# TABLE OF CONTENTS

Table of Contents ....1
Revision History ....4
01 Introductory Unit ....5
TE-TM-01-01 Overview of the Trace Evidence Training Program ....5
TE-TM-01-02 Instrumental Analysis Overview ....9
TE-TM-01-03 General Microscopy ....11
02 Evidence Collection and Preservation Unit ....15
TE-TM-02-01 Evidence Collection and Preservation ....15
TE-TM-02-02 Collection of Gunshot Primer Residue Samples ....19
03 Physical Comparison Unit ....22
TE-TM-03-01 Physical Comparison Cut-Tear ....22
TE-TM-03-02 Physical Comparison ....25
04 Glass Unit ....28
TE-TM-04-01 Introduction to Glass Evidence ....28
TE-TM-04-02 Initial Evaluation of Glass Evidence ....31
TE-TM-04-03 Determination of Glass Refractive Index ....34
TE-TM-04-04 Glass Analysis by X-Ray Fluorescence ....37
TE-TM-04-05 Interpretation of Glass Evidence ....40
05 Lamp Filament Unit ....43
TE-TM-05-01 Introduction to Filament Evidence ....43
TE-TM-05-02 Lamp Filament Examination ....45
TE-TM-05-03 Interpretation of Lamp Filament Evidence ....49
06 Hair Unit ....51
TE-TM-06-01 Introduction to Hair ....51
TE-TM-06-02 Macroscopic Examination and Comparisons of Human Hair ....53
TE-TM-06-03 Examination of Animal Hair ....56
TE-TM-06-04 Microscopic Characteristics of Human Hair ....59
TE-TM-06-05 Microscopic Comparison of Human Hair ....62
TE-TM-06-06 Interpretation of Hair Evidence ....66
07 Paint Unit ....70
TE-TM-07-01 Introduction to Paint and Polymer Evidence ....70
TE-TM-07-02 Initial Evaluation of Paint and Polymer Evidence ....73
TE-TM-07-03 Infrared Spectroscopy Classification of Paints and Polymers ....76

TE-TM-07-04 Pyrolysis GCMS of Paints and Polymers....79
TE-TM-07-05 Paint Data Query....82
TE-TM-07-06 Interpretation of Paint and Polymer Evidence....85
08 Fiber Unit....88
TE-TM-08-01 Introduction to Fiber and Textile Evidence....88
TE-TM-08-02 Stereomicroscopic Examination of Fibers, Yarns, and Fabrics....91
TE-TM-08-03 Polarized Light Microscopic Examination of Fibers....94
TE-TM-08-04 Comparison Microscope....98
TE-TM-08-05 Manufactured Fibers – Cross-Section....100
TE-TM-08-06 Infrared Spectroscopy of Fibers....103
TE-TM-08-07 Color Comparison of Fibers by Microspectrometry....105
TE-TM-08-08 Color Comparison of Fibers by Thin Layer Chromatography....108
TE-TM-08-09 Fiber Solubility Examinations....111
TE-TM-08-10 Interpretation of Fiber Evidence....113
09 Gunshot Primer Residue Unit....116
TE-TM-09-01 Gunshot Primer Residue Examination....116
10 Fire Debris Analysis Unit....121
TE-TM-10-01 Overview of the Fire Debris Analysis Training Unit....121
TE-TM-10-02 Organic Chemistry Review....125
TE-TM-10-03 Introduction to Petroleum Products and Petroleum Manufacturing....127
TE-TM-10-04 Introduction to Fire and Arson Investigation....129
TE-TM-10-05 Evaluation and Characterization of Fire Debris....132
TE-TM-10-06 Extraction Methods, Sample Preparation, and Data Collection....135
TE-TM-10-07 Instrumental Analysis....138
TE-TM-10-08 Report Writing....142
TE-TM-10-09 Practical Assessment....146
11 Impression Evidence Unit....149
TE-TM-11-01 Introduction to Impression Evidence....149
TE-TM-11-02 Detection and Recovery of Impression Evidence....152
TE-TM-11-03 Impression Test Prints....155
TE-TM-11-04 Fabric Impressions....158
TE-TM-11-05 Enhancement of Impression Evidence....161
TE-TM-11-06 Digital Image Processing....164
TE-TM-11-07 Comparison of Impression Evidence....169

12 Pressure Sensitive Tape Unit ..... 173
TE-TM-12-01 Introduction to Pressure Sensitive Adhesive Tape ..... 173
TE-TM-12-02 Examination of Pressure Sensitive Adhesive Tape ..... 175
TE-TM-12-03 Interpretation of Pressure Sensitive Adhesive Tape Evidence ..... 179
13 Unknown Substances Unit ..... 182
TE-TM-13-01 Unknown Substances Examination ..... 182
14 Forms ..... 187
Training Forms 187
Introductory Unit Training Checklist ..... 187
Evidence Collection and Preservation Unit Checklist ..... 187
Physical Comparison Unit Checklist ..... 187
Glass Unit Checklist ..... 187
Lamp Filament Unit Checklist ..... 187
Hair Unit Checklist ..... 187
Paint Unit Checklist ..... 187
Fiber Unit Checklist ..... 187
Gunshot Primer Residue Unit Checklist ..... 187
Fire Debris Unit Checklist ..... 187
Impression Evidence Unit Checklist ..... 187
Pressure Sensitive Tape Unit Checklist ..... 187
Unknown Substances Unit Checklist ..... 187
Appendices ..... 188
Appendix 01 GSR Stubbing Guidelines ..... 188
Appendix 02 Fire Debris Glossary ..... 189
Appendix 03 Recommended Readings for Fire Debris Analysis ..... 193

# REVISION HISTORY

| Effective Date | Brief Description of Change(s) |
|---|---|
| 3/31/2020 | Original Issue<br>Previous revision history for individual chapters included in archived documents |
| | |

# 01 INTRODUCTORY UNIT

## TE-TM-01-01 OVERVIEW OF THE TRACE EVIDENCE TRAINING PROGRAM

### 1 Introduction

The Trace Evidence discipline of the Texas Department of Public Safety Crime Laboratory Service is comprised of several sub-disciplines that cover the analysis and/or comparison of different types of material. This training program is designed to train Forensic Scientists assigned to the discipline of Trace Evidence in a select number of those sub-disciplines. Trainees will learn to properly process, preserve, identify and/or compare evidence using the suggested techniques and procedures outlined in this training program.

Upon successful completion of this training program, a Trace Evidence examiner will be able to competently perform the relevant analysis, accurately report case examinations and results, and effectively present their findings as an expert witness.

### 2 Requirements

Forensic Scientists employed by the Texas Department of Public Safety in the Trace Evidence discipline shall meet the degree and coursework requirements listed in the job description as well as successfully obtain and maintain their Forensic Analyst License through the Texas Forensic Science Commission.

A Trace Evidence examiner shall successfully complete the designated training modules, comprehensive written examination, competency testing, mock trial, and supervised work before obtaining authorization to perform independent work.

### 3 Purpose

The Trace Evidence Training Manual is designed to provide the trainee with sufficient background, laboratory skills, education, competency, and supervised hands-on experience to adequately perform independent work with minimal supervision.

The training time can vary depending on sub-disciplines. Trainees having prior experience in a particular Trace Evidence sub-discipline may be evaluated to determine if a modified training program is appropriate.

### 4 Program Format

The training program is divided into several units, each unit consisting of a set of modules. The modules consist of discussions and observations with the trainer(s), supervised exercises, and independent exercises. The modules may be dependent on, or independent of, other modules within the unit. Any prerequisite modules/units will be noted. Modules of instruction may be studied concurrently with other modules as determined by the trainer.

Throughout training, it is encouraged that trainees observe experienced examiners in their work and court testimony. Specialized training classes in the relevant sub-discipline of Trace Evidence should be completed when available.

**Note:** The Introductory Unit and the Evidence Collection and Preservation Unit will serve as prerequisites for the other sub-disciplines; however, they are optional for Fire Debris.

A. **Introductory Unit** is a series of modules that will provide the trainee with foundational knowledge in General Microscopy and Instrumental Analysis.

B. **Evidence Collection and Preservation Unit** will introduce the trainee to the proper techniques to collect, preserve, and macroscopically examine physical evidence.

C. **Physical Comparison Unit** will introduce the trainee to the comparison of edges for physical match and overall physical properties targeting a possible common source for various types of materials.

D. **Glass Unit** will introduce the trainee to the analysis and comparison of various sources of glass.

E. **Lamp Filament Unit** will introduce the trainee to the examination of incandescent lamp filaments to determine if they are functional or on/off.

F. **Hair Unit** will introduce the trainee to the analysis of hair including animal/human determination, somatic origin, racial characteristics, and macroscopic and microscopic comparisons.

G. **Paint Unit** will introduce the trainee to the analysis and comparison of automotive paint, architectural paint, and other categories of paint.

H. **Fiber Unit** will introduce the trainee to the analysis and comparison of fibers, threads, textiles, ropes, and cordage.

I. **Gunshot Primer Residue Unit** will introduce the trainee to the detection and analysis of gunshot primer residue.

J. **Fire Debris Analysis Unit** will introduce the trainee to the identification of ignitable liquid residue either in liquid form or in debris, other burned materials, and any other non-biological materials from a possible arson crime scene.

K. **Impression Evidence Unit** will introduce the trainee to the detection, recovery, examination and comparison of footwear, tire track and fabric impressions.

L. **Pressure Sensitive Tape Unit** will introduce the trainee to the analysis and comparison of pressure sensitive tape. **Prerequisites for this Unit are successful completion of the Fiber Unit and the Paint Unit**

M. **Unknown Substances Unit** will introduce the trainee to the analysis, comparison, and identification of various substances.

## 5 Safety

Safety precautions outlined in the Safety Manual will be followed at all times during the training program. Any specific safety considerations will be designated within the modules.

## 6 Responsibilities

### 6.1 Trainer Responsibilities

A. The trainer will meet with the trainee to discuss training goals and reasonable deadlines to meet these goals. The trainer may utilize other trained laboratory staff to assist in training, as needed.

B. Meetings between the trainee, the trainer, and/or supervisor should be held periodically in order to evaluate the trainee's progress, plan future study and practical assignments, and address any deficiencies that may require additional training.

C. The trainer will ensure satisfactory completion of Observed Performance, Supervised Performance, and Independent Exercises.

D. The trainer will review all exercises, exams, competencies, and supervised work before submitting the trainee for independent work authorization.

### 6.2 Trainee Responsibilities

A. The training program covers a large amount of material that the trainee will need to keep up with on a self-study basis. The trainee is responsible for informing his/her trainer or supervisor when problems arise at any time during the training period.

B. The trainee is required to maintain a training notebook to document completion of assignments and overall progress. Completion of modules will be recorded and dated on the respective training checklist, and will be approved by the trainer.

The following is a list of items maintained in the training notebook:

1. Training record (LAB-303), if utilized
   - *a) List of additional reading literature completed (if applicable)*
   - *b) List of additional in-house training videos and lectures attended (if applicable)*
2. Training checklists
3. Supervised exercises
4. Independent exercises
5. Competency tests and results
6. Special project assignments with summary reports, as applicable
7. Written exams
8. Memo from trainer documenting type of cases and/or reports reviewed (no actual case numbers are to be included in the training notebook with the exception of the Supervised Work Log – LAB-307)
9. Courtroom testimony attended and observations/evaluations

## 7 Review and Authorization

### 7.1 Module and Unit Assessment

A. Each Unit consists of several training modules. Each assigned module is assessed upon the completion of the associated readings, observed and supervised performances, and independent exercises. Once all assigned module requirements in the Unit have been satisfied, the trainee will complete a comprehensive written exam, a minimum of two competency exams, and a mock trial in order to successfully complete the unit.

B. A competency exam can include mock casework, re-analysis of previously worked cases, and proficiency tests, so long as the exam would encompass the majority of skills taught in the unit.

### 7.2 [Sub-Discipline] Training Unit

The [Sub-Discipline] Training Unit requirements will conclude with examiner approval to conduct supervised work when the following are met:

A. All required reading assignments are completed.

B. All observed/supervised performances are successfully completed.

C. All independent exercises are successfully completed.

D. A comprehensive written exam at the end of each unit is successfully completed. The criteria for passing is a grade of 75% or higher.

E. All competency exams are successfully completed.

F. Courtroom testimony requirements are satisfied.

### 7.3 Courtroom Testimony

Courtroom testimony requirements will be satisfied when the trainee has completed the following:

A. The trainee will observe or discuss with a trainer at least 5 examples of testimony covering relevant sub-disciplines. The examples of testimony can include past or current trials. In order to maximize the benefit to the trainee the testimonies should include prosecution and defense questioning.

B. The trainee will present at least one mock case in a mock trial setting. The case will be chosen by the trainer and should allow for prosecution and defense questioning. The case(s) chosen should also reflect the materials and analytical methods applicable to relevant sub-discipline(s). A LAB-313 and LAB-314 will be completed.

C. Courtroom testimony requirements shall be satisfied, per unit (excluding Introductory Unit) prior to a trainee being authorized for supervised work in that unit

### 7.4 Evaluation of Training

A. The training notebook and other training records documenting completion of training requirements are reviewed by the trainer.

B. The trainee will complete an evaluation of the unit content and the trainer using the Laboratory Training Program Evaluation Form (LAB-304).

C. The trainer(s) recommend that the examiner be approved for supervised work to the Laboratory Director using the Work Authorization (LAB-309).

D. The Laboratory Director approves the examiner to perform supervised work.

## 8 Supervised Work

Supervised work requirements will conclude with independent examiner approval when the following are met:

A. Supervised work consisting of successful completion of at least 3 cases per unit, which may include mock casework as needed. Evidence encountered in supervised work that was used to produce a probative conclusion will be verified and documented by the trainer or an experienced analyst. The experienced analyst/trainer shall initial all relevant pages/results in the examination documentation indicating that they concurred with the examination/results.

B. Trainer or designee is consulted at each step of the analysis procedure prior to trainee proceeding with that step.

C. Trainee maintains a record of supervised work using the Supervised Work Log (LAB-307 or electronic equivalent).

D. The trainer(s) recommend that the examiner be approved for independent work to the Quality Manager using the Work Authorization (LAB-309).

E. The Quality Manager approves the examiner to perform independent work.

# TE-TM-01-02 INSTRUMENTAL ANALYSIS OVERVIEW

**Duration** Two to three weeks

**Purpose** Familiarize the trainee with the theory, capabilities and limitations of the analytical instruments used in evidence analysis.

**Prerequisite** None

## 1 Objectives

### 1.1 Theoretical

Instrumental analysis of physical evidence is an integral part of the modern forensic laboratory. A fundamental understanding of the theory, capabilities, and limitations of the different types of equipment available is critical to determining appropriate analytical methods and communicating results to peers, as well as juries.

### 1.2 Practical

Following the completion of this module, the trainee will be able to:

A. Understand the theory, capabilities, and limitations of each of the instruments used in trace evidence analysis

B. Explain, in lay terms, the operation of each instrument

## 2 Training Outline

### 2.1 Lesson Plan

The trainee will be taught the theory, capabilities, and limitations for the following instruments used in trace evidence analysis

A. Infrared Spectroscopy

B. Microspectrometry

C. Gas Chromatography

D. GRIM

E. Mass Spectrometry

F. SEM/EDS

G. X-Ray Fluorescence

H. X-Ray Diffraction

### 2.2 Required Readings

A. Heinrich KFJ. *Electron Beam X-Ray Microanalysis*. Van Nostrand Reinhold Company, 1981, pp. 467-514.

B. Refner J, and Martoglio P. Uniting Microscopy and Spectroscopy. Humecki H, ed. *Practical Guide to Infrared Microspectroscopy*. Marcel Dekker, Inc, 1995, pp. 41-84.

C. Skoog DA, and Leary JJ. *Principles of Instrumental Analysis*. Saunders College Publishing, 1992, pp. 46-56, 58-77, 79-120, 123-147, 174-184, 252-284, 357-381, 394-399, 420-450, 579-601, 605-625.

D. Smith RM. *Understanding Mass Spectra*. Wiley-Interscience, 2004, pp. 1-55.

E. Vandeberg JT, and et. al. *An Infrared Spectroscopy Atlas for the Coatings Industry*. Federation of Societies for Coatings Technology, 1980, pp. 1- 48.

F. Wampler TP. Analytical Pyrolysis: An Overview with Forensic Applications. CDS Analytical, Inc.

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Observed Performance

The trainee will observe an experienced analyst(s) prepare samples, operate the instruments available in their laboratory, and interpret data.

## 3.5 Independent Exercises

The trainee will provide written responses to the following questions:

1. Describe in lay terms how the GC/MS works.
2. Explain what Fourier Transform is and which instrument uses it.
3. What is Beer's Law?
4. What are the limitations of the SEM?
5. What type(s) of evidence is X-ray Diffraction used for?
6. What type of analysis could you use to identify and analyze the following:
   *a) Sugar*
   *b) Paint*
   *c) Unknown white powder*
   *d) Fibers*
   *e) A piece of metal*

# 4 Assessment

## 4.1 Competency and Qualifying Examination

This module is a prerequisite module for certain sub-disciplines and does not require a set of competency exams or a comprehensive written exam for completion.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Trace Evidence Introductory Unit Training Checklist (LAB-TE-TM-01).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-01-03 GENERAL MICROSCOPY

**Duration** One week

**Purpose** Introduce the trainee to the basic concepts and applications of polarized light microscopy, comparison microscopy, and fluorescence microscopy.

**Prerequisite** None

## 1 Objectives

### 1.1 Theoretical

Microscopy is a powerful tool for the forensic scientist. A fundamental understanding of the types of microscopes available, the theory behind their operation, and their capabilities and limitations is essential for the trace evidence examiner.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Describe the functions of compound microscopes in general, and stereomicroscopes, polarized light microscopes, comparison microscopes, and fluorescence microscopes specifically

B. Perform modified Köhler illumination

C. Use the Michel-Levy birefringence chart to determine birefringence

D. Measure refractive indices of one and two-refractive index materials

E. Take photomicrographs.

## 2 Training Outline

### 2.1 Lesson Plan

A. Review of properties of electromagnetic radiation; un-polarized and polarized light

B. Discuss Snell's Law, refraction, refractive index, optics of lenses

C. Discuss aberrations and correcting aberrations

D. Review microscope parts and function

E. Abbe's Law of Resolution, resolving power, numerical aperture

F. Demonstrate focal planes, Köhler illumination, contrast vs. resolution

G. Micrometry

H. Discuss crystal systems, isotropy, anisotropy

I. Polarized light microscopy

J. Michel-Levy chart

K. Demonstrate sample preparation, mounting media

L. Comparison microscope

M. Fluorescence microscope

N. Photomicrography

### 2.2 Required Readings

A. McCrone W, McCrone L, and Delly J. *Polarized Light Microscopy*. McCrone Research Institute, 1984.

B. McCrone W. Particle Characterization by PLM Part I: No Polars. *The Microscope*. 1982, 30(31), pp. 185-196.

C. McCrone W. Particle Characterization by PLM Part II: Single Polar. *The Microscope*. 1982, 30(4), pp. 315-331.

D. McCrone W. Particle Characterization by PLM Part III: Crossed Polars. *The Microscope*. 1983, 31(2), pp. 127-206.

E. Saferstein R, ed. *Forensic Science Handbook, Volume II*. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 4: Microscopy and Microchemistry of Physical Evidence, pp. 161-208.

F. Cook R, and Norton D. An Evaluation of Mounting Media for use in Forensic Textile Fibre Examination. *J For Sci Soc*. 22. 1982, pp. 57-63.

G. Spring KR, and Davidson MW. Introduction to Fluorescence Microscopy. Nikon Microscopy U: Fluorescence Microscopy. Accessed: September 23, 2008. Online, http://www.microscopyu.com/articles/fluorescence/fluorescenceintro.html

### 2.3 Suggested Readings

A. McCrone W, Draftz R, and Delly J. *The Particle Atlas*. Ann Arbor Science Publishers Inc, Ann Arbor, MI, 1967.

B. McCrone W, and Delly J. *The Particle Atlas Edition Two*. Ann Arbor Science Publishers Inc, Ann Arbor, MI, 1973.

C. Saferstein R, ed. *Forensic Science Handbook, Volume II*. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination, pp. 243-244.

D. Hartshorne AW, and Laing DK. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres: Part 1 – Fluorescence emission spectra. *For Sci Int*. 1991. 51, pp. 203-220.

E. Hartshorne AW, and Laing DK. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres: Part 2 – Colour Measurements. *For Sci Int*. 1991, 51, pp. 221-237.

F. Hartshorne AW, and Laing DK. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres: Part 3 – Fluorescence decay phenomena. *For Sci Int*. 1991. 51, pp. 203-220.

## 3 Practice

### 3.1 Safety

A. Use a UV shield when operating the fluorescence microscope

B. Refer to SDS sheets for applicable mounting media

C. Universal Safety Precautions and use of appropriate Personal Protective Equipment (PPE)

### 3.2 Standards, Control, Reagent Preparation

- Permount
- Xylene/Xyless
- Glycerol
- Other mounting media as determined by trainer

### 3.3 Equipment

- Stereoscope
- Polarized Light Microscope
- Comparison Microscope
- Fluorescence Microscope

### 3.4 Observed Performance

The trainee will demonstrate and explain how to properly obtain Köhler illumination and demonstrate conjugate focal planes.

### 3.5 Supervised Performance

A. The trainee will calibrate an ocular micrometer for various objectives.

B. The trainee will be given samples in which they will have to prepare and mount the samples in various ways.

C. The trainee will be given a set of samples in which they will have to measure their refractive index and determine their optic sign.

D. The trainee will be given a set of samples in which they will have to determine the amount of birefringence using the Michel-Levy chart.

E. The trainee will mount a set of fluorescent particles in 3 different mounting mediums and observe their characteristics under varying filter sets.

### 3.6 Independent Exercises

A. The trainee will be given a set of unknown samples to determine the optical properties (refractive indices, optic sign, birefringence, fluorescence).

B. The trainee will provide written answers to the following questions:

1. What are the advantages of Köhler illumination?
2. What is the function of the polarizer?
3. What does the sub-stage diaphragm control? What is affected by changing the sub-stage diaphragm?
4. What is refraction?
5. What is the difference between isotropic, uniaxial, and biaxial substances?
6. What is the Stokes shift?
7. What is the function of the Excitation/Barrier filter?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

This module is a prerequisite module for certain sub-disciplines and does not require a set of competency exams or a comprehensive written exam for completion

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Trace Evidence Introductory Unit Training Checklist (LAB-TE-TM-01).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# 02 EVIDENCE COLLECTION AND PRESERVATION UNIT

# TE-TM-02-01 EVIDENCE COLLECTION AND PRESERVATION

**Duration** One to two weeks

**Purpose** The trainee will become familiar with the various techniques used to collect and preserve transfer evidence such as hair, fibers, paint, and glass.

**Prerequisite** None

## 1 Objectives

### 1.1 Theoretical

The Locard Exchange Principle states that whenever two objects come into contact, a transfer of material will take place. This transferred material can be used to associate objects, people, and/or locations. Material transferred during the commission of a crime shall be collected and preserved to allow for its analysis, assessment of its significance, and admission into court as evidence.

### 1.1 Practical

Upon completion of this module, the trainee will be able to:

A. Properly document evidence packaging and the original condition of an item of evidence;

B. Evaluate an item to determine the appropriate techniques required to collect and preserve the various types of trace evidence that may be present;

C. Apply those techniques while maintaining the integrity of the evidence and prevent any loss or contamination;

D. Report conclusions; and

E. Perform technical and administrative reviews.

## 2 Training Outline

### 2.1 Lesson Plan

A. Packaging documentation

1. Condition of seal
2. Package description

B. Item documentation

1. Written
   - *a) Physical condition including any damage or stains*
   - *b) Any identifying information, such as tag information on a garment*
   - *c) Drawing a sketch*
2. Photographic
   - *a) Overall condition*
   - *b) Areas of interest, such as stains or smears*

C. Introduction to recovery techniques including demonstration and case record documentation - each technique will be demonstrated by an experienced examiner
   1. Picking
   2. Tape lifting
   3. Scraping
   4. Combing
   5. Clipping
   6. Vacuum sweeping

D. Discussion of recovery techniques
   1. When to use each technique
   2. How to prevent loss and/or contamination for each technique
   3. Advantages and disadvantages of each technique
   4. Proper documentation

E. Stereoscopic exam of recovered evidence
   1. Setting up the stereoscope
   2. Screening examinations of recovered evidence
   3. Documentation of stereoscopic findings (hairs, fibers, paint, etc.)

F. The trainer and trainee will discuss collection of standards (for various types of evidence including but not limited to: fiber standards, hair standards, and paint standards)
   1. When to collect a standard
   2. How to collect a standard
   3. Proper documentation

G. Discuss report writing

H. Discuss technical reviews, administrative reviews, as well as pertinent documentation and necessary components of a completed case folder

I. Discuss court testimony

**2.2 Required Readings:**

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Examination and Recovery Techniques Unit.

B. Technical Working Group for Materials Analysis. Trace Evidence Recovery Guidelines. January 1998. *For Sci Comm*. October 1999. 1(3).

C. Robertson J, ed. *Forensic Examination of Fibres*. Ellis Horwood; New York, 1992, pp. 50-52.

D. Saferstein R, ed. *Forensic Science Handbook, Volume II*. Prentice-Hall; Englewood Cliffs, New Jersey, 1988.
   1. Chapter 4: Microscopy and Microchemistry of Physical Evidence, pp. 161-171
   2. Chapter 5: The Forensic Aspects of Textile Fiber Examination, pp. 215-221

E. Pounds CA. The Recovery of Fibres from the Surface of Clothing for Forensic Examination. *J For Sci Soc*. 15, pp. 127-132.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, and Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Observed Performance

A. The trainee will observe a trained analyst(s) collect and preserve evidence in casework or mock casework. The number of cases/mock cases observed is determined by the trainer.

B. When possible, the trainee should observe actual court testimony by an experienced evidence collection and preservation examiner.

## 3.5 Supervised Performance

A. The trainee will practice the individual recovery techniques on different items of evidence. The trainee shall demonstrate proper documentation, application of technique, and proper attention to loss and contamination potential.

B. The trainee will practice recovery of standards on different items of evidence. The trainee shall demonstrate proper documentation, application of technique, and proper attention to loss and contamination potential.

C. The trainee will stereoscopically examine and document recovered trace evidence on a series of tape lifts and at least one petri dish of scrapings. The tape lifts and petri dish(s) should be typical of those encountered in routine casework and allow for the detection of evidence discussed previously. The trainer will determine if the trainee has adequately examined and documented the recovered trace evidence.

D. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be given various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

E. Technical and administrative reviews

1. The trainee will be given case records that have been previously reviewed. The trainee will familiarize themselves with performing technical and administrative reviews. The number of reviews will be determined by the trainer.
2. The trainee will be given non-reviewed case records to perform a practice technical review before they are given to a qualified reviewer. The results of the trainee's review will be evaluated by the trainer. The number of reviews will be determined by the trainer.

### 3.6 Independent Exercises

A. The trainer will provide the trainee with at least 5 mock items of evidence. The trainee will determine the best way to document each item, determine which evidence recovery and preservation technique should be used, apply that technique, recover standards if appropriate, and prevent any loss and/or contamination.

B. The trainee will stereoscopically examine, document, and report the recovered trace evidence, where appropriate.

C. The trainee will document and prepare mock report(s) of unknown debris from various collections.

D. The trainee will provide written responses to the following questions:

1. What is the most efficient recovery technique used for trace evidence?
2. What is the least efficient recovery technique used for trace evidence?
3. What is the proper way to collect a fiber standard for comparison?
4. What potential trace evidence could exist on clothing from a hit and run victim?
5. Name at least two things you can do to prevent loss and/or contamination.
6. How would you process wet evidence?
7. What magnification is best for fiber screening?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Evidence Collection and Preservation Unit Checklist (LAB-TE-TM-02).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-02-02 COLLECTION OF GUNSHOT PRIMER RESIDUE SAMPLES

**Duration** One week

**Purpose** Familiarize the trainee with the collection of gunshot primer residue samples from clothing and other inanimate surfaces.

**Prerequisite** Evidence Collection and Preservation (TE-TM-02-01)

## 1 Objectives

### 1.1 Theoretical

Gunshot primer residue is formed by the firing of a weapon. The residue is expelled from the barrel and other openings of the weapon. The residue, primarily as a gaseous cloud, expands and may deposit gunshot primer residue particles on nearby objects. The detection of gunshot primer residue particles may indicate an association between an inanimate surface and the firing of a weapon.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand GSR formation and deposition

B. Collect and preserve possible gunshot primer residue particles from clothing and other inanimate surfaces.

## 2 Training Outline

### 2.1 Lesson Plan

A. Introduction to gunshot primer residue
   1. Particle morphology and composition
   2. Formation and deposition of particles
   3. Items suitable for gunshot primer residue collection
   4. Significance and limitations of analysis procedure
   5. Other gunshot residue deposits

B. Preparations for collection
   1. SEM stubs
   2. Site preparation

C. Sample collection
   1. Control sample
   2. Clothing (See GSR Stubbing Guidelines)
   3. Other inanimate objects

D. Documentation of samples

### 2.2 Required Readings

A. Wright DM, and Trimpe MA. Summary of the FBI Laboratory's Gunshot Residue Symposium, May 31-June 3, 2005. *For Sci Comm*. July 2006. 8(3), pp. 1-19.

B. Mann M, and Espinoza EO. The Incidence of Transient Particulate Gunshot Primer Residue in Oregon and Washington Bow Hunters. *J For Sci*. 1993. 38, pp. 23-27.

C. Chavez D, Crowe C, and Franco L. The Retention of Gunshot Residue on Clothing After Laundering. *SWAFS Journal*. 1998, 8(2), pp. 22-29.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Observed Performance

A. The trainee will observe trained analyst(s) collect and preserve GSR evidence in casework or mock casework. The number of cases/mock cases observed is determined by the trainer.

B. When possible, the trainee should observe actual court testimony by an experienced examiner.

### 3.5 Supervised Performance

A. The trainee will practice properly preparing the site for the collection of gunshot primer residue from clothing.

B. The trainee will practice collecting gunshot primer residue from an article of clothing and other inanimate objects.

### 3.6 Independent Exercises

A. The trainee will explain and demonstrate the collection of gunshot primer residue by stubbing at least two articles of clothing.

B. The trainee will explain the collection of gunshot primer residue from other inanimate objects and, if practicable, demonstrate the collection of gunshot primer residue from an inanimate object.

C. The trainee will provide a written response to the following questions:

1. What types of objects are not appropriate for the collection of GSR samples?
2. Why is it important to collect a control sample?
3. What are the considerations/limitations for sample collection?
4. How are gunshot primer residue particles formed and deposited?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams. The competency exams could be mock casework, case reexaminations, or old proficiencies.

B. The trainee will complete a comprehensive written exam.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Evidence Collection and Preservation Unit Checklist (LAB-TE-TM-02).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 03 PHYSICAL COMPARISON UNIT

# TE-TM-03-01 PHYSICAL COMPARISON CUT-TEAR

**Duration** One week

**Purpose** Familiarize the trainee with the examination of products to determine cut/tear

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Many items (textiles, window screens, upholstery, etc.) may become damaged as a result of a violent assault. The damage resulting from a tear can, at times, be distinguished from the damage caused by a cut.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Examine an item for defects,

B. Form an opinion about the cause of the damage arising from a cut or a tear,

C. Understand how to report conclusions and opinions,

D. Understand how to perform technical and administrative reviews, and

E. Have the knowledge to provide expert testimony that appropriately conveys the significance of the analysis.

## 2 Training Outline

### 2.1 Lesson Plan

A. General cut, tear, and puncture characteristics

1. Textile type (knitted, woven, etc.), wire security screen, tape (electrical and duct), paper
2. Force
3. Direction
4. Implement used
5. Other variables

B. Visual and stereoscopic exams

C. Test cuts and tears

D. Documentation

1. Notes
2. Photography

E. Interpretation, limitations, and significance

F. Discuss report writing

G. Discuss technical reviews, administrative reviews, pertinent documentation, and necessary components of a completed case folder.

H. Discuss court testimony

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Determination of Cuts/Tears

B. Monahan, D.L., Harding, H.W., Damage to Clothing – Cuts and Tear. *Journal of Forensic Sciences*, Vol. 35, No. 4, July 1990, pp. 901-912.

C. Green, M.A., Stab Wound Dynamics – A Recording Technique for Use in Medico-Legal Investigations. *Journal of the Forensic Science Society*, Vol. 18, 1978, pp. 161-163.

D. Taupin, J.M., Clothing Damage Analysis and the Phenomenon of the False Sexual Assault. *Journal of Forensic Sciences*, 2000; 45(3): 568-572.

E. Taupin, J.M., Testing Conflicting Scenarios – A Role for Simulation Experiments in Damage Analysis of Clothing. *Journal of Forensic Sciences*, 1998; 43(4): 891-896.

F. Robertson, James, and Michael Grieve. Examination of Damage to Textiles. *Forensic Examination of Fibres*, 2nd ed., Ellis Horwood Limited, 1992, pp. 65–87.

G. Taupin J.M., Damage to a Wire Security Screen: Adapting the Principles of Clothing Damage Analysis. *Journal of Forensic Sciences*, 1998;43(4):897–900.

H. ASTM Standard E2288 – 09, "Standard Guide for Physical Match of Paper Cuts, Tears, and Perforations in Forensic Document Examinations," ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/E2288-09, www.astm.org

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Observed Performance

A. The trainee will observe trained analyst(s) conduct cut/tear analysis in casework or mock casework. The number of cases/mock cases observed is determined by the trainer.

B. When possible, the trainee should observe actual court testimony by an experienced cut/tear examiner.

### 3.5 Supervised Performance

A. The trainee will examine several items and perform test cuts, tears, and punctures.

1. The items should include, at a minimum, various clothing items (woven and knitted) and window screening.

2. The characteristics of the test cuts, tears, and punctures should be documented and compared.

3. The test cuts and tears should be made using various implements, with varying amounts of force, and in different directions relative to the weave.

B. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results. The trainee will prepare mock reports based on the provided scenarios or results.

C. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be given non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

A. The trainee will be given a set of at least 5 items with cuts/tears and will determine the nature of the damage present. All observations and conclusions should be documented.

B. The trainee will prepare mock case reports based on the conclusions of the cut/tear exams.

C. The trainee will provide written answers to the following questions:

1. What are the general characteristics that are observed in items that have been cut?
2. What are the general characteristics that are observed in items that have been torn?
3. What are circumstances in which the determination of a cut vs. tear can be complicated?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Physical Comparison Unit Checklist (LAB-TE-TM-03).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-03-02 PHYSICAL COMPARISON

**Duration** One week

**Purpose** Familiarize the trainee with the comparison of objects based upon class and randomly acquired characteristics

**Prerequisite** Physical Comparison Cut-Tear (TE-TM-03-01)

## 1 Objectives

### 1.1 Theoretical

Class characteristics are those characteristics shared by a finite number of items while randomly acquired characteristics are characteristics unique to one particular object. The physical comparison of items involves the comparison of the class characteristics and the randomly acquired characteristics of the items.

Physical match comparisons, also known as jigsaw fit comparisons, are performed in an attempt to uniquely associate a piece of material with an item from which it is thought to have originated, based upon randomly acquired characteristics.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Compare objects based upon class and randomly acquired characteristics,

B. Report conclusions and opinions,

C. Perform technical and administrative reviews, and

D. Provide expert testimony that appropriately conveys the significance of the physical comparison/match.

## 2 Training Outline

### 2.1 Lesson Plan

A. Class characteristics vs. randomly acquired characteristics

B. Physical comparisons

1. Visual/stereoscopic exam
2. Documentation
3. Photography
4. Significance

C. Physical matches

1. Visual/stereoscopic exam
2. Documentation
3. Photography
4. Significance

D. Discuss report writing

E. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

F. Discuss court testimony.

### 2.2 Required Readings

A. Bradley MJ, Keagy RL, Lowe PC, Rickenbach MP, Wright DM, and LeBeau MA. A Validation Study for Duct Tape End Matches. *J For Sci.* 2006. 51(3), pp. 504-508.

B. Trace Evidence Manual, Texas DPS Crime Laboratory

1. Physical Comparison.
2. Fracture Physical Match Comparison

C. Saferstein R. *Criminalistics: An Introduction to Forensic Science*. Prentice-Hall. 1995. pp. 65-71.

D. VanHoven HA, and Fraysier HD. The Matching of Automotive Paint Chips by Surface Striation Alignment. *J For Sci*. 1983.28(2), pp. 463-467.

E. Zugibe F, and Costello J. The Jigsaw Puzzle Identification of a Hit and Run Automobile. *J For Sci*.1986. 31(1), pp. 329-332.

F. Saferstein R, ed. *Forensic Science Handbook*. Prentice-Hall, New Jersey. 1982. pp. 151-153.

G. Bodziak WJ. *Footwear Impression Evidence, 2nd edition*. CRC Press. 2000. pp 329-338.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Observed Performance

When possible, the trainee should observe actual court testimony by an experienced examiner.

### 3.5 Supervised Performance

A. The trainee will prepare a number of practice physical comparisons using different techniques (ex. cutting with scissors and a scalpel, ripping, breaking) and using different materials such as duct tape, cloth, plastic, and paint.

1. Note how each technique affects the different materials.
2. The trainee will perform a physical match comparison on these same items, demonstrating proper documentation.

B. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will issue reports based on those results.

C. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.

2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

A. The trainee will be given at least 2 sets of broken material. The trainee will be responsible for conducting a physical comparison examination, as well as for properly documenting any physical matches that might be found.

1. The types of material selected will be typical of what is seen in actual casework.

2. Successful completion of the practical exam will occur when all physical matches have been properly identified, documented, and reported.

B. The trainee will provide a written response to the following questions:

1. What is a class characteristic?

2. What is a randomly acquired characteristic?

3. What materials are suitable for physical comparison examination?

4. List the requirements for documenting a physical match.

5. What is the significance of a physical match?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams could be mock casework, case reexaminations, or old proficiencies.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Physical Comparison Unit Checklist (LAB-TE-TM-03).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# 04 GLASS UNIT

# TE-TM-04-01 INTRODUCTION TO GLASS EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the basic concepts and theoretical knowledge of glass products and the forensic examination and comparison of glass.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Glass can be encountered as evidence at a variety of scenes. Analysis of the glass may be used to demonstrate the possible source, the direction of force from which the glass broke, or to provide investigative information as to the possible uses of a particular type of glass. Analysis techniques include examinations of both physical and chemical properties. A basic understanding of glass, its manufacturing processes, and available analysis techniques is required to begin forensic examination and comparison of glass evidence.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand the characteristics of glass,

B. Understand the principles of glass manufacture and applications,

C. Understand the available analysis techniques, and

D. Understand the process of glass evidence transfer and persistence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Definition of glass and its characteristics

B. Composition

C. Glass types, manufacturing processes, and end uses
   1. Tempered glass
   2. Float glass
   3. Soda-lime-silica glass
   4. Laminated glass
   5. Glass fibers
   6. Other

D. Overview of analysis techniques
   1. Visual
   2. Microscopic
   3. Density
   4. Refractive index
   5. Elemental analysis

E. Collection of known samples

1. Crime scene
2. Laboratory setting

F. Transfer and persistence

### 2.2 Required Readings

A. Brewster F, Thorpe JW, Gettinby G, and Caddy B. The Retention of Glass Particles on Woven Fabrics. *J For Sci*. 1985; 30: pp. 798-805.

B. Copley G. Caddy B, ed. *Forensic Examination of Glass and Paint*, Taylor & Francis, New York, NY; 2001. Chapter 2: The Composition and Manufacture of Glass and Its Domestic and Industrial Applications, pp. 27-46

C. Curran JM, Hicks TN, and Buckleton JS. *Forensic Interpretation of Glass Evidence*. Boca Raton: CRC Press, 2000.

1. Chapter 1: Examination of Glass, pp. 1-26
2. Chapter 5: Transfer and Persistence Studies, pp. 103-131

D. Hickman DA. A Classification Scheme for Glass. *For Sci International*. 1981. 17, pp. 265-281.

E. Hicks T, Vanina R, and Margot P. Transfer and Persistence of Glass Fragments on Garments. *Science and Justice*. 1996. 36, pp. 101-107.

F. Koons RD, and Buscaglia, J. The Forensic Significance of Glass Composition and Refractive Index Measurements. *J For Sci*. 1999. 44(3), pp. 496-503.

G. McCrone W. Microscopical Characterization of Glass Fragments. *J of Am Org Analytical Chemists*. 1972. 55(4), pp. 834-839.

H. McCrone W. Microscopical Characterization of Glass Fragments. *J of Am Org Analytical Chemists*. 1974. 57(3), pp. 668-670.

I. Saferstein R, ed. *Forensic Science Handbook*, Prentice-Hall, Englewood Cliffs, NJ. 1982. Chapter 4: Forensic Glass Comparisons, pp. 139-183.

J. Almirall JR. “Glass Exam and Comparison”, Presentation, California Criminalistics Institute, 1997.

K. Skirda MA. Forensic Glass Comparisons. *Proceedings of the International Symposium on the Forensic Aspects of Trace Analysis*. 1991, pp. 79-90.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Independent Exercises

The trainee will provide a written response to the following questions:

1. What type of glass would you typically find in a wine bottle? Windshield? Window pane?
2. Describe how float glass is made and how it can be identified.
3. A burglary suspect breaks a window to gain entrance into a house. Two hours later the suspect is caught. Describe likely places where the broken glass may have transferred on his person.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Glass Unit Training Checklist (LAB-TE-TM-04).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-04-02 INITIAL EVALUATION OF GLASS EVIDENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the examination and comparison of the physical properties of glass evidence

**Prerequisite** Introduction to Glass Evidence (TE-TM-04-01)

## 1 Objectives

### 1.1 Theoretical

Glass has certain physical properties such as color, thickness and fluorescence that can be quickly and easily observed. These properties of questioned and known glass samples from a case are documented and compared. A meaningful difference in these physical properties between the questioned and known glass samples would eliminate the need for any further analysis.

Direction of force or physical match comparisons are other common examinations that may be requested of submitted glass evidence. These characteristics can also be observed prior to any instrumental analysis.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Identify glass based on physical characteristics and/or microscopic examinations,

B. Document and compare physical characteristics of glass,

C. Determine direction of force of glass fragments, and

D. Determine the presence of physical matches in glass evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Initial examination and identification techniques

1. Recovery
2. Cleaning
3. Stereoscope
4. Polarized light microscope

B. Color evaluation

C. Thickness measurements

D. UV reactions

E. Fracture processes and characteristics

1. Fracture shapes
2. Concoidal fractures
3. Hackle marks
4. Direction of force indicators

5. Radial and concentric cracks
6. Sequence of cracks
7. Center frost lines

F. Physical match

G. Documentation and use of the “Glass Examination” worksheet

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Glass Initial Examination and Overview.

B. Dabbs MDG, and Pearson EF. Some Physical Properties of a Large Number of Window Glass Specimens. *J For Sci.* 1972, 17(1), pp. 70-78.

C. Hamer P. Caddy B, ed. *Forensic Examination of Glass and Paint*, Taylor & Francis, New York, NY, 2001.

1. Chapter 3: Microscopic Techniques for Glass Examination, pp. 47-64
2. Chapter 6: Interpretation of Physical Aspects of Glass Evidence, pp. 97-122

D. Thornton JI. Glass Fracture Mechanism – A Rethinking. *J For Sci*. 1986. 31(3), pp. 818-824.

E. Webb KH. “Glass Fracture Documentation at the Scene and Reconstruction Techniques.” Southwestern Association of Forensic Scientists, Training Seminar. Fall 1994.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

The calipers/micrometers are checked day of use:

A. Perform at least two different size measurements using NIST traceable gauge blocks or other equivalent reference standard.

B. If the observed measurements are not within ± 0.02 mm of the specified gauge block, the calipers/micrometers should be visually inspected for damage or debris. The gauge blocks should then be re-measured.

C. If the observed measurement still falls outside of the acceptable range, the calipers/micrometers should be taken out of service until issue is resolved.

D. A logbook of the results of performance verification checks should be maintained.

### 3.3 Equipment

- Stereomicroscope
- Polarized Light Microscope
- Ultraviolet light
- Calipers/micrometer
- Forceps

### 3.4 Supervised Performance

A. The trainee will be provided with samples of various glass and non-glass material similar to the type that may be encountered in casework (i.e. plastic, quartz, salt) to demonstrate how to identify glass from non-glass items.

B. The trainee will examine various types of glass and will document color, thickness, UV reactions, edge characteristics, and microscopic characteristics using the “Glass Examination” worksheet.

### 3.5 Independent Exercises

A. The trainee will examine a set of question and known glass samples and will perform a comparison of those samples based on color, thickness, UV reactions, edge characteristics, and microscopic characteristics. This sample set should include some non-glass samples as encountered in casework.

B. The trainee will provide a written response to the following questions:

1. What are some common characteristics of glass that help distinguish it from other types of trace evidence?
2. What are the limitations of a color comparison in glass fragments?
3. Explain how the sequence of cracks can be determined on a pane of glass?
4. What type of glass “dices” when it fractures?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Glass Unit Training Checklist (LAB-TE-TM-04).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-04-03 DETERMINATION OF GLASS REFRACTIVE INDEX

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the operation of the GRIM instrument and the determination of the refractive index of glass

**Prerequisite** Introduction to Glass Evidence (TE-TM-04-01), Initial Evaluation of Glass Evidence (TE-TM-04-02)

**Note** Module can be completed concurrently with Glass Analysis by X-Ray Fluorescence (TE-TM-04-04)

## 1 Objectives

### 1.1 Theoretical

The refractive index of glass is used to discriminate between glass samples of different origins. Glass particles from the same source will have the same refractive index, while glass particles from different sources may have a different refractive index. Refractive index can vary across a distance in a single item. The refractive index of even very small glass particles can be accurately determined by a semi-automated microscopy technique using the GRIM instrument.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Explain the property of refractive index and

B. Measure the refractive index of glass fragments

## 2 Training Outline

### 2.1 Lesson Plan

A. Refractive Index
   1. Definition
   2. Measurement techniques
   3. Variation in glass samples

B. GRIM instrument
   1. Theory
   2. Operation
   3. Calibration
   4. QC procedures
   5. Refractive index oil choice
   6. Sample preparation
   7. Measurements and edge counts
   8. Interpretation

## 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Glass Refractive Index Determination.

B. Almirall JR. Discrimination of Glass Sources Using Elemental Composition and Refractive Index: Development of Predictive Models. *Science and Justice*. 1998. 38(2), pp. 93-100.

C. ASTM E1967-98. Standard Test Method for the Automated Determination of Refractive Index of Glass Samples Using the Oil Immersion Method and a Phase Contrast Microscope.

D. Brown GA. Factors Affecting the Refractive Index Distribution of Window Glass. *J For Sci*. 1985. 30(3), pp. 806-813.

E. Cassista AR, and Sandercock PML. Precision of Glass Refractive Index Measurements: Temperature Variation and Double Variation Methods, and the Value of Dispersion. *Can. Soc. Forens. Sci. J*. 1994. 27(3), pp. 203-208.

F. Ojena SM, and De Forest PR. A Study of the Refractive Index Variation Within and Between Sealed Beam Headlight Using a Precise Method. *J For Sci*. 1972. 17, pp. 409-425.

G. De Forest PR, and Ojena SM. Precise Refractive Index Determination by the Immersion Method, Using Phase Contrast Microscopy and the Mettler Hot Stage. *J For Sci Soc*. 1972. 12, pp. 315-329.

H. Evett IW. The Interpretation of Refractive Index Measurements. *For Sci International*. 1977. 9, pp. 209-217.

I. Foster and Freeman. GRIM3, Glass Refractive Index Measurement System User Manual. February 2010.

J. Heideman D. Glass Comparison Using a Computerized Refractive Index Database. *J For Sci*. 1975. 20(1), pp. 103-108.

K. Koons RD, and Buscaglia J. Distribution of Refractive Index Values in Sheet Glasses**.** *For Sci Comm*. 2001. 3(1).

L. Koons RD, and Buscaglia J. The Forensic Significance of Glass Composition and Refractive Index Measurements. *J For Sci*. 1999. 44(3), pp. 496-503.

M. Koons RD, Peters CA, and Rebbert PS. Comparison of Refractive Index, Energy Dispersive S-Ray Fluorescence and Inductively Coupled Plasma-Atomic Emission Spectrometry for Forensic Characterization of Sheet Glass Fragments. *J Analytical Atomic Spectrometry*. 1991. 6, pp. 451-456.

N. Dabbs MDG and Pearson EF. The Variation in Refractive Index and Density Across Two Sheets of Window Glass. *J For Sci Soc*. 1970. 10, pp. 139-148.

O. Locke Scientific, Reference Glasses and Silicone Oils for Refractive Index Determination.

P. Slater DP, and Fong W. Density, Refractive Index, and Dispersion in the Examination of Glass: Their Relative Worth as Proof. *J For Sci.* 1982, 27(3), pp. 474-483.

Q. Underhill M. Multiple Refractive Index in Float Glass. *J For Sci Soc*. 1980. 20, pp. 169-176.

# 3 Practice

## 3.1 Safety

Appropriate personal protection from flying glass particles

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

GRIM instrument

## 3.4 Supervised Performance

A. The trainee will measure the refractive index of a set of glass samples using the GRIM instrument. The samples should necessitate the use of various oils for the measurements.

B. The trainee will measure the refractive index of various locations of a single glass sample in order to assess variation within the sample.

## 3.5 Independent Exercises

A. The trainee will examine a set of question and known glass samples and will perform a comparison of those samples based on refractive index measurements.

B. The trainee will provide a written response to the following questions:

1. What are edge counts and why are they important?
2. What are the limitations of refractive index comparisons?
3. What is the match point or match temperature?
4. What are tramlines?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Glass Unit Training Checklist (LAB-TE-TM-04).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-04-04 GLASS ANALYSIS BY X-RAY FLUORESCENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the elemental analysis and comparisons of glass samples using x-ray fluorescence instrumentation

**Prerequisite** Introduction to Glass Evidence (TE-TM-04-01), Initial Evaluation of Glass Evidence (TE-TM-04-02)

**Note** Module can be completed concurrently with Determination of Glass Refractive Index (TE-TM-04-03)

## 1 Objectives

### 1.1 Theoretical

The elemental composition of glass can be determined through the use of x-ray fluorescence (XRF) analysis. Once the elemental composition has been determined, a comparison between glass samples can be performed using a semi-quantitative technique that compares spectral shape and elemental peak intensity ratios.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Operate x-ray fluorescence instrumentation for elemental analysis of glass and

B. Perform semi-quantitative comparison of glass samples using XRF data.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss elemental composition of various glass types

B. XRF theory

C. Instrument familiarization

D. Instrument operation

1. Operating parameters
2. Calibration
3. QC procedures
4. Sample preparation
5. Element identification
6. Spectral comparisons (overlays)
7. Elemental ratio analysis

E. Limitations

1. Element range
2. Concentration
3. Sample size

F. Interpretation

### 2.2 Required Readings

A. Trace Evidence Standard Operating Procedures, Texas DPS Crime Laboratory: Glass Analysis by X-Ray Fluorescence.

B. Caddy B, ed. *Forensic Examination of Glass and Paint*, Taylor & Francis, New York, NY. 2001. Chapter 4: Elemental Analysis of Glass Fragments, pp. 65-84.

C. Eagle III µ-EDXRF User School Notebook. EDAX Inc, April 2009.

D. Scientific Working Group for Materials Analysis (SWGMAT). Elemental Analysis of Glass. January 2005. *For Sci Comm*. 7(1).

E. Howden CR, Dudley RJ, and Smalldon KW. The Analysis of Small Glass Fragments Using Energy Dispersive X-Ray Fluorescence Spectrometry. *J For Sci Soc*. 1978. 18, pp. 99-112.

F. Seaman A. "Analysis of 'as-is' glass particulates using µ-beam EDXRF methods." Presented at the Pittcon 2000 Technical Papers, July 2001.

G. Skoog DA, Holler FJ, and Nieman TA. *Principles of Instrumental Analysis*, 5th edition. Saunders College Publishing. Chapter 12: Atomic X-Ray Spectroscopy, pp.357-378.

## 3 Practice

### 3.1 Safety

A. Protective eyewear must be worn when filling the detector with liquid nitrogen.

B. Refer to Safety Manual, *Radiation Safety* chapter

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

X-ray Fluorescence instrument

### 3.4 Supervised Performance

A. The trainee will be provided various glass samples to prepare for XRF analysis to include full thickness pieces. These samples will be analyzed using XRF and the elemental composition identified.

B. The trainee will be given a set of glass samples to analyze via XRF. These samples will then be compared using spectral overlays and elemental ratio comparisons.

### 3.5 Independent Exercises

A. The trainee will examine a set of question and known glass samples and will perform a comparison of those samples based on XRF analysis.

B. The trainee will provide a written response to the following questions:

1. What are some major elements encountered in glass samples?
2. What are some minor and/or trace elements encountered in glass samples?
3. Why are cerbium, erbium, or arsenic containing compounds sometimes added to glass samples?
4. What element can be used to classify glass as to float or container glass?

5. Why is iron sometimes added to glass?
6. What are the limitations and benefits of XRF analysis over other elemental analysis techniques?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Glass Unit Training Checklist (LAB-TE-TM-04).

B. The trainee will evaluate the module content and the trainer at the completion of the unit .

# TE-TM-04-05 INTERPRETATION OF GLASS EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the factors that affect interpretation of the significance of glass evidence.

**Prerequisite** Introduction to Glass Evidence (TE-TM-04-01) *through* Glass Analysis by X-Ray Fluorescence (TE-TM-04-04)

## 1 Objectives

### 1.1 Theoretical

Glass can be encountered as evidence at a variety of scenes. Its ultimate evidentiary value is dependent on factors and circumstances surrounding the case and the commonness of the particular glass fragments. The forensic scientist must be able to provide expert testimony concerning the significance of an association based upon glass evidence.

### 1.2 Practical

Upon completion of this module, the trainee will:

A. Understand the factors affecting the significance of glass evidence,

B. Understand how to report conclusions and opinions,

C. Understand how to perform technical and administrative reviews, and

D. Be able to provide expert testimony that appropriately conveys the significance of glass evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the interpretation, significance, and limitations of glass comparisons and associations

1. Variations in physical and chemical characteristics within individual samples
2. Variation within the glass population
3. Effects of sample size
4. Quantity and distribution of recovered glass
5. Persistence of glass transfers

B. Discuss report wording

C. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

D. Discuss court testimony

### 2.2 Required Readings

A. Evett IW. The Theory of Interpreting Scientific Transfer Evidence. *For Sci Progress*. 1990. 4, pp.141-178.

B. Evett IW, and Buckleton J. The Interpretation of Glass Evidence: A Practical Approach. *J For Sci* Soc. 1990. 30, pp. 215-223.

C. Evett IW, and Lambert JA. Further Observations on Glass Evidence Interpretation. *Science and Justice*. 1995. 35, pp. 283-289.

D. Fong W. Value of Glass as Evidence. *J For Sci*. 1973. 18(4), pp. 398-404.

E. McQuillan J, and Edgar K. A Survey of the Distribution of Glass on Clothing. *J For Sci* Soc. 1992. 32(4), pp. 333-348.

F. Caddy B, ed. *Forensic Examination of Glass and Paint*. New York, NY: Taylor & Francis. 2001; Chapter 5: Statistical Interpretation of Glass Evidence, pp. 85-96.

G. Pearson EF, May RW, and Dabbs, MDG. Glass and Paint Fragments Found in Men's Outer Clothing – Report of a Survey. *J For Sci*. 1971. 16(3), pp. 283-300.

H. Walsh K, and Buckleton J. On the Problem of Assessing the Evidential Value of Glass Fragments Embedded in Footwear. *J For Sci* Soc. 1986. 26, pp. 55-60.

I. Curran JM, Hicks TN, and Buckleton JS. *Forensic Interpretation of Glass Evidence*, Boca Raton: CRC Press. 2000.

1. Chapter 2: The Conventional Approach to Evidence Interpretation, pp. 27-54
2. Chapter 4: Glass Found at Random and Frequency of Glass, pp. 87-102

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced glass examiner.

## 3.5 Supervised Performance

A. Report writing

1. The trainee will review case reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

B. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

The trainee will provide a written response to the following question: What factors can affect the significance of a glass association and how?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Glass Unit Training Checklist (LAB-TE-TM-04).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 05 LAMP FILAMENT UNIT

# TE-TM-05-01 INTRODUCTION TO FILAMENT EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the basic concepts and theoretical knowledge of vehicle lamps and the forensic examination of filaments.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Forensic filament examinations are used primarily for automotive lamps involved in traffic accidents to determine if the lamps were on or off. Information derived through a forensic filament examination can be helpful in corroborating witness testimony and/or developing useful information for the investigation. Analysis of the filament and the bulb may yield information as to whether the bulbs were on or off when the damage occurred. A basic understanding of vehicle lamps and their components as well as the manufacturing processes is required to begin forensic examinations of filament evidence.

### 1.2 Practical

Upon completion of this module, the trainee will understand:

A. Characteristics of tungsten filaments,

B. Principles of lamp/coil manufacture and applications, and

C. Collection of filament evidence

## 2 Training Outline

### 2.1 Lesson Plan

A. Tungsten filament characteristics
   1. Physical properties (melting point, tensile strength, coefficient of linear expansion)
   2. Oxidation states
   3. Incandescence process
   4. Halogen cycle
   5. Water cycle

B. Coil manufacturing processes
   1. Retractable mandrel process
   2. Continuous coil process

C. Lamp construction
   1. B style bulbs
   2. C style bulbs
   3. Other bulb styles
   4. Posts and supports
      *a) Getter*
      *b) Bases*

D. Discuss specific automotive bulbs and locations in vehicles

E. Collection of evidence samples

1. Crime scene
2. Laboratory setting

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Lamp Filament Examination

B. Baker JS, Aycock TL, and Lindquist T. *Lamp Examination for On or Off in Traffic Accidents*. Northwestern University Traffic Institute. 1999.

C. Dolan. Vehicle Lights and Their Use as Evidence. *J For Sci Soc*. 11(2), pp. 69.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Stereoscope

### 3.4 Supervised Performance

The trainee will examine multiple styles of vehicle bulbs noting the different components that are present. These bulbs should include, but not be limited to, vacuum bulbs, halogen bulbs, posts with getter, and various coil constructions and placements.

### 3.5 Independent Exercises

The trainee will provide the answers to the following questions:

A. What substance is the filament of an automobile headlight made of and why?

B. Should lamps be turned on or off at the scene of an accident to see if they function? Why or why not?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Lamp Filament Unit Training Checklist (LAB-TE-TM-05).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-05-02 LAMP FILAMENT EXAMINATION

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the forensic examination of filament evidence.

**Prerequisite** Introduction to Filament Evidence (TE-TM-05-01)

## 1 Objectives

### 1.1 Theoretical

The physical properties of incandescent tungsten lamp filaments differ from their cold properties, which will affect how the filament will behave when it encounters a shock force, such as in a traffic accident. The resultant condition of the filament can be used to assess whether or not the filament was incandescent at the time it was damaged.

### 1.2 Practical

Upon completion of this module, the trainee will be able to examine a filament and form an opinion as to its on/off status at the time of damage to the filament.

## 2 Lesson Plan

### 2.1 Instructional Outline

A. Normal use lamp characteristics
   1. Coil shape and spacing
   2. Color
   3. Mechanical distortions
   4. Squirm
   5. Age sag
   6. Pitting

B. Damage characteristics
   1. Cold break
   2. Hot shock or thermal shock
   3. Broken glass envelope
   4. Oxidation
   5. Melted glass
   6. Missing filaments
   7. Burnouts
   8. Water exposure
   9. Glass etching

C. Lamp examinations
   1. Continuity tests with ohm meter
   2. Stereoscopic examinations and photography

3. Techniques for breaking glass envelopes

D. Documentation using the Filament Examination form

E. Discuss interpretation and significance of the observations

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Lamp Filament Examination

B. Baker JS, Aycock TL, and Lindquist T. *Lamp Examination for On or Off in Traffic Accidents*. Northwestern University Traffic Institute. 1999.

C. Greenlay, Juzkow, Mikkelsen, and Beveridge. The Effect of Impact on the Filaments of Quartz Halogen Headlamps. *J Can Soc For Sci*. 19(2), pp. 77.

D. Murphy, Rioux, Stone, and Stuart. Determination of the Temperature of the Filament Adjacent to the Incandescent Filament in a Double Beam Headlight. *J Can Soc For Sci*. 24(2), pp. 91-96.

E. Powell. Interpretation of Vehicle Globe Failures – The Unlit Condition. *J For Sci*. 22, pp. 628.

F. Reynolds. Metallurgical Investigation of Component Failures. *J For Sci Soc*. 14, pp. 275.

G. Thompson. Switched On?. *J For Sci Soc*. 11(3), pp. 151.

H. Camps, ed. Lamp Filaments – A Method of Determining Whether Lights were "On" or "Off". *Grahwohl's Legal Medicine*, 2nd edition. 1968, pp. 235-238.

I. Tobin WA. Noninvasive Evaluation of Vehicular Lamp Bulbs. *Crime Lab Digest*. January 1994. 21(1), pp. 5-7.

J. Lavabre R, and Baudoin P. Examination of Lightbulb Filaments After a Car Crash: Difficulties in Interpreting the Results. *J For Sci*. 46(1), pp. 147.

## 3 Practice

### 3.1 Safety

A. Protective eyewear and gloves shall be worn while opening sealed lamps.

B. Universal Safety Precautions and use of appropriate Personal Protective Equipment (PPE)

### 3.2 Standards, Controls, Reagent Preparation

A. The ohmmeter operation is checked before use:

1. Turn the ohmmeter on.
2. Set the ohmmeter to read resistance (ohms).

B. The ohmmeter is operating properly if the resistance reads zero when the leads are in contact and if the resistance reads infinity (one) when the leads are not in contact.

### 3.3 Equipment

- Ohmmeter
- Stereomicroscope

- Heating device
- Water
- Hacksaw or other cutting device
- Vise
- Diamond scribe
- Insulated gloves
- Protective eyewear

### 3.4 Supervised Performance

A. The trainee will demonstrate that they can break the bulbs of lamps and expose the bare filaments without damaging the filaments. At least one sealed-lamp and one B-type lamp should be used.

B. The trainee will correctly identify at least one example of each of the following: age-sag, pitting, tungsten deposition, various oxidation states (blackening and secondary colors), oxide dust/deposits, hot shock distortion, angular breaks and a normal functioning burnout.

C. The trainee will bring lamps of various types to incandescence and determine how much comparative force is needed to produce significant distortion. At least one “peanut” lamp, one B-type lamp and one halogen lamp should be examined.

D. The trainee will demonstrate the proper way to operate an ohmmeter on at least one sealed-lamp, one B-type lamp and one halogen lamp (preferably still mounted in a housing unit as well as loose.)

### 3.5 Independent Exercises

A. The trainee will examine various style bulbs and determine if the bulbs were on or off. The trainee will document their observations using the **“Filament Examination”** form.

B. The trainee will provide a written response to the following questions:

1. What is meant by the term age sag, and what characteristics differentiate age sag from distortion caused by an impact?
2. What is the purpose of performing a conductivity test on the filaments in a light?
3. What causes the “coloration” (green, purple, blue etc.) sometimes observed on a filament where the glass has been broken?
4. How would you interpret a lamp if the bulb is broken and the filament is stretched out, but no apparent oxidation is present?
5. How would you interpret the absence of distortion in an unbroken bulb?
6. How would you interpret the presence of an angular break in the filament if the bulb is unbroken?
7. How would you interpret a lamp where the bulb is broken and the filament is bright with angular fractures?
8. How would you interpret a lamp where the bulb is broken, filament A is tinted with no distortion, filament B is stretched out, blackened and broken with melted ends?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Lamp Filament Unit Training Checklist (LAB-TE-TM-05).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-05-03 INTERPRETATION OF LAMP FILAMENT EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the factors that affect interpretation of the significance of filament evidence.

**Prerequisite** Introduction to Filament Evidence (TE-TM-05-01), Lamp Filament Examination (TE-TM-05-02)

## 1 Objectives

### 1.1 Theoretical

The forensic filament examiner must be able to provide expert testimony concerning the significance and limitations of forensic filament examinations and convey that information to a jury in a manner that can be understood.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand the limitations and significance of filament examinations,

B. Understand how to report conclusions and opinions,

C. Understand how to perform technical and administrative reviews, and

D. Be able to provide expert testimony that appropriately conveys the significance of filament examinations.

## 2 Lesson Plan

### 2.1 Instructional Outline

A. Discuss the significance of filament examinations

B. Discuss the limitations of filament examinations

C. Discuss report wording

D. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

E. Discuss court testimony

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Lamp Filament Examination.

B. Baker JS, Aycock TL, and Lindquist T. *Lamp Examination for On or Off in Traffic Accidents*. Northwestern University Traffic Institute. 1999.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced filament examiner.

### 3.5 Supervised Performance

A. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

B. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

The trainee will provide a written response to the following question: What are some limitations of filament examinations?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Lamp Filament Unit Training Checklist (LAB-TE-TM-05).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 06 HAIR UNIT

# TE-TM-06-01 INTRODUCTION TO HAIR

**Duration** One to two weeks

**Purpose** Familiarize the trainee with forensic hair examination and comparison.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

The ability to properly identify and characterize hair can be useful in providing investigative leads, eliminating hairs from possible contributors and comparison to known source(s). The information in this module will help the examiner understand the many features utilized in forensic hair examination and the valuable information that can be gained from such exams.

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Discuss the development of forensic examination and comparison of hair evidence

B. Discuss the techniques used to examine and compare hair evidence

## 2 Training Outline

### 2.1 Lesson Plan

A. History and development of forensic examination and comparisons of hair evidence and the current state of hair evidence

B. The structure and chemical composition of human hair

C. Growth cycle and root stages of human hair

D. Wig hair

E. Transfer and persistence

F. Hair examinations and comparisons

G. Hair conclusions

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Saferstein R, ed. *Forensic Science Handbook.* Prentice-Hall; Englewood Cliffs, NJ, 1982. Chapter 5: The Forensic Identification and Association of Human Hair, pp. 184-221.

B. Federal Bureau of Investigation. Forensic Science Research and Training Center. *Proceedings of the International Symposium on Forensic Hair Comparisons*. U.S. Department of Justice, 1985.

C. Hicks, JW. *Microscopy of Hair*, Federal Bureau of Investigation, 1977.

D. Ogle, RR, and Fox, MJ. *Atlas of Human Hair Microscopic Characteristics*, CRC Press, Boca Raton, FL. 1999.

E. Robertson, J. *Forensic Examination of Hair*. Taylor and Francis, London. 1999, pp. 1-79.

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Independent Exercises

The trainee will provide a written response to the following questions:

A. Describe the structure and chemical composition of human hair.

B. Discuss the growth cycle of hair and the root stages

C. On average, how many hairs does a person shed in a day?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-06-02 MACROSCOPIC EXAMINATION AND COMPARISONS OF HUMAN HAIR

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the macroscopic examination of human hair.

**Prerequisite** Introduction to Hair (TE-TM-06-01)

## 1 Objectives

### 1.1 Theoretical

Hair identification and comparison, to a limited degree, can be accomplished by visual or macroscopic techniques. An understanding of the class characteristics of hair along with the use of low-powered microscopy can enable an examiner to assess the need for microscopic comparison.

### 1.2 Practical

Upon completion of this module, the trainee will be able to visually or macroscopically examine/compare hair samples.

## 2 Training Outline

### 2.1 Lesson Plan

A. Macroscopic characteristics of
   1. Human
      *a) Head hair*
      *b) Pubic hair*
      *c) Body hair*
   2. Animal

B. Visual and macroscopic differences of human hairs from common animal hairs and fibers
   1. Diameter
   2. Color (shade, uniformity and banding)
   3. Luster
   4. Length
   5. Cross-sectional shape

C. Macroscopic characteristics of roots
   1. Anagen
   2. Catagen
   3. Telogen
   4. Presence of tissue

D. Required documentation for a macroscopic comparison
   1. Length
   2. Root
   3. Color
   4. Configuration

E. Criteria for an association and the limitations of a macroscopic association

F. Factors that may affect a macroscopic hair comparison
   1. Length
   2. Time lapse
   3. Sample size

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Standard Operating Procedures, Texas DPS Crime Laboratory: Macroscopic Examination of Hair.

B. Hicks JW. *Microscopy of Hair*. Federal Bureau of Investigation. 1977.

C. Ogle RR, and Fox MJ. *Atlas of Human Hair: Microscopic Characteristics*. CRC Press. 1999, Chapter 1-2.

D. Robertson J. *Forensic Examination of Hair*. Taylor and Francis, London. 1999, p. 79-98.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will macroscopically examine and document human hairs, animal hairs, and fibers.

B. The trainee will examine and document the macroscopic characteristics of head hair, pubic hair, and body hair.

C. The trainee will collect 10 hairs in different growth cycles (pulling and combing) and document the presence or absence of a root and tissue.

D. The trainee will determine the criteria of an association by comparing one hair designated as the question hair to the known hair of the same individual.

### 3.5 Independent Exercises

A. The trainee will determine if questioned material is human hair, animal hair, or fibers based on the macroscopic characteristics.

B. The trainee will determine somatic origin and the presence/absence of a root of an unknown set of hairs based on the macroscopic characteristics.

C. The trainee will compare questioned hair samples to known hair samples to determine if they are visually similar or dissimilar to one another. Document any conclusions using appropriate reporting statements.

D. The trainee will provide a written response to the following questions:

1. What are macroscopic characteristics of human hair, animal hair and fibers?
2. What are the required characteristics to document for a macroscopic hair comparison?
3. What are some factors that may affect a macroscopic hair comparison?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-06-03 EXAMINATION OF ANIMAL HAIR

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the characteristics used in the determination of genus or species of animal hair.

**Prerequisite** Introduction to Hair (TE-TM-06-01)

**Note** Module can be completed concurrently with Macroscopic Examination of Human Hair (TE-TM-06-02), Microscopic Characteristics of Human Hair (TE-TM-06-04)

## 1 Objectives

### 1.1 Theoretical

An animal hair recovered from a victim or an item of evidence can provide investigative lead information for a potential suspect, corroborate a victim's statement, or provide a basis for further investigation. Animal hairs are typically not followed by a microscopic comparison and may be examined for possible genus or species identification.

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Identify the most common animal hairs,

B. Apply the techniques used to characterize and identify hairs as animal, and

C. Identify the characteristics of hairs that determine various animal genera or species.

## 2 Training Outline

### 2.1 Lesson Plan

A. Microscopic characteristics of various known animal guard and fur hair.

1. Roots
2. Medulla
3. Pigmentation
4. Scales
5. Other pertinent characteristics

B. Different microscopic characteristics between animal and human hairs:

1. Medullary pattern
2. Scales
3. Roots
4. Tips
5. Color and banding
6. Shape
7. Diameter

C. Scale casting method, including suitable medium (e.g., Permount, nail polish, Norland adhesive, etc.)

D. Animal hair examination:

1. Conclusions
2. Limitations of hair comparisons
3. Report writing

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas Department of Public Safety Crime Laboratory: Species Determination of Hair.

B. Hicks JW. *Microscopy of Hair*, Federal Bureau of Investigation, 1977.

C. Mauersberger HR, ed. *Matthews' Textile Fibers.* John Wiley & Sons. 1947.

D. Ogle R, and Mitosinka G. Rapid Method of Preparing Hair Cuticle Scale Casts. *J For Sci.* 1972. 18, p. 82.

E. Safety Data Sheets for the following chemicals:

1. Xylene,
2. Permount,
3. Acetone,
4. Fingernail polish (clear)

F. Deedrick DW, and Koch SL. *Microscopy of Hair Part 1: A Practical Guide and Manual for Human Hairs*, Federal Bureau of Investigation Trace Evidence Unit. January 2004.6(1).

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will perform the nail polish scale casting technique on a minimum of five (5) animal hairs

B. The trainee will microscopically examine a minimum of ten (10) animal hairs including dog, cat, rabbit, cow, horse and deer and document the microscopic characteristics.

### 3.5 Independent Exercises

A. The trainee will be given a minimum of 10 hairs to determine microscopically if the hairs are human or animal. The trainee will document the microscopic characteristics to support their conclusion.

B. The trainee will be given a set of unknown common animal hairs to microscopically determine the family of animal and document relevant microscopic characteristics.

C. The trainee will provide a written response to the following questions:

1. List three characteristics that are different between animal hair and human hair?
2. Describe the medulla of an animal.
3. Does the hair of lower animals exhibit radical color changes within short distances? If yes, what is it called?
4. What is necessary for accurate identification of animal hair specimens?
5. How are hairs of deer family and antelope distinguished?
6. How are hairs of domestic animals distinguished?
7. How is a scale cast performed?
8. What are the limitations of animal hair comparisons?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-06-04 MICROSCOPIC CHARACTERISTICS OF HUMAN HAIR

**Duration** One to three weeks

**Purpose** Familiarize the trainee with the microscopic characteristics of human hair.

**Prerequisite** Introduction to Hair (TE-TM-06-01)

**Note** Module can be completed concurrently with Macroscopic Examination of Human Hair (TE-TM-06-02), Examination of Animal Hair (TE-TM-06-03)

## 1 Objectives

### 1.1 Theoretical

The somatic origin of human hair may be classified as head, pubic, and body hairs, which includes limb (arm or leg), facial, chest, axillary (underarm) or other (eyebrow, eyelash, trunk). A human hair may have certain characteristics indicative of Caucasian, Mongoloid or Negroid race. The somatic origin and racial characteristics of a hair recovered from a victim or an item of evidence can provide investigative lead information for a potential suspect, corroborate a victim's statement, or provide a basis for further investigation. Additionally, identification of the growth stage of evidentiary hairs may provide valuable information. Hair roots in the anagen and catagen stages are indicative of being forcibly removed and have the potential of providing nuclear DNA results, whereas roots in the telogen stage indicate the hair is ready to be shed and most often contain little nuclear DNA.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Identify probative microscopic hair characteristics,

B. Classify hair according to somatic and racial characteristics, and

C. Determine the growth stage of hairs.

## 2 Training Outline

### 2.1 Lesson Plan

A. Method of mounting with an appropriate medium and proper documentation of the hairs slide.

B. Microscopic observations including:

1. Type of root growth stages
2. Medulla
3. Pigmentation
4. Cortical fusi
5. Ovoid bodies
6. Cuticle
7. Damage areas
8. Demarcation lines
9. Postmortem banding

10. Characteristics of diseases
11. Characteristics of artificial treatment
12. Other pertinent characteristics

C. Microscopic observations of Caucasian, Negroid, and Mongoloid hairs and discuss the differences between them with the trainee.

D. Cross-section of Caucasian, Negroid, and Mongoloid head hairs and discuss the differences with the trainee.

E. Difference between head hair, pubic hair, and body hair.

F. Procedures for demounting hairs from slide that will be submitted for DNA testing using the following methods:

1. Liquid nitrogen method
2. Xylene method

G. Suitability for DNA analysis

1. Nuclear DNA
2. Mitochondrial DNA testing

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Racial Characteristics and Somatic Origin Determination of Human Hair.

B. Hicks JW. *Microscopy of Hair*, Federal Bureau of Investigation, 1977.

C. Ogle RR, and Fox MJ. *Atlas of Human Hair: Microscopic Characteristics*, CRC Press, Boca Raton, FL. 1999, pp. 15-53.

D. Robertson J. *Forensic Examination of Hair*. Taylor and Francis, London. 1999, pp. 79-154.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will demonstrate to the trainer the method of mounting with permount, making proper documentation on hair slide and demounting hairs.

B. The trainee will mount Caucasian, Negroid, and Mongoloid head hair and pubic hair and examine and document the following microscopic characteristics:

1. Roots
2. Medulla
3. Pigmentation
4. Cortical fusi
5. Ovoid bodies
6. Cuticle
7. Other pertinent characteristics

C. The trainee will mount body hair including chest, beard/mustache, underarm hairs, eyebrow, eyelash, and trunk hair. They will examine and document relevant microscopic characteristics.

D. The trainee will microscopically examine the growth cycles, (pulled and combed) and status of root sheath of a minimum of ten head hairs.

### 3.5 Independent Exercises

A. Identify somatic origin of at least ten human hairs

B. Identify racial origin of at least ten head and pubic hairs

C. The trainee will provide a written response to the following questions:

1. Name the main parts of the hair and describe how each can vary.
2. List at least three characteristics that distinguish animal hair from human hairs.
3. Describe the growth cycle of human scalp hair and how to identify each stage of growth.
4. Describe the racial characteristics observed in human scalp hair.
5. Why is selection of the proper mounting medium so important for microscopic hair examination?
6. What are the pigments which give hair it's color?
7. Define "Hair".
8. How does one distinguish head hair from pubic hair?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-06-05 MICROSCOPIC COMPARISON OF HUMAN HAIR

**Duration** Two to four weeks

**Purpose** Familiarize the trainee with the microscopic comparison of human hair.

**Prerequisite** Introduction to Hair (TE-TM-06-01), Macroscopic Examination of Human Hair (TE-TM-06-02), Microscopic Characteristics of Human Hair (TE-TM-06-04)

## 1 Objectives

### 1.1 Theoretical

A hair recovered from a victim or an item of evidence that exhibits similar microscopic characteristics as the hair from a possible suspect indicates that suspect may be the source of the questioned hair. Hair comparisons involve a subjective comparison of the microscopic characteristics found in a questioned hair to the microscopic characteristics exhibited by a representative sample of hair from an individual. It is essential that the analyst be knowledgeable and proficient in the use of the comparison microscope and in describing the varying morphology of hair. Upon the finding of an association of probative value based upon microscopic comparison, verified by a second experienced hair examiner, DNA testing of the questioned hair should be performed.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Perform hair comparisons using a comparison microscope, and

B. Evaluate the evidentiary value and significance of such comparison.

## 2 Training Outline

### 2.1 Lesson Plan

A. Microscope set-up

1. Proper procedure on how to set-up and operate the comparison microscope (Köhler illumination) to ensure that the light is optimized
2. Color balance the light source and correct any defects in the system using two slides containing the same hair

B. Microscopic characteristics of human hairs used in comparison.

C. Suitability of hairs for microscopic comparison.

1. Damage
2. Length
3. Color
4. Fragments

D. Factors that affect a microscopic comparison and/or conclusions

1. Improper Köhler illumination
2. Insufficient representative sample
3. Time lapse between transfer of Q hair to collection of K hair,
4. Known hair samples consisting of cut hairs

5. Known hair samples consisting of hairs from a hair brush
6. Known hair samples consisting of hairs less than ½ inch
7. Known hair samples consisting of hair that have been artificially colored soon after the date of offense

## 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Microscopic Examination and Comparison of Hair.

B. Hicks JW. *Microscopy of Hair*. Federal Bureau of Investigation. 1977.

C. Ogle RR, and Fox MJ. *Atlas of Human Hair: Microscopic Characteristics*. CRC Press, 1999.

D. Robertson J. *Forensic Examination of Hair*. Taylor and Francis, London. 1999.

E. Barnett P, and Ogle R. Probabilities and Human Hair Comparison. *J For Sci*. 1982. 27, pp. 272-278.

F. Bisbing RE, and Wolner M. Microscopical Discrimination of Twins' Head Hair. *J For Sci*. 1984. 29, pp. 780-786.

G. Federal Bureau of Investigation. Proceedings of the International Symposium on Forensic Hair Comparison. Forensic Science Research and Training Center, U.S. Department of Justice. 1985.

H. Gaudette B.D., and Keeping ES. An Attempt at Determining Probabilities in Human Scalp Hair Comparison. *J For Sci*. 1974. 19, pp. 599-606.

I. Gaudette B.D., Probabilities and Human Pubic Hair Comparisons. *J For Sci*. 1976. 21, pp. 514-517.

J. Gaudette. B.D., and Tessarolo A. Secondary Transfer of Human Scalp Hair. *J For Sci*. 1987. 32, pp. 1241-1253.

K. Gaudette B.D., Some Further Thoughts on Probabilities and Human Hair Comparisons. *J For Sci*. 1978. 23, pp. 758-763.

L. Gaudette B.D., A Supplementary Discussion of Probabilities and Human Hair Comparisons. *J For Sci*. 1982. 27, pp. 279-289.

M. Kind SS, and Owen GW. The Assessment of Information Content Gained from the Microscopical Comparison of Hair Samples. *J For Sci*. Soc. 1976. 16, pp. 235.

N. Gaudette B.D., Strong Negative Conclusions in Hair Comparison – A Rare Event. *Can Soc For Sci J*. 18(1). 1985, pp. 32-37.

O. Wickenheiser R, and et al. Further Evaluation of Probabilities in Human Scalp Hair Comparisons. *J For Sci*. 1990. 35, pp. 1323-1329.

P. Linch CA, and et al. Human Hair Histogenesis for the Mitochondrial DNA Forensic Scientist. *J For Sci*. 2001. 46, pp. 844-853.

Q. Houck MM, and Budowle B. Correlation of Microscopic and Mitochondrial DNA Hair Comparisons. *J For Sci*. 2002. 47, pp. 964-967.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Performance

A. The trainee will prepare slides to assist in balancing the illumination of the microscope using a brown, black, or red hair. Two preparations from the same hair will be produced by cutting the hair in half and mounting each half on a slide. After both sides of the microscope have been set-up with Kohler illumination, the trainee will use these slides to assist in balancing the light source.

B. The trainee will collect hairs from at least 5 different known sources; at least 20 -25 hairs from different areas of the head and pubic region.

C. The trainee will mount a representative sample from the 5 different collected hair samples. The trainee will microscopically examine the known hair samples and document the microscopic characteristics as well as the variation within the known sample.

D. The trainee will mount one hair from each of the 5 different collected hair samples for a questioned hair. The trainee will compare this hair to its known source and to all other known mounted hairs to determine the criteria of an association or an exclusion.

## 3.5 Independent Exercises

A. The trainee will be given a minimum of 5 sets of questioned and known hairs. These samples should consist of both head and pubic hairs from various racial origins. The trainee will:

1. Determine if any of the question hairs could have originated from the known samples.
2. Document the microscopic characteristics, the variation of the known sample and the conclusion of the comparison.

B. The trainee will provide a written response to the following questions:

1. What are the different microscopic characteristics compared in a microscopic comparison?
2. Discuss the importance of a representative known hair sample
3. What types of hair are not suitable for a microscopic hair comparison and why?
4. What are the limitations of a microscopic hair comparison?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-06-06 INTERPRETATION OF HAIR EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the factors that affect interpretation of the significance of hair evidence.

**Prerequisite** Introduction to Hair (TE-TM-06-01) *through* Microscopic Comparison of Human Hair (TE-TM-06-05)

## 1 Objectives

### 1.1 Theoretical

Hair evidence can provide strong corroborative information for placing an individual at a scene or in contact with another individual. Its ultimate evidentiary value is dependent on factors and circumstances surrounding the case and the type and characteristics of the hair. The forensic scientist must be able to provide accurate expert testimony concerning the significance of hair evidence.

### 1.2 Practical

Upon completion of this module, the trainee will:

A. Understand and discuss the factors affecting the significance of hair evidence,

B. Understand how to report conclusions and opinions,

C. Understand how to perform technical and administrative reviews, and

D. Be able to provide expert testimony that appropriately conveys the significance of hair evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the interpretation, significance, and limitations of hair examinations/comparisons and associations

1. Variations within known samples
2. Variation within the population
3. Color, condition, and characteristics of hair
4. Quantity and location of recovered hair and the relationship between the individuals/scene
5. Root stage
6. Time lapse between transfer of questioned hair and collection of known hairs

B. Discuss why probative hair associations in casework is verified by a second examiner.

C. Discuss why hair comparisons are not a means of absolute personal identification.

D. Discuss why a disclaimer “It is recognized that hair comparisons do not constitute a basis for absolute personal identification” is part of a probative association.

E. Discuss report wording on the following examples:

1. The hair from the questioned (Q) source exhibits the same microscopic characteristics as the hairs in a known (K) hair sample.
2. The hairs from the questioned source are microscopically dissimilar to the hairs in a known hair sample.
3. The questioned hairs exhibit both similarities and slight differences to hairs found in a known hair sample, and no conclusion can be reached whether they could have originated from the known source. It may be that, in the opinion of the examiner, the differences are not sufficient to eliminate the source of the known hairs as being a possible source of the questioned hairs. At the same time, the presence of these differences precludes an association being made between the questioned and known hairs.

F. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

G. Discuss court testimony

## 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Microscopic Examination and Comparison of Hair.

B. Hicks JW. *Microscopy of Hair*. Federal Bureau of Investigation. 1977.

C. Ogle RR, and Fox MJ. *Atlas of Human Hair: Microscopic Characteristics*. CRC Press. 1999.

D. Robertson J. *Forensic Examination of Hair*. Taylor and Francis, London. 1999.

E. Barnett P, and Ogle R. Probabilities and Human Hair Comparison. *J For Sci*. 1982. 27, p. 272.

F. Bisbing RE, and Wolner M. Microscopical Discrimination of Twins' Head Hair. *J For Sci*. 1984. 29, p. 780.

G. Federal Bureau of Investigation. Proceedings of the International Symposium on Forensic Hair Comparison. Forensic Science Research and Training Center, U.S. Department of Justice. 1985.

H. Gaudette BD, and Keeping ES. An Attempt at Determining Probabilities in Human Scalp Hair Comparison. *J For Sci*. 1974. 19, p. 599.

I. Gaudette BD. Probabilities and Human Pubic Hair Comparisons. *J For Sci*. 1976. 21, p. 514.

J. Gaudette BD, and Tessarolo A. Secondary Transfer of Human Scalp Hair. *J For Sci*. 1987. 32, p. 1241.

K. Gaudette BD. Some Further Thought on Probabilities and Human Hair Comparisons. *J For Sci*. 1978. 23, p. 758.

L. Gaudette BD. A Supplementary Discussion of Probabilities and Human Hair Comparisons. *J For Sci*. 1982. 27, p. 279.

M. Kind SS, and Owen GW. The Assessment of Information Content Gained from the Microscopical Comparison of Hair Samples. *J For Sci*. 1976. 16, p. 235-239.

N. Gaudette BD. Strong Negative Conclusions in Hair Comparison – A Rare Event. *Can Soc For Sci J*. 18(1). 1985, pp. 32-37.

O. Wickenheiser R, and et al. Further Evaluation of Probabilities in Human Scalp Hair Comparisons. *J For Sci*. 1990. 35, p. 1323.

P. Linch CA, and et al. Human Hair Histogenesis for the Mitochondrial DNA Forensic Scientist. *J For Sci*. 2001. 46, pp. 844-853.

Q. Houck MM, and Budowle B. Correlation of Microscopic and Mitochondrial DNA Hair Comparisons. *J For Sci*. 2002. 47, pp. 964-967.

R. Deedrick DW, and Koch SI. Microscopy of Hair Part1: A Practical Guide and Manual for Human Hairs. *For Sci Comm*. January 2004. 6(1).

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced hair examiner.

## 3.5 Supervised Performance

A. Report writing

1. The trainee will review case reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

B. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

## 3.6 Independent Exercises

The trainee will provide a written response to the following question: What factors can affect the significance of a hair association and how?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Hair Unit Training Checklist (LAB-TE-TM-06).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 07 PAINT UNIT

# TE-TM-07-01 INTRODUCTION TO PAINT AND POLYMER EVIDENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with basic concepts of forensic paint and polymer examination and terminology, application, and composition.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

This module will introduce the trainee to the classification of paint according to binder types, the classification of polymers including plastics and rubbers, the uses of the different classes of paint and polymers, and the tests used to compare these samples in a forensic laboratory.

### 1.2 Practical

Upon completion of this module, the trainee will be able to discuss the forensic examination and comparison of paint and polymer evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Classification of different types of paints
   1. Automobile
   2. Architectural
   3. Maintenance
   4. Other end uses

B. Classification of generic polymers
   1. Plastics
   2. Rubber
   3. Substrates
   4. Other polymers

C. General aspects of paint/polymer examinations for
   1. Color
   2. Layer sequence
   3. Chemical solubility and microchemical tests
   4. Binder type
   5. Polymer classification
   6. Chemical composition

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Fisher B, Svenson A, and Wendel O. *Techniques of Crime Scene Investigation*. Elsevier Science Publishing. 1987, pp. 146-149.

B. Thornton J. Forensic Paint Examination. Saferstein R, ed. *Forensic Science Handbook*. Prentice Hall, Inc. 1982, pp. 530-561.

C. Caddy B, ed. *Forensic Examination of Glass and Paint*. Taylor and Francis. 2001, Chapter 7: Composition, manufacture and use of paint.

D. *Auto Refinishing Handbook*. Dupont Corp. 1991, pp. 3-22 and 31-130.

E. Stoecklein W. Forensic Analysis of Automotive Paints at the Bundeskriminalamt: The Evidential Value of Automotive Paints. *Crime Lab Digest*. 22(3). 1995, pp. 98.

F. Gothard J. Evaluation of Automotive Paint Flakes as Evidence. *J For Sci Soc*. 1976. 21, pp. 636.

G. McDermott S, and Willis S. A Survey of the Evidential Value of Paint Transfer Evidence. *J For Sci*. 1997. 2(6), pp. 1012-1018.

H. Scientific Working Group on Materials Analysis (SWGMAT). Forensic Paint Analysis and Comparison Guidelines. May 2000. *For Sci Comm*. July 1999. 1(2).

I. Technical Working Group for Materials Analysis. Trace Evidence Recovery Guidelines. January 1998. *For Sci Comm*. October 1999. 1(3).

J. Saferstein, R., editor, *Forensic Science Handbook, Volume II*, Prentice Hall, 1988. Chapter 4: Microscopy and Microchemistry of Physical Evidence, pp. 197-199.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Independent Exercises

The trainee will provide a written response to the following questions:

A. What are the most common types of automotive and architectural paints?

B. Describe the difference in the mode of formation (curing) between enamel and lacquer paint

C. Why are both FTIR and pyrolysis examinations made on paint samples?

D. What are some common substrates used for automotive parts?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-07-02 INITIAL EVALUATION OF PAINT AND POLYMER EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the initial assessment of paint and polymer samples, including physical characteristics, layer sequence, solubility and micro-chemical testing

**Prerequisite** Introduction to Paint and Polymer Evidence (TE-TM-07-01)

## 1 Objectives

### 1.1 Theoretical

The examination of paint and polymer evidence begins with a thorough macroscopic examination to assess the color, layer sequence, texture, and other physical characteristics. In order to detect all layers in a multi-layer system, the examination of a cross-section of the chip is required. Solubility and micro-chemical testing of questioned and known paint samples can be useful in the differentiation of visually similar paint samples, however, they are destructive tests and should be used only when sufficient paint sample is available. Solubility testing classifies paint samples as enamel or lacquer, and micro-chemical testing may easily distinguish paint samples of different composition.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Compare the physical characteristics of paint and polymer samples, and

B. Perform and interpret solvent and micro-chemical tests on paints.

## 2 Training Outline

### 2.1 Lesson Plan

A. Physical characteristics of paint and polymers (color, texture, effects, etc.).

B. Demonstrate cross-section of samples and examination of cross-sections.

C. Demonstrate solubility and micro-chemical tests of samples and interpretation of results.

D. Macroscopic and microscopic comparison of samples.

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory:

1. Paint and Polymer Initial Examination and Overview
2. Paint Chemical Reactivity Tests

B. Scientific Working Group on Materials Analysis (SWGMAT). Forensic Paint Analysis and Comparison Guidelines. May 2000.*For Sci Comm*. July 1999. 1(2).

C. ASTM E1610. Standard Guide for Forensic Paint Analysis and Comparison. (current edition)

D. May RW, and Porter J. An Evaluation of Common Methods of Paint Analysis. *J For Sci Soc*. 1975. 15(2), pp. 137-146.

E. Thornton JI, and et al. Solubility Characterization of Automotive Paints. *J For Sci*. 1983. 28, pp. 1004-1007.

F. Saferstein, R., editor, *Forensic Science Handbook, Volume II*, Prentice Hall, 1988. Chapter 4: Microscopy and Microchemistry of Physical Evidence, pp. 197-199.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Performance

The trainer will provide known automotive and architectural paints, plastic, and rubber samples.

A. The paints should include lacquer, enamel, nitrocellulose and latex paints with a variety of layer sequences.

B. The trainee will describe (as applicable);

1. Color and effect
2. Texture
3. Layer sequence
4. Chemical properties

## 3.5 Independent Exercises

A. The trainer will provide automotive and architectural paints, plastic, and rubber samples for the trainee to determine the:

1. Color and effect
2. Texture
3. Layer sequence
4. Chemical properties

B. The trainee will provide a written response to the following questions:

1. How can it be determined if a paint is a lacquer paint?
2. What can be determined from a cross section of a paint chip?
3. What is “effect” in a paint?
4. Describe how to preliminarily identify rubber samples.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-07-03 INFRARED SPECTROSCOPY CLASSIFICATION OF PAINTS AND POLYMERS

**Duration** Two weeks

**Purpose** Introduce the trainee with infrared microspectroscopy and binder classification of paint samples and general polymer classification.

**Prerequisite** Introduction to Paint and Polymer Evidence (TE-TM-07-01), Initial Evaluation of Paint and Polymer Evidence (TE-TM-07-02)

## 1 Objectives

### 1.1 Theoretical

The paint binder type and polymer classification may be determined by comparison and interpretation of the infrared spectra obtained for the sample. The spectra of the various layers from the known and the questioned samples can be compared to determine if differences are present.

### 1.2 Practical

Upon completion of this module the trainee will be able to

A. Properly operate and maintain the FTIR spectrometer,

B. Obtain and compare the infrared spectra, and

C. Determine the binder or polymer classification of evidence samples.

## 2 Training Outline

### 2.1 Lesson Plan

A. Theory and application of FTIR spectroscopy related to the examination of paint and polymers.

B. Demonstrate preparation of paint/polymer samples and the use and maintenance of infrared spectrometer.

C. Paint binder and extender classification based on FTIR spectra.

D. General polymer classification based on FTIR spectra.

E. Comparison of FTIR spectra.

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Fourier Transform Infrared Spectroscopy (FTIR).

B. Scientific Working Group on Materials Analysis (SWGMAT). Forensic Paint Analysis and Comparison Guidelines. May 2000. *For Sci Comm*. July 1999. 1(2).

C. Ryland SG. Infrared Microspectroscopy of Forensic Paint Evidence. Humecki H, ed. *Practical Guide to Infrared Microspectroscopy*. Marcel Dekker. 1995, pp. 163-243.

D. Burke P, and et al. A Comparison of Pyrolysis Mass Spectrometry, Pyrolysis Gas Chromatography and Infra-red Spectroscopy for the Analysis of Paint Resins. *For Sci Int*. 28(3).1985, pp. 201-219.

E. Automotive Paint Database, P.D.Q. User Manual. Royal Canadian Mounted Police.

F. Saferstein, R., editor, *Forensic Science Handbook, Volume III*, Prentice Hall, 1993. Chapter 4: Infrared Microscopy and Its Forensic Applications, pp. 196-252.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Fourier Transform Infrared Spectrometer

## 3.4 Supervised Performance

A. The trainer will provide the trainee with automotive and architectural paints with known binder and extender composition and general polymer samples to determine the classification.

B. The samples will include;

1. Acrylic paint
2. Alkyd and polyester paint
3. Epoxy paint
4. Lacquer paint
5. Latex paint
6. Rubber (including car parts such as tires, bumpers, and door guards)
7. Plastic

## 3.5 Independent Exercises

A. The trainer will provide the trainee with automotive and architectural paints to determine the binder and extender classifications and to determine possible associations.

B. The trainer will provide the trainee with plastic and rubber samples to determine polymer classification and possible associations.

C. The trainee will provide a written response to the following questions:

1. What type of molecular energy is measured to generate a FTIR spectra?
2. How can binder type be determined from a FTIR spectra?
3. Name three binder types of architectural paint.
4. Is FTIR a valuable technique for rubber identification? Why?
5. Describe how to prepare a rubber sample for FTIR analysis.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-07-04 PYROLYSIS GCMS OF PAINTS AND POLYMERS

**Duration** Two weeks

**Purpose** Introduce the trainee with pyrolysis gas chromatography mass spectrometry (PGCMS) of paint and polymer samples.

**Prerequisite** Introduction to Paint and Polymer Evidence (TE-TM-07-01), Initial Evaluation of Paint and Polymer Evidence (TE-TM-07-02)

**Note** Module can be completed concurrently with Infrared Spectroscopy Classification of Paints and Polymers (TE-TM-07-03)

## 1 Objectives

### 1.1 Theoretical

Pyrolysis Gas Chromatography Mass Spectrometry (PGCMS) of paint and polymer samples offers increased discrimination power over infrared microspectroscopy. It should be used whenever questioned and known samples are of sufficient size and quality to allow comparison.

### 1.2 Practical

Upon completion of this module the trainee will be able to:

A. Properly operate and maintain the pyrolysis gas chromatograph mass spectrometer,

B. Obtain and compare the pyrograms from paint and polymer samples, and

C. Identify components within the pyrograms via mass spectral data.

## 2 Training Outline

### 2.1 Lesson Plan

A. Theory and application of pyrolysis gas chromatography mass spectrometry related to the examination of paint and polymers.

B. Demonstrate preparation of samples and the use and maintenance of the pyrolysis gas chromatograph mass spectrometer.

C. Interpretation and comparison of pyrograms and identification of components via mass spectral data.

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at the trainer's discretion.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Pyrolysis Gas Chromatography Mass Spectrometry (PGCMS).

B. Scientific Working Group on Materials Analysis (SWGMAT). Forensic Paint Analysis and Comparison Guidelines. May 2000. *For Sci Comm*. July 1999. 1(2).

C. Burke P, and et al. A Comparison of Pyrolysis Mass Spectrometry, Pyrolysis Gas Chromatography and Infra-red Spectroscopy for the Analysis of Paint Resins. *For Sci International*. 28(3). 1985, pp. 201-219.

D. Cardosi PJ. Pyrolysis-Gas Chromatographic Examination of Paints. *J For Sci*. 27(3). 1982, pp. 695-707.

E. ASTM Standard E1610: Standard Guide for Forensic Paint Analysis and Comparison. (current edition)

F. Manufacturer's operating manual for the Chemical Data System Pyroprobe.

G. McMinn DG, Carlson TL, and Munson TO. Pyrolysis Capillary Gas Chromatography/Mass Spectrometry for Analysis of Automotive Paints. *J For Sci*. 30(4). 1985, pp. 1064-1073.

H. Wampler TP. Analytical Pyrolysis: An Overview with Forensic Applications. CDS Instruments.

I. Wampler TP, Bishea GA, and Simonsick WJ. Recent Changes in Automotive Paint Formulation Using Pyrolysis Chromatography/Mass Spectrometry. *J Anal Appl Pyrolysis*. 1997. 40-41, pp. 78-89.

J. Shin T, Hajime O, Chuichi W. *Pyrolysis-GC/MS Data Book of Synthetic Polymers: Pyrograms, Thermograms and MS of Pyrolyzates*, Elsevier, 2011.

K. Stevens M, ed., *Polymer Chemistry: An Introduction*, 3rd Edition, Oxford University Press, 1999.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Pyrolysis Gas Chromatograph

## 3.4 Supervised Performance

A. The trainer will provide the trainee with automotive and architectural paints, plastics, and rubbers to obtain and compare pyrograms to determine possible associations. At least five paints with different binder types will be examined.

B. The trainee will demonstrate the ability to identify components within the pyrograms using mass spectra.

## 3.5 Independent Exercises

A. The trainer will provide the trainee with automotive and architectural paints, plastics, and rubbers to obtain and compare pyrograms to determine possible associations.

B. The trainee will demonstrate the ability to identify components within the pyrograms using mass spectra.

C. The trainee will provide a written response to the following questions:

1. What is the result of pyrolysis of a sample?
2. What makes pyrolysis a reproducible examination?
3. What may be determined if pyrolysis of individual layers is performed?
4. How can pyrolysis support the determinations of organic composition made with FTIR analysis?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-07-05 PAINT DATA QUERY

**Duration** Two to three weeks

**Purpose** Introduce the trainee to the identification of possible sources of automotive paint by utilizing the Paint Data Query database and other searching tools.

**Prerequisite** Introduction to Paint and Polymer Evidence (TE-TM-07-01), Initial Evaluation of Paint and Polymer Evidence (TE-TM-07-02), Infrared Spectroscopy Classification of Paints and Polymers (TE-TM-07-03)

**Note** Module can be completed concurrently with Pyrolysis GCMS of Paints and Polymers (TE-TM-07-04)

## 1 Objectives

### 1.1 Theoretical

Using a database of automotive paints, it is possible to provide an investigative lead as to the make and model of automobile that may be the source of automotive paint recovered from the scene or victim.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Use the Munsell Color Coordinate System,

B. Search the Paint Data Query (PDQ) automotive paint database,

C. Search the PDQ spectral libraries, and

D. Use the refinish color collections.

## 2 Training Outline

### 2.1 Lesson Plan

A. Paint examinations
   1. OEM
   2. Repaint systems

B. FTIR and spectral coding
   1. Binders
   2. Extenders
   3. Substrates

C. Munsell Color Coordinate System books for primer coding

D. Paint Data Query
   1. PDQ participants and requirements
   2. Database content and sample information
   3. PDQ software/appendix overview
   4. Layer sequence descriptors and other coding
   5. Searches and their significance

6. Layer System Queries (LSQ)
7. Fill-in-the-Blank searches (FITB)
8. Spectral library searches and software
9. Assembly plant lists

E. Refinish color collections

F. Choosing a search scheme

G. Significance of a hit list

1. Ranges
2. Limitations
3. Report wording

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Paint Data Query Database

B. Automotive Paint Database, PDQ User Manual. Royal Canadian Mounted Police.

C. Buckle JL, MacDougall DA, and Grant RR. PDQ-Paint Data Queries: The History and Technology Behind the Development of the Royal Canadian Mounted Police Forensic Laboratory Services Automotive Paint Database. *Can Soc For Sci J*. 30(4). 1997, pp. 199-212.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

None

### 3.5 Supervised Performance

A. The trainee will utilize PDQ to identify possible manufacturer, plant, and year range information on set of at least 5 paint samples. Specific vehicle information should also be identified.

B. The trainee will write sample reports for the paint sample set.

### 3.6 Independent Exercises

A. The trainee will identify possible manufacturer, plant, vehicle, and year range information for a sample set of known paints.

B. The trainee will provide a written response to the following questions:

1. What information is stored in PDQ database?
2. Describe a possible search scheme for an OEM 4 layer paint chip.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-07-06 INTERPRETATION OF PAINT AND POLYMER EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the significance of paint and polymer evidence examinations.

**Prerequisite** Introduction to Paint and Polymer Evidence (TE-TM-07-01) *through* Paint Data Query (TE-TM-07-05)

## 1 Objectives

### 1.1 Theoretical

Paint as a protective and decorative coating is common on numerous items encountered in everyday activities. Plastics and rubbers are commonly encountered in automotive parts and other sources. The association of paint and polymer evidence results from the forensic analysis of the physical and chemical properties of the samples. The significance of the results of forensic analysis of paint and polymers is dependent not only on the physical and chemical properties but also manufacturing, application, transfer and environmental factors.

### 1.2 Practical

Upon completion of this module the trainee will be able to:

A. Assess the significance of paint and polymer examinations,

B. Understand how to report observations and opinions,

C. Understand how to perform technical and administrative reviews, and

D. Be able to provide expert testimony that appropriately conveys the significance of associations and eliminations.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the significance of associations for

1. Automotive paint
   - *a) OEM*
   - *b) Repaint systems*
2. Architectural paint
3. Tool paint
4. Maintenance paint
5. Plastics and substrates
6. Rubber

B. Discuss report writing

C. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

D. Discuss court testimony

### 2.2 Required Readings

A. Ryland S, and Kopec R. The Evidential Value of Automobile Paint Chips. *J For Sci*. 1979. 24(1), pp. 140-147.

B. Ryland SG, and et al. The Evidential Value of Automobile Paint. Part II: Frequency of Occurrence of Topcoat Colors. *J For Sci*. 1981. 26(1), pp. 64-74.

C. Ryland S. *Forensic Paint Examinations and Comparisons*. Training Manual, Section 10, pp. 22-40. Presentation to Texas DPS Crime Laboratory, March 12-16, 2006.

D. Edmondstone G, and et al. An Assessment of the Evidential Value of Automotive Paint Comparisons. *Can. Soc. For Sci J.* 2004. 37(3), pp. 147-153.

E. McNorton SC, and et al. The Characterization of Automotive Body Fillers. *J For Sci*. 2008. 53(1), pp. 116-124.

F. Alwi AR, and Kuppuswamy R. Studies on the Layer Structure of Paint Flakes Collected from Motor Vehicles in Kuala Lumpur, Malaysia. *J For Sci Ident*. 2004. 54(6), pp. 645-652.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced paint examiner.

### 3.5 Supervised Performance

A. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

B. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

The trainee will provide a written response to the following:

1. What testimony in court would be appropriate for an association of a multilayer OEM paint transfer between two vehicles?
2. What can be concluded from the detection of transfer paint, determined to be from a repaint system, on a victim's clothes?
3. What factors can strengthen the significance of an association based on paint or polymer evidence?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Paint Unit Training Checklist (LAB-TE-TM-07).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 08 FIBER UNIT

# TE-TM-08-01 INTRODUCTION TO FIBER AND TEXTILE EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the basic concepts and theoretical knowledge of fibers and textile products, along with fiber examinations and comparisons.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Many objects in our environment are composed of fibers, the fundamental unit of a textile. In order to testify about fiber evidence as an expert, advanced knowledge of fibers is necessary.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Discuss the forensic examination and comparison of fiber and textile evidence.

B. Discuss the significance of fibers as associative evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Textile Definitions
   1. Fiber
   2. Filament
   3. Staple fibers
   4. Yarn
   5. Warp
   6. Weft/Fill
   7. Dye
   8. Pigment

B. Types of fibers
   1. Man-made (Cellulosics)
   2. Synthetics including Bicomponent
   3. Natural

C. Manufacturing Process
   1. Melt spinning
   2. Wet spinning
   3. Dry spinning

D. Fiber Transfer and Persistence

E. Textile Labeling

F. Fiber examinations

1. Type of exam
2. Conclusion of exam

G. Conclusions

### 2.2 Required Readings

A. Saferstein R, ed. *Forensic Science Handbook, Volume II*. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination, pp. 243-244.

B. Saferstein R, ed. *Forensic Science Handbook*. Prentice-Hall, 1982, Chapter 9: Foundations of Forensic Microscopy.

C. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis, London, 1999, Chapter 1: Classification of Textile Fibres: Production, Structure, and Properties.

D. Technical Working Group for Materials Analysis. Forensic Fiber Examination Guidelines. January 1998. *For Sci Comm*. April 1999. 1(1).

E. Technical Working Group for Materials Analysis. Trace Evidence Recovery Guidelines. January 1998. *For Sci Comm*. October 1999. 1(3).

F. A Quick Guide to Manufactured Fibers. Accessed: November 10, 2008, Online: http://www.fibersource.com/f-tutor/q-guide.htm. Located at e-Train library on Sharepoint.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Independent Exercises

The trainee will provide written answers to the following questions:

1. What is the difference between man-made and synthetic fibers?
2. What is a brief description of the chemical composition of the following generic fiber classes?
   - *a) acetate,*
   - *b) acrylic,*
   - *c) polyester,*
   - *d) nylon,*
   - *e) rayon,*
   - *f) olefin.*

3. What are possible end uses to the following generic fiber classes?
   a) *acetate,*
   b) *acrylic,*
   c) *polyester,*
   d) *nylon,*
   e) *rayon,*
   f) *olefin.*
4. What is a brief description for the following terms?
   a) *filament,*
   b) *yarn,*
   c) *stable,*
   d) *wet spinning,*
   e) *dry spinning,*
   f) *melt spinning*
5. What is the difference between a dye and a pigment?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-02 STEREOMICROSCOPIC EXAMINATION OF FIBERS, YARNS, AND FABRICS

**Duration** One week

**Purpose** To familiarize the trainee with stereoscopic characteristics of fibers, thread, and fabrics as well as to identify target fibers.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

Examination of fibers using the stereomicroscope will enable an analyst to examine various characteristics to determine which fibers, if any, will be selected for further comparison.

Yarns and fabric can also be examined using the stereoscope for basic construction.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Identify fibers as natural or synthetic,

B. Document stereoscopic characteristics of fibers,

C. Recognize and recover target fibers from debris,

D. Describe the weave and knit patterns of fabric, and

E. Determine the characteristics of yarns.

## 2 Training Outline

### 2.1 Lesson Plan

A. Introduction to fabric construction
   1. Knits, non-woven, and woven fabrics
   2. Documentation

B. Introduction to rope/cordage and yarns
   1. Documentation of characteristics – (ply, twist, crown, etc.)
   2. Relationship of yarns in fabric construction

C. Representative sampling and mounting of fibers from different known fabric types
   1. Selection criteria used
   2. Demonstration of fiber mounting methodology

D. Discuss and demonstrate observable characteristics of different fibers
   1. Color
   2. Relative Diameter
   3. Shape
   4. Man-made versus natural
   5. Luster

6. Crimp
7. Documentation

E. Introduction to the criteria used to select target fibers for further comparison
1. Developing search image for questioned fibers
2. Demonstrate the methods for removing and mounting fibers
3. Documentation

F. Demounting fibers

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory:
1. Fiber Initial Examination and Overview
2. Comparison of Thread, Yarn, and Cordage

B. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis, London, 1999.
1. Chapter 1: Classification of Textile Fibres: Production, Structure, and Properties, pp. 1-31
2. Chapter 2: The Structure of Textiles: An Introduction to the Basics, pp. 33-54
3. Chapter 3: Ropes and Cordage, pp. 55-64

C. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination, pp. 209-223, 239-241

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will examine fabric of various construction and document construction characteristics (weave, knit, etc.).

B. The trainee will mount known fibers in an appropriate fashion for target fiber comparison.

C. The trainer will provide debris samples (tape-lifts, scrapings, etc.) with known fibers for the trainee to examine. The trainee will document observed characteristics of the fibers within the debris and select target fibers for further comparison.

D. The trainee will remove and mount above questioned fibers for further comparison.

E. The trainee will examine various types of cordage and document the characteristics of ropes and cordage.

### 3.5 Independent Exercises

A. Identify and document the construction characteristics of an unknown piece of fabric. Mount known fibers for target fiber comparison.

B. Use the known fibers to screen debris samples (tapelifts, scrapings, etc.), document observed characteristics of the fibers within the debris, and select and mount target fibers for further comparison.

C. Identify and document characteristics of an unknown and known piece of cordage and compare to make the determination if further testing is warranted.

D. The trainee will provide a written response to the following questions:

1. What characteristics can be observed from a macroscopic examination of fibers?
2. How can color be compared using the stereoscope?
3. What characteristics are considered for selecting fibers for further comparison?
4. What characteristics are considered to eliminate a fiber at this stage?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-03 POLARIZED LIGHT MICROSCOPIC EXAMINATION OF FIBERS

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the microscopic characteristics of manufactured and natural fibers.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

The polarized light microscope can be used to evaluate three basic optical properties of manufactured fibers: refractive index, birefringence, and sign of elongation. These optical properties are sometimes sufficient to identify the generic classification of man-made fibers as a preliminary step in the identification process. Other features that may be observed microscopically include cross-section shape, diameter, surface features, inclusions, internal structure and color.

Many fibers for commercial and domestic use are natural in origin and can be broadly classified as animal, vegetable, or mineral. Animal fibers of forensic interest are hairs (from textiles, pets, livestock, game animals, etc.) and silk. Vegetable fibers include cotton, linen, ramie, jute, etc. Classification of animal and vegetable fibers is usually accomplished based upon their microscopic appearance. Mineral fibers are rarely encountered in forensic casework. Glass fibers are occasionally encountered.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Classify man-made fibers into the most common generic classes based on optical properties.

B. Document other observed features of fibers.

C. Identify common animal and vegetable fibers.

## 2 Training Outline

### 2.1 Lesson Plan

A. Demonstrate mounting fibers

B. Discuss and demonstrate the optical properties of various known man-made fibers including:

1. Relative refractive indices,
2. Birefringence,
3. Sign of elongation,
4. Optical cross-section,
5. Diameter,
6. Surface features,
7. Inclusions,
8. Delustrant,

9. Internal structure,
10. Color, and
11. Pleochroism/dichroism.

C. Discuss advantages and disadvantages

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory:
   1. Microscopic Examination of Fibers
   2. Optical Characteristics of Vegetable Fibers
   3. Species Determination of Hair

B. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination

C. Saferstein R, ed. *Forensic Science Handbook*. Prentice-Hall, 1982, Chapter 9: Foundations of Forensic Microscopy.

D. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibers*, 2nd edition. Taylor and Francis; London, 1999. Microscopical Examination of Fibers, pp. 173-175.

E. Palenik S. Microscopy and Microchemistry of Physical Evidence. Saferstein R, ed. *Forensic Science Handbook*. Prentice-Hall, 1982.

F. Stoeffler S. A Flowchart for the Identification of Common Synthetic Fibers by Polarized Light Microscopy. *J For Sci*. 41, pp. 297-299.

G. Robertson J, ed. *Forensic Examination of Fibres*, Ellis Harwood Limited, West Sussex, England, 1992.

H. Catling D, and Grayson J. *Identification of Vegetable Fibres*. Henry Ling Ltd.

I. Hicks JW. *Microscopy of Hair*. Federal Bureau of Investigation. 1977.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

Microscope with polarized light capabilities

### 3.4 Supervised Performance

A. The trainer will provide samples of man-made fibers of a variety of shapes, sizes and delustrant from the most common generic classes for the trainee to mount. The man-made fibers will included:
   1. Acetate
   2. Triacetate
   3. Acrylic

4. Modacrylic
5. Nylon 6 and nylon 6,6
6. Olefin,
7. Polyester
8. Rayon
9. Lyocell
10. Glass

B. The trainee will examine and document the following properties:

1. Delustrant
2. Diameter
3. Birefringence
4. Sign of Elongation
5. Refractive indices

C. Trainee will mount, examine and document the following natural fibers:

1. Cotton
2. Linen
3. Wool
4. Silk

### 3.5 Independent Exercises

A. The trainee will examine, document and identify the generic class of a set of unknown fibers.

B. The trainee will provide a written response to the following questions:

1. Define polarized light.
2. How are interference colors produced?
3. Define refractive indices.
4. Define birefringence.
5. Define extinction.
6. Define sign of elongation.
7. Define pleochroism/dichroism.
8. How and why are fibers delustered?
9. Can the generic class of a fiber be identified with PLM?
10. What are bi-component fibers? How are some of them manufactured?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-04 COMPARISON MICROSCOPE

**Duration** One week

**Purpose** To compare the color and morphological features of fibers using the comparison microscope.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

A comparison microscope is used to perform side by side comparisons of questioned fibers with those from a known source. A comparison microscope consists of two compound transmitted light microscopes connected with an optical bridge that enables both samples to be observed simultaneously in the same field of view. In order to gain optimal resolution, specimen contrast and color balance, it is essential that the optical conditions on both sides of microscope be properly balanced.

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Properly illuminate a comparison microscope, and

B. Compare color and morphological features of fibers.

## 2 Training Outline

### 2.1 Lesson Plan

A. Demonstrate

1. How to set-up and operate the microscope,
2. Color balance the light source and correct any defects in the system using two slides containing the same fibers.

B. Discuss criteria used for comparison.

C. Discuss factors that affect comparison.

D. Discuss advantages and disadvantages.

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Fiber Initial Examination and Overview

B. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination, pp. 243-244.

C. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis; London, 1999. Section 5.3: Protocols for Fibre Examinations and Initial Preparation, pp. 121-124.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

Comparison Microscope

### 3.4 Supervised Performance

A. The trainee will prepare slides to assist in balancing the illumination of the microscope using colored yarns that are uniformly dyed or pigmented and preferably delustered. Two identical preparations from the same source will be produced by cutting the yarns in half and mounting the fibers on two slides. After both sides of the microscope have been set-up with Kohler illumination, the trainee will use these slides to assist in balancing the light source.

B. The trainee will make sets of slides consisting of two slides of the same sample to determine the criteria for a match and compare the samples on the comparison microscope. The samples should consist of fibers of various types, colors and morphological features.

### 3.5 Independent Exercises

A. The trainee will be given a set of question and known fibers to determine if any of the question fibers could have originated from the known samples based on comparison scope.

B. The trainee will provide a written response to the following questions:

1. What criteria can be used in a comparison?
2. What factors can affect comparison?
3. What are the advantages and disadvantages for the comparison microscope?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-05 MANUFACTURED FIBERS – CROSS-SECTION

**Duration** One week

**Purpose** Familiarize the trainee with fiber cross-sectioning techniques and the type of information obtained from them.

**Prerequisite** TE-TM-08-01

## 1 Objectives

### 1.1 Theoretical

The examination and comparison of the cross-sectional shape of fibers is an imperative part of fiber examination. Often times, the cross-sectional shape of a fiber can be determined optically. However, other information, such as modification ratio, the spinning process used, the possible end-use, fiber quality, quality and method of dyeing, is obtained from examining the cross-section of a fiber.

### 1.2 Practical

Following the completion of this module, the trainee will be able to

A. Obtain cross-sections from single fibers, multiple fibers and fiber tufts

B. Determine the modification ratio of multi-lobed fibers

C. Observe microscopic characteristics of the fiber from its cross-section.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the significance of cross sections

1. Modification ratio
2. End use
3. Dye penetration
4. Sampling and variation within a sample

B. Techniques -single fibers, multiple fibers and fiber tufts

1. Jolliff
2. Polyethylene
3. Other methods

C. Microscopic characteristics of cross-sections

1. Documentation of the observed characteristics
2. Relationship between the fiber cross-sectional shape and its longitudinal appearance.

D. Microscopic comparison

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Cross-Sectioning of Fibers

B. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination

C. Palenik S, and Fitzsimons C. Fiber Cross-sections: Part I. *The Microscope*. 1990. 38, pp. 187-195.

D. Palenik S, and Fitzsimons C. Fiber Cross-sections: Part II. *The Microscope*. 1990. 38, pp. 313-320.

E. Barna CE, and Stoeffler SF. A New Method for Cross Sectioning Single Fibers. *J For Sci*. 1987. 32, pp. 761-767.

F. Fong W, and Inami S. Simple, Rapid and Unique Techniques for Cross-Sectioning Fibers and Hairs. *J For Sci*. 1988. 33, pp. 305-309.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainer will provide samples of man-made fibers of various known cross-sectional shapes for the trainee to cross-section and examine. These should include round, peanut, bean, multi-lobed, bicomponent and several different trilobal shapes. The trainee will cross-section the fiber samples using various techniques.

B. The trainee will examine the physical cross-section and compare to the longitudinal cross-section.

### 3.5 Independent Exercises

A. The trainee will cross-section an unknown sample set, identify the cross-sectional shape and document the cross-section with photomicrographs.

B. The trainee will provide written answers to the following questions:

1. What is the modification ratio? Why is this important?
2. How does manufacturing processing affect cross-sectional shape?
3. List different cross-sectional shapes associated with melt, wet and dry spinning and end use.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-06 INFRARED SPECTROSCOPY OF FIBERS

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the use of infrared spectroscopy for identification and comparison of manmade fibers.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

Infrared spectroscopy is an important part of forensic fiber analysis. Use of the infrared microscope attachment allows analysis of a small sample and provides information about the polymer composition of the fiber. It is valuable not only in determining the generic group to which a fiber belongs, but also in separating fibers within generic groups on the basis of differences in composition.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Properly operate and maintain the infrared spectrometer and its accessories.

B. Obtain spectra from fiber samples.

C. Identify and compare the polymer composition of man-made fibers.

## 2 Training Outline

### 2.1 Lesson Plan

A. Sample preparation

B. Use and routine maintenance/calibration of the infrared spectrometer

C. Evaluation of spectra and discuss libraries

D. Advantages and disadvantages

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Fourier Transform Infrared Spectroscopy (FTIR)

B. Saferstein R, ed. *Forensic Science Handbook, Volume II*. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination

C. Saferstein R, ed. *Forensic Science Handbook, Volume III*. Regents/Prentice Hall, 1993.

1. Chapter 3: Forensic Applications of Infrared Spectroscopy.
2. Chapter 4: Infrared Microscopy and Its Forensic Applications..

D. Humecki HJ, ed. *Practical Guide to Infrared Microspectroscopy*. Marcel Dekker, Inc.; New York, 1995. Chapter 7: Forensic Examination of Synthetic Textile Fibers by Microscopic Infrared Spectrometry.

E. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis; London, 1999. Chapter 8: Infrared Microspectroscopy of Fibres.

F. ASTM D276-87. Standard Test Methods for Identification of Fibers in Textiles.

G. ASTM E1421-94. Standard Practice for Describing and Measuring Performance of Fourier Transform Infrared (FT-IR) Spectrometers: Level Zero and Level One Tests.

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

Fourier Transform Infrared Spectroscopy (including any accessories, ex. ATR)

## 3.4 Supervised Performance

A. The trainer will provide samples of man-made fibers from the most common generic classes for the trainee to analyze.

B. The fibers shall include:

1. Acetate
2. Triacetate
3. Acrylic (three types)
4. Modacrylic,
5. Nylon 6
6. Nylon 6,6
7. Olefin
8. Polyester
9. Rayon

## 3.5 Independent Exercises

A. The trainee will be given an unknown sample set consisting of at least five different fiber types to analyze, evaluate and identify.

B. The trainee will provide a written response to the following questions:

1. Describe the FTIR theory and application in layman terms
2. What fibers cannot be distinguished solely on FTIR?
3. What are the limitations of FTIR?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-07 COLOR COMPARISON OF FIBERS BY MICROSPECTROMETRY

**Duration** One week

**Purpose** Familiarize the trainee with the use of the microspectrometer for color comparison of fibers.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

Microspectrometry provides a nondestructive, objective evaluation of color from very small areas of a fiber. The human eye can be used as a screening tool for color differentiation, however it cannot determine whether or not the colors are actually the same or a metameric pair or if differences in color shade are due to different dye absorption or different colorants. The microspectrometer can differentiate colors by measuring absorbance across visible and/or ultraviolet light wavelengths in order to obtain the absorption spectra of a fiber. A valid comparison of a single questioned fiber color to that of a known fiber item requires comprehensive sampling and analysis of the known fibers.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Properly operate and maintain the microspectrometer.

B. Obtain and compare the spectra of questioned and known fibers.

## 2 Training Outline

### 2.1 Lesson Plan

A. Use and routine maintenance/calibration of the microspectrometer

1. Visible vs. UV region
2. Sampling
   - *a) Selection*
   - *b) Mounting media*

B. Evaluation and comparison of spectra.

C. Effects of various characteristics

1. Cross sectional shape
2. Dye penetration
3. Fiber types
4. Fiber morphology
5. Dye method

D. Advantages and disadvantages

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Microspectrophotometry of Fibers

B. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination.

C. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis; London, 1999. Chapter 10: Microspectrophotometry/Colour Measurement.

D. Grieve MC, Dunlop J, and Haddock P. An Assessment of the Value of Blue, Red, and Black Cotton Fibers as Target Fibers in Forensic Science Investigation. *J For Sci*. 1988. 33(6), pp. 1332-1344.

E. Grieve MC, Dunlop J, and Haddock P. An Investigation of Known Blue, Red and Black Dyes Used in the Coloration of Cotton Fibers. *J For Sci*. 1990. 35(2), pp. 301-315.

F. Cassista A, and Peters AD. Survey of Red, Green and Blue Cotton Fibers. *Can Soc of For Sci*. 1997. 30(4), pp. 225-231.

G. ASTM Standard E 275-93. Standard Practice for Describing and Measuring Performance of Ultraviolet, Visible, and Near-Infrared Spectrophotometers.

H. Macrae R, Dudley RJ, and Smalldon KW. The Characterization of Dyestuffs on Wool Fibers with Special Reference to Microspectrophotometry. *J For Sci*. 24, pp. 117-129.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

Microspectrophotometer

### 3.4 Supervised Performance

A. Using the microspectrophotometer, obtain Holmium Oxide and Neutral Density spectra in the ultra-violet and visible range.

B. The trainer will provide samples of colored fibers of various cross-sectional shapes for the trainee to examine.

1. The trainee will obtain 10 transmittance spectra along the length of a single fiber for multiple fibers of various cross-sectional shapes.
2. The trainee will scan an appropriate number of known fibers in the visible and ultraviolet range based on the color uniformity and cross-sectional shape and plot the range of spectra from a set of fibers.
3. The trainee will scan a fiber from the same sample and treat the fiber as a questioned fiber and compare known and questioned spectra to determine the criteria of a match.

### 3.5 Independent Exercises

A. The trainee will obtain spectra from a set of unknown and known fibers to determine if the color is similar based on the MSP spectra.

B. The trainee will provide a written response to the following questions:

1. Describe in layman's terms the theory and application of the MSP.
2. Define metamerism.
3. How many sample scans should be performed on a single fiber?
4. How can weather affect a fiber's color?
5. How should you obtain a known sample from a T-shirt?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-08 COLOR COMPARISON OF FIBERS BY THIN LAYER CHROMATOGRAPHY

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the proper application of the Thin Layer Chromatography (TLC) technique for fiber color comparison.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

Thin Layer Chromatography (TLC) is used to compare the dye components of colored fibers. Many dyes used to color textile fibers can be extracted and separated using TLC. The separated colors can be easily and quickly compared from the TLC plate.

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Extract dyes from a variety of sample sizes and fiber types; and

B. Perform thin layer chromatography on the extracts and compare the colors.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss TLC
   1. Theory
   2. Dye types associated with different fiber types

B. Extraction techniques
   1. Extraction solvent
   2. Temperature

C. Different eluent systems
   1. Comparison
      *a) Migration*
      *b) Number of components*
      *c) UV characteristics*

D. Advantages and disadvantages.

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory:
   1. Thin Layer Chromatography of Fibers
   2. Thin Layer Chromatography of Cotton Fibers
   3. Thin Layer Chromatography of Wool Fibers

B. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination.

C. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres*, 2nd edition. Taylor and Francis; London, 1999. Chapter 11: Thin Layer Chromatographic Analysis for Fibre Dyes.

D. Cheng, et al. The extraction and classification of dyes from cotton fibres using different solvent systems. *J For Sci Soc*. 1991. 31, pp. 31-40.

E. Technical Working Group for Materials Analysis. Forensic Fiber Examination Guidelines. January 1998. *For Sci Comm*. April 1999. 1(1).

F. Beattie, et al. Thin layer chromatography of dyes extracted from polyester, nylon and polyacrylonitrile fibres. *For Sci International*. 1981. 17, pp. 57-69.

G. Beattie, et al. The extraction and classification of dyes from cellulose acetate fibres. *J For Sci Soc*. 1981. 21, pp. 233-237.

H. Hartshorne AW, and Laing DK. The dye classification and discrimination of coloured polypropylene fibres. *For Sci International*. 1984. 25, pp. 133-141.

I. Grieve MC. Forensic Examination of Fibres. *Forensic Science Progress, Vol. 4*. Springer Verlag, Heidelberg. 1990, pp. 41-125.

J. Laing DK, Boughey L, and Hartshorne AW. The Standardisation of Thin Layer Chromatographic Systems for Comparison of Fibre Dyes. *J For Sci Soc.* 1990. 30, pp. 299-307.

K. Home JM, and Dudley RJ. Thin layer chromatography of dyes extracted from cellulosic fibres. *For Sci International*. 1981. 17, pp. 71-78.

L. Laing DK, et al. Thin layer chromatography of azoic dyes extracted from cotton fibres. *J For Sci Soc*. 1990. 30, pp. 309-315.

M. Laing DK, et al. The extraction and classification of dyes from cotton and viscose fibres. *For Sci International*. 1991. 50, pp. 23-35.

N. Macrae R, and Smalldon KW. The extraction of dyestuffs from single wool fibres. *J For Sci*, 1979. 24, pp. 109-116.

O. Macrae, et al. The characterization of dyestuffs on wool fibres with special reference to microspectrophotometry. *J For Sci Soc*. 1979, pp. 117-129.

P. Resua R. A semi-micro technique for the extraction and comparison of dyes in textile fibers. *J For Sci*. 1980. 25, pp. 168-173.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will extract the dye from a variety of colored fibers of various sizes.

B. The trainee will perform the thin layer chromatography of the extracted dyes using various eluting systems

### 3.5 Independent Exercises

A. The trainee will extract dye from questioned and known fibers, perform thin layer chromatography using an appropriate eluting system and determine if they originated from the same source, based on TLC results.

B. The trainee will provide a written response to the following questions:

1. Describe the process of TLC in layman's terms.
2. What are the limitations of TLC?
3. When should TLC be performed?
4. What characteristics are used for comparison?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit

# TE-TM-08-09 FIBER SOLUBILITY EXAMINATIONS

**Duration** One to two weeks

**Purpose** Familiarize the trainee with solubility and thermal microscopy techniques used to examine certain manufactured fibers.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01)

## 1 Objectives

### 1.1 Theoretical

Certain polymers can be distinguished from one another by their solubility behavior when mounted in specific organic liquids. Acetate (diacetate) and triacetate fibers exhibit similar optical properties and infrared spectra, making it potentially difficult to distinguish between these two generic fiber classes using these techniques alone. The chemical differences between these two fibers are due to the percent of acetylated hydroxyl groups on the cellulose backbone of these two polymers. In normal cellulose acetate (diacetate) approximately 60% of the hydroxyl groups are acetylated while in the triacetate more than 90% of these sites are acetylated. The percentage of hydroxyl groups that have been acetylated affects the solubility behavior of these polymers. Although solubility testing is destructive, when carried out according to the microchemical procedure described here, the loss of material is negligible in relation to the certainty of information gained.

### 1.2 Practical

Upon completion of this module, the trainee will be able to apply the technique of solubility testing to determine the difference between acetate and triacetate.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss solubility testing, including techniques and solvents

1. 75% aqueous acetone
2. Chloroform

B. Advantages and disadvantages

### 2.2 Required Readings

A. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination.

B. Robertson J, ed. *Forensic Examination of Fibres.* Ellis Harwood Limited, West Sussex, England, 1992.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainer will provide samples of acetate and triacetate fibers for the trainee to examine.

B. The trainee will distinguish between acetate and triacetate fibers using aqueous acetone and chloroform.

### 3.5 Independent Exercises

A. The trainee will identify unknown fibers based on solubility testing.

B. The trainee will provide written answers to the following questions:

1. Which fiber is soluble in chloroform?
2. What is a situation that solubility may be useful?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-08-10 INTERPRETATION OF FIBER EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the factors that affect interpretation of the significance of fiber evidence.

**Prerequisite** Introduction to Fiber and Textile Evidence (TE-TM-08-01) *through* Fiber Solubility Examinations (TE-TM-08-09)

## 1 Objectives

### 1.1 Theoretical

Fibers occur in a variety of items, so they are often encountered as evidence. Their ultimate evidentiary value is dependent on factors and circumstances surrounding the case and the commonness of the particular evidence fibers. The forensic scientist must be able to provide expert testimony concerning the significance of an association based upon fiber evidence.

### 1.2 Practical

Upon completion of this module, the trainee will:

A. Understand the factors affecting the significance of fiber evidence,

B. Understand how to report conclusions and opinions,

C. Understand how to perform technical and administrative reviews, and

D. Be able to provide expert testimony that appropriately conveys the significance of fiber evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the interpretation of fiber associations and the significance with the trainee.

1. The types of fibers recovered
2. Color or variation of color in the fibers
3. Number of fibers found, location of fibers
4. Fabric type
5. One-way or two-way transfer
6. Multiple fiber associations
7. Multiple color / type question fibers consistent with color / type known fibers from one item
8. The use of RN/WPL information to determine manufacturer production and distribution and the value of target fiber studies

B. Discuss report wording

C. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

D. Discuss court testimony

### 2.2 Required Readings

A. Saferstein R, ed. *Forensic Science Handbook*, Volume II. Prentice-Hall; Englewood Cliffs, New Jersey, 1988. Chapter 5: The Forensic Aspects of Textile Fiber Examination.

B. Grieve M. Robertson J, ed. *Forensic Examination of Fibres*, Ellis Harwood Limited, West Sussex, England, 1992, Chapter 8: Information Content: The Interpretation of Fibres Evidence.

C. Technical Working Group for Materials Analysis. Forensic Fiber Examination Guidelines. January 1998. *For Sci Comm*. April 1999. 1(1).

D. Grieve M. Robertson J, and Grieve MC, eds. *Forensic Examination of Fibres, 2nd edition*. Taylor and Francis, London, 1999, Chapter 13: Interpretation of Fibres Evidence.

E. Fong W, and Inami SH. Results of a Study to Determine the Probability of Chance Match Occurrence Between Fibers Known to be from Different Sources. *J For Sci*. 1986. 31(1), pp. 65-72.

F. Grieve MC, and Biermann T. The Population of Coloured Textile Fibres on Outdoor Surfaces. *Science and Justice*. 1997. 37(4), pp. 231-239.

G. Palmer R, and Chinherende V. A Target Fiber Study Using Cinema and Car Seats as Recipient Items. *J For Sci.* 1996. 41(5), pp. 802-803.

H. Roux C, and Margot P. The Population of Textile Fibers on Car Seats. *Science and Justice*. 1997. 37(1), pp. 25-30.

I. Robertson J, and Olaniyan D. Effect of Garment Cleaning on the Recovery and Redistribution of Transferred Fibers. *J For Sci*. 1986. 31(1), pp. 73-78.

J. Spencer R. Significant Fiber Evidence Recovered from the Clothing of a Homicide Victim After Exposure to the Elements for Twenty-Nine Days. *J For Sci*. 1994. 39(3), pp. 854-859.

K. Deadman H. Fiber Evidence and the Wayne Williams Trial (Part I). *FBI Law Enforcement Bulletin*. March 1984, pp. 13-20.

L. Deadman H. Fiber Evidence and the Wayne Williams Trial (Conclusion). *FBI Law Enforcement Bulletin*. May 1984, pp. 10-19.

M. The Melissa Brannen Case. *Forensic Science Update*. 1992. 1(1).

N. Bruschweiler W, and Grieve M. A Study on the Random Distribution of a Red Acrylic Target Fibre. *Science and Justice*. 1997. 37(2), pp. 85-89.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced fiber examiner.

### 3.5 Supervised Performance

A. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results. The trainee will prepare mock reports based on the provided scenarios or results.

B. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

The trainee will provide a written response to the following: Discuss the factors that affect the significance of fiber associations.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fiber Unit Training Checklist (LAB-TE-TM-08).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 09 GUNSHOT PRIMER RESIDUE UNIT

# TE-TM-09-01 GUNSHOT PRIMER RESIDUE EXAMINATION

**Duration** Four to eight months

**Purpose** The trainee will become familiar with the theoretical and practical aspects of gunshot primer residue deposition and the SEM analysis stubs for gunshot primer residue.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Antimony, barium, and lead compounds are components of most primer mixtures and are commonly found in gunshot primer residue. Significant levels of these three elements can be deposited on the hands of a person who discharges a weapon, is near a weapon when it is fired, or handles a weapon or ammunition component.

Scanning Electron Microscopy-Energy Dispersive Spectrometry (SEM-EDS) is a highly sensitive and discriminating analytical technique. SEM-EDS is used to analyze stubs for the presence of antimony, barium, lead and particle morphology characteristic of gunshot primer residue.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand the origin, occurrence, and significance of gunshot primer residue;

B. Properly collect SEM stubs for gunshot primer residue analysis;

C. Determine if the stubs warrant analysis;

D. Interpret the data obtained from case samples;

E. Understand and explain the theory and principles of SEM-EDS analysis;

F. Properly operate and maintain the SEM-EDS instrumentation;

G. Report conclusions and opinions;

H. Perform technical and administrative reviews; and

I. Provide expert testimony that appropriately conveys the significance of GSR evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss gunshot primer residue

1. Formation
2. Composition
3. Morphology
4. Sources
5. History of analysis and collection
6. Significance

B. SEM-EDS instrumentation
   1. Theory
   2. Operation
   3. Calibration
   4. QC procedures
   5. Sample preparation
   6. Elemental identification
   7. Limitations
   8. Maintenance

C. Sample collection and analysis
   1. Hand stub collection
   2. Inanimate object collection
   3. Criteria for GSR collection (DPS policy and its development)
   4. Sample preparation for SEM-EDS analysis

D. Interpretation and significance

E. Discuss report writing

F. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

G. Discuss court testimony

**2.2 Required Readings**

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Gunshot Residue Analysis by Scanning Electron Microscopy-Energy Dispersive Spectrometry (SEM-EDS)

B. Saferstein R. *Criminalistics: An Introduction to Forensic Science*, 6th ed. Prentice-Hall, 1988. Chapter 11: Detection of Gunshot Residue: Present Status.

C. Aaron, R. Gunshot Primer Residue, The Invisible Clue, *FBI Law Enforcement Bulletin*, June 1991, p 19-22.

D. DiMaio, V. *Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques*. Elsevier Science Publishing Co. Inc., 1985. Chapter 12: Detection of Gunshot Residues.

E. Harrison, H. et al,. 1959. Firearms Discharge Residues. *J. For Sci*, 4:184-199.

F. Havekost, D. et al, Barium and Antimony Distributions on the Hands of Nonshooters, *J. For Sci*. CA 1990, 35(5):1096-1114.

G. Kilty, J. Activity After Shooting and its Effect on the Retention of Primer Residue, *J. For Sci.* 1975, 20(2):219-230.

H. Krishnan, S. Detection of Gunshot Residue on the Hands by Trace Element Analysis, *J. For Sci.* 1997, 22 (2):304-324.

I. Stone, I. C. Characteristics of Firearms and Gunshot Wounds as Markers of Suicide, *The American Journal of Forensic Medicine and Pathology*, 1992, 13(4):275-280.

J. Goldstein, J. *Scanning Electron Microscopy and X-Ray Microanalysis*, 4th Edition. Springer, 2018.

1. Chapter 1: Electron Beam—Specimen Interactions: Interaction Volume
2. Chapter 2: Backscattered Electrons
3. Chapter 3: Secondary Electrons
4. Chapter 4: X-Rays
5. Chapter 5: Scanning Electron Microscope (SEM) Instrumentation
6. Chapter 6: Image Formation
7. Chapter 7: SEM Image Interpretation
8. Chapter 8: The Visibility of Features in SEM Images
9. Chapter 9: Image Defects
10. Chapter 16: Energy Dispersive X-ray Spectrometry: Physical Principles and User-Selected Parameters
11. Chapter 18: Qualitative Elemental Analysis by Energy Dispersive X-Ray Spectrometry

K. Schwoeble, A and Exline, D, *Current Methods in Forensic Gunshot Residue Analysis*, CRC Press, 2000

L. Nesbitt, R. et al, Detection of Gunshot Residue by Use of the Scanning Electron Microscope, *J. For Sci.* 21, July 1976.

M. Andrasko, J. and Mackly, Detection of Gunshot Residue on Hands by Scanning Electron Microscope, *J. For Sci.*" 22(2), April 1977.

N. Samarendra Basu. Formation of Gunshot Residue. *J. For Sci.* 27(1), January 1982.

O. Wolten et al. Particle Analysis for the Detection of Gunshot Residue, Part I and Part II. *J. For Sci.*, 24. 1979

P. Wolten et al. Particle Analysis for the Detection of Gunshot Residue, Part III. *J. For Sci.* 24(4), 1979

Q. Wallace, J et al. Discharge Residues from Cartridge Operated Industrial Tools. *J. For Sci. Society*, 24, 1984

R. Giaelamas, D et al. Officers, Their Weapons and Their Hands: An Empirical Study of GSR on the Hands of Non Shooting Police Officers. *J. For Sci.* 40(6), 1995

S. Mosher, P et al. Gunshot Residue Similar Particles Produced by Fireworks. *Canadian Society of Forensic Science* 31(3), 1998

T. Garofano, L et al. Gunshot Residue, Further studies on particles of environmental and occupational origin. *Forensic Sci. Int.*, 103, 1999

U. Torre, C et al. Brake Lining: A Source of Non-GSR Particles Containing Lead, Barium and Antimony. *J. For Sci.* 47(3), 2002

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

- Elemental Standard(s): as referenced in the Instrument Instructions and Instrument Log
- Organic, liquid, pressure sensitive adhesive, such as Duro-Tak 80-1061, (National Starch and Chemical)
- Image Standard

## 3.3 Equipment

- Scanning Electron Microscope-Energy Dispersive Spectrometer
- Stereomicroscope

## 3.4 Observed Performance

A. The trainee will observe trained analyst(s) conduct Gunshot Primer Residue analysis in casework or mock casework. The number of cases/mock cases observed is determined by the trainer.

B. When possible, the trainee should observe actual court testimony by an experienced Gunshot Primer Residue examiner.

## 3.5 Supervised Performance

A. The trainer will provide sets of stubs prepared by the trainer or other qualified personnel for the trainee to analyze. At least 10 stubs should be included in the sets. The samples will contain stubs with a variety of known gunshot residue particles.

B. Report writing

1. The trainee will review GSR reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results. The trainee will prepare mock reports based on the provided scenarios or results.

C. Technical and administrative reviews

1. The trainee will be provided with case records that have been previously reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be given non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

## 3.6 Independent Exercises

A. The trainer will provide 5 sets of stubs prepared by the trainer or another qualified personnel for the trainee to analyze. The stubs will contain a variety of known gunshot residue particles.

B. The trainee will prepare mock case reports based on the conclusions of the analysis.

C. The trainee will provide written answers to the following questions:

1. How is gunshot primer residue formed?
2. What is the definition of characteristic GSR particles? Indicative particles?
3. Why are GSR kits collected from a victim's hands not normally analyzed by this lab?
4. What are some environmental sources for indicative GSR particles?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may consist of mock casework, case reexaminations, or old proficiencies.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Gunshot Primer Residue Unit Training Checklist (LAB-TE-TM-09).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 10 FIRE DEBRIS ANALYSIS UNIT

# TE-TM-10-01 OVERVIEW OF THE FIRE DEBRIS ANALYSIS TRAINING UNIT

## 1 Introduction

Fire Debris Analysis involves the identification of ignitable liquid residue either in liquid form (swabs of unknown liquid) or in debris, other burned materials, and any other materials except for blood and tissue retrieved from a possible arson crime scene.

## 2 Purpose

A. The following modules comprise the training program for Fire Debris Analysis:

1. Overview of the Fire Debris Analysis Training Unit
2. Organic Chemistry Review
3. Introduction to Petroleum Products and Petroleum Manufacturing
4. Introduction to Fire and Arson Investigation
5. Evaluation and Characterization of Fire Debris
6. Extraction Methods, Sample Preparation and Data Collection
7. Instrumental Analysis
8. Report Writing
9. Practical Assessment

B. It should be noted that each training module is not meant to be followed in exact order and overlap among and between modules is to be expected.

## 3 Trainee Responsibilities

A. All analysts, regardless of their prior experience, are required to read, review and be familiar with all Fire Debris related SOPs, especially

1. Trace Evidence Manual chapters:
   a) *Handling of Fire Debris Analysis Items,*
   b) *Instrumental Analysis of Fire Debris,*
   c) *Fire Debris Analysis Equipment,*
   d) *Ignitable Liquid Reference Standards and Materials, and*
2. Appropriate sections of the Crime Laboratory Service and LIMS Manuals.

B. The trainee shall read all modules in their entirety in order to develop a complete understanding of the requirements.

C. During the training period, the trainee will observe forensic arson cases being processed/analyzed by an authorized analyst or section supervisor for a period of 2 to 6 weeks (to be determined by section supervisor). During this time, the trainee will complete the required sections of the training manual which includes preparation and analysis of samples from the ignitable liquid reference library; and preparation of these in mixed matrices.

D. Parts of the training notebook that can be saved in a computer data file (i.e. word, excel, pdf) should be retained by the trainee for ease of recording, editing and reviewing. This will be temporarily copied to the Fire Debris folder on the P:drive (in a folder with the analyst's name) and be updated at least once a month to ensure the FD Section retains a copy until such time as it can be added to the system record per work authorization protocols.

1. At the end of each month (or when prompted by the trainer), the trainee will print out the training log and place the printed copies in a binder labeled with their name and "Training Notebook" to be reviewed by the trainer.
2. No case numbers are to be included in the training notebook with the exception of the Supervised Work Log (LAB-307)
3. A Statement of Qualifications (SOQ) will also be completed and saved per DPS protocol (CLS Manual: Forensic Disclosure and Compliance Policy, *Personnel-Specific Disclosure* section).

E. The trainee will successfully complete supervised analysis of **non-evidence** samples either created by the trainer from ignitable liquid or of chromatographic data pulled from previously analyzed cases (i.e. documented case file data found on the various GC/MS's in the instrument room of the laboratory). These are to be assigned by the trainer or Section Supervisor and documented in the training notebook.

F. All analysts, regardless of their prior experience, shall pass at least one in-house competency test conducted by the FD Section Supervisor.

G. Analysts are encouraged to request training in the various modules as a refresher when external training is unavailable due to budgetary constraints.

## 4 Trainer Responsibilities

A. A new analyst will work closely with the FD Section Supervisor or another designated, senior analyst who will act as a primary mentor when being assigned a fire debris analysis case. Background readings, previous case files and discussion of case approach would take place prior to supervised casework by a new analyst.

B. The amount of time allotted for training will largely depend upon the trainee's particular background and experience, and the available resources. Generally, this is 9-12 months from their start date. The trainer will record completion of the training modules.

C. Individuals who come to the FD section as qualified examiners from another laboratory system will generally move more quickly through the training program. The trainer will review the individual's previous experience and training and will assess competency in each required area. This training generally involves a familiarization with the SOP's and instrumentation and proceeds quickly to competency testing if the individual is performing the same analysis in which he/she was previously qualified. Modifications to the training program may be recommended by the trainer or FD Section Supervisor and shall be approved by the System Quality Manager. Training and modifications will be documented in a training notebook and follow CLS protocols for record retention when completed (Employee Training Program, Expunction and Destruction of Laboratory Records and Information, and Electronic Storage and Archival of Records chapters).

D. If the FD Section Supervisor is not conducting the training, the trainer will work in conjunction with the FD Section Supervisor when modifications are made to personalize the training program based upon an individuals' experience.

E. Members of the FD Section who are identified as those that would benefit from remedial training will be given a written outline of the areas to be covered by the trainer. This will be documented in the training notebook and will follow CLS Manual training requirements (Employee Training Program chapter).

## 5 Training Resources

A. Suggested Readings are listed as such because they should be read by the trainee and available to him or her as a resource. The trainer and the trainee will review the pertinent points of suggested readings material selected by the trainer. Instrument manufacturers' manuals along with numerous other references are not specified but are available to the trainee and the trainee should become familiar with these. The trainer will orient the trainee as to the location of these materials. Additionally, the trainee should review the relevant procedures as they progress through the components and complete any additional tasks, practical exercises, quizzes or tests assigned by the trainer or FD Section Supervisor. This process, including the reading of assigned reading materials, will be documented in the trainee's training notebook.

B. As the trainee progresses through their training, opportunities to take outside courses and workshops relative to their training may arise. The trainee should be encouraged to participate in outside classes and these classes will be documented in their training notebooks. A copy of any certificates received from the courses or workshops will also be retained. If one was not received, written documentation of the date and title of the course or workshop can be documented in its place in the training notebook. The course titles and dates completed should also be added to the appropriate section of their SOQ.

C. Additional reference materials are outlined in appendices to the Trace Evidence Training Manual.

## 6 Assessment

A. It is both the trainer and trainee's responsibility to ensure that all aspects of the training are documented as completed on the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. Whenever practicable, the trainee should ensure a copy(ies) of the most recent training notebook documents (i.e. word, excel, pdf, etc.) are saved to a folder bearing the trainee's name in the Fire Debris folder of the P:drive.

C. A module will be considered to have been successfully completed after all questions, exercises, and assessments within the module have been finished and addressed to the satisfaction of the trainer and signed off by the FD Section Supervisor.

D. Prior to being authorized to perform supervised casework, a trainee shall have successfully completed at least one competency test and a mock trial. Additional competency tests or mock trial may be needed if determined by the trainer or FD Section Supervisor. A memo as to review of testimony protocol and criteria for analysis may take the place of a second mock trial.

E. After the successful completion of all modules within the training unit and at the recommendation of the trainer and/or FD Section Supervisor, the trainee may begin performing supervised casework with the approval of the Laboratory Director, using the Work Authorization form (LAB-309).

## 7 Supervised Casework

Supervised casework requirements will conclude with independent examiner approval when the following are met:

A. The trainer or Section Supervisor will oversee the trainee's casework for 2-4 months of supervised casework analysis and will initial chromatographic data and other work documentation to show their concurrence with the work performed. Protocols for appropriate administrative and technical reviews will also be followed (LIMS Manual; CLS Manual: Laboratory Records; Laboratory Reports, Letters, and Certificates; Review of Laboratory Records; and Records Requests and Release of Laboratory Records and Information chapters).

B. The trainee shall successfully complete at least one other competency test and/or successfully complete the external proficiency test (preferably both) prior to being authorized to conduct technical reviews on active casework.

C. The trainer(s) who recommend the trainee be approved for independent casework will ensure that all the required documentation of training is completed in the trainee's training notebook and will follow protocols for Work Authorization in the CLS Manual.

## 8 Evaluation of Training

The trainee will complete an evaluation of each module's content or that of the entire training unit, including the trainer, using the Laboratory Training Program Evaluation Form (LAB-304).

# TE-TM-10-02 ORGANIC CHEMISTRY REVIEW

**Duration** 1 to 2 weeks

**Purpose** The trainee will review the basic classes of organic compounds as a precursor to discussing petroleum products and their components.

**Prerequisite** *Optional:* Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. Organic chemistry as it relates to fire debris analysis

B. Key (chemistry) components in the various ignitable liquid classes

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Identify key components (ions) as it pertains to ignitable liquid classes

B. Apply organic chemistry knowledge (hydrocarbons) to the fire debris analysis process

## 2 Training Outline

### 2.1 Lesson Plan

A. Review of key ion profiles in ignitable liquid classes (i.e. alkanes, aromatics, cycloalkanes/isoalkanes, indanes, polynuclear aromatics, etc.)

B. Be familiar with basic structure of particular hydrocarbons

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. Boyd, Robert and Robert Morrison. *Organic Chemistry.* Englewood Cliffs, New Jersey: Prentice Hall, 1992. Chapters 7, 17

B. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic, 2008. Chapters 3-4

### 2.3 Suggested Readings

A. Gutsche, C.D & Pasto, D., *Fundamentals of Organic Chemistry*, 1st edition. New Jersey: Prentice Hall Inc.,1975, Chapters 3, 4, 5, 6, 7, 8, 10, 12, 13, 18, 19, 31.

B. Kroschwitz, Jacqueline I., and Melvin Winokur. *Instructor's Manual to Accompany: Chemistry A First Course*. San Francisco: McGraw-Hill, 1987.

C. Gates, Bruce C., James R. Katzer, and G. C. A. Schuit. *Chemistry of Catalytic Processes*. New York et al.: McGraw-Hill, 1979.

D. Prudent Practices for Disposal of Chemicals from Laboratories. Washington, D.C.: National Academy, 1983.

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Observed Performance

A. The trainer and trainee will discuss the topics listed in the objectives as they relate to organic chemistry in fire debris analysis along with the pertinent points of selected readings.

B. The trainee will discuss with the trainer the basic classes of organic compounds and how this applies to petroleum products, their components, and fire debris analysis.

C. The trainer and the trainee will review and discuss other pertinent points as it relates to the handling and analysis of ignitable liquid residue.

## 3.5 Independent Exercises

A. The trainee will provide written answers to a set of questions provided by the trainer.

B. If possible, the trainee should attend outside training courses or workshops in Organic Chemistry as it may apply to chemical analysis in arson investigation.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the independent exercise with the trainee.

B. The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-03 INTRODUCTION TO PETROLEUM PRODUCTS AND PETROLEUM MANUFACTURING

**Duration** 1 to 2 weeks

**Purpose** Introduce the trainee to the history, composition, and manufacturing of petroleum products that may be encountered during Fire Debris analysis.

**Prerequisite** Concurrent with Organic Chemistry Review (TE-TM-10-02)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. History of petroleum products.

B. Composition of various petroleum fractions.

C. Manufacturing processes of petroleum distillates and the end use of products.

D. Major processes for manufacturing of petroleum products and how this affects final analysis results

E. The true definition of 'octane' ratings in gasoline

## 2 Training Outline

### 2.1 Lesson Plan

A. Review of hydrocarbons found in petroleum products

B. Review chromatographic data in relation to various petroleum products, including those 'naturally' occurring in (mixed) matrices to distinguish from actual ignitable liquid residues

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic, 2008. Chapters 7 and 25

B. Speight, James G. *The Chemistry and Technology of Petroleum.* Boca Raton, FL: CRC Press, 2007. Chapters 9, 14-15, 20.6, 25-26

### 2.3 Suggested Readings

Gary, James H., and Glenn E. Handwerk. *Petroleum Refining: Technology and Economics*. New York: M. Dekker, 1994.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

A. The trainee will discuss with the trainer the pertinent aspects of petroleum products and their manufacturing.

B. The trainer and trainee will review and discuss other pertinent points of petroleum products and their manufacturing as it relates to fire debris analysis and detection of ignitable liquid residue.

C. The trainer and trainee will review and discuss the pertinent points of selected readings.

### 3.5 Independent Exercises

A. The trainee will provide written answers to a set of questions provided by the trainer.

B. If possible, the trainee should attend outside training courses or workshops regarding petroleum products, ignitable liquids and their extraction and/or analysis, as it may apply to fire debris analysis and detection of ignitable liquid residue.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the Independent Exercise questions with the trainee.

B. The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-04 INTRODUCTION TO FIRE AND ARSON INVESTIGATION

**Duration** 1 to 2 weeks

**Purpose** Introduce the trainee to investigation of fire scenes, including related terminology and procedures for evidence collection.

**Prerequisite** Organic Chemistry Review (TE-TM-10-02), Introduction to Petroleum Products and Petroleum Manufacturing (TE-TM-10-03)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. Arson and accelerant terminology

B. Fire scene investigations and the dynamics of a fire scene

C. Proper techniques in recovery, collection, preservation and packaging of fire debris evidence

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Define fire debris analysis and arson related terminology

B. Communicate and conduct proper procedures for collecting, packaging and storing fire debris evidence

## 2 Training Outline

### 2.1 Lesson Plan

A. Compare and contrast the meanings and uses of:

1. Combustible vs. flammable
2. Accelerant vs. ignitable
3. Fire triangle vs. fire tetrahedron

B. Define key fire science/scene and fire debris analysis terms

C. Review of flash point and limiting factors

D. Discuss any considerations that should be made prior to the collection of evidence; areas of collection around a pour, and selection of samples from crime scene (i.e. where and what to collect)

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. DeHaan, John D., Paul Leland Kirk, and David J. Icove. *Kirk's Fire Investigation*. Boston, MA: Pearson, 2012. Chapters 1-7, 9, 11, 13-14, 16-17

B. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic, 2008. Chapters 1, 6

C. National Fire Protection Association. *NFPA 921: Guide for Investigation of Fire and Explosion Investigations*. Quincy, MA: 2014. Chapters 3, 14, 17, 20

D. Texas DPS Crime Laboratory Service Manual: Trace Evidence Analysis, *Fire Debris* section

### 2.3 Suggested Readings

A. Fisher, Barry A. J. *Techniques of Crime Scene Investigation*. Boca Raton, FL: CRC, 1993.

B. Carroll, John Richard. *Physical and Technical Aspects of Fire and Arson Investigation*. Springfield, IL: Thomas, 1979.

C. Canter, David V. *Fires and Human Behavior*. London: Fulton, 1990.

D. Benedetti, Robert P. *Flammable and Combustible Liquids Code Handbook*. Quincy, MA: National Fire Protection Association, 1991.

E. Fire Scene Investigations Protocol. State Fire Marshal's Office Investigations Standard of Operations. Austin, TX: State Fire Marshal's Office, Standard Operating Procedures, 2013.

## 3 Practice

### 3.1 Safety

A. Follow guidelines for crime scene safety.

B. Refer to the Safety Manual.

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

A. The trainer and trainee will review and discuss the pertinent points of selected readings.

B. If possible, the trainee should visit fire scenes, observe evidence collection, and observe controlled burns, and work with SFMO Fire Investigators and SFMO K9 Fire Investigation teams.

### 3.5 Independent Exercises

The trainee will provide written answers to a set of questions provided by the trainer.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the independent exercise questions with the trainee.

B. The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-05 EVALUATION AND CHARACTERIZATION OF FIRE DEBRIS

**Duration** 2 to 3 weeks

**Purpose** Familiarize trainee with different types of fire debris evidence and matrices, known reference samples, and the ignitable liquid classifications.

**Prerequisite** Introduction to Fire and Arson Investigation (TE-TM-10-04)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. The effect that the substrate/debris can have on the identification of petroleum products.

B. Manufacturing processes of turpentine.

C. The composition of soft woods versus terpenes.

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Explain how the different substrates and matrices can affect ignitable liquid residues (e.g. soil, plastics, inks/toners, soft woods, etc.) and how to minimize these 'background effects'

B. The limitation in identifying turpentine (vs. terpenes) and other single non-oxygenated peaks

C. Understand pyrolysis products and distinguish them from actual ignitable liquid residues

## 2 Training Outline

### 2.1 Lesson Plan

A. Review chromatographic data of matrices and substrates against known ignitable liquid reference samples and be able to distinguish their peak patterns and ion profiles

B. Review the criteria for identifying single non-oxygenated peaks, limonene, and turpentine in final analysis results

C. Review chromatographic data to identify possible pyrolysis products

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. Trace Evidence Manual, DPS Crime Laboratory: Ignitable Liquid References, Standards and Materials

B. Newman, Reta, Michael Gilbert, and Kevin Lothridge. *GC-MS Guide to Ignitable Liquids*. Boca Raton: CRC, 1998. Pages 1-25

C. Mann, D. C. and Gresham, W. R. Microbial Degradation of Gasoline in Soil. *Journal of Forensic Sciences*, Vol. 35, No. 4, July 1990, pp. 913-923.

D. Trimpe, M. A. Turpentine in Arson Analysis. *Journal of Forensic Sciences*, Vol. 36, No. 4, July 1991, pp. 1059-1073.

E. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic, 2008. Chapter 9-10

F. ASTM 1618 "Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry."

### 2.3 Suggested Readings

A. Kurz, M.E. et al. Effect of Background Interference on Accelerant Detection by Canines. *Journal of Forensic Sciences*, Vol. 41, No. 5, 1996, pp. 868-873.

B. Kurz, M.E. et al. Evaluation of Canines for Accelerant Detection at Fire Scenes. *Journal of Forensic Sciences*, Vol. 39, No. 6, 1994, pp. 1528- 1536.

C. Lentini, J. J, et al. The Petroleum-Laced Background. *Journal of Forensic Sciences*, Vol. 45, No. 5, 2000, pp. 968-989

D. Midkiff, C.R. Is It a Petroleum Product? How Do You Know? *Journal of Forensic Sciences*, Vol. 31, No. 1, Jan. 1986, pp 231-234.

E. Tindall, R. An Evaluation of 42 Accelerant Detection Canine Teams. *Journal of Forensic Sciences*, Vol. 40, No. 4, 1995, pp. 561-564.

F. Hilado, Carlos J. *Flammability Handbook for Plastics*. Westport, CT: Technomic Pub., 1974.

## 3 Practice

### 3.1 Safety

A. Follow standard procedures for use of personal protective equipment.

B. Refer to the Safety Manual.

C. Perform exercises in hood.

### 3.2 Standards, Controls, Reagent Preparation

- Ignitable liquid known reference samples
- Solvents

### 3.3 Equipment

- Chemical hood
- Ignitable liquids oven
- Butane torch

### 3.4 Observed Performance

A. The trainer and trainee will review and discuss the pertinent points of each reading.

B. The trainer will discuss the criteria for ignitable liquid identification as outlined in ASTM E1618.

C. The trainer and trainee will review the required criteria for the various ignitable liquid classes and the differences when compared to known spectra from the various matrices and substrates

### 3.5 Supervised Performance

A. The trainee will collect samples of materials commonly seen with fire debris that are known to give off pyrolysis products to be extracted and run by GC/MS in order to make a pyrolysis library for the training log (see TE-TM-FD-07). GC/MS run to be performed by the trainer and chromatographic results discussed with trainee.

B. The trainee will prepare mixed matrix debris for K9 teams and run one uncontaminated can and one can spiked with ignitable liquid through the analysis process to see differences in results.

C. If possible, melt some ABS plastic, newsprint, and softwood in separate cans and take through analysis process to see chromatographic results.

D. Repeat steps described in A through C above with known ignitable liquid reference samples.

### 3.6 Independent Exercises

The trainee will provide written answers to a set of questions provided by the trainer.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the Independent Exercise questions with the trainee.

B. The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-06 EXTRACTION METHODS, SAMPLE PREPARATION, AND DATA COLLECTION

**Duration** 2 to 4 weeks

**Purpose** Introduce the trainee to extraction techniques used by the Fire Debris analyst.

**Prerequisite** Evaluation and Characterization of Fire Debris (TE-TM-10-05)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. Case documentation including note-taking, use of worksheets, and approved abbreviations.

B. Extraction techniques for Fire Debris analysis.

C. Quality control procedures for the GC/MS.

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Perform extraction techniques to include headspace, solvent, dynamic and passive adsorption/elution.

B. Determine which extraction procedure to use under varying sample conditions.

C. Prepare samples for injection into the GC/MS.

D. Prepare blanks and Standard Ignitable Mixes (SIM).

E. Perform an instrument Tune.

F. Perform various instrument maintenance procedures (i.e. changing septa, injection needles, filaments, etc.)

## 2 Training Outline

### 2.1 Lesson Plan

A. Review and discuss the extraction process.

B. Discuss and review the various maintenance and quality assurance/quality control requirements for the GC/MS.

C. Review solvent use and known ignitable liquid reference library.

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Standard Abbreviations List

B. ASTM E 1412 "Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Activated Charcoal."

C. ASTM 1386 "Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction."

D. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic, 2008. Chapters 2.2, 11

### 2.3 Suggested Readings

A. Dietz, W. R. Improved Charcoal Packaging for Accelerant Recovery by Passive Diffusion. *Journal of Forensic Sciences*, Vol. 36, No. 1, January 1991, pp. 111-121.

B. Lentini, J. J. and Armstrong, A. T. Comparison of the Eluting Efficiency of Carbon Disulfide with Diethyl Ether: The Case for Laboratory Safety. *Journal of Forensic Sciences*, Vol. 42, No. 2, 1997, pp. 307-311.

C. Newman, R. T., Dietz, W. R. and Lothridge, K. The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion, Part I: The Effects of Time, Temperature, Strip Size, and Sample Concentration. *Journal of Forensic Sciences*, Vol. 41, No. 3, May 1996, pp. 167-176.

D. Waters, L. V. and Palmer, L. A. Multiple Analysis of Fire Debris Samples Using Passive Headspace Concentration. *Journal of Forensic Sciences*, Vol. 38, No. 1, January 1993, pp. 165-183.

E. Buffington, Rosemary, Wilson, Michael K. *Detectors for Gas Chromatography: A Practical Primer.* Avondale, PA: Hewlett-Packard, 1991.

F. Jennings, Walter. *Analytical Gas Chromatography*. Orlando: Academic, 1997.

## 3 Practice

### 3.1 Safety

A. Follow standard procedures for use of personal protective equipment and applicable safety practices.

B. Perform exercises in hood.

C. Refer to the Safety Manual.

### 3.2 Standards, Controls, Reagent Preparation

- Ignitable liquid known reference samples
- Solvents and Standard Ignitable Mix

### 3.3 Equipment

- Ignitable liquids oven
- Chemical hood
- GC/MS
- Can lid press

### 3.4 Observed Performance

A. The trainer will discuss with the trainee how to take appropriate notes, how to properly use worksheets and what abbreviations are used for documentation of fire debris cases.

B. The trainer will demonstrate headspace vapor extraction via use of c-strip and preparation of solvent vial for injection into the GC/MS.

C. The trainer and trainee will review and discuss the pertinent points of selected readings.

### 3.5 Supervised Performance

A. The trainee will receive a set of unknown samples consisting of paint cans prepared by the trainer from reference library samples. These unknown samples will be extracted by passive adsorption/elution (charcoal strip) in conjunction with the Independent Exercises for **Instrumental Analysis** (TE-TM-10-07).

B. The trainee will receive a set of unknown samples prepared in mixed matrices to be extracted by passive adsorption/elution (charcoal strip) in conjunction with the Independent Exercises for **Instrumental Analysis** (TE-TM-10-07).

### 3.6 Independent Exercises

The trainee will provide written answers to a set of questions provided by the trainer.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the Independent Exercise questions with the trainee.

B. The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-07 INSTRUMENTAL ANALYSIS

**Duration** 2 to 3 months

**Purpose** Familiarize the trainee with the fundamental theory and operations of the GC/MS instrument as it relates to Fire Debris analysis.

**Prerequisite** Extraction Methods, Sample Preparation and Data Collection (TE-TM-10-06)

## 1 Objectives

### 1.1 Theoretical

Upon completion of this training, the trainee will have knowledge of:

A. The principles of Gas Chromatography/Mass Spectrometry (GC/MS).

B. The process of pattern recognition and ion-profiling when identifying ignitable liquids.

C. Testimony regarding the analysis process and final analysis results.

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Describe and demonstrate the application of GC/MS to the identification of petroleum products and ignitable liquid residue classes.

B. Utilize GC chromatographic data pattern recognition coupled with ion-profiling in the evaluation of GC/MS data.

C. Identify volatile compounds vs compounds intrinsic in substrates/matrices in the headspace of samples.

D. Describe these above referenced processes in layman's terms for testimony purposes.

## 2 Training Outline

### 2.1 Lesson Plan

A. Review of exercises to include a discussion regarding major pattern differences, weathering, and overlap.

B. Review of exercises to include ASTM standard criteria for the various ignitable liquid classes.

C. Discussion of mixed matrices and substrate patterns and ion profiles, including discussion of hydrocarbon pattern similarities to ignitable liquids.

D. Discussion of various instrument quality assurance checks and maintenance plans, to include the ignitable liquids oven.

E. Discussion and review of key legal elements regarding evidence and testimony on casework.

### 2.2 Required Readings

Readings that have been completed in previous modules may be omitted or reviewed at trainer's discretion. For literature references, use of the most current edition is recommended.

A. DeHaan, John D., Paul Leland Kirk, and David J. Icove. *Kirk's Fire Investigation.* 7th Edition. Boston: Pearson, 2012. Chapter 8 – Wildland Fires and Their Investigation, Sections 1-3.

B. Stauffer, Eric, Julia Ann Dolan, and Reta Newman. *Fire Debris Analysis*. Boston, MA: Academic Press, 2008. Chapter 8 – Gas Chromatography and Gas Chromatography-Mass Spectrometry, Sections 4-6; Chapter 12

C. McNair, Harold Monroe, and James M. Miller. *Basic Gas Chromatography*. New York: Wiley, 1998. Chapter 10, 12

D. ASTM E1388 "Standard Practice for Static Headspace Sampling of Vapors from Fire Debris Samples."

E. Yinon, Jehuda, ed., *Forensic Applications of Mass Spectrometry.* CRC Press, 1995. Chapter 4 – Analysis of Accelerants in Fire Debris by Gas Chromatography/Mass Spectrometry, pp. 129-169.

F. Smith, R.M. Mass Chromatographic Analysis of Arson Accelerants. *Journal of Forensic Sciences*, Vol. 28, No. 2, 1983, pp. 318-329.

G. Yinon, Jehuda. *Forensic Mass Spectrometry*. Boca Raton, FL: CRC, 1987. Chapter 4

### 2.3 Suggested Readings

A. Buffington, Rosemary, Wilson, Michael K. *Detectors for Gas Chromatography: A Practical Primer.* Avondale, PA: Hewlett-Packard, 1991.

B. Jennings, Walter. *Analytical Gas Chromatography*. Orlando: Academic, 1987.

C. Tebbett, I. *Gas Chromatography in Forensic Science*. New York: E. Horwood, 1992.

D. Hyver, K. J., and P. Sandra. *High Resolution Gas Chromatography*. United States: Hewlett-Packard, 1989.

E. Nowicki, J. An Accelerant Classification Scheme Based on Analysis by Gas Chromatography/Mass Spectrometry (GC-MS). *Journal of Forensic Sciences*, Vol. 35, No. 5, 1990, pp. 1064-1086.

F. Wallace, J. R. GC/MS Data from Fire Debris Samples: Interpretation and Application. *Journal of Forensic Sciences*, Vol. 44, No. 5, 1999, pp. 996-1012.

G. McLafferty, Fred W., and František Tureček. *Interpretation of Mass Spectra*. Mill Valley, CA: U Science, 1993.

## 3 Practice

### 3.1 Safety

A. Follow standard procedures for use of personal protective equipment.

B. Perform exercises in hood.

C. Refer to Safety Manual.

### 3.2 Standards, Controls, Reagent Preparation

- Ignitable liquid known reference samples
- Solvents and Standard Ignitable Mix (SIM)

### 3.3 Equipment

- GC/MS
- Ignitable Liquids Oven
- Chemical Hood

### 3.4 Observed Performance

A. The trainer and trainee will review and discuss the pertinent points of selected readings.

B. The trainer will demonstrate use of the GC/MS for producing chromatographic case file data, including use of the various macros, library spectra extraction, and production of required total ion chromatogram (TIC) data and extracted ion chromatogram (EIC) data.

C. The trainer will demonstrate various quality assurance checks for the GC/MS and ignitable liquid oven, including maintenance procedures.

D. The trainer will demonstrate protocol naming conventions and labeling requirements on case file chromatographic data.

E. The trainer and the trainee will discuss the interpretation of fire debris evidence and its relevance and weight in reports and in testimony. Discussion will include identifying a class of products versus individual identification of a commercial product.

### 3.5 Supervised Performance

A. The trainee will perform the QC procedures for the gas chromatograph/mass spectrometers for a minimum of one week.

B. The trainee will demonstrate the carbon strip extraction method to the trainer.

C. The trainee will demonstrate use of the GC/MS for analytical data retrieval, including quality assurance and maintenance checks, to include the ignitable liquids residue oven.

D. The trainee will demonstrate use of the database within LIMS to practice editing case file information and results, entering information into the database, and reporting cases. The trainee will also demonstrate proficiency using LIMS to retrieve information on previously worked cases.

E. Where practicable, the trainee will attend courses in either fire debris analysis, instrumental analysis, GC/MS maintenance and troubleshooting and/or expert testimony.

### 3.6 Independent Exercises

A. The trainee will provide written answers to a set of questions provided by the trainer.

B. Known samples: obtain Total Ion Chromatograms (TIC) and Extracted Ion Chromatograms (EIC) by passive adsorption/elution (charcoal strip) for each substance below. Identify the class of each sample.

*Substitutions should be of the same ASTM class as the original product*

1. 100% gasoline
2. 50% weathered gasoline

3. 100% kerosene
4. 50 % weathered kerosene
5. 100% diesel fuel
6. Royal Oak Charcoal Lighter fuel
7. Citronella Lamp Oil
8. Coleman Fuel
9. Ronsonol Cigarette Lighter Fluid
10. Smokeless Odorless candle oil
11. Ethanol
12. Methanol
13. Isopropanol
14. Acetone
15. Isopar H and/or Isopar
16. Condea Vista 142 (or its equivalent)

C. The trainee will run their samples from the Supervised Performance exercises in **Extraction Methods, Sample Preparation and Data Collection** (TE-TM-10-06) using GC-MS.

1. Obtain the TIC and EIC profile for each liquid
2. Identify the class of each liquid.

D. The trainee will run the extracts of the pyrolysis product samples collected in the Supervised Performance exercise of **Evaluation and Characterization of Fire Debris** (TE-TM-10-05).

E. The trainee will prepare a case record as per the Procedure section of the *Instrumental Analysis of Fire Debris* chapter of the Trace Evidence Manual.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

A. The trainer will review the written answers to the Independent Exercise questions with the trainee.

B. The trainee will complete either a verbal or written quiz in instrumental analysis of fire debris. The trainer will review the answers to the questions with the trainee.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-08 REPORT WRITING

**Duration** 2 to 4 weeks

**Purpose** To familiarize the trainee with writing reports for fire debris casework, as well as technical and administrative case review.

**Prerequisite** Instrumental Analysis (TE-TM-10-07)

## 1 Objectives

### 1.1 Theoretical

The laboratory report is used to communicate analytical results to its reader. The report must be correct in all details including description of evidence, results of analysis, and any administrative information available to the laboratory.

### 1.2 Practical

Following the completion of training, the trainee will be able to:

A. Explain all the steps necessary in producing and releasing a case report after the completion of the analysis of a case.

B. Enter the results from case analysis into LIMS.

C. Technically review a completed case record.

D. Administratively review a completed case record.

## 2 Training Outline

### 2.1 Lesson Plan

A. Reporting guidelines (refer to CLS Manual: Laboratory Reports, Letters, and Certificates)

B. Elements of a technical review

1. Checking each page in the case folder for laboratory case number, analyst initials, and any page numbering required.
2. Conformance with proper technical procedures (test methods) and applicable laboratory policies and procedures.
3. Printout of sequence data, with case number for that particular case file highlighted or marked in some way.
4. Accuracy of results and/or conclusions in the case report and that it is supported by analytical data.
5. Required labeling and identification protocols have been followed on the analytical/chromatographic data.
6. Required chromatographic data of knowns if test results are positive.
7. Required quality assurance printouts (i.e. blanks between samples, Standard Ignitable Mixes or SIMs, tune evaluations, etc.)
8. Associations are properly qualified in the case report; transcription of results correct.

C. Elements of an administrative review:

1. The case report contains all required information.
2. Information between submission form and case report agree.
3. Appropriate information recorded on an analysis worksheet, especially final results, were correctly transcribed to the case report.
4. Corrections of typos, mismatched and/or nonsensical information from numbers 1 and 2.

D. Special Circumstances

1. Exemplars or controls: not requested by laboratory, but when submitted and analyzed are to be identified on the report either in the evidence description or in the result

   a) *Gauze (control)*

   b) *Negative (exemplar)*

2. Packaging issues: if analysis is performed on evidence with either broken seals and/or damage/breach in packaging, this is to be reflected in the report

   a) **Due to improper packaging (i.e. holes in cans, rusted cans, lid not secured etc.), the results may not be accurate as improper packaging leads to both evidence loss and cross contamination.*

   b) **Due to improper packaging (i.e. use of a container other than a sealed metal can), the results may not be accurate as improper packaging leads to both evidence loss and cross contamination.*

3. Exam gloves included in evidence: where practicable, a photo should be taken and possible cross-contamination from exam gloves should be noted on the report:

   *CROSS-CONTAMINATION (possible): Examination glove(s) was/were found inside the evidence container of this item. This practice is **not** recommended for evidence undergoing this type of analysis as it is possible to unknowingly contaminate the *inside* of an examination glove through contact with skin exposed to an ignitable liquid. Therefore, laboratory **cannot** confirm that the positive result comes from the evidence and **not** the glove(s).

4. No analysis wording: when analysis is **not** performed on evidence, the reason shall be cited on the report

   a) *NO ANALYSIS: Evidence was **not** analyzed as the laboratory does not conduct this type of examination.*

   b) *NO ANALYSIS (PACKAGING): Evidence was **not** analyzed due to improper packaging. The evidence can lacked structural integrity, possibly due to corrosion or other causes, leaving the evidence vulnerable to possible contamination before analysis.*

   c) *NO ANALYSIS (PACKAGING): Evidence was **not** analyzed due to improper packaging. The evidence packaging (i.e. paper bag) is **not** considered appropriate packaging for this type of analysis due to its porous nature which lends to possible cross contamination and/or rapid evidence loss.*

   d) *NO ANALYSIS (EMPTY): Evidence can in this item contained no debris or any significant item nor had any indication of any residue present.*

5. Preliminary results: preliminary results may be released to submitting agencies per their request in order to aid in investigation as long as they have been technically reviewed.

### 2.2 Required Readings

DPS Crime Laboratory Service Manual:

1. Laboratory Reports, Letters, and Certificates
2. Review of Laboratory Records
3. Electronic Storage and Archival of Records

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

A. The trainer will review and discuss with the trainee the standard analysis report wording for cases with fire debris evidence, including wording for special issues such as possible contamination, packaging breaches, etc.

B. The trainer will demonstrate reporting of analytical results using LIMS, including entry of result(s) and/or disposition notes. At least ten cases shall be demonstrated.

C. The trainer will demonstrate and discuss review of case/item numbers entered in a sequence run (i.e. batch data), review of worklists against case file and physical data, technical and administrative review of cases. At least ten cases shall be demonstrated.

### 3.5 Supervised Performance

The trainer will provide fifty cases, if possible, previously examined by other qualified fire debris examiners for the trainee to practice technical and administrative review.

A. The exact number of cases will be determined by the trainer.

B. The trainer will review the cases and discuss any findings with the trainee.

**Note**: Trainee can go through review process in LIMS under trainer's supervision, but <u>will not</u> complete milestones.

### 3.6 Independent Exercises

A. Using a test case or one designated/created by the section supervisor, the trainee will generate appropriate worksheets and analysis reports using the LIMS software for given training samples as part of analysis training.

B. Refer to the LIMS Manual and the **Instrumental Analysis of Fire Debris** chapter of the Trace Evidence Manual.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

The trainee will complete either a verbal or written quiz. The trainer will review the answers to the questions with the trainee.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-10-09 PRACTICAL ASSESSMENT

**Duration** 3 to 9 months

**Purpose** To assess the trainee's ability to independently analyze, evaluate, and report results for fire debris evidence.

**Prerequisite** Report Writing (TE-TM-10-08)

## 1 Objectives

### 1.1 Theoretical

The trainee will be able to:

A. Identify criteria for the classification of ignitable liquids as outlined by both the American Society for Testing and Materials (ASTM) E1618 and additional criteria outlined by the fire debris section (see *Instrumental Analysis of Fire Debris* chapter of the Trace Evidence Manual).

B. Use above referenced criteria to characterize fire debris and issue accurate conclusions.

C. Be able to evaluate the analysis of other fire debris analysts.

D. Update case file data, including marking milestones in the LIMS systems, and issue proper final analysis reports.

E. Be able to perform required quality assurance checks both in casework preparation and analysis as well as in all instrumentation involved in the analysis process; be able to troubleshoot fire debris instrumentation.

F. Ability to testify with appropriate courtroom presentation and demeanor

### 1.2 Practical

Following the completion of training, the trainee will be able to independently demonstrate:

A. Familiarity with the instrumentation and appropriate software, including ability to perform quality checks and troubleshooting.

B. Competence in the analysis of fire debris evidence.

C. Ability to evaluate and report the analytical results in accordance with laboratory policy.

D. Successfully complete a mock trial.

## 2 Training Outline

### 2.1 Lesson Plan

A. Sequence set-up, including preparation of quality controls

B. Performance checks and troubleshooting, including preventive maintenance where practicable

C. Evidence examination and analysis

D. Data Assessment

E. Documentation and reporting of analytical results

F. Demonstrate ability to testify professionally in a mock trial to include:

1. Addressing and making direct eye contact with the prosecution, defense, and/or jury.
2. Dressing professionally.
3. Maintaining composure on the witness stand and being aware of verbal inflections and body language.
4. Respond to questions in a clear, concise and accurate manner.
5. Answer technical questions in layman's terms.
6. Maintain unquestionable ethical standards and conduct.
7. Prepare for court with good note taking and documentation skills.
8. Prepare for court with good communication skills.

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Instrumental Analysis of Fire Debris

B. ASTM Standard E1618 "Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas-Chromatography-Mass Spectrometry"

C. Appropriate instrument manuals available in workstations and online

D. Various Frye and Daubert Standard, Brady and Morton Act articles as assigned by section supervisor

E. Texas DPS Crime Laboratory Service Manual: Court Testimony and Monitoring

## 3 Practice

### 3.1 Safety

A. Follow standard procedures for use of personal protective equipment.

B. Perform exercises in hood.

C. Refer to Safety Manual.

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Observed Performance

None

### 3.5 Supervised Performance

None

### 3.6 Independent Exercises

A. As the trainee progresses through fire debris training, the trainee will begin to process training samples as if these samples were submitted for real casework analysis, to include issuing an analysis report.

B. There will be a minimum of three of these “case” files completed prior to issuance of the final competency test.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

A. The trainee will complete a competency exam which cover the scope of work in which the trainee is seeking authorization.

1. The trainee will be provided with a minimum of six (6) competency samples for analysis.
2. The trainee will provide conclusions and chromatographic data to support these conclusions following analysis protocols as described in the *Instrumental Analysis of Fire Debris* chapter of the Trace Evidence Manual.

B. The trainee will complete a comprehensive written exam.

C. Mock Trial

1. The trainee will complete a mock trial using the competency test sample(s) or a case file from evidence previously analyzed by another authorized analyst.
2. The trainee will be assessed on the applications of practical training covering technical knowledge, sample receipt/preparation, extraction, instrumental testing and reporting. A LAB-313 and LAB-314 will be completed.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Fire Debris Analysis Training Checklist (LAB-TE-TM-10).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit (LAB-304).

# 11 IMPRESSION EVIDENCE UNIT

# TE-TM-11-01 INTRODUCTION TO IMPRESSION EVIDENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the basic concepts of footwear and tire track imprint/impression evidence and comparison.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Impression evidence is generally defined as "*objects or materials that have retained the characteristics of other objects or materials through direct physical contact*." By this definition impression evidence can be left by a wide variety of objects. For the purposes of this training, impression evidence will be limited to footwear and tire impressions.

Footwear and tires are mass produced using different manufacturing processes in a variety of designs and are used extensively in the population. Through daily wear and tear, additional randomly acquired markings are created. Combine these factors and it becomes possible to associate an impression to a particular tire or footwear.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand the different types of manufacturing processes, and

B. Identify and describe the value of class characteristics, randomly acquired characteristics and wear patterns on shoe soles, tires and impressions.

## 2 Training Outline

### 2.1 Lesson Plan

A. Footwear manufacturing process
   1. Molding processes
   2. Cutting processes

B. Tire manufacturing process
   1. Shell mold
   2. Segmented mold
   3. Noise treatment
   4. Tread wear indicators

C. Tire components

D. Tire sidewall information

E. Types of tire tread design
   1. Rib and center rib tires
   2. Block design

3. All-terrain and off-road tires
4. Motorcycle tires
5. Snow tires
6. High-performance tires
7. Agriculture and construction tires
8. All-season tires
9. Spare tires
10. Self-sealing tires
11. Run flat tires or self-supporting tires
12. Implement tires
13. Bicycle tires

F. Characteristics and conclusions
1. Class characteristics
2. Randomly acquired characteristics
3. Wear characteristics

G. Databases

### 2.2 Required Reading

A. Bodziak WJ. *Footwear Impression Evidence*. CRC Press. 2000.
1. Chapter 1: Awareness, Detection, and Treatment of Footwear Impression Evidence
2. Chapter 9: Wear Characteristics, Footwear Impression Evidence
3. Chapter 10: Class and Identifying Characteristics

B. McDonald P. *Tire Imprint Evidence*. Elsevier. 1993.
1. Chapter 6: The Crime Scene
2. Chapter 9: A Tire Imprint Identification System. Tire Imprint Evidence

C. Bodziak WJ. Manufacturing processes for athletic shoe soles and their significance in the examination of footwear impression evidence. *J For Sci* 1986. 31(1), pp.153-176.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Independent Exercises

The trainee will provide written responses to the following questions:

1. Explain the footwear manufacturing process for both mold and cutting manufacturing.
2. Describe mold characteristics.
3. What is acid etching? How can it be identified?
4. What is noise treatment?
5. Describe the tread design of a rib tire.
6. Is wear considered a class or randomly acquired characteristic? Why?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-02 DETECTION AND RECOVERY OF IMPRESSION EVIDENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the techniques used to detect, recover, and preserve footwear and tire track impression evidence.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01)

## 1 Objectives

### 1.1 Theoretical

Impression evidence is left anytime two objects come into contact and there is a transfer of pattern. These impressions can be left in a variety of substrates such as dust, mud, or bodily fluid. This makes impression evidence likely at a crime scene but possibly difficult to detect. Different lighting and photographic techniques are available to help detect impressions in both dry and wet substances. It is also possible to detect some wet impressions using chemical techniques which will be addressed during chemical enhancement training.

The next step is to recover and preserve the impression for analysis and comparison. Recovery can be challenging depending on whether the impression is wet or dry, on a collectable item such as tile or on a permanent object such as a driveway, two dimensional or three dimensional. Photography is critical to all recovery and preservation efforts followed by casting and or lifting techniques.

### 1.2 Practical

Upon completion of this module, the trainee will be able to detect and recover wet, dry, two- and three-dimensional impression evidence using photography, lifting and casting techniques.

## 2 Training Outline

### 2.1 Lesson Plan

A. Introduction to detection of impressions
   1. Oblique lighting
   2. Alternate light source

B. Specific discussion and demonstration of impression recovery techniques
   1. Photography (documentation vs. examination quality photos)
   2. Techniques used for casting of impressions
   3. Electrostatic lifting
   4. Gel lifts

C. Evaluation of recovery techniques
   1. Advantages
   2. Disadvantages

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory:

1. Detection of Impression Evidence by Oblique Lighting
2. Casting of Impression Evidence
3. Recovery of Impressions Using Electrostatic Lifting
4. Gelatin Lift

B. Bodziak WJ. *Footwear Impression Evidence*, 2nd edition. CRC Press. 2000.

1. Chapter 2: Photography of Footwear Impressions.
2. Chapter 3: Casting Three-Dimensional Footwear Impressions
3. Chapter 4: Treatment of Two-Dimensional Footwear Impressions

C. Bodziak WJ. *Tire Tread and Tire Track Evidence*. CRC Press 2008. Chapter 3: Documenting and Recovering Tire Impression Evidence

D. McDonald P. *Tire Imprint Evidence*. Elsevier. 1993. Chapter 7: Recording Tire Imprints

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will document and photograph impressions (footwear/tire) in different substrates and environments in order to obtain both general and examination quality photos.

B. The trainee will recover impressions (footwear/tire) using the discussed techniques. The trainer will provide impressions that are suitable for the particular technique being used. The amount of samples for each technique will be determined by the trainer depending on the performance of the trainee.

1. Castings
2. Electrostatic lifting
3. Gel lifts

### 3.5 Independent Exercises

A. The trainee will be provided multiple impressions to document, evaluate and correctly apply the techniques discussed. At least one example for each technique should be provided by the trainer.

B. The trainee will provide a written response to the following questions:

1. What is oblique lighting and what is its purpose?
2. What is the difference between an examination quality photograph and general photograph? Give examples of each as it applies at a crime scene.
3. What general options should a camera being used for examination photos have? Please describe the proper procedure to take an examination quality photograph of an impression?
4. What does a casting of an impression capture that a photograph does not? Why is this important?
5. When is an electrostatic lifter typically used? Describe the general procedure and some of the safe guards that need to be taken while processing and during storage of the evidence?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-03 IMPRESSION TEST PRINTS

**Duration** One week

**Purpose** Familiarize the trainee with the techniques used to generate footwear and tire track test prints for comparison purposes.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01), Detection and Recovery of Impression Evidence (TE-TM-11-02)

**Note** Module can be completed concurrently with Enhancement of Impression Evidence (TE-TM-11-05), Digital Image Processing (TE-TM-11-06)

## 1 Objectives

### 1.1 Theoretical

Comparison of an evidence impression to a shoe or tire can be difficult. A visual examination cannot show how a feature or characteristic within a shoe or tire will appear in an impression. Test prints of suspected shoes or tires are made to compare to the recovered evidence impression.

### 1.2 Practical

Upon completion of this module, the trainee will be able to produce two- and three-dimensional test prints from footwear and tires

## 2 Training Outline

### 2.1 Lesson Plan

A. Discussion and demonstration of techniques used
   1. Large ink pad
   2. Silicone spray
   3. Invisible ink
   4. Petroleum jelly
   5. Bio-foam
   6. Casts

B. Labeling of test prints

C. Evaluation of the techniques
   1. Advantages
   2. Disadvantages

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Known Footwear and Tire Track Impressions.

B. Bodziak WJ. *Footwear Impression Evidence*. CRC Press. 2000. Chapter 8: Known Shoes of Suspects and the Preparation of Known Impressions.

C. McDonald P. *Tire Imprint Evidence*. Elsevier. 1993. Chapter 14: What Can Be Learned When You Do Have a Suspect's Tire.

D. Bodziak WJ. *Tire Tread and Tire Track Evidence*. CRC Press. 2008. Chapter 4: Known Exemplars of Tires for Elimination and Examination.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Performance

A. The trainer will provide the trainee with several items (shoes, boots, tires, etc.) which will be used to produce test prints. The items should have several randomly acquired characteristics that are reproducible for evaluation purposes.

B. The trainee will produce and evaluate several test prints. Observations made by the trainee should be documented for further evaluation by the trainer.

   1. Multiple techniques should be used for each item
   2. Duplicate test prints should be made for each technique used

C. The trainee and the trainer will compare the test prints created and discuss the differences observed between techniques and evaluate their advantages and disadvantages.

## 3.5 Independent Exercises

A. The trainee will be provided a tire and shoe to produce test prints.

   1. The trainee will properly document the items, including a general description (class characteristics, measurements, etc.)
   2. The trainee will produce a test print of each item. Proper documentation of reproducible randomly acquired characteristics should be documented and verified by the trainer.

B. The trainee will provide written responses to the following questions:

   1. Describe in depth the steps that should or shouldn't be taken to create an ideal tire test print and shoe test print?
   2. What needs to be considered before attempting a test print on evidentiary items?
   3. Can a comparison be made with only a test impression and questioned impressions submitted? Why or why not?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-04 FABRIC IMPRESSIONS

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the collection of test fabric impressions and comparison of known and questioned fabric impressions.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01), Detection and Recovery of Impression Evidence (TE-TM-11-02), Impression Test Prints (TE-TM-11-03)

## 1 Objectives

### 1.1 Theoretical

Fabric impressions are the transfer of the weave characteristics and/or knit pattern on a textile material through direct physical contact and are usually observed as a pattern of thin parallel lines. As with other types of impressions, the class and randomly acquired characteristics of fabric impressions may be compared and associations or identifications can be made.

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Detect and recover fabric impressions using photography, enhancement, and lifting techniques;

B. Prepare test impressions of fabric materials; and

C. Identify and compare the class characteristics and, if present, randomly acquired characteristics of fabric impressions.

## 2 Training Outline

### 2.1 Lesson Plan

A. Textile patterns
   1. Weave
   2. Knit
   3. Fancy weaves
   4. Non-woven fabrics

B. Types of impressions
   1. Two-dimensional – positive and negative impressions
   2. Three-dimensional

C. Collection and documentation of fabric impression evidence
   1. Photography
   2. Enhancement
   3. Lifting

D. Describing fabric impressions and known fabric standards
   1. Class characteristics (e.g., yarn twist, seam location, etc.)
   2. Randomly acquired characteristics (e.g., cuts, tears, unraveling, etc.)

E. Test impression methods
   1. Fingerprint ink or washable paint
   2. Inkless kit
   3. Petroleum jelly and fingerprint powder
   4. Fingerprint powder and lift tape or gel lifter

F. Comparisons, interpretation, and testimony

### 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory. Fabric Impression Evidence

B. Doller, D.W. An Unusual Case Involving the Individualization of Fabric Impressions Made by a Sock-clad Foot. *J For Ident* 2000. 50(5), pp. 447-454.

C. Drummond, F.C. and Pizzola, P.A. An Unusual Case Involving the Individualization of a Clothing Impression on a Motor Vehicle. *J For Sci* 1990. 35(3), pp. 746-752.

D. Schwartz, T. Impression Evidence Workshop PowerPoint (PDF)

E. Schubert, G. Fabric Impression Workshop PowerPoint (PDF)

F. Fisher, B.A.J. *Techniques of Crime Scene Investigation*, CRC Press, 7th ed, 2004, pp. 238-240.

G. Kadolph, S.J. *Textiles*, Pearson Education, 11th ed, 2010, pp. 263-285, 294-306, 313-334, and 340-368.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Supervised Performance

A. The trainee will demonstrate proper documentation and collection of questioned fabric impressions on various surfaces including, but not limited to, metal, glass and plastic.

B. The trainee will prepare test impressions of fabric materials, including dragging/sliding impressions, using at least two different test impression methods.

C. The trainee will compare test and questioned impressions, properly document observations, and draw conclusions (shall include one association and one elimination).

D. Additional samples may be assigned as determined by the trainer.

### 3.5 Independent Exercises

A. The trainer will provide a questioned impression(s) and a known item(s) for comparison.
   1. At the discretion of the trainer, the trainee may be provided samples that require the impression to be collected or enhanced for comparison.

2. The trainee will perform the comparison(s), prepare appropriate documentation, determine a conclusion(s), and write reporting statements, as is appropriate.

B. The trainee will provide written responses to the following questions:

1. Define and describe two types of textile patterns and provide an example of each.
2. What are three methods that a fabric impression may be transferred to a surface?
3. How is a fabric impression documented and collected?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-05 ENHANCEMENT OF IMPRESSION EVIDENCE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the chemical treatments used to enhance footwear and tire track impressions for comparison purposes.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01), Detection and Recovery of Impression Evidence (TE-TM-11-02)

**Note** Module can be completed concurrently with Impression Test Prints (TE-TM-11-03), Digital Image Processing (TE-TM-11-06)

## 1 Objectives

### 1.1 Theoretical

Some impressions may be obvious to the unaided eye, while others may be very faint or not seen at all. Detection and enhancement of these faint impressions with chemical treatments may cause them to become of sufficient quality to allow comparison to suspected footwear or tires. The chemical techniques discussed here are most often used to detect and enhance bloody impression evidence.

### 1.2 Practical

Upon completion of this module, the trainee will be able to detect and enhance faint impressions on a variety of substrates.

## 2 Training Outline

### 2.1 Lesson Plan

A. Chemical enhancement techniques
   1. Diaminobenzidine
   2. Amido black
   3. Luminol
   4. Leucocrystal violet

B. Evaluation of the techniques
   1. Advantages
   2. Disadvantages

C. Documentation and quality control

D. Effects of other testing before and after chemical treatments

### 2.2 Required Readings:

A. Trace Evidence Manual, Texas DPS Crime Laboratory:
   1. Enhancement of Impressions Using Diaminobenzidine (DAB)
   2. Sulfosalicylic Acid Fixer Solution
   3. Enhancement of Impressions by Amido Black
   4. Detection of Blood Impressions by Luminol
   5. Enhancement of Impressions by Leucocrystal Violet

B. Bodziak WJ. *Footwear Impression Evidence*. CRC Press. 2000. Chapter 5: The Enhancement of Footwear Impressions.

C. Safety Data Sheets for:

1. 5-sulfosalicylic acid
2. 3,3-Diaminobenzidine tetrahydrochloride
3. Amido black
4. glacial acetic acid
5. methanol
6. citric acid
7. luminol
8. sodium carbonate
9. sodium perborate
10. sodium acetate
11. Leucocrystal violet dye

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Performance

A. The trainer will provide the trainee with several bloody impressions on different substrates to chemically enhance. There should be enough impressions for multiple enhancements with each technique covered.

B. The trainee will demonstrate proper documentation and quality control of the following:

1. Diaminobenzidine
2. Amido black
3. Luminol
4. Leucocrystal violet

C. The trainee will enhance multiple bloody impressions provided by the trainer using each technique covered.

D. The trainee should demonstrate proper documentation before and after enhancement so an evaluation by the trainer can be completed.

### 3.5 Independent Exercises

A. The trainee will be provided a bloody impression(s) to chemically enhance.

1. The trainee will chemically enhance the impression(s).
2. The trainee should demonstrate proper selection and documentation of the enhancement technique(s) and proper enhancement of the impression(s) provided.
   a) *Proper documentation of the enhancement solution and technique(s) used should be completed by the trainee.*
   b) *Proper documentation of the bloody impression before and after enhancement should be completed by the trainee*

B. The trainee will provide written responses to the following questions:

1. What is the purpose of chemically enhancing a bloody impression and how do you decide which method to use?
2. Please describe what needs to be done before enhancing a bloody impression with the impression itself and the solutions being used?
3. Where would you get the safety information for the reagents used to make the enhancement solutions? Please provide an example copy(s) of the relevant paperwork along with a brief explanation.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-06 DIGITAL IMAGE PROCESSING

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the use of Photoshop in digital image processing.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01), Detection and Recovery of Impression Evidence (TE-TM-11-02)

**Note** Module can be completed concurrently with Impression Test Prints (TE-TM-11-03), Enhancement of Impression Evidence (TE-TM-11-05)

## 1 Objectives

Prior to beginning this unit, the trainee should already have the ability to capture and acquire images. The unit will include the introduction, use, and application of software to carry out digital image processing.

### 1.1 Theoretical

Many of the traditional darkroom techniques that were historically accepted for use in forensic science have a direct counterpart by applying digital image processing. Adobe Photoshop is used for the viewing and processing of digital images of various impressions acquired through digital photography and scanning. The goal of digital image processing is to improve the contrast of an impression against the background so that comparison to known shoes/tires can be performed more effectively. The software records the sequence of digital processing made by the forensic scientist and is essential to the integrity of the image.

The trainee will gain extensive knowledge of the equipment used for digital image processing and archiving, as well as have an extensive understanding of the available image processing tools for calibration, color evaluation, and tonal rage and contrast adjustments to apply in sequence to impressions.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Evaluate images for clarity (focus), distortion, and capture area (inclusion of scale)

B. Perform digital image processing on impression evidence using image processing software

## 2 Training Outline

### 2.1 Lesson Plan

A. Image processing software: Adobe Photoshop (current version)

1. Photoshop tools and tool bars

   a) *Approved tools vs. prohibited tools*

   b) *Special tools requiring guidelines for use (levels, area selection, dodge, and burn)*

2. Image size

   a) *Calibration: Resample shall be off - to ensure that changes to the dimensions of the image (width and height) are also made to the resolution*

   b) *Re-sizing: Resample shall be on – to ensure that changes made to the resolution are not made to the dimensions of the image*

3. Shortcuts
    - *a) Setups/settings*
    - *b) History tracking functionality*
    - *c) Camera raw viewer*
    - *d) White balance adjustments*
    - *e) Exposure adjustments: shadow and highlights adjustments (fill light)*

B. Recommended general workflow for Adobe Photoshop digital image processing

1. Copy/duplicate image
2. Calibrate
    - *a) Crop Method*
    - *b) Ruler (measure) Tool Method*
3. Rotate, if necessary (90° increments)
4. Evaluate Color
    - *a) Color mode (select single color channel)*
        - *i. RBG*
        - *ii. CMYK*
        - *iii. Lab Color*
    - *b) Adjusting individual color values*
        - *i. Black and white*
        - *ii. Hue/saturation*
        - *iii. Calculations*
        - *iv. Color Balance*
    - *c) Chromatic FFT (Pattern Removal Filter)*
    - *d) Convert to Grayscale Mode*
    - *e) Pattern Removal Filter*
    - *f) Adjust tonal range and contrast*
        - *i. Brightness/contrast*
        - *ii. Levels*
            - ***Legal ramifications***
            - ***Suggested guidelines***
        - *iii. Shadow and highlights*
        - *iv. Curves*
        - *v. Dodge/burn*
            - ***Legal ramifications***
            - ***Suggested guidelines***
        - *vi. Exposure*
        - *vii. Apply image*

5. Fine tune
    a) *Noise*
        i. *Dust and scratches*
        ii. *Reduce noise*
    b) *Sharpen*
        i. *Unsharp mask*
        ii. *Smart sharpen*
        iii. *Sharpen edges*
6. Specialized techniques
    a) *JPG artifact reduction*
    b) *Image stitching*
7. Archiving
    a) *Legal ramifications*
        i. *Do not alter original file*
            - ***Save original file***
        ii. *Save processed image*
    b) *Electronic Media*
        i. *Non-rewritable electronic media (i.e. CD-R or DVD-R)*
    c) *Foray*
8. Printing
    a) *Printer, paper, and ink selection*
        i. *Specification*
    b) *Life size representations and enlargements*
    c) *Documentation of printed photo*
        i. *Info placed on photo*
        ii. *Processed vs. original*
9. Contact sheet

## 2.2 Required Readings

A. Trace Evidence Manual, Texas DPS Crime Laboratory: Digital Imaging and Processing of Impression Evidence.

B. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 5: Guidelines for Image Processing, Version 2.1 2010.01.15. https://www.swgit.org/.

C. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 9: General Guidelines for Photographing Footwear and Tire Impressions, Version 1.0 2013.09.27. https://www.swgit.org/.

D. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 11: Best Practices for Documenting Image Enhancement, Version 1.3 2010.01.15. https://www.swgit.org/.

E. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 16: Best Practices for Forensic Photographic Comparison, Version 1.1 2013.01.11. https://www.swgit.org/.

F. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 17: Digital Imaging Technology Issues for the Courts, Version 2.2 2012.01.13. https://www.swgit.org/.

G. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 18: Best Practices for Automated Image Processing, Version 1.0 2010.01.15. https://www.swgit.org/.

H. Scientific Working Group Imaging Technology. Guidelines for the Forensic Imaging Practitioner, Section 19: Issues Relating to Digital Image Compression and File Formats, Version 1.1 2011.01.15. https://www.swgit.org/.

I. Digital Processing of Footwear Impressions and Trace Evidence. David Witzke, Foray Technologies.

J. Mitigating Artifacts of JPG Compression in Digital Images. Foray Technologies. April 21, 2013

K. Digital Image Integrity. Adobe Systems Incorporated. 2004

L. Grady, D. Using Adobe Photoshop's Channel Mixer as an Evidence Enhancement Tool. *Journal of Forensic Identification*. 51(4), 2001.

M. Osborn, S., Wilson, K. Digital Enhancement of Latent Prints using Adobe Photoshop Black and White Adjustments. *Journal of Forensic Identification*. 59(4), 2009.

N. Smith, J. Computer Forensic Enhancement: The Joy of Lab Color. *Journal of Forensic Identification*. 62(5), 2012.

O. Witzske, D. RAW Benefits in Forensic Science. *Evidence Technology Magazine*. May-June 2014.

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Performance

The trainee will process at least five images with different backgrounds. Once completed, the trainee will provide the trainer with the original photo, processed photo, and history.

### 3.5 Independent Exercises

A. The trainee will process three images with different backgrounds. Once completed, the trainee will provide the trainer with the original photo, processed photo, and history.

B. The trainee will provide written responses to the following questions:

1. What are three tools that should not be used in Photoshop to process an image?
2. What is DPI and PPI? What does each one refer to?
3. What are the main differences between RAW and JPG formats?
4. Explain the steps to calibrate an image.
5. What information needs to be present on a printed photograph?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-11-07 COMPARISON OF IMPRESSION EVIDENCE

**Duration** Two to three weeks

**Purpose** Familiarize the trainee with the process, conclusions and significance of impression evidence comparison.

**Prerequisite** Introduction to Impression Evidence (TE-TM-11-01) *through* Digital Image Processing (TE-TM-11-06)

## 1 Objectives

### 1.1 Theoretical

Even though footwear and tires are mass-produced, there are a finite number of shoes and tires that share the class characteristics of a specified size and design. Each of these items becomes exposed to damage that cannot be exactly reproduced from one item to the other. This damage, known as randomly acquired characteristics, can be used to identify a particular shoe print or tire track as being made from one shoe (or tire).

### 1.2 Practical

Upon completion of this module, the trainee will be able to

A. Identify and compare the class characteristics, randomly acquired characteristics and wear patterns on shoe soles, tires and question impressions;

B. Understand how to report conclusions and opinions;

C. Understand how to perform technical and administrative reviews; and

D. Be able to provide expert testimony that appropriately conveys the significance of impression evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Comparison methodology
   1. Documentation of questioned and known
   2. Test prints of known exemplars
   3. Side by side method and overlay method
   4. Conformation of randomly acquired characteristics to known item
   5. Randomly acquired characteristics verified by second examiner

B. Comparison process
   1. Criteria used to make a class association will be discussed and demonstrated
   2. Criteria used to make an identification will be discussed and demonstrated
   3. Criteria used to make an elimination or exclusion will be discussed and demonstrated

C. Conclusions and disclaimers or limitations

D. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

E. Discuss court testimony

### 2.2 Required Readings

A. Trace Evidence Standard Operating Procedures, Texas DPS Crime Laboratory: Comparison of Impression Evidence

B. Bodziak WJ. *Footwear Impression Evidence,* 2nd edition. CRC Press. 2000.

1. Chapter 11: Comparison of the Questioned Impression with Known Shoes
2. Chapter 12: The Footwear Impression Examiner in Court

C. Bodziak WJ. *Tire Tread and Tire Track Evidence*. CRC Press. 2008.

1. Chapter 8: Tire Wear
2. Chapter 9: Individual Characteristics
3. Chapter 10: Examination Methodology and Procedure for Comparison of Tire Impressions
4. Chapter 12: Resources and Databases

D. McDonald P. *Tire Imprint Evidence*. CRC Press 1993.

1. Chapter 9: A Tire Imprint Identification System
2. Chapter 18: Preparation for Trial

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced impression examiner.

### 3.5 Supervised Performance

A. The trainer will provide a questioned impression(s) and a known item(s) (shoe/tire) for comparison; conclusions will include:

1. Class association
2. Identification
3. Elimination

B. The trainee will demonstrate proper documentation of the comparison along with appropriate conclusion statements for the samples provided.

1. The trainer will evaluate the documentation and conclusion statements and discuss recommendations and/or corrections if required.
2. Additional samples may be assigned as determined by the trainer after the evaluation

C. Trainee will review reports written by experienced examiners

D. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.

2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

A. The trainee will be provided with a questioned impression(s) and a known item(s) (shoe/tire) for comparison. At the discretion of the trainer, the trainee may be provided samples that require the impression to be collected or enhanced for comparison.

1. The trainee will complete a comparison(s) with the items provided and the conclusion(s) will be determined.

2. The trainee's documentation and report shall support the comparison and conclusion.

B. The trainee will provided written responses to the following questions:

1. Explain what a class association is and provide an example? Discuss the significance of a class association.

2. Explain what a positive identification is and provide an example? Discuss the significance of a positive identification.

3. What is distortion as it applies to impressions? Give some possible causes.

4. Please discuss how the time line between incident and recovery of a known item can affect an impression comparison or conclusion? Give an example of a conclusion statement where a class association is present but a difference in wear is observed. The known item was worn/ used for several months after the incident in question.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Impression Evidence Unit Training Checklist (LAB-TE-TM-11).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 12 PRESSURE SENSITIVE TAPE UNIT

# TE-TM-12-01 INTRODUCTION TO PRESSURE SENSITIVE ADHESIVE TAPE

**Duration** One to two weeks

**Purpose** Familiarize the trainee with the examination and comparison of adhesive tape products.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02), Paint Unit (07), and Fiber Unit (08)

## 1 Objectives

### 1.1 Theoretical

The trainee must have general knowledge about the forensic examination of pressure sensitive adhesive tape evidence. This module will introduce the trainee to the type of tape encountered in case work and the tests used to compare pressure sensitive adhesive tape samples in a forensic laboratory.

### 1.2 Practical

Upon completion of this module, the trainee will be able to discuss the forensic examination and comparison of pressure sensitive adhesive tape evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Classification of different types of tapes
   1. Duct tape
   2. Electrical tape
   3. Filament tape
   4. Packaging tape
   5. Masking/paper/acetate tapes

B. Manufacturing process

### 2.2 Required Readings

A. Snodgrass H. “Duct Tape Analysis As Trace Evidence.” Proceedings of the International Symposium on the Forensic Aspects of Trace Evidence, Federal Bureau of Investigation. 1991, pp. 69-73.

B. Smith J. The Forensic Value of Duct Tape Comparisons. *Midwestern Association of Forensic Scientists Newsletter*. January 1998. 27(1), pp. 28-33.

## 3 Practice

### 3.1 Safety

None

### 3.2 Standards, Controls, Reagent Preparation

None

### 3.3 Equipment

None

### 3.4 Independent Exercises

The trainee will provide written responses to the following question: Describe the different types of tape and how likely they are to be encountered in case work.

## 4 Assessment

### 4.1 Competency and Qualifying Examination

None

### 4.2 Evaluation of Training

A. The trainee and trainer will complete the Pressure Sensitive Tape Unit Training Checklist (LAB-TE-TM-12).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-12-02 EXAMINATION OF PRESSURE SENSITIVE ADHESIVE TAPE

**Duration** Two to three weeks

**Purpose** Familiarize the trainee with the examination and comparison of adhesive tape products.

**Prerequisite** Introduction to Pressure Sensitive Adhesive Tape (TE-TM-12-01)

## 1 Objectives

### 1.1 Theoretical

The first step in pressure sensitive adhesive tape analysis is to determine if a physical match exists between the known and questioned tape sources. A physical match between a known and questioned tape source excludes the need for additional testing. If no physical match is present, then the physical characteristics of the backing, scrim fabric (if present), and adhesive are used to compare questioned tape to known tape. A meaningful difference in the physical properties of the questioned and known tape samples would eliminate the need for any further analysis.

Instrumental/microscopic analysis of the backing, scrim fabric, and adhesive may be performed by Infrared Spectroscopy and/or Pyrolysis Gas Chromatography. Comparison and interpretation of microscopic characteristics, spectra, and pyrograms can help determine differences that may be present in questioned and known samples.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Discuss the forensic examination and comparison of pressure sensitive adhesive tape evidence and the significance of tape as associative evidence, and

B. Examine and compare pressure sensitive adhesive tapes and form an opinion as to possible common origin.

## 2 Training Outline

### 2.1 Lesson Plan

A. Trace evidence recovery from tape

B. Physical characteristics

1. Width of tape
2. Color of backing
3. Presence and shape of any calendering
4. Overall thickness and thickness of the backing
5. Fabric weave
6. Number of threads per inch in the warp and fill directions
7. Color of the adhesive
8. Polymer orientation

C. Microscopic analysis

1. Examination of adhesive and backing

2. Cross sections of tape
3. Fiber Analysis

D. Chemical and polymer analysis
1. Fiber analysis
2. Backing analysis
3. Adhesive analysis

E. Instrumental analysis
1. Fourier Transfer Infrared Spectroscopy (FTIR)
2. X-Ray Diffractometer (XRD)
3. X-Ray Fluorescence (XRF)
4. Pyrolysis Gas Chromatography (PGC) or Pyrolysis Gas Chromatography Mass Spectrometry (PGCMS)

**2.2 Required Readings**

A. Trace Evidence Manual, Texas DPS Crime Laboratory:
1. Comparison of Pressure Sensitive Tape.
2. Fiber Initial Examination and Overview
3. Fluorescence Microscopy
4. Physical Comparison
5. Fracture Physical Match Comparison
6. Microscopic Examination of Fibers
7. Cross-Sectioning of Fibers
8. Fourier Transform Infrared Spectroscopy (FTIR)
9. Pyrolysis Gas Chromatography Mass Spectrometry (PGCMS)

B. Benson JD. “Forensic Examination of Duct Tape.” Proceedings of the International Symposium on the Analysis and Identification of Polymers, Federal Bureau of Investigation. 1984, pp. 145-146.

C. Williams M. The Comparison of Black Polyvinylchloride (PVC) Tapes by Pyrolysis Gas Chromatography. *J For Sci*. 33(5), pp. 1163-1170.

D. Keto R. Forensic Characterization of Black Polyvinylchloride Electrical Tape. *Crime Lab Digest*. October 1988.11(4), pp. 71-74.

E. Goodpaster JV, Sturdevant AB, Andrews KL, and Brun-Conti L. Identification and Comparison of Electrical Tapes Using Instrumental and Statistical Techniques: I. Microscopic Surface Texture and Elemental Composition. *J For Sci*. 52(3), pp. 610-629.

F. Hobbs A, Gauntt J, Keagy R, Lowe P. and Ward D. A New Approach for the Analysis of Duct Tape Backings. *For Sci Comm.* January 2007. 9.

G. Bradley MJ. “Forensic Analysis of Pressure-Sensitive Tapes” presented at the Pressure Sensitive Tape Council Technical Meeting, Orlando Florida. 2001

H. Safety Data Sheets for:
   1. Hexane
   2. Xylene
   3. Permount
   4. Other relevant chemicals

# 3 Practice

## 3.1 Safety

Refer to relevant SOP(s)

## 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

## 3.3 Equipment

Refer to relevant SOP(s)

## 3.4 Supervised Casework

The trainer will provide the trainee with several types and brands of adhesive tape in order to document physical characteristics and obtain infrared spectra and pyrograms of tape components. The types of tape should include multiple samples of each of the following types of tape:

- duct tape
- electrical tape
- filament tape
- packaging tape
- masking/paper/acetate tapes

## 3.5 Independent Exercises

A. The trainer will provide the trainee with tape samples to
   1. Compare and document physical and microscopic characteristics, and
   2. Obtain and compare infrared spectra and pyrograms.

B. The trainee will prepare a written report on the results of the practical examination.

C. The trainee will provide written responses to the following questions:
   1. Why are physical and microscopic comparisons so important in tape examinations?
   2. What instrumental analysis can be used in tape comparison?
   3. Describe the layers found in duct tape and how they can be used to differentiate samples.

# 4 Assessment

## 4.1 Competency and Qualifying Examination

None

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Pressure Sensitive Tape Unit Training Checklist (LAB-TE-TM-12).

B. The trainee will evaluate the module content and the trainer(s) at the completion of the unit.

# TE-TM-12-03 INTERPRETATION OF PRESSURE SENSITIVE ADHESIVE TAPE EVIDENCE

**Duration** One week

**Purpose** Familiarize the trainee with the significance of pressure sensitive adhesive tape evidence examinations.

**Prerequisite** Introduction to Pressure Sensitive Adhesive Tape (TE-TM-12-01), Examination of Pressure Sensitive Adhesive Tape (TE-TM-12-02)

## 1 Objectives

### 1.1 Theoretical

Pressure sensitive adhesive tapes are encountered in a variety of different cases. Its ultimate evidentiary value is dependent on factors and circumstances surrounding the case and the commonness of the particular type of pressure sensitive adhesive tape. The forensic scientist must be able to provide expert testimony concerning the significance of an association based upon pressure sensitive adhesive tape evidence.

### 1.2 Practical

Upon completion of this module, the trainee will be able to:

A. Understand the factors affecting the significance of pressure sensitive adhesive tape evidence,

B. Report conclusions and opinions,

C. Perform technical and administrative reviews, and

D. Provide expert testimony that appropriately conveys the significance of pressure sensitive adhesive tape evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Discuss the interpretation, significance, and limitations of pressure sensitive adhesive tape comparisons and associations.

B. Discuss report wording

C. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

D. Discuss court testimony

### 2.2 Required Readings

A. Smith J. The Forensic Value of Duct Tape Comparisons. *Midwestern Association of Forensic Scientists Newsletter*. January 1998. 27(1), pp. 28-33.

B. Maynard P, and et al. Adhesive Tape Analysis: Establishing the Evidential Value of Specific Techniques. *J For Sci*. 46(2), pp. 280-287.

C. Courtney M. Evidential examinations of duct tape. *J Southwest Assoc For Sci*. 1994.16(1), pp.10–16.

D. Maureen J, and et al. A Validation Study for Duct Tape End Matches. *J For Sci*. 51(3), pp. 504-508.

# 3 Practice

## 3.1 Safety

None

## 3.2 Standards, Controls, Reagent Preparation

None

## 3.3 Equipment

None

## 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced tape examiner.

## 3.5 Supervised Performance

A. The trainee will explain the significance of the results of a mock pressure sensitive adhesive tape case.

B. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

C. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

## 3.6 Independent Exercises

The trainee will provide a written response to the following questions:

1. Discuss the factors that affect the significance of pressure sensitive adhesive tape examinations.
2. Explain why a physical match is more probative than other conclusions.
3. What other types of evidence can be encountered on pressure sensitive adhesive tape?
4. What conclusions can be drawn after a tape comparison?

# 4 Assessment

## 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

## 4.2 Evaluation of Training

C. The trainee and trainer will complete the Pressure Sensitive Tape Unit Training Checklist (LAB-TE-TM-12).

D. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 13 UNKNOWN SUBSTANCES UNIT

# TE-TM-13-01 UNKNOWN SUBSTANCES EXAMINATION

**Duration** Four to six weeks

**Purpose** Develop within the trainee the ability to apply a systematic approach to the analysis and identification or characterization of unknown materials.

**Prerequisite** Introductory Unit (01), Evidence Collection and Preservation Unit (02)

## 1 Objectives

### 1.1 Theoretical

Trace evidence analysts will be required at times to analyze materials that do not fit into one of the sub-disciplines within the Trace Evidence SOP. Forensic analysis of unknown substances requires a systematic approach, utilizing all the tools at the disposal of the forensic scientist. The tools available include wet chemical methods, polarized light microscopy, microchemical methods, and instrumental methods.

### 1.2 Practical

Following the completion of this module, the trainee will:

A. Be able to apply the principles of chemical microscopy to the analysis of unknown materials,

B. Understand and use a systematic approach to the analysis of unknown materials,

C. Understand the capabilities and limitations of the various instruments used,

D. Be able to identify, or characterize for comparison to knowns, solid and liquid unknown materials,

E. Understand how to report conclusions and opinions,

F. Understand how to perform technical and administrative reviews, and

G. Be able to provide expert testimony that appropriately conveys the significance of hair evidence.

## 2 Training Outline

### 2.1 Lesson Plan

A. Review of microscopy (Kohler illumination, refractive index, retardation, birefringence, crystal optics)

B. Analysis of solids

1. Stereomicroscopic exam
2. Chemical microscopy
3. Instrumental analysis

C. Analysis of liquids

1. Aqueous liquids
2. Organic liquids

D. Particle manipulation techniques

E. Types of unknown substance cases
   1. General unknowns, solids and liquids
   2. Pre- and post-blast low explosives
   3. Product tampering
   4. Residues on clothing, including but not limited to lubricants, lachrymators, and chemical dye packs

F. Discuss report writing

G. Discuss technical and administrative reviews, pertinent documentation, and necessary components of a completed case folder

H. Discuss court testimony

## 2.2 Required Readings

A. McCrone W, McCrone L, and Delly J. *Polarized Light Microscopy*. McCrone Research Institute. 1984.

B. McCrone W. Particle Characterization by PLM Part I: No Polars. *The Microscope*. 1982. 30(3), pp. 185-196.

C. McCrone W. Particle Characterization by PLM Part II: Single Polar. *The Microscope*. 1982. 30(4), pp. 315-331.

D. McCrone W. Particle Characterization by PLM Part III: Crossed Polars. *The Microscope*. 1983. 31(2), pp. 127-206.

E. Palenik S. Microscopy and Microchemistry of Physical Evidence. Saferstein R, ed. *Forensic Science Handbook*, Vol II. pp. 161-208.

F. Blackledge RD, and Cabiness LR. Examination for Petrolatum Based Lubricants in Evidence from Rapes and Sodomies. 1983. *J For Sci*. 28(2), pp. 451-462.

G. Martz, Reutter, and Lasswell. A Comparison of Ionization Techniques for Gas Chromatography/Mass Spectroscopy Analysis of Dye and Lachrymator Residues from Exploding Bank Security Devices. *J For Sci*. 1983. 28(1), pp. 200-207.

H. Haas, Whipple, Grant, and Andresen. Chemical and Elemental Composition Comparison of Two Formulations of Oleoresin Capsicum. *Science and Justice*. 1997. 37(1), pp.15-24.

I. Mongan AL, and Buel E. Identification of Dog Repellant in the Clothes of an Assault Suspect Using Gas Chromatography/Mass Spectrometry. *J For Sci*. 1995. 40(3), pp. 513-514.

J. Lewis K, and Lewis RJ. An Assessment of Four Solvents for the Recovery of 2-chlorobenzylidenemalononitrile and Capsaicins from “CS” and “Pepper” Type Lachrymator Sprays, and an Examination of Their Persistence on Cotton Fabric. *J For Sci*. 2001. 46(2), pp. 352-355.

K. Nowicki J. Analysis of Chemical Protection Sprays by Gas Chromatography/Mass Spectroscopy. *J For Sci*. 1982. 27(3), pp. 704-709.

L. Smith S. “Increased Discrimination in the Analysis of Oleoresin Capsicum (OC) Defense Sprays.” Proceedings of the International Symposium on the Forensic Examination of Trace Evidence in Transition. 1996. San Antonio, TX.

M. Fung T, Jeffery W, and Beveridge AD. The Identification of Capsaicinoids in Tear-Gas Spray. *J For Sci*. 1982. 27(4), pp. 812-821.

N. Reilly CA, Crouch DJ, and Yost GS. Quantitative Analysis of Capsaicinoids in Fresh Peppers, Oleoresin Capsicum, and Pepper Spray Products. *J For Sci*. 2001. 46(3), pp. 502-509.

O. Egan JM, Rickenbach M, Mooney KE, Palenik CS, Golombeck R, and Mueller KT. Bank Security Dye Packs: Synthesis, Isolation, and Characterization of Chlorinated Products of Bleached 1-(methylamino)anthraquinone. *J For Sci*. 2006. 51(6), pp. 1276-1283.

### 2.3 Suggested Readings

A. Bloss FD. *An Introduction to the Methods of Optical Crystallography*. Saunders College Publishing, 1990.

B. Chamot EM, and Mason CW. *Handbook of Chemical Microscopy Vol I.* John Wiley & Sons, 1944.

C. Chamot EM, and Mason CW. *Handbook of Chemical Microscopy Vol II.* McCrone Research Institute, 1989.

D. Delly JG. Microchemical Tests for Selected Cations. *The Microscope*. 1989. 37, pp. 139-166.

E. McCrone W, Draftz R, and Delly J. *The Particle Atlas*. Ann Arbor Science Publishers Inc, Ann Arbor, MI, 1967.

F. McCrone W, and Delly J. *The Particle Atlas,* Edition Two. Ann Arbor Science Publishers Inc, Ann Arbor, MI, 1973.

G. Feigl F, and Anger V. *Spot Tests in Inorganic Analysis*, 6th edition. Elsevier Publishing Co, New York, 1972.

H. Feigl F. *Spot Tests in Organic Analysis*, 7th edition. Elsevier Publishing Co, New York, 1966.

I. Teetsov A. Unique Preparation Techniques for Nanogram Samples. Humecki, ed. *Practical Guide to Infrared Microspectroscopy*. Marcel Dekker, Inc, 1995.

## 3 Practice

### 3.1 Safety

Refer to relevant SOP(s)

### 3.2 Standards, Controls, Reagent Preparation

Refer to relevant SOP(s)

### 3.3 Equipment

Refer to relevant SOP(s)

### 3.4 Observed Performance

When possible, the trainee should observe actual testimony by an experienced unknown substance examiner.

### 3.5 Supervised Performance

A. The trainee will be provided with solid samples to analyze using the various techniques in unknown substance analysis.

B. The trainee will be provided with liquid samples to analyze using the various techniques in unknown substance analysis.

C. The trainee will be provided with samples to practice identifying contaminants in household items and food products.

D. The trainee will be provided with samples to identify residues on clothing, to include OC spray, lubricants, and MAAQ.

E. Report writing

1. The trainee will review reports written by experienced examiners.
2. The trainee will be provided with various case scenarios and/or mock evidence results and the trainee will prepare mock reports based on those results.

F. Technical and administrative reviews

1. The trainee will be provided with case records that have previously been reviewed by a qualified examiner. The trainee will familiarize themselves with performing technical and administrative reviews. The number of case records provided will be determined by the trainer.
2. The trainee will be provided with non-reviewed case records and allowed to complete a practice technical review before they are given to a qualified reviewer. The results of the trainee's reviews will be evaluated by the trainer. The number of completed case records reviewed will be determined by the trainer.

### 3.6 Independent Exercises

A. The trainee will be given unknown substances to analyze and identify using the techniques demonstrated above.

B. The trainee will provide written answers to the following questions:

1. Name and describe the characteristics of the six crystal systems. Which are isotropic? Uniaxial? Biaxial?
2. Describe a method to separate a mixture of unknown crystalline substances.
3. Describe an analytical scheme to identify an unknown liquid.
4. Can an unknown substance be identified by using a mass spectra library match? Why or why not?
5. An unknown substance was analyzed on a GC/MS and resulted in a blank chromatogram, without any peaks. Why?

## 4 Assessment

### 4.1 Competency and Qualifying Examination

The type of questions and samples assigned should be representative of those encountered in routine casework.

A. The trainee will complete at least two competency exams which cover the scope of work in which the trainee is seeking authorization. The competency exams may be mock casework, case reexaminations, or old proficiency tests.

B. The trainee will complete a comprehensive written exam.

C. The trainee will complete a mock trial.

## 4.2 Evaluation of Training

A. The trainee and trainer will complete the Unknown Substances Unit Training Checklist (LAB-TE-TM-13).

B. The trainee will evaluate the module content and the trainer at the completion of the unit (LAB-304).

# 14 FORMS

## TRAINING FORMS

| | Document Name | FRN |
|---|---|---|
| 1 | Introductory Unit Training Checklist | LAB-TE-TM-01 |
| 2 | Evidence Collection and Preservation Unit Checklist | LAB-TE-TM-02 |
| 3 | Physical Comparison Unit Checklist | LAB-TE-TM-03 |
| 4 | Glass Unit Checklist | LAB-TE-TM-04 |
| 5 | Lamp Filament Unit Checklist | LAB-TE-TM-05 |
| 6 | Hair Unit Checklist | LAB-TE-TM-06 |
| 7 | Paint Unit Checklist | LAB-TE-TM-07 |
| 8 | Fiber Unit Checklist | LAB-TE-TM-08 |
| 9 | Gunshot Primer Residue Unit Checklist | LAB-TE-TM-09 |
| 10 | Fire Debris Unit Checklist | LAB-TE-TM-10 |
| 11 | Impression Evidence Unit Checklist | LAB-TE-TM-11 |
| 12 | Pressure Sensitive Tape Unit Checklist | LAB-TE-TM-12 |
| 13 | Unknown Substances Unit Checklist | LAB-TE-TM-13 |

# APPENDICES

## APPENDIX 01 GSR STUBBING GUIDELINES

These are minimum requirements. More stubs may be collected at the analyst's discretion or as the case dictates. Analyst should consider collecting additional stubs if garment can easily be worn inside out (i.e. undershirt)

### 1 Long- sleeve shirts

A. Right sleeve

B. Left sleeve

C. Front

D. Back

E. Inside shirttail

F. Each pocket (separate stub for each)

### 2 Short-sleeve shirts

A. Front

B. Back

C. Inside shirttail

D. Each pocket (separate stub for each)

### 3 Pant and shorts

A. Front (down to knees)

B. Back (down to knees)

C. Inside waistband

D. Each pocket (separate stub for each except coin pocket, this can be stubbed with corresponding pocket)

E. Belt can be stubbed with front and back if it is through the belt loops

### 4 Jackets and hoodies

A. Right sleeve

B. Left sleeve

C. Front

D. Back

E. Hood (this can be stubbed with back or separated out)

F. Each pocket (separate stub for each)

# Appendix 02 FIRE DEBRIS GLOSSARY

## 1 Scope

A glossary of terms as they are applied to the series of documents within the Trace Manual that pertain to Fire Debris analysis.

## 2 Terms

**Analysis Worksheet**: A form used to record the description of the evidence and the procedures employed in the preparation of the evidence for analysis. The bottom of the page has space for the analyst to describe the analysis and interpretation of data. Multiple forms may be used within a case when there are multiple items of evidence, multiple tests performed, or copious notes regarding data interpretation.

**Blank** – Sample of quality tested solvent run before each evidence sample run to verify that no cross-contamination has occurred between each run

**Chain of Custody –** the record of every transfer of evidence to a person, evidence vault or other laboratory location to include (at the minimum) the date and initials or name of person making the transfer. For a complete record, the time of transfer may also be included.

**Chemical Extraction** – A planned and systematic removal of analyte(s) of interest from material in order to concentrate and separate the analyte(s) from as many background interferences as possible. Extraction promotes representative sampling. Extraction seeks to place the analyte of interest into a form which may be more easily analyzed. For some analyte(s) multiple extraction methods may be required. Extraction may be, but is not limited to:

- Vapors from the vapor space above solid materials
- Vapors from the vapor space above liquids
- Vapors from the vapor space above mixed solid and liquid materials

**Comparison sample**: Materials collected by an investigator at a crime scene with the reasonable expectation that its identity is as purported (examples include: liquid from a can labeled “charcoal starter fluid” collected from a storage shelf in a home that had a fire, liquid from a bottle labeled “lamp oil” from a business storeroom that sells hurricane lamps, etc…).

**Evidence tape** – A specialized tape that is used to seal the opening(s) of evidence containers. This tape will be made of thin plastic or paper and is either serrated edged or scored so that the tape cannot be removed from the container without indication that the seal has been breached (cut, torn, shredded). The tape may be colored and imprinted with the word “Evidence” or other imprints identifying its source.

**Extracted Ion Chromatogram (EIC)** – The display of a selected ion or set of combined ions accumulated in a mass spectrometer and displayed in a graphical manner with time from injection as the x- axis and the abundance of the ion(s) as the y-axis. A chromatogram that is re-assembled from the total data collected in a TIC to show only a specific ion fragment or summed combination of ion fragments. Essential component of “Ion Profiling” performed in fire debris analysis. (Sometimes referred to as a “Reconstructed Ion Chromatogram”)

**Extraction** – The act of removing an item or information of interest. The technique of selectively removing an item or information of interest from a larger, non-representative sample in order to increase the probability of obtaining an analyzable sample.

**Full Scale Chromatogram (FSC)** – a single page graph in landscape format showing a chromatogram with the “X” axis covering “0” minutes through the end of data collection for the

sample being analyzed and with the "Y" axis as 100% relative scale. A Full Scale Chromatogram may be a Total Ion Chromatogram (TIC) or Reconstructed Ion Chromatogram.

**Gas Chromatography (GC)** – A chemical separation method whereby a complex mixture of organic compounds may be separated into individual and similar components by passing the complex mixture, which is carried by a mobile phase of inert gas, over a stationary phase. This phase interacts with the components in the mixture so that they will pass through the stationary phase at different rates of speed.

**Gas Chromatography/Mass Spectrometry (GC/MS)** – Coupling a mass spectrometer as a detector on a gas chromatograph to allow a separation of mixed organic materials while collecting the mass spectra of the separated components. Through the use of algorithms, ion profiles of ignitable liquids can be produced and used as diagnostics in determining the presence and identity of ignitable liquids.

**Holding time** – time elapsed from the date of evidence item preparation until the start of analysis.

**Mass Spectroscopy (MS)** – A spectroscopic analytical technique based on causing the controlled fragmentation of organic chemical compounds into characteristic fragments. All organic molecules will fragment predictably based on their structure. This allows the identification of specific compounds by examination of mass spectra. Additionally, experience with mass spectroscopy has shown that certain organic classes of compounds contain fragments of a characteristic mass (amu). For example, alkane compounds typically will have fragments with a mass to charge ratio (m/z) of 57, 71, 85, and 99 amu. Whereas, aromatic compounds often have fragments with m/z of 91, 105, 119, and 134 amu.

**Matrix comparison sample**: Matrix materials collected by an investigator at a crime scene with the reasonable expectation that it is free of any ignitable liquid or explosive residue. The item is collected to determine if there are compounds inherent to the matrix that are of the same composition and abundance as found on the unknown (examples include: carpet from unburned bedroom #3 that is the same type of carpet as is in bedroom #1 where the fire occurred). Matrix comparison samples may also be deliberately burned in order to determine the type and quantity of chemicals produced from the thermolysis of the material. Note that this type of comparison sample is NOT needed at this laboratory and is actually discouraged.

**Matrix reference samples**: Physical materials and manufactured artifacts which are purchased or donated by a lumber, home improvement, or retail store for the purpose of determining any interference compounds or inherent ignitable liquids that may be extracted from the item. Matrix reference samples may also be deliberately burned in order to determine the type and quantity of chemicals produced from the thermolysis of the material.

**Passive Headspace Concentration** – ASTM E1412 (current edition) "Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration With Activated Charcoal" – A technique for extracting ignitable liquids and other volatile organic compounds from fire debris that is sensitive, relatively non-invasive of the evidence sample, and representative of a full range of the components of an ignitable liquid. Some variations on parameters described in the ASTM practice may be permitted but shall be explained.

**Primary chemical standard**: pure chemical compounds, or standardized chemical mixtures from chemical supply vendors (Fisher, ACROS, etc…), or reference standards vendors (AccuStandard, NIST, Cerilliant, etc…) with known origins. This also includes reference ignitable liquids purchased from the National Center for Forensic Science, Ignitable Liquids Reference Collection or directly from manufacturers, refineries, formulators, or distributors of ignitable liquids.

**Reference Sample** – Known samples of uncontaminated, quality tested ignitable liquids maintained in the laboratory that are used to provide representative chromatographs for comparison/matching to evidence samples. Also referred to as Reference Standards or Ignitable Liquid References. Used as comparison (chromatograms) in cases with positive, identifiable results

**Reference Standards** –Liquid samples (i.e. ASTM Test Mix) prepared by the laboratory with known peak outcomes used to quality check GC/MS sensitivity and functionality. Its introduction serves as a marker that the extraction process worked for samples with no appreciable concentration of extracted organics and as a measure of the consistency of chromatographic separation from one sample to another by the regularity of the retention time.

**Representative Sample** – a sample that is typical of the whole product. This is only possible if the sample is homogenous. Not all samples are homogenous. In that event, an extraction (vapor or liquid) may be used to obtain a homogenous sample from which a representative sample may be taken for analysis; type of sample selection

**Sampling** – Selection of a sample for testing, according to a procedure. Taking a part of a substance, material, or product for analysis as a representative sample of the whole. Two key factors are (1) the report shall state conclusions about "the whole" based on testing only a portion, and (2) from the start, there shall be a reasonable assumption of homogeneity (or made so by the analyst) of the whole.

**Sample Selection** – A practice of selecting a sample(s) from the whole based upon training, experience, and competence. There is no assumption of homogeneity of the whole. Testing is carried out on the selected sample(s) and the report is clear that the results are based only on the portion(s) analyzed.

**Scraping** – Removal of a portion of solid material from a surface and in some instances from the break in an item's surface so that the interior of the item is exposed. This results in samples that are in the form of powder, crystals, or slivers that may be directly analyzed for the analyte of interest.

**Secondary chemical standard**: chemicals or ignitable liquids purchased from local vendors (examples include charcoal lighter fluid from Home Depot, automotive engine cleaners from automobile supply stores, or liquid candles from a boutique).

**Shelf Life:** The amount of time that a product or chemical can be expected to remain stable and efficacious at normal room temperature and humidity before it deteriorates or destabilizes. While the shelf life or stability of many compounds can be found in various sources of literature, the preferred resource for the FAL is the United States National Library of Medicine Website, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. Chemicals can be searched by name and under a sub-search of its "Chemical Safety & Handling", Stability/Shelf Life. Note that not all chemicals and materials found in the FAL have a shelf life. Those that do can be found in the aforementioned resource.

**Swabbing** – Utilizing a clean piece of absorbent material to rub against the surface of an object suspected of containing deposits of the analyte of interest. A swabbing may be directly tested by some analytical techniques, but is typically subjected to extraction.

**Total Ion Chromatogram (TIC)** – The display of all ions within a broad designated range of atomic masses which are accumulated in a mass spectrometer and displayed in a graphical manner, with time from injection (retention time) as the x- axis and the abundance of the ion as the y-axis. The initial graphical display, from a gas chromatograph /mass selective detector-mass spectrometer, that shows all ions within the same range.

**Turnaround Time** – time (measured in days) from receipt of the evidence into the laboratory and the completion of the analysis by the assigned analyst (defined by the issuing of final analysis report)

**Vapor Space** – Within a closed system, the space or volume of the container above the material that may be off-gassing vapors.

# Appendix 03 RECOMMENDED READINGS FOR FIRE DEBRIS ANALYSIS

## 1 Scope

A list of recommended reading materials for the trainee/analyst. It should be noted, some of the referenced periodicals, articles, and texts may already appear in the training modules. These readings are not required to complete training unless noted in a training module or specifically assigned by the trainer. Additional completed readings can be noted on the Training Record form (LAB-303).

## 2 Readings

1. Armstrong, A. et al The Evaluation of the Extent of Transporting or Tracking an Identifiable Ignitable Liquid (Gasoline) Throughout Fire Scenes During the Investigative Process. *Journal of Forensic Sciences*. Vol. 49, No. 4, 2004, pp. 741-748.
2. ASTM 1386-00(2005) “Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction.”
3. ASTM E 1388-05 “Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples.”
4. ASTM E 1412-07 “Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Activated Charcoal.”
5. ASTM E1618-06e1 “Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry”.
6. Babitsky, S. & Mangraviti, J. *How to Excel During Cross-Examination*. S.E.A.K Inc., Falmount, Massachusetts, 1998, Chapter 1, 4, & 5.
7. Betsch, W. and Holzer, G. Analysis of Accelerants in Fire Debris by Gas Chromatography/Mass Spectrometry. *Forensic Applications of Mass Spectrometry*, Yinon, J. ed., CRC Press, 1995, pp. 129-169.
8. Davis, R. & Frearson, M., *Mass Spectrometry*, John Wiley and Sons, Chichester, 1989, chapters 1, 2, 3, 4, and 9.1, 9.2, 9.7, and 10.
9. DeHaan, J.D. *Kirk’s Fire Investigation*, 4th edition. Prentice Hall, NJ, 1997.
10. Dietz, W. R. Improved Charcoal Packaging for Accelerant Recovery by Passive Diffusion. *Journal of Forensic Sciences*. Vol. 36, No. 1, January 1991, pp. 111- 121.
11. Gary, J. & Handwerk, G. *Petroleum Refining: Technology and Economics*, 4th edition. Marcel Dekker, New York, 2001, Chapters 1, 2, 3, 4, 5, 6, 7, 11, 12, 15, 16.
12. Gutsche, C.D & Pasto, D. *Fundamentals of Organic Chemistry*, 1st edition. Prentice Hall Inc., NJ, 1975. Chapters 3, 4, 5, 6, 7, 8, 10, 12, 13, 18, 19, 31.
13. Katz, S.R. and Midkiff, C.R. Unconfirmed Canine Accelerant Detection: A Reliability Issue in Court. *Journal of Forensic Sciences*. Vol. 43, No. 2, 1998, pp. 329-333.
14. Kinard, W.D. and Midkiff, C.R. Arson Evidence Container Evaluation: II. New Generation Kapak Bags. *Journal of Forensic Sciences*. Vol. 35, No. 6, Nov. 1991, pp. 1714-1721.

15. Kirkbride, K.P and Kobus, H.J. The Explosive Reaction Between Swimming Pool Chlorine and Brake Fluid. *Journal of Forensic Sciences*. Vol. 36, No. 3, 1991, pp. 902-907.

16. Kurz, M.E. et al. Effect of Background Interference on Accelerant Detection by Canines. *Journal of Forensic Sciences*. Vol. 41, No. 5, 1996, pp. 868-873.

17. Lentini, J. J. and Armstrong, A. T. Comparison of the Eluting Efficiency of Carbon Disulfide with Diethyl Ether: The Case for Laboratory Safety. *Journal of Forensic Sciences*. Vol. 42, No. 2, 1997, pp. 307-311.

18. Lentini, J. J, et al. The Petroleum-Laced Background. *Journal of Forensic Sciences*. Vol. 45, No. 5, 2000, pp. 968-989.

19. Mann, D. C. and Gresham, W. R. Microbial Degradation of Gasoline in Soil. *Journal of Forensic Sciences*. Vol. 35, No. 4, July 1990, pp. 913-923.

20. Matson, Jack, V., *Effective Expert Witnessing*, Lewis Publishers, Chelsea Michigan, 1990; Chapters 1, 2, 3, 5, & 6.

21. McLafferty, F. W. & Turecek, F. *Interpretation of Mass Spectra*. University Science Books, CA, 1993, chapters 1-6, 10 & 11.

22. McNair, H.M et al. *Basic Gas Chromatography*. Varian Press, 1969, chapters 1-9, & 11.

23. Midkiff, C.R. Is It a Petroleum Product? How Do You Know?" *Journal of Forensic Sciences*. Vol. 31, No. 1, Jan. 1986, pp 231-234.

24. National Fire Protection Association, NFPA 921: Guide to Fire and Explosion Investigations. NFPA, Quincy, MA, 2008, Chapter 2113.

25. Newman, R. et al. *GC-MS Guide to Ignitable Liquids*. CRC Press, 1998.

26. Newman, R. T., Dietz, W. R. and Lothridge, K. The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion, Part I: The Effects of Time, Temperature, Strip Size, and Sample Concentration. *Journal of Forensic Sciences*. Vol. 41, No. 3, May 1996, pp. 167-176.

27. Nordby, Jon J. Countering Chaos: Logic, Ethics, and the Criminal Justice System. *Forensic Science*. James, S. & Nordby, J. ed., CRC Press, Boca Raton, 2003

28. Pannell LK, Pu QL, Fales HM, Mason RT, and Stephenson JL. Intermolecular Processes in the Ion Trap Mass Spectrometer. *Analytical Chemistry*, 1989; 61(22): 2500-3

29. Pannell LK, Pu QL, Fales HM, Mason RT, and Stephenson JL. Self Chemical Ionization in an Ion Trap Mass Spectrometer. *Analytical Chemistry*,1988; 60: 2312-4.

30. Nowicki, J. An Accelerant Classification Scheme Based on Analysis by Gas Chromatography/Mass Spectrometry (GC-MS). *Journal of Forensic Sciences*. Vol. 35, No. 5, Sept. 1990, pp. 1064-1086.

31. Preston, S. & Pankratz, R. *A Guide to the Analysis of Hydrocarbons by Gas Chromatography*, 4th edition. PolyScience, IL, 1990, Section 1, General Instructions.

32. Silverstein, R.M, et.al. *Spectrometric Identification of Organic Compounds*, 3rd edition. Wiley & sons, 1974, chapter 2.

33. Smith, R.M. Mass Chromatographic Analysis of Arson Accelerants. *Journal of Forensic Sciences*. Vol. 28, No. 2, 1983, pp. 318-329.

34. Stauffer, E., Dolan, J., & Newman, R. *Fire Debris Analysis*. Elsevier, MA, 2008.

35. Technical Working Group on Fire/Arson Scene Investigation. Fire and Arson Scene Evidence: A Guide to Public Safety Personnel. U.S. Department of Justice Research Report, June 2000.

36. Tindall, R. An Evaluation of 42 Accelerant Detection Canine Teams. *Journal of Forensic Sciences*. Vol. 40, No. 4, 1995, pp. 561-564.

37. Trimpe, M. A. Turpentine in Arson Analysis. *Journal of Forensic Sciences*. Vol. 36, No. 4, July 1991, pp. 1059-1073.

38. Wallace, J. R."GC/MS Data from Fire Debris Samples: Interpretation and Applications. *Journal of Forensic Sciences*. Vol. 44, No. 5, 1999, pp. 996-1012.

39. Waters, L. V. and Palmer, L. A. Multiple Analysis of Fire Debris Samples Using Passive Headspace Concentration. *Journal of Forensic Sciences*. Vol. 38, No. 1, January 1993, pp. 165-183.

40. Willard, H. et al. *Instrumental Methods of Analysis*, 7th edition. Wadsworth, 1981, chapters 17 & 18.