internships, and specialized training by experienced examiners.

1.2.4. Continuing education and training is recommended. Additional training provides a forensic paint examiner with the opportunity to remain current in the field.

1.2.5. Paint samples occasionally are evaluated for physical matches of broken edges. This document does not provide training requirements for physical match comparisons. Additional training is required to conduct this type of analysis.

1.3. This document is in a modular format for easy adaptation to an individual laboratory's training program. Recommendations as to lessons, practical exercises, progress monitoring, and trainee evaluations are included. Reading assignments with full citations are listed in each subsequent section of this document.

1.4. A paint training program provides a theoretical foundation and basic practical skills necessary to prepare a trainee to become a qualified forensic paint examiner. At the end of the

paint training program, the trainee is capable of forming opinions based upon sound scientific knowledge, proper examinations, and practical experience. The trainee also is able to independently work cases, write reports, testify in court, and peer review cases.

1.5. This standard practice does not address human factors (e.g. cognitive bias). It is the responsibility of the user of this standard to address human factors during the initial or general training of a forensic scientist. Refer to ASTM E2917 Standard Practice for Forensic Scientist Practitioner Training, Continuing Education, and Professional Development Programs.

1.6. This standard practice does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1. ASTM E2917 Standard Practice for Forensic Scientist Practitioner Training, Continuing Education, and Professional Development Programs

2.2. ASTM D16 Terminology for Paint, Related Coatings, Materials, and Applications

2.3. ASTM D1535 Practice for Specifying Color by the Munsell System

2.4. ASTM E308 Practice for Computing the Colors of Objects by Using the CIE System

2.5. ASTM E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory

2.6. ASTM E1610 Standard Guide for Forensic Paint Analysis and Comparison

2.7. ASTM E2808 Guide for Microspectrophotometry in Forensic Paint Analysis

2.8. ASTM E2809 Guide for Using Scanning Electron Microscopy/X-ray Spectrometry in Forensic Paint Examinations

2.9. ASTM E2937 Guide for Using Infrared Spectroscopy in Forensic Paint Examinations

3. Significance and Use

3.1. The procedures outlined herein are grounded in the generally accepted body of knowledge and experience in the field of forensic paint examination and comparison.

3.2. With successful completion of this paint training program, the trainee gains the theoretical knowledge and practical skills necessary to perform forensic paint examinations and comparisons.

3.3. This training document covers a variety of instrumental methods which can be used in the analysis of paint. Not all laboratories will have access to all of the instrumentation.

3.3.1. Instrumental methods that provide organic and inorganic analysis capabilities are utilized in the laboratory training program. Examples include Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, Pyrolysis Gas Chromatography (PGC), Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM/EDS), X-ray Fluorescence (XRF), and X-ray Diffraction (XRD).

4. Responsibilities

4.1. Each trainee is trained by and works under the guidance of, one or more qualified forensic paint examiners.

4.1.1. The trainee shall meet the objectives set forth in the training program.

4.2. A trainer shall be technically qualified in forensic paint examination and comparison or associated techniques. Other members of the laboratory are encouraged to offer relevant information regarding their specialty to the trainee. The trainer(s) is responsible for:

4.2.1. Introducing the trainee to the relevant scientific literature, proper procedures, training material, and reference collections.

4.2.2. Discussing readings and theory with the trainee.

4.2.3. Teaching basic microscopy and instrumental methods for the analysis and comparison of paint evidence.

4.2.4. Teaching case management.

4.2.5. Fostering ethical and proper professional conduct.

4.2.6. Teaching appropriate quality assurance and quality control procedures.

4.2.7. Reviewing tests, practical exercises, and casework samples with the trainee.

4.2.8. Teaching expert testimony skills through moot court and/or observation.

4.2.9. Monitoring the trainee's progress.

4.3. Each laboratory is required to maintain:

4.3.1. An up-to-date training program.

4.3.2. Documentation of training.

4.3.3. Documentation of competency tests and proficiency tests.

5. Syllabus

5.1. A paint training program provides the trainee theoretical knowledge and practical skills in examining, interpreting, reporting, testifying, and reviewing forensic paint cases. This is accomplished through a combination of the following training methods:

5.1.1. Reading of relevant literature

5.1.1.1. The reading assignments listed are suggestions. Newer versions can be used. Other relevant literature can be used or substituted.

5.1.2. Instruction and observation of forensic paint examiners.

5.1.2.1. Lectures and discussions.

5.1.2.2. Practical demonstration of basic skills.

5.1.2.3. Casework.

5.1.2.4. Court testimony.

5.1.3. Practical skills.

5.1.3.1. Practical exercises which includes analysis of reference materials and known samples.

5.1.4. Final competency evaluations.

5.1.4.1. Written or oral tests.

5.1.4.2. Practical laboratory tests.

5.1.4.3. Mock cases.

5.1.4.4. Moot court or oral exam.

5.1.5. Performing supervised casework.

5.2. The recommended training period is between three to six months, full time, for a forensic examiner that has been previously trained and is competent in the analytical techniques utilized in the analysis of paint evidence. For new examiners with no previous training in

microscopical or instrumental techniques, the expected training period is between twelve to eighteen months.

6. Paint Analysis Training Program Objectives

6.1. Encountering Paint Evidence

6.1.1. This section introduces the trainee to the types of cases and the various conditions in which paints are encountered as physical evidence.

6.1.2. Types of paints which could be encountered as evidence include automotive paint, other vehicle paint (e.g., motorcycle, aircraft, marine, trains, bicycle.), architectural paint, maintenance paint, spray paint, and other specialty paints.

6.1.3. Reading Assignment

6.1.3.1. Ryland, S., "Infrared Microspectroscopy of Forensic Paint Evidence," Humecki, H., ed., *Practical Guide to Infrared Microspectroscopy*, Marcel Dekker, NY, 1995, pp. 163-170 and pp. 185-191.

6.1.4. Practical Exercises

6.1.4.1. Demonstrate knowledge of the types of cases and the various conditions in which paints are encountered as physical evidence through an oral or written exercise.

6.1.5. The methods of instruction for this unit are reading and research by the trainee and discussions with the trainer(s).

6.1.6. The method of evaluation for this unit is a review of the trainee's completed exercise by the trainer.

6.2. Paint Terminology

6.2.1. This section introduces the trainee to the following terms:

6.2.1.1. Additives
6.2.1.2. Binder (resin)
6.2.1.3. Coating
6.2.1.4. Cross-linker
6.2.1.5. Drier
6.2.1.6. Drying oils
6.2.1.7. Enamel
6.2.1.8. Extender
6.2.1.9. Lacquer
6.2.1.10. Latex
6.2.1.11. Paint
6.2.1.12. Pigment
6.2.1.13. Plasticizer
6.2.1.14. Solvent
6.2.1.15. Stain
6.2.1.16. Thermoplastic polymer
6.2.1.17. Thermosetting polymer
6.2.1.18. Varnish
6.2.1.19. Vehicle

6.2.2. Reading Assignments

6.2.2.1. Lambourne, R., "Paint Composition and Applications – a General Introduction," Lambourne, R. and Strivens, T., eds., *Paint and Surface Coatings, Theory and Practice,* William Andrew Publishing, 1999, pp. 1-3.

6.2.2.2. Koleske, J., ed., *Paint and Coating Testing Manual, 15th Edition of the Gardner-Sward, Handbook,* ASTM International, 2012.

6.2.3. Practical Exercise

6.2.3.1. Define the terms listed in this section.

6.2.4. The methods of instruction for this unit are reading and research by the trainee.

6.2.5. The method of evaluation for this unit is an oral or written quiz.

6.3. The Use and Composition of Paint

6.3.1. This section introduces the trainee to the uses and compositions of different types of paints to include the following:

6.3.1.1. The significance of oils, driers, solvents, plasticizers, resinous vehicles, extenders, and pigments in the formation of paint films, examples of materials used in each of these components, and the differences between a liquid paint and a dried paint film in terms of each of these components.

6.3.1.2. The manner in which latex, thermoplastic and thermosetting paint films are formed.

6.3.1.3. The impact of the film formation mechanism on a forensic paint examination.

6.3.1.4. Various types of paint to end-use applications.

6.3.1.5. Additives used in latex paints.

6.3.2. Reading Assignment

6.3.2.1. Morgans, W., *Outlines of Paint Technology*, 3rd ed., Halsted Press, NY, 1990, pp. 316-422.

6.3.3. Practical Exercise

6.3.3.1. Explain the uses and differences of the paint components listed in this section.

6.3.4. The methods of instruction for this unit are reading and research by the trainee.

6.3.5. The method of evaluation for this unit is an oral or written quiz.

6.4. Manufacturing Processes

6.4.1. This section introduces the trainee to paint manufacturing and application processes to include the following:

6.4.1.1. How raw materials are acquired and mixed.

6.4.1.2. What variations could be present in raw materials.

6.4.1.3. What variations could exist in binders from different companies.

6.4.1.4. What a batch of paint is and typically how large it is.

6.4.1.5. What quality control procedures are used in the manufacture of paint.

6.4.1.6. How paint is packaged and distributed.

6.4.1.7. Application processes for non-motor vehicle paints (e.g., brush, spray, powder coating, coil-coating).

6.4.1.8. The application process of original equipment manufacturer (OEM) finishes to motor vehicles.

6.4.1.9. Processes used in repainting and repairing vehicles.
6.4.1.10. The purposes of each motor vehicle finish layer.
6.4.1.11. Differences between OEM and repainted motor vehicle finishes.
6.4.1.12. Analytical and physical testing methods used by the paint industry.
6.4.2. Reading Assignments
6.4.2.1. Bentley, J., "Composition, Manufacture and Use of Paint," *Forensic Examination of Glass and Paint; Analysis and Interpretation*, Caddy, B., ed., Taylor & Francis, London, England, 2001, pp. 123-141.
6.4.2.2. Farkas, F., "The Industrial Paint-Making Process," *Paint and Surface Coatings, Theory and Practice*, Lambourne, R. and Strivens, T., eds., William Andrew Publishing, 1999, pp. 286-329.
6.4.2.3. Ryer, D., "Alkyd Chemistry and New Technology Trends in Coatings Resin Synthesis," *Paint & Coatings Industry*, January 1998, pp. 76-83.
6.4.2.4. Ryntz, R., "Automotive Coatings: Current Trends for Coating Plastic – Part 1," *Paint and Coatings Industry*, March 1997, pp. 36-43.
6.4.2.5. Wright, D., and Mehltretter, A., "The Prevalence of Original Equipment Manufacturer (OEM) Factory Repairs in Automotive Paint Samples," *Journal of the American Society of Trace Evidence Examiners*, Vol. 6, Issue 3, 2015, pp. 4-20.
6.4.3. Practical Exercises
6.4.3.1. Explain the manufacturing and application processes of paint.
6.4.3.2. Visit paint manufacturing facilities when practical.
6.4.4. The method of instruction for this unit is reading by the trainee.
6.4.5. The method of evaluation for this unit is an oral or written quiz.

6.5. Overview of Forensic Paint Examinations
6.5.1. This section introduces the trainee to the basic steps in forensic paint examinations and how these steps are used to identify the components of a paint film.
6.5.2. Reading Assignments
6.5.2.1. Laboratory specific paint analysis procedure(s)
6.5.2.2. Scientific Working Group for Materials Analysis (SWGMAT), "Trace Evidence Recovery Guidelines," ASTEEtrace.org/ Resources/SWGMAT/Trace Subgroup
6.5.2.3. ASTM E1610 Standard Guide for Forensic Paint Analysis and Comparison, ASTM International, West Conshohocken, PA.
6.5.2.4. Ryland, S., "Infrared Microscopy of Forensic Paint Evidence," Humecki, H., ed., *Practical Guide to Infrared Microscopy*, Marcel Dekker, NY, 1995, pp. 163-243.
6.5.2.5. Ryland, S., Jergovich, T., and Kirkbride, P., "Current Trends in Forensic Paint Examination", *Forensic Science Review*, Vol. 18, No. 2, 2006, pp. 97-117.
6.5.2.6. Stoecklein, W., "Forensic Analysis of Automotive Paints at the Bundeskriminalamt: The Evidential Value of Automotive Paints", *Crime Laboratory Digest, Vol.* 22, No. 3, 1995, p.98.
6.5.3. Practical Exercises: None
6.5.4. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.
6.5.5. The method of evaluation for this unit is an oral or written quiz.

6.6. Search, Collection and Preservation Techniques for Paint Evidence

6.6.1. This section introduces the trainee to methods for locating, collecting, and preserving all types of paint evidence. The trainee is exposed to evidence handling issues such as transfer, persistence, and loss of trace evidence. Topics include the following:

6.6.1.1. The recognition of paint fragments and paint smears.

6.6.1.2. The use of visual examinations and low power magnification.

6.6.1.3. The use of the particle picking and scraping methods to collect loose debris.

6.6.1.4. Understanding the persistence, transfer, and loss of paint evidence.

6.6.1.5. Preservation techniques appropriate for various types of paint evidence.

6.6.2. Reading Assignments

6.6.2.1. ASTM 1459, Standard Guide for Physical Evidence Labeling and Related Documentation, ASTM International, West Conshohocken, PA.

6.6.2.2. ASTM E1492, Standard Practice for Receiving, Documenting, Storing and Retrieving Evidence in a Forensic Laboratory, ASTM International, West Conshohocken, PA.

6.6.2.3. ASTM E1610, Standard Guide for Forensic Paint Analysis and Comparison, ASTM International, West Conshohocken, PA.

6.6.2.4. Palenik, S., "Microscopy and Microchemistry of Physical Evidence", Saferstein, R., ed., *Forensic Science Handbook*, Vol. II, Prentice Hall, Englewood Cliffs, NJ, 1988, pp.164-171.

6.6.2.5. Pearson, E.F., et al, "Glass and Paint Fragments Found in Men's Outer Clothing - Report of a Survey," *Journal of Forensic Sciences*, Vol 16, No 3, July 1971, pp. 283-300.

6.6.2.6. Scientific Working Group for Materials Analysis (SWGMAT), "Trace Evidence Recovery Guidelines," ASTEEtrace.org/ Resources/SWGMAT/Trace Subgroup

6.6.2.7. Scientific Working Group for Materials Analysis (SWGMAT), "Trace Evidence Quality Assurance Guidelines,"ASTEEtrace.org/ Resources/SWGMAT/Trace Subgroup

6.6.3. Practical Exercises

6.6.3.1. Perform collections from several paint samples to include paint fragments, paint smears and high impact transfers from a variety of materials utilizing the methods learned above.

6.6.3.2. Demonstrate appropriate packaging techniques for debris collected and items of evidence.

6.6.4. The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.6.5. The method of evaluation for this unit is an evaluation of the practical exercises.

6.7. Recognition, Description and Categorization of Paint

6.7.1. This section introduces the trainee to the recognition, description, and categorization of paint by:

6.7.1.1. Recognizing paint utilizing microscopical techniques including stereomicroscopy.

6.7.1.2. Describing paint layers in terms of color, layer sequence, layer thickness, gloss, and texture.

6.7.1.3. Recognizing after-market treatments, surface defects, weathering, aging, contaminants, damage, and intra/interlayer features.

6.7.1.4. Categorizing paint as automotive, other vehicle (e.g., motorcycle, aircraft, marine, trains, bicycle.), architectural, maintenance, spray, or other specialty types.

6.7.1.5. Categorizing automotive OEM finishes and automotive repaints by their layer structures. This includes the recognition of spot putties, body fillers, color coordinated primers, monocoats, and tri-coat systems.

6.7.1.6. Recognizing various types of pigments and extenders (e.g. metal flake, pearlescent, interference, effect, hiding).

6.7.2. Reading assignments

6.7.2.1. Boudreau, A., Cortner, G., "Application of Differential Interference Contrast Microscopy to the Examination of Paints," *Journal of Forensic Sciences*, Vol. 24, No. 1, 1979, pp. 148-153.

6.7.2.2. Govaert, F., and Bernard, M., "Discriminating Red Spray Paints by Optical Microscopy, Fourier Transform Infrared Spectroscopy, and X-Ray Fluorescence", *Forensic Science International*, Vol.140, No. 1, pp. 61-70.

6.7.2.3. Hamer, P., "Pigment Analysis in the Forensic Examination of Paints III: A Guide to Motor Vehicle Paint Examination by Transmitted Light Microscopy," *Journal of the Forensic Science Society*, Vol 22, 1982, pp. 187-192.

6.7.2.4. Iden, R., "Teamwork Brings Innovative Effect Pigment to Light", *Journal of Coatings Technology*, Vol. 67, No. 843, pp. 57-59.

6.7.2.5. Kilbourn, J., and Marx, R., "Polarized Light Microscopy of Extenders in Structural Paints – Forensic Applications," *The Microscope*, Vol. 42, No. 2, 1994, pp. 167-175.

6.7.2.6. Koleske, J., ed., *Paint and Coating Testing Manual, 15th Edition of the Gardner-Sward, Handbook*, ASTM International, 2012, Chapters 6 and 7.

6.7.2.7. McNorton, S., Nutter, G., and Siegel, J., "The Characterization of Automotive Body Fillers," *Journal of Forensic Sciences*, Vol. 53, No. 1, 2008, pp. 116-124.

6.7.2.8. Novinski, S., Noak, P., and Venturini, M., "Employing Pearlescent Pigments in High Performance Coatings", *Paint and Coatings Industry*, May 1998, pp. 62-68.

6.7.2.9. Orzechowski, A., "An Optical Microscopy Method to Display Pigment Agglomerates in Polymer Particles," *The Microscope*, Vol. 27, No. 1, 1979, pp. 5-9.

6.7.2.10. Streitberger, H., and Dossel, K., ed., *Automotive Paints and Coatings*, 2nd ed., VCH Publishers, NY, 2008.

6.7.2.11. Walsh, B., et al., "New Zealand Body Fillers: Discrimination Using IR Spectroscopy, Visible Microspectrophotometry, Density and SEM-EDAX," *Forensic Science International*, Vol. 32, No. 3, 1986, pp. 193-204.

6.7.3. Practical Exercise

6.7.3.1. Describe and categorize a set of paint samples. Samples should consist of a variety of paint systems including automotive paint, other vehicle paint (e.g., motorcycle, aircraft, marine, trains, bicycle.), architectural paint, maintenance paint, spray paint, and other specialty paints. Automotive systems with color coordinated primers, tri-coat systems and a variety of effect pigments should also be included.

6.7.4. The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.7.5. The method of evaluation for this unit is an evaluation of the practical exercise.

6.8. Color Assessments of Paint

6.8.1. This section introduces the trainee to the techniques used in the color assessments of paint including:

6.8.1.1. Understanding the definition of color.

6.8.1.2. Performing color comparisons using the unaided eye as well as the stereomicroscope and higher powered microscopes.

6.8.1.3. Understanding metamerism and the usage of various light sources in the evaluation and comparison of color

6.8.1.4. Demonstrating knowledge of the various systems available to assess color, measure color and perform color comparisons of paint samples (e.g., the Munsell System, L*a*b* color space, and the CIE System).

6.8.1.5. Determining standard values for paint colors.

6.8.1.6. Demonstrating familiarity with the use of various spectrophotometers used to measure color samples.

6.8.2. Reading Assignments

6.8.2.1. Cartwright, L., Cartwright, N., Norman, E., Cameron, R., MacDougall, D.A., and Clark, W.H., "The Classification of Automotive Paint Primers Using the Munsell Color Coordinate System – a Collaborative Study," *Canadian Society of Forensic Science Journal*, Vol. 17, No. 1, 1984, pp. 14-18.

6.8.2.2. Droll, F., "Just What Color is That Car?" *Paint and Coatings Industry*, February 1998, pp. 54-57.

6.8.2.3. The Munsell Book of Color Glossy Collection.

6.8.2.4. The Munsell Book of Color Matte Collection.

6.8.2.5. Thornton, J., "Visual Color Comparison in Forensic Science," *Forensic Science Review*, Vol 9, No. 1, 1997, pp. 38-57.

6.8.3. Practical Exercise

6.8.3.1. Demonstrate the ability to utilize available resources (e.g., Munsell System, L*a*b* color space, CIE System) to determine standard color values for a given set of paint samples.

6.8.4. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.8.5. The method of evaluation for this unit is a review of the practical exercise.

6.9. Sample Preparation Techniques

6.9.1. This section introduces the trainee to the sample preparation techniques used in paint analysis including:

6.9.1.1. Performing manual manipulation of a paint fragment with a scalpel or other cutting tool to expose underlying layers

6.9.1.2. Preparing samples of individual layers for transmitted and reflected light microscopical examinations

6.9.1.3. Preparing thin cross-sections of several paint fragments.

6.9.2. Reading assignments

6.9.2.1. Allen, T., "Modifications of Sample Mounting Procedures and Microtome Equipment for Paint Sectioning," *Forensic Science International*, Vol. 52, 1991, pp. 93-100.

6.9.2.2. Derrick, M., "Infrared Microspectroscopy in the Analysis of Cultural Artifact," Humecki, H., ed., *Practical Guide to Infrared Microspectroscopy*, Marcel Dekker, NY, 1995, pp. 294-298.

6.9.2.3. Laing, D. et al, "The Examination of Paint Films and Fibers as Thin Sections," *The Microscope*, Vol. 35, No. 3, 1987, pp. 233-248.

6.9.3. Practical Exercises

6.9.3.1. Expose layers of several paint fragments using various cutting techniques (e.g., bevel (wedge), stair step, thin peels, and cross-sections.)

6.9.3.2. Prepare microscope slides of individual layers from a paint sample.

6.9.3.3. Prepare thin cross-sections of several samples provided by the trainer.

6.9.4. The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.9.5. The method of evaluation for this unit is an evaluation of the practical exercises.

6.10. Microscopical Examination and Comparison

6.10.1. This section introduces the trainee to the microscopical examination and comparison of paint including:

6.10.1.1. Using stereomicroscopy and comparison microscopy to determine whether paint samples are distinguishable from one another.

6.10.1.2. Examining paint samples utilizing other microscopical techniques which may include polarized light and fluorescence microscopy.

6.10.1.3. Recognizing the microscopical characteristics of pigments, extenders, and additives.

6.10.2. Reading assignments

6.10.2.1. Delly, J., McCrone, L., and McCrone, W., *Polarized Light Microscopy*, Fifth Printing, Microscope Publications, Division of McCrone Research Institute, Chicago, IL, 1985.

6.10.2.2. DeForest, P., "Foundations of Forensic Microscopy," Saferstein, R., ed., *Forensic Science Handbook*, Vol. 1, 2nd ed., Prentice Hall, Englewood Cliffs, New Jersey, 2002, pp. 216- 319.

6.10.3. Practical Exercise

6.10.3.1. Examine and compare several samples provided by the trainer and determine whether any items within a set can be distinguished from the others.

6.10.4. The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.10.5. The method of evaluation for this unit is an evaluation of the practical exercise.

6.11. Microchemical Examinations

6.11.1. This section introduces the trainee to classifying paint binders, pigments and extenders by use of microchemical examinations to include:

6.11.1.1. Using solvent tests to correctly classify an automotive paint layer in terms of enamel, acrylic lacquer, nitrocellulose lacquer, solution lacquer, or dispersion lacquer.

6.11.1.2. Using solvent tests to correctly classify automotive paints as OEM or repaint (if possible)

6.11.1.3. Using solvent tests to correctly classify non-automotive paints in terms of enamel or lacquer.
6.11.1.4. Using microchemical testing to classify pigments and extenders
6.11.2. Reading assignments
6.11.2.1. Palenik, S., "Applying Chemical Microscopy to the Coatings Industry," *Paint and Coatings Industry*, March 1998, pp. 48-56.
6.11.2.2. Thornton, J., Krause, S., Lerner, B., and Kahane, D., "Solubility Characterization of Automotive Paints," *Journal of Forensic Sciences*, Vol. 28, No. 4, 1983, pp. 1004-1007.
6.11.2.3. Ryland, S., "Infrared Microscopy of Forensic Paint Evidence," Humecki, H., ed., *Practical Guide to Infrared Microscopy*, Marcel Dekker, NY, 1995, pp. 163-243.
6.11.2.4. Beattie, B., Dudley, R., and Smalldon, K.W., "The Use of Morin Staining for the Microscopic Characterization of Multilayered White Paint Flakes," *Forensic Science International*, Vol. 13, 1979, pp. 41-49.
6.11.2.5. Linde, H., Stone, R., "Application of the LeRosen Test to Paint Analysis," *Journal of Forensic Sciences*, Vol. 24, 1979, pp. 650-655.
6.11.2.6. Home, J., Laing, D., and Richardson, S., "The Discrimination of Small Fragments of Household Gloss Paint Using Chemical Tests," *Journal of the Forensic Science Society*, Vol. 23, No. 1, 1983, pp. 43-47.
6.11.3. Practical Exercise
6.11.3.1. Classify several paint samples using microchemical tests.
6.11.4. The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.
6.11.5. The method of evaluation for this unit is an evaluation of the practical exercise.

6.12. Fourier Transform Infrared Spectroscopy (FTIR)
6.12.1. This section introduces the trainee to the classification and comparison of a variety of paint binders, pigments, extenders and additives based on their chemical composition using FTIR.
6.12.2. Include the following points of instruction:
6.12.2.1. Understanding the theory of FTIR analysis (unless previously authorized to use the instrument)
6.12.2.2. Preparing samples for analysis by FTIR.
6.12.2.3. Performing computer searches of spectral libraries, if available.
6.12.2.4. Using FTIR to classify and compare binders, pigments, and extenders found in automotive, architectural, and other types of paint.
6.12.2.5. Understanding the strengths and limitations of the technique.
6.12.3. Reading Assignments
6.12.3.1. McEwen, D., and Cheever, G., "Infrared Microscopic Analysis of Multiple Layers of Automotive Paints", *Journal of Coatings Technology*, Vol. 65, No. 819, 1983, pp. 35-41.
6.12.3.2. Home, J., Twibell, J., and Smalldon, K., "The Characterization of Automotive Body Fillers", *Journal of Forensic Sciences*, Vol. 53, No. 1, 2008, pp. 116-124.
6.12.3.3. Norman, E., Cameron, R., Cartwright, L., Cartwright, N.S., Clark, W.H., and MacDougall, D.A., "The Classification of Automotive Paint Primers Using Infrared Spectroscopy

– A Collaborative Study", *Canadian Society of Forensic Science Journal,* Vol. 16, No. 4, 1983, pp. 163-173.

6.12.3.4. Ryland, S., "Infrared Microspectroscopy of Forensic Paint Evidence", Humecki, H., ed., *Practical Guide to Infrared Microspectroscopy,* Marcel Dekker, NY, 1995, pp. 163-243.

6.12.3.5. Wilkinson, J., Locke, J., and Laing, D., "The Examination of Paints as Thin Sections Using Visible Microspectrophotometry and Fourier Transform Infrared Microscopy," *Forensic Science International,* Vol. 38, 1988, pp. 43-52.

6.12.4. Practical Exercises

6.12.4.1. Prepare and analyze several single layer and multiple layered structural and automotive paint samples having a variety of binder types, pigments, extenders and additives.

6.12.4.2. Search several spectra against a spectral library.

6.12.4.3. Perform binder, pigment, extender and additive classifications and comparisons for the spectra of several unknown samples.

6.12.5. The methods of instruction for this unit are reading by the trainee and lectures and demonstrations from the trainer.

6.12.6. The method of evaluation for this unit is an evaluation of the practical exercises.

6.13. Raman Spectroscopy

6.13.1. This section introduces the trainee to the comparison of a variety of paint components based on their chemical composition using Raman spectroscopy.

6.13.2. Include the following points of instruction:

6.13.2.1. Understanding the theory of Raman spectroscopy (unless previously authorized to use the instrument)

6.13.2.2. Preparing samples for analysis by Raman spectroscopy.

6.13.2.3. Performing computer searches of spectral libraries, if available.

6.13.2.4. Using Raman to classify and compare binders, pigments, and extenders found in automotive, architectural, and other types of paint.

6.13.2.5. Understanding the strengths and limitations of the technique

6.13.3. Reading Assignments

6.13.3.1. Bell, S.; Fido, L.; Speers, S.; Armstrong, W.; Spratt, S., "Forensic Analysis of Architectural Finishes Using Fourier Transform Infrared and Raman Spectroscopy, Part I: The Resin Bases", *Applied Spectroscopy,* Vol. 59, No. 11, 2005, pp. 1333- 1339.

6.13.3.2. Bell, S.; Fido, L.; Speers, S.; Armstrong, W.; Spratt, S., "Forensic Analysis of Architectural Finishes Using Fourier Transform Infrared and Raman Spectroscopy, Part II: White Paint", *Applied Spectroscopy,* Vol. 59, No. 11, 2005, pp. 1340–1346.

6.13.3.3. Buzzini, P., and Massonnet, G., "A Market Study of Green Spray Paints by Fourier Transform Infrared (FT-IR) and Raman Spectrometry", *Science & Justice,* Vol. 44, No. 3, 2004, pp. 123-131.

6.13.3.4. Kuptsov, A., "Applications of Fourier Transform Raman Spectroscopy in Forensic Science", *Journal of Forensic Science,* Vol. 39, 1994, pp. 305-318.

6.13.3.5. Massonnet, G., Stoecklein, W., "Identification of Organic Pigments in Coatings: Applications to Red Automotive Topcoats. Part III: Raman Spectroscopy (NIR FT-Raman)", *Science & Justice,* Vol. 39, 1999, pp. 181-187.

6.13.3.6. Muehlethaler, C., Massonnet, G., and Buzzini, P., "Influence of the Shaking Time on the Forensic Analysis of FTIR and Raman Spectra of Spray Paints", *Forensic Science International,* Vol. 237, 2014, pp. 78-85.

6.13.3.7. Palenik, C., Palenik, S., Herb, J., and Groves, E., Fundamentals of Forensic Pigment Identification by Raman Microspectroscopy: A Practical Identification Guide and Spectral Library for Forensic Science Laboratories, US Department of Justice, 2011. www.ncjrs.gov/pdffiles1/nij/grants/237050.pdf.

6.13.3.8. Palenik, C., Groves, E., Herb, J., and Palenik, S., Raman Spectroscopy of Automotive and Architectural Paints: In situ Pigment Identification and Evidentiary Significance, US Department of Justice, 2013. https://www.ncjrs.gov/pdffiles1/nij/grants/243162.pdf.

6.13.4. Practical Exercises

6.13.4.1. Prepare and analyze several single layer and multiple layered structural and automotive paint samples having a variety of binder types, pigments, extenders and additives.

6.13.4.2. Search several spectra against a spectral library.

6.13.4.3. Perform component classifications for the spectra of several unknown samples.

6.13.5. The methods of instruction for this unit are reading by the trainee and lectures and demonstrations from the trainer.

6.13.6. The method of evaluation for this unit is an evaluation of the practical exercises.

6.14. Pyrolysis Gas Chromatography/Mass Spectrometry (PGC and PGC/MS)

6.14.1. This section introduces the trainee to the comparison of a variety of paint binders based on their chemical composition using pyrolysis gas chromatography with flame ionization detection (PGC) or pyrolysis gas chromatography/mass spectrometry (PGC/MS).

6.14.2. Include the following points of instruction:

6.14.2.1. Understanding the theory of PGC or PGC/MS (unless previously authorized to use the instrument)

6.14.2.2. Preparing samples for analysis by PGC or PGC/MS.

6.14.2.3. Performing computer searches of spectral libraries, if available.

6.14.2.4. Using PGC or PGC/MS to classify and compare binders and plasticizers found in automotive, architectural, and other types of paint.

6.14.2.5. Understanding the strengths and limitations of the technique.

6.14.3. Reading Assignments

6.14.3.1. Burke, P., Curry, C., Davies, L., and Cousins, D., "A Comparison of Pyrolysis Mass Spectrometry, Pyrolysis Gas Chromatography and Infrared Spectroscopy for the Analysis of Paint Resins," *Forensic Science International,* Vol. 28, 1985, pp. 201-219.

6.14.3.2. Challinor, J., "Examination of Forensic Evidence", Wampler, T., ed., *Applied Pyrolysis Handbook*, 2nd ed., CRC Press, Taylor & Francis, Boca Raton, FL, 2007, pp. 175-199.

6.14.3.3. McMinn, D., Carlson, T., and Munson T., "Pyrolysis Capillary Gas Chromatography/Mass Spectrometry for Analysis of Automotive Paints", *Journal of Forensic Sciences,* Vol. 30, No. 4, 1985 pp. 1064-1073.

6.14.3.4. Stafford, D., "Forensic Capillary Gas Chromatography", Saferstein, R., ed., *Forensic Science Handbook, Vol. II*, Prentice Hall, Englewood Cliffs, NJ, 1988, pp. 38-65.

6.14.3.5. Wampler, T., *Applied Pyrolysis Handbook*, 2nd ed.; Taylor & Francis Group, Boca Raton, FL, 2007.

6.14.3.6. Scientific Working Group for Materials Analysis (SWGMAT), "Standard Guide for Using Pyrolysis Gas Chromatography and Pyrolysis Gas Chromatography-Mass Spectrometry in Forensic Paint Examinations", *Journal of American Society of Trace Evidence Examiners,* Vol. 5, No. 1, 2015, pp. 22 – 33.

6.14.4. Practical Exercise

6.14.4.1. Classify and compare binders and plasticizers found in automotive, architectural, and other types of paint using PGC or PGC/MS.

6.14.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.14.6. The method of evaluation for this unit is a review of the practical exercise.

6.15. Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS)

6.15.1. This section introduces the trainee to the comparison of a variety of paints based on their elemental components using SEM/EDS.

6.15.2. Include the following points of instruction:

6.15.2.1. Understanding the theory of SEM/EDS (unless previously authorized to use the instrument)

6.15.2.2. Preparing samples for analysis by SEM/EDS.

6.15.2.3. Knowing the types of SEM detectors and understanding when each detector can be used.

6.15.2.4. Performing computer searches of spectral libraries, if available.

6.15.2.5. Demonstrating the ability to use the technique to compare samples based upon their elemental components.

6.15.2.6. Understanding the strengths and limitations of the technique.

6.15.3. Reading Assignments

6.15.3.1. ASTM E2809 Guide for Using Scanning Electron Microscopy/X-ray Spectrometry in Forensic Paint Examinations, ASTM International, West Conshohocken, PA.

6.15.3.2. Goldstein, J., et al., *Scanning Electron Microscopy and X-Ray Microanalysis*, 2nd ed., Plenum Press, NY, 1992, pp. 1-415.

6.15.3.3. Flegler, S., Heckman, J., and Klomparens, K., *Scanning and Transmission Electron Microscopy: An Introduction*, Oxford University Press, 1995.

6.15.4. Practical Exercise

6.15.4.1. Compare the elemental components in a variety of paint samples using SEM/EDS.

6.15.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.15.6. The method of evaluation for this unit is a review of the practical exercise.

6.16. X-ray Fluorescence Spectroscopy (XRF)

6.16.1. This section introduces the trainee to the comparison of a variety of paints based on the elemental components using XRF.

6.16.2. Include the following points of instruction:

6.16.2.1. Understanding the theory of XRF (unless previously authorized to use the instrument)
6.16.2.2. Preparing samples for analysis by XRF.
6.16.2.3. Performing computer searches of spectral libraries, if available.
6.16.2.4. Demonstrating the ability to use the technique to compare samples based upon their elemental components.
6.16.2.5. Understanding the strengths and limitations of the technique.
6.16.3. Reading Assignments
6.16.3.1. ASTM D5381 Standard Guide for X-Ray Fluorescence (XRF) Spectroscopy of Pigments and Extenders, ASTM International, West Conshohocken, PA.
6.16.3.2. ASTM D4764 Standard Test Method for Determination by X-Ray Fluorescence (XRF) Spectroscopy of Titanium Dioxide Content in Paint , ASTM International, West Conshohocken, PA.
6.16.3.3. Jenkins, R., Buhrke, V., Smith, D., editors, *A Practical Guide for the Preparation of Specimens for X-Ray Fluorescence and X-Ray Diffraction Analysis*, Wiley-VCH, New York, 1998.
6.16.3.4. Massonnet, G., "Comparison of X-ray Fluorescence and X-ray Diffraction Techniques for the Analysis of Metallic Automotive Paints," *Crime Laboratory Digest*, Vol. 22, No. 3, 1995, p.95.
6.16.4. Practical Exercise
6.16.4.1. Compare the elemental characteristics in a variety of paints using XRF.
6.16.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.
6.16.6. The method of evaluation for this unit is a review of the practical exercise.

6.17. X-ray Diffraction (XRD)
6.17.1. This section introduces the trainee to the comparison of a variety of paints based on the diffraction pattern using XRD.
6.17.2. Include the following points of instruction:
6.17.2.1. Understanding the theory of XRD (unless previously authorized to use the instrument)
6.17.2.2. Preparing samples for analysis by XRD.
6.17.2.3. Performing computer searches of diffractograms, if available.
6.17.2.4. Demonstrating the ability to use the technique to compare samples based upon their diffraction patterns.
6.17.2.5. Understanding the strengths and limitations of the technique.
6.17.3. Reading Assignments
6.17.3.1. ASTM D5380, Standard Test Method for Identification of Crystalline Pigments and Extenders in Paint by X-Ray Diffraction Analysis, ASTM International, West Conshohocken, PA.
6.17.3.2. Jenkins, R., Buhrke, V., Smith, D., editors, *A Practical Guide for the Preparation of Specimens for X-Ray Fluorescence and X-Ray Diffraction Analysis*, Wiley-VCH, New York, 1998.
6.17.3.3. Curry, C., Rendle, D., and Rogers, A., "Pigment Analysis in the Forensic Examination of Paints. I. Pigment Analysis by X-Ray Powder Diffraction*," Society of Forensic Science Journal,* Vol. 22, No. 2, 1982, pp. 173-177.

6.17.4. Practical Exercise

6.17.4.1. Compare the diffraction pattern in a variety of paints using XRD.

6.17.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.17.6. The method of evaluation for this unit is a review of the practical exercise.

6.18. Microspectrophotometry (MSP)

6.18.1. This section introduces the trainee to the comparison of paint samples using MSP.

6.18.2. Include the following points of instruction:

6.18.2.1. Understanding the theory of MSP (unless previously authorized to use the instrument)

6.18.2.2. Preparing samples for analysis by MSP.

6.18.2.3. Demonstrating the ability to use the technique to compare spectra.

6.18.2.4. Understanding the strengths and limitations of the technique.

6.18.3. Reading Assignments

6.18.3.1. ASTM E2808, Standard Guide for Microspectrophotometry and Color Measurement in Forensic Paint Analysis, ASTM International, West Conshohocken, PA.

6.18.3.2. Cousins, D., Platoni, C., and Russell, L., "The Variation in the Colour of Paint on Individual Vehicles," *Forensic Science International*, Vol. 24, No. 3, 1984, 197-208.

6.18.3.3. Eyring, M., "Visible Microscopical Spectrophotometry in the Forensic Sciences," Saferstein, R., ed., *Forensic Science Handbook*, Vol. I, 2nd ed., Prentice Hall, Upper Saddle River, New Jersey, 2002, pp. 322-387.

6.18.3.4. Kopchick, K., and Bommarito, C., "Color Analysis of Apparently Achromatic Automotive Paints by Visible Microspectrophotometry," *Journal of Forensic Sciences*, Vol. 51, No. 2, 2006, pp. 340-343.

6.18.3.5. Laing, D., Dudley, R., Home, J., and Issacs, M., "The Discrimination of Small Fragments of Household Gloss Paint by Microspectrophotometry," *Forensic Science International*, Vol. 20, 1982, pp. 191-200.

6.18.3.6. Laing, D., Dudley, R., and Issacs, M., "Colorimetric Measurements on Small Paint Fragments Using Microspectrophotometry," *Forensic Science International*, Vol. 16, 1980, pp. 159-171.

6.18.3.7. Nowicki, J., and Paten, R., "Examination of U.S. Automotive Paints: 1. Make and Model Determination of Hit-and-Run Vehicles by Reflectance Microspectrophotometry," *Journal of Forensic Sciences*, Vol. 31, No. 2, 1986, pp. 464-470.

6.18.3.8. Stoecklein, W., "The Role of Colour and Microscopic Techniques for the Characterization of Paint Fragments," Caddy, B., ed., *Forensic Examination of Glass and Paint; Analysis and Interpretation*, Taylor & Francis, London, England, 2001, pp. 143-162.

6.18.3.9. Stoecklein, W., and Fujiwara, H., "The Examination of UV-Absorbers in 2-coat Metallic and Non-metallic Automotive Paints," *Science and Justice*, Vol. 39, No. 3, 1999, pp. 188-195.

6.18.3.10. Stone, S., Barber, M., Wojciechowski, R., and Martin, P., "Measurement and Variation of UV Absorbers within Multi-Year Samples of Automotive Clear Coat Paint," *Journal of the American Society of Trace Evidence Examiners*, Vol. 4, No. 1, 2013, pp. 2-12.

6.18.4. Practical Exercise

6.18.4.1. Compare the spectra from a variety of paint samples using MSP.

6.18.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.18.6. The method of evaluation for this unit is a review of the practical exercise.

6.19. Comparison and Discrimination of Paint

6.19.1. This section introduces the trainee to the comparison of a variety of paints based on their physical and chemical characteristics.

6.19.2. Include the following points of instruction:

6.19.2.1. Assessing the comparison results and attaching significance to those results.

6.19.2.2. Defining and recognizing meaningful differences.

6.19.2.3. Explaining the discrimination power of the analytical protocol used.

6.19.3. Reading Assignments

6.19.3.1. Beveridge, A.., Fung, T., and MacDougall, D., "Use of Infrared Spectroscopy for the Characterization of Paint Fragments," Caddy, B., ed., *Forensic Examination of Glass and Paint; Analysis and Interpretation,* Taylor & Francis, London, England, 2001, pp. 220-241.

6.19.3.2. Buzzini, P., Massonnet G., Birrer, S., Egli, N., Mazzella, W., Fortini, A., "Survey of Crowbar and Household Paints in Burglary Cases – Population Studies, Transfer and Interpretation," *Forensic Science International*, Vol. 152, No. 2, 2005, pp. 221-234.

6.19.3.3. Dabdoub, G., and Severin, P., "The Identification of Domestic and Foreign Automobile Manufacturers through Body Primer Characterization", *Journal of Forensic Sciences,* Vol. 34, No. 6, 1989, pp. 1395-1404.

6.19.3.4. Dolak, E., Weimer, R., "The Physical and Chemical Characterization of Multipurpose Architectural Paint", *Journal of the American Society of Trace Evidence Examiners*, Vol. 6, Issue 3, 2015, pp. 21-45.

6.19.3.5. Edmondstone, G., Hellman, J., Legate, K., Vardy, G.L., and Lindsay, E., "An Assessment of the Evidential Value of Automotive Paint Comparisons", *Canadian Society of Forensic Science Journal*, Vol. 37, No. 3, 2004, pp. 147-153.

6.19.3.6. Gothard, J., "Evaluation of automobile paint flakes as evidence," *Journal of Forensic Sciences*, Vol. 21, No. 3, 1976, pp. 636-641.

6.19.3.7. Lau, L., et al, "The Frequency of Occurrence of Paint and Glass on the Clothing of High School Students," *Canadian Society of Forensic Science Journal*, Vol. 30, No. 4, 1997, pp. 233-240.

6.19.3.8. McDermott, S., and Willis, S., "A Survey of the Evidential Value of Paint Transfer Evidence," *Journal of Forensic Sciences*, Vol. 42, No. 6, 1997, pp. 1012-1018.

6.19.3.9. McDermott, S., and Willis, S., "The Evidential Value of Paint. Part II: A Bayesian Approach," *Journal of Forensic Sciences,* Vol. 44, No. 2, 1999, pp. 263-269.

6.19.3.10. Robertson, B., Vignaux, G., and Berger, C., *Interpreting Evidence: Evaluating Forensic Science in the Courtroom,* 2nd ed., Wiley Publishers, 2016.

6.19.3.11. Ryland, S., "Discrimination of retail black spray paints," *Journal of the American Society of Trace Evidence Examiners,* Vol. 1, No. 2, 2010, pp.109-126.

6.19.3.12. Ryland, S., and Kopec, R., "The evidential value of automobile paint chips," *Journal of Forensic Sciences*, Vol. 24, No. 1, 1979, pp. 140-147.

6.19.3.13. Sandercock, M., Ho, A., and Hodgins, T., “Survey of new, single layer architectural paints”, Canadian Society of Forensic Science Journal, Vol. 49, Issue 2, pp. 78-105.

6.19.3.14. Scientific Working Group for Materials Analysis. Forensic Paint Analysis and Comparison Guidelines, ASTEETrace.org/Resources/SWGMAT/Paint Subgroup

6.19.3.15. Tippett, C., et al, "The evidential value of the comparison of paint flakes from sources other than vehicles," *Journal of the Forensic Science Society*, Vol. 8, Issue 2-3,1968, pp. 61-65.

6.19.3.16. Willis, S., McCullough, J., and McDermott, S., “The Interpretation of Paint Evidence,” Caddy, B., ed., *Forensic Examination of Glass and Paint; Analysis and Interpretation*, Taylor & Francis, London, England, 2001.

6.19.3.17. Wright, D., Bradley, M., and Mehltretter, A., “Analysis and discrimination of architectural paint samples via a population study,” *Forensic Science International*, Vol. 209, 2011, pp. 86-95.

6.19.3.18. Wright, D., Bradley, M., and Mehltretter, A., “Analysis and discrimination of single- layer white architectural paint samples,” *Journal of Forensic Sciences*, Vol. 58, No. 2, 2013, pp. 358-364.

6.19.3.19. Wright, D., and Mehltretter, A., “The Prevalence of Original Equipment Manufacturer (OEM) Factory Repairs in Automotive Paint Samples,” *Journal of the American Society of Trace Evidence Examiners*, Vol. 6, Issue 3, 2015, pp. 4-20.

6.19.4. Practical Exercise

6.19.4.1. Complete comparisons and summarize the completed practical exercise sets utilized in previous instruction.

6.19.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.19.6. The method of evaluation for this unit is a review of the practical exercise.

6.20. Motor Vehicle Make, Model and Year Determinations

6.20.1. This section introduces the trainee to the methods used to produce possible make, model, and year determinations for vehicle paint samples.

6.20.2. Include the following point of instruction:

6.20.2.1. Utilizing available resources (e.g., Paint Database Query, spectral IR libraries, Collaborative Testing Services Paint Collection, automotive refinish books and websites) to suggest potential source make(s), model(s), and year(s).

6.20.3. Reading Assignments

6.20.3.1. Buckle, J., MacDougall, D., and Grant, R., “PDQ – Paint Data Queries: The History and Technology Behind the Development of the Royal Canadian Mounted Police Forensic Laboratory Services Automotive Paint Database,” *Journal of Forensic Sciences*, Vol. 54, No. 2, 2009, pp. 328-338.

6.20.3.2. Hodgins, T., Ho, A., and Sandercock, M., “Identification of Modern Automotive Paint Systems using Paint Data Query (PDQ): A Collaborative Study”, *Journal of the American Society of Trace Evidence Examiners*, Vol. 6, No. 3, 2015, pp. 46-63.

6.20.3.3. Wright, D., “A Make-Model-Year Case Involving Unusual Primer Chemistry and Good Resources”, *Journal of the American Society of Trace Evidence Examiners*, Vol. 1, No. 2, 2010, pp. 137-148.

6.20.3.4. Wright, D., "Sourcing Paint Smears: A Hate Crime Highlights the Utility of the Paint Data Query (PDQ) Database", *Journal of the American Society of Trace Evidence Examiners*, Vol. 1, No. 2, 2010, pp. 137-148.

6.20.4. Practical Exercise

6.20.4.1. Demonstrate the ability to utilize available resources (e.g., Paint Database Query, spectral IR libraries, Collaborative Testing Services Paint Collection, automotive refinish books and websites) to suggest potential source vehicle(s).

6.20.5. The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

6.20.6. The method of evaluation for this unit is a review of the practical exercise.

6.21. Report Writing

6.21.1. This section introduces the trainee to writing technically and administratively accurate reports for forensic paint examinations.

6.21.2. Reading Assignment

6.21.2.1. Laboratory specific paint analysis procedure(s) on reporting.

6.21.3. Practical Exercise

6.21.3.1. Write reports for the previously completed practical exercises.

6.21.4. The methods of instruction for this unit are reading completed technically reviewed reports and lecture from the trainer.

6.21.5. The method of evaluation for this unit is a review of the reports written by the trainee.

6.22. Testimony

6.22.1. This section introduces the trainee to testimony in forensic paint analysis.

6.22.2. Reading Assignments

6.22.2.1. Scientific Working Group for Materials Analysis (SWGMAT), "Paint Daubert Final – Main Text," at ASTEEtrace.org/Resources/SWGMAT/Paint Subgroup

6.22.2.2. Daubert v. Merrell Dow Pharmaceuticals (92-102), 509 U.S. 579 (1993)

6.22.2.3. Frye v. United States 293 F. 1013 (D.C. Cir. 1923)

6.22.2.4. Kumho Tire Co. v. Carmichael 526 US 137 (1999)

6.22.3. Practical Exercises

6.22.3.1. Prepare a list of suggested questions and a sheet of educational questions and answers for the court.

6.22.3.2. Review relevant materials for an admissibility hearing.

6.22.4. The methods of instruction for this unit are lecture from the trainer and viewing court testimony (if possible).

6.22.5. The method of evaluation for this unit is a review of the court documents prepared by the trainee.

6.23. Final Training Evaluations

6.23.1. This section evaluates the knowledge, skills and abilities of the trainee through the following methods:

6.23.1.1. Completing a final, comprehensive, written or oral examination on forensic paint examinations.

6.23.1.2. Conducting mock case(s) for competency evaluation.

6.23.1.3. Participating in a mock trial using one of the mock cases completed during training. If the trainee has previous mock trial or court experience, an oral review may replace the mock trial.

6.23.2. The method of evaluation for this unit is a passing grade on the written examination, successful completion of the competency evaluation, and successful completion of the mock trial or oral review.

6.24. Supervised Casework and Peer Reviews

6.24.1. This section introduces the trainee to performing independent casework as well as technical and administrative peer reviews.

6.24.2. Practical Exercises:

6.24.2.1. Observe an experienced paint examiner perform casework.

6.24.2.2. Perform actual casework under the supervision of a qualified paint examiner before performing independent casework.

6.24.2.3. Complete mock technical and administrative review exercises.

6.24.3. The methods of instruction for this unit are demonstration by the trainer and discussion with the trainee.

6.24.4. The methods of evaluation for this unit are evaluation of the casework with no technical errors and minimal administrative errors and evaluation of the peer reviews completed by the trainee.

7. Keywords

7.1. Forensic science; training; paint; paint analysis; materials