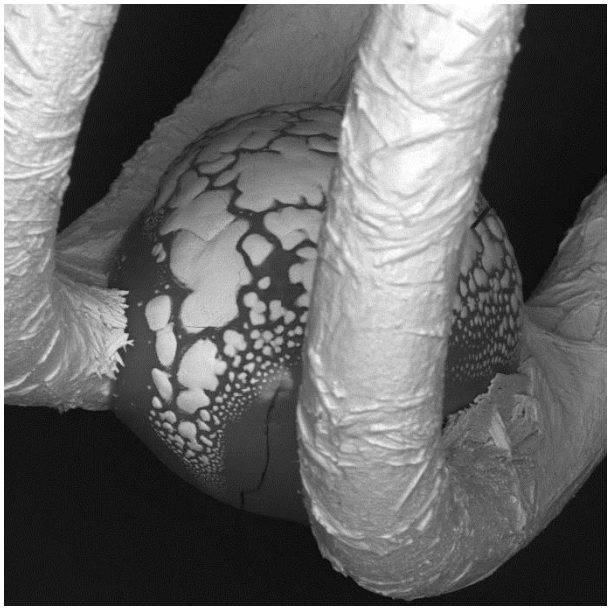
Washington State Patrol



Crime Laboratory Division

Materials Analysis
Vehicle Lamps Training Manual

July 2018

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This manual contains an outline for training and/or assessing a forensic scientist in the area of vehicle lamp analysis. The various study segments should be covered in the order presented.

This manual endeavors to promote and maintain consistency and quality among forensic scientists performing Vehicle Lamp analyses across the Crime Laboratory Division. Certain inherent aspects of vehicle lamp analysis prohibit the establishment of a rigid set of standard procedures to cover every case. Sufficient latitude should be given to allow for independent thought and individual freedom in selecting alternative courses of action. Upon completion of this training program, the trainee will be thoroughly familiar with the options available to perform an examination of most types of evidence that may be received.

1.2 EXPECTATIONS

The trainee is expected to have successfully completed the Foundation Training Manual and the following study segments from the Instrument and Techniques Training Manual: Scanning Electron Microscopy – Energy Dispersive X-Ray Spectroscopy (SEM-EDX), X-Ray Fluorescence (XRF), Basic Microscopy, Imaging and Visualization, and Evidence Recovery.

Trainees who have prior related training and experience may be able to progress through the training program at an accelerated pace or skip certain study segments. The required documentation of such related training and/or experience will be left to the technical lead(s) or their designee.

The instructor must be experienced in the area of vehicle lamp analysis. The instructor's casework and courtroom experiences, both prior and present, provide a unique aspect to the trainee's learning process that is impossible to duplicate in this training program. The instructor will share such experiences with the trainee. The instructor will also discuss with the trainee the training and reference materials (if any) available on the FLSB Portal. Although the trainee's primary interaction will be with the assigned instructor, this program promotes and encourages discussions with other experienced examiners. When possible, the trainee should also take outside courses in vehicle lamp analysis.

The trainee will maintain a notebook or multiple notebooks throughout the duration of this training program and will record notes and observations for each study segment. The trainee notebook should be maintained in a neat and current fashion and should be present during conversations with the trainer. Upon completion of training, the trainee will maintain the training notebook for the duration of their career.

The trainee should be continuously evaluated throughout the training for comprehension and competency in theoretical knowledge, basic practical skills, and critical thinking skills. Training is progressive and continuously builds on and reinforces prior learning. Deficiencies on any of the training steps may occur during the course of the training and should be rectified. It is important that these deficiencies be openly and promptly discussed among the trainee, trainer, technical lead, and/or supervisor, as appropriate. Repeating training steps and testing may be necessary to satisfactorily complete this training program.

In order to successfully complete this training program the trainee must, after completion of all topic areas, successfully complete a closed book written exam passed with 80%, a competency exam passed with a 100%, and an oral testimony exam with a pass/fail. The completion of these steps will be documented on a training checklist located at the end of this manual. The competency exam will take the form of a mock case, which will include a draft report. The oral testimony exam may either be a full moot court or an oral examination of testimony type questions between the trainer and the trainee. Supervised casework is optional and dependent on the trainee's repertoire of subdisciplines as well as performance on mock casework.

The trainer is responsible for writing an interoffice communication (IOC) to the trainee's supervisor when the trainee has successfully completed the Vehicle Lamp Training Manual. The trainee's supervisor will maintain copies of training IOCs and authorizations in their files.

1.3 ORGANIZATION OF THE TRAINING MANUAL

This training manual consists of two segments, each covering different aspects of vehicle lamp analysis. The study segments are organized in a specific manner to build on each other. Collection and preservation of lamp evidence is the first section and is intended to allow the examiner to be able to convey to officers the proper method for collecting this potentially fragile evidence. The second section discusses the methods used to open various lamps in a safe manner. This allows the examiner to make a detailed examination of the submitted lamps. The construction of new undamaged lamps is the subject of the third section. It is necessary for the examiner to understand what a new lamp should look like when evaluating the condition of used and damaged lamps. The largest and most important section of this training is the next section, assessing lamps damaged in collisions. This section addresses the evaluations which are the heart of this sub-discipline, were the lights on or off at the time of the collision. The final section addresses the significance which can be attributed to the examinations and prescribes the mock casework necessary to complete the training plan.

Each study segment is comprised of five sections:

Objectives – Summarize the purpose of each study segment.

Topic Areas – Designates topics to be included in the study segment.

Readings – Lists the reference materials that should be read to complete the study segment.

Study Questions – Lists questions that assist the trainee in comprehension of the readings, promotes active discussion between the trainer and trainee, and documents understanding of the topic areas. Written answers to these questions will be maintained in the training notebook as documentation of training.

Practical Exercises – Hands on activities that are designed to provide the trainee first-hand experience with the main concepts of each study segment. Data or written explanation for each exercise must be maintained in the training notebooks.

1.4 SAFETY

Care should be used when handling vehicle lamps. Eye and body protection as well as appropriate gloves should be worn whenever vehicle lamps are being broken or lamps are energized.

Good chemical safety practices should be employed.

2 COLLECTION AND PRESERVATION OF LAMP EVIDENCE

2.1 OBJECTIVES

- To become familiar with the procedures used to properly document, collect, and preserve vehicle lamp evidence.
- To be able to advise law enforcement on the proper methods to collect and preserve vehicle lamp evidence

2.2 TOPIC AREAS

1. Documentation
   a. Diagram
   b. Speed and Direction
   c. Vehicle Information
   d. Photographs
   e. Previous Damage
   f. Time of Day
   g. Weather
   h. Switch Position
   i. Daytime Running Lights
2. Collection
   a. Mark Orientation
   b. All Lamps
   c. Remove Lamps
      i. Remove from socket as normal
      ii. Cut wires
   d. Collect broken filaments in or near housing
      i. Tweezers
      ii. Post-it Notes
   e. Label
      i. Location
      ii. Usage
      iii. Vehicle Information
3. Packaging
   a. Protect the Filaments
      i. Foam/paper cups
      ii. Avoid packaging touching filaments
   b. Label
4. Submission
   a. Hand deliver

2.3 READINGS

1. Baker JS and Lindquist T **(1983)** “Lamp Examination for On or Off in Traffic Accidents”, 3rd Ed., Publication No. 802, Traffic Institute; Northwestern University (1. Circumstances Warranting Lamp Examination, pp 1-2; 5. At-Scene Observations, p 26; 6. Handling and Storing Lamps, pp 33-37).

2. Hochgraf FG **(2001)** “Review of Lamp Examination for ON or OFF in Traffic Accidents”, downloaded March 27, 2018 from https://mfes.com/lamps.htm.
3. WSP FLSB Forensic Services Guide (current), section on Vehicle Lamps.

2.4 STUDY QUESTIONS

1. A detective wants to turn on the headlamps at a collision scene to see if they work. Is this a good idea? Why or why not?
2. This same detective has asked for advice on how to collect the lamps from the vehicles at his scene. What do you tell him?
3. The Forensic Services Guide and other publications dictate that the orientation of a collected lamp be noted by marking the up or 12 o’clock position. Why?

2.5 PRACTICAL EXERCISES

1. Collect a set of headlamps and backup/brake/turn signal lamps from one vehicle that exhibits damage sustained in an accident. Properly document the collection and preservation as if it were a crime scene using the following steps:
   a. Record year, make and model of vehicle, license plate number and VIN number.
   b. Document vehicle damage and specifically damage to all lamps near impact area.
   c. Document the original position of all lamp switches in vehicle. Prior to removal of any lamps, document filament position within the lamp housing. You may want to sketch and photograph their position. Orient the lamps by labeling them with a directional arrow.
   d. Do not unplug, but cut wires to remove lamps to prevent additional damage to filaments. Remove the entire lamp and lamp housing as one unit if possible. Disconnect the battery prior to cutting any electrical wires. Remember safety is first.
   e. If you are removing damaged lamps you may want to tape a bag under the lamp to prevent any fragments from being dislodged and lost.
   f. If the filament(s) are missing, search the immediate area around the lamp for fragments.
   g. Package lamps carefully in separate container.

3 OPENING THE GLASS ENVELOPE AND SAFETY CONCERNS

3.1 OBJECTIVES

- To demonstrate techniques in opening vehicle lamps in a safe manner.

3.2 TOPIC AREAS

1. Safety
   a. Broken Glass
      i. Eye Protection
      ii. Cut Prevention
   b. Burn Prevention
2. Sealed beam lamps
   a. Scribe, Charcoal Starter, Water
3. Miniature Lamps
   a. Scribe, Charcoal Starter, Water
   b. Scribe, Vise
   c. Safety box if breaking while incandescent
4. Halogens
   a. High Pressure
   b. Vise
   c. Safety box if breaking while incandescent

3.3 READINGS

1. Baker JS and Lindquist T **(1983)** "Lamp Examination for On or Off in Traffic Accidents", 3rd Ed., Publication No. 802, Traffic Institute; Northwestern University (5. Examining Lamps and Testing Circuits, pp 26-33).
2. Tobin WA **(1994)** "Noninvasive Evaluation of Vehicular Lamp Bulbs" *Crime Laboratory Digest* 21(1) 5-7.

3.4 STUDY QUESTIONS

1. The Baker and Lindquist article in the readings discussed using a low voltage (~3V) to test filaments for continuity. What is a better way to make this determination?
2. The same article discusses several methods available to open vehicle lamps for analysis. Discuss the methods mentioned and any potential problems those methods may present.

3.5 PRACTICAL EXERCISES

1. Observe the instructor demonstrate the safe opening of a sealed beam headlamp and a miniature lamp. Now it's your turn, safely remove the glass lens from a sealed beam headlamp and open a miniature lamp.

4 LAMP CONSTRUCTION

4.1 OBJECTIVES

- To observe the components, type, design features and usage of common lamps encountered in casework.
- To learn the techniques for proper photography of lamps and filaments.

4.2 TOPIC AREAS

1. Lamp Components
    a. Contacts
    b. Pins
    c. Bulb
    d. Stem
    e. Posts
    f. Filament
    g. Clamp
    h. Tails
    i. Getter
    j. Reflectors
    k. Shields
    l. Front Lens
2. Lamp Types
    a. Peanut Bulbs
        i. SAE 57, 158, 168, 194
    b. Miniature Lamps
        i. SAE XX54, XX56,XX57
    c. Halogen
        i. Headlamps
            1. SAE 9004, 9005, 9006, 9007
        ii. Other
            1. SAE 880, 881, 889, 890
3. Photography
    a. Lighting To Reduce Glare
    b. May Have To Open Lamp
    c. Backlighting

4.3 READINGS

1. Baker JS and Lindquist T **(1983)** “Lamp Examination for On or Off in Traffic Accidents”, 3rd Ed., Publication No. 802, Traffic Institute; Northwestern University (2. The Normal Lamp, pp 2-9.; 7. Lamps Commonly Used in Motor Vehicles, pp 38-40).
2. Gieszl R **(unpublished)** “Properties of Tungsten Filament Lamps”, class handout from “Headlamp Examination” course, April 9-11, 2002; California Criminalistics Institute, Instructor: Ray Gieszl.
3. Gieszl R **(unpublished)** “Halogen Cycle”, class handout from “Headlamp Examination” course, April 9-11, 2002; California Criminalistics Institute, Instructor: Ray Gieszl.

4. Gieszl R **(unpublished)** “Water Cycle”, class handout from “Headlamp Examination” course, April 9-11, 2002; California Criminalistics Institute, Instructor: Ray Gieszl.
5. Powell GLF **(1977)** “Interpretation of Vehicle Globe Failures: The Unlit Condition” *Journal of Forensic Sciences* 22(3) 628-635.
6. Ryland S **(unpublished)** “Junkyard Collection of Miniature Lamps Not Involved in Impact”, class handout from “Headlamp Examination” course, April 9-11, 2002; California Criminalistics Institute, Instructor: Ray Gieszl.

4.4 STUDY QUESTIONS

1. Draw a schematic of a halogen and a sealed beam lamp and label all the key parts.
2. Describe the water cycle. What can be added to a lamp to counteract this cycle?
3. Describe the halogen cycle.
4. In the halogen cycle evaporated tungsten is redeposited back on the filament. If this is true why doesn’t a halogen lamp last forever?

4.5 PRACTICAL EXERCISES

1. Obtain a new miniature lamp; use a stereomicroscope to examine the components. Photograph the lamp filaments at a range of magnifications showing the draw marks in the tungsten filament, uniformity of filament coils, silver luster, attachment posts, getter if present, and differences in filament diameter.
2. Non-halogen lamps new out of the box can have some filament coil distortion. Filaments from US manufacturers tend to exhibit less distortion then foreign manufacturers’. ‘Peanut’ lamp filaments like those used in dome lights, can appear very distorted new out of the box, and are therefore seldom used in determinations of on or off. Examine 10 new ‘peanut’ lamp filaments and document the range of distortion seen in new lamps of this type.
3. Examine 10 new/unused miniature lamps from a variety of manufacturers visually and with the stereomicroscope. Compare lamp filaments for variations in filament sag and squirm observed between the lamps to obtain a qualitative range of what is ‘normal’ for new lamps. Macro-photograph each lamp with a digital camera making sure the filaments are in focus and will fill the frame. A light box may be used to achieve transmitted light for the macro-photographs. Print out the photos with a figure caption that includes the type and manufacturer. Also take stereophotomicrographs using transmitted light.
4. Using SEM/EDS or XRF analyze the components of at least one miniature and one halogen lamp. The analysis should include the filaments, posts, glass bulb, glass stem, getter, and metal portions of the base. (Analysis of additional lamps from different manufacturers is encouraged.)

5 EXAMINATION OF VEHICLE LAMPS FROM COLLISIONS

5.1 OBJECTIVES

- To observe, document, and interpret the types of damage commonly seen in vehicle lamps from vehicles involved in collisions

5.2 TOPIC AREAS

1. Bulb Broken-Incandescent
    a. Oxides
        i. Black
        ii. Yellow-White
        iii. Iridescent
    b. Melted Adhering Glass
    c. Filament Deformation
    d. Bulbous or tapered ends
2. Bulb Broken-Not Incandescent
    a. Filament Shiny
    b. Glass if Present Not Adhering
    c. Filament Intact or Broken But Coils Generally Not Deformed
    d. Jagged Cold Fracture
3. Bulb Intact-Incandescent
    a. Filament shiny
    b. No Glass
    c. Distorted Filament
    d. Filament Possibly Broken
    e. Broken Ends Possibly Bulbous/Tapered
    f. Defect in Glass From Contact With Energized Filament
4. Bulb Intact-Not Incandescent
    a. Filament Shiny
    b. No Glass
    c. Filament Possibly Distorted
    d. Filament Possibly Broken
    e. Jagged Cold Fracture
5. Lamp Turned On After Impact
    a. Glass Intact
        i. Filament Normal
        ii. Cold Shock
    b. Glass Broken
        i. Burned Out, Rounded Ends, No Glass
        ii. Cold Shock
6. Normal Burnout
    a. Glass Intact
        i. Shiny Filament Rounded Ends
        ii. Possible Cold Shock

b. Glass Broken
   i. Shiny Filament, Rounded Ends
   ii. Possible Cold Shock

5.3 READINGS

1. Baker JS and Lindquist T **(1983)** "Lamp Examination for On or Off in Traffic Accidents", 3rd Ed., Publication No. 802, Traffic Institute; Northwestern University (3. Lamp Abnormalities Resulting from Accidents, pp 9-19; 4. Special Considerations, pp 19-26).
2. Dydo JR, Bixel RA, Wiechel JF, Stansifer RL, and Guenther DA **(1988)** "Response of Brake Light Filaments to Impact", SAE Technical Paper 880234.
3. Ehmann R and Yu JCC **(2009)** "Determination of energization state of Xenon high intensity discharge automobile headlights" *Forensic Sci J* 8(1): 13-28.
4. Fries TR and Lapp RO **(1989)** "Accident Reconstruction - Response of Halogen Light Filaments during Vehicle Collisions", SAE Technical Paper 890856.
5. Gieszl R **(unpublished)** "Forensic Vehicle Lamp Examination", class handout from "Headlamp Examination" course, April 9-11, 2002; California Criminalistics Institute, Instructor: Ray Gieszl.
6. Greenlay WRA, Juzkow M, Mikkelsen SR, and Beveridge AD **(1986)** "The Effect of Impact on the Filaments of Quartz Halogen Headlamps", *Can Soc Forensic Sci J* 19(2) 77-82.
7. Haas MA, Camp MJ, and Dragen RF **(1975)** "A Comparative Study of the Applicability of the Scanning Electron Microscope and the Light Microscope in the Examination of Vehicle Light Filaments", *J Forensic Sci* 20(1) 91-102.
8. Horvat R, Barišić-Jaman B, Mršić G, Špoljarić I, Vrdoljak A, and Pehar I **(2010)** "Method of Light Bulbs Analysis on Vehicles Damaged in Traffic Accidents", *Traffic and Transportation* 22(4) 259-271.
9. Kawakami A, Sekimori H, and Shinohara A **(1993)** "Accident Information for Traffic Accident Reconstruction - The Role of the Automobile Lamp Filament", SAE Technical Paper 930661.
10. Keskin AT, Reed WS, and Friedrich RL **(1988)** "Brake Light Filament Deformation Analysis for Vehicular Collisions", SAE Technical Paper 880233.
11. Ray SP, Jewell MF, and Treat B **(2001)** "Light Bulb Filament Analysis - Understanding the Effect of Inertial Impact Forces", SAE Technical Paper 2001-01-1282.
12. Rioux JM, Murphy KJ, Stone HS, and Stuart AW **(1997)** "Determination of the Cooling Rate for an Incandescent Headlight Filament", *Can Soc Forensic Sci J* 30(2) 61-64.
13. Wen X, Okraszewski B, Babber P, Cash J, Cain S, Klotzkin D **(2018)** "Effects of High-g Impact on Physical, Electrical, and Optical Characteristics of Light-Emitting Diodes" *J Forensic Sci* 63(2) 563-570.

5.4 STUDY QUESTIONS

1. What is hot shock?
2. In many cases hot shock is not seen in filaments more than a few feet from the point of impact. Why?
3. Describe the appearances of filaments broken while cold and incandescent.
4. In a two filament lamp recovered from a collision the low beam filament is heavily distorted and blackened. The high beam filament exhibits a variety of colors. What does this indicate?

5. A filament in a lamp from a vehicle known to be in a high speed collision is noted to be undistorted but is blackened with oxidation. What might this indicate? Would your conclusions be different if the speed is unknown?
6. A collision occurs with a vehicle waiting to turn and the driver of the colliding vehicle says that the impacted vehicle did not have its turn signal on. Is it possible to make a determination in this scenario? How might this differ if it is the front or rear signal lamp that is examined?
7. How does “hot shock” differ from “age sag”?
8. What role does electrical continuity play in reaching a conclusion?

5.5 PRACTICAL EXERCISES

1. The trainer will demonstrate the use of the multi-meter and UV lamp.
2. Examine the lamps given to you by your trainer. The lamps must include a miniature lamp, a halogen lamp, and an HID lamp. Fully document the condition of the lamps and state your opinion as to whether the lamps were on or off when damaged.
3. Using SEM/EDS or XRF analyze at least one miniature and one halogen lamp that has been broken while illuminated. Analyze the glass bulb and compare to glass adhering to the filament. Analyze any oxidation which may be adhering to the interior components of the lamp.

6 EVIDENTIARY SIGNIFICANCE AND MOCK CASEWORK

6.1 OBJECTIVES

- To develop an understanding of the significance and limitations of vehicle lamp exams
- To ensure appropriate documentation and report writing skills
- To ensure appropriate techniques and confidence for court presentation

6.2 TOPIC AREAS

1. Assessment of Submitted Evidence
   a. Requires Scene Knowledge
   b. Determine Which/All Lamps to be Analyzed
2. Note Taking
   a. Reasoning for Conclusions reached
3. Conclusions
   a. Contradictory Analyses
   b. Assessment of Significance
4. Report Wording
5. Court Testimony

6.3 READINGS

1. Lavabre R and Baudoin P **(2001)** "Examination of Lightbulb Filaments After a Car Crash: Difficulties in Interpreting the Results", *J Forensic Sci* 46(1) 147-155.
2. Stauffer E **(2007)** "Interpretation of Automotive Light Bulb Examination Results: An Intriguing Case", *J Forensic Sci* 52(1) 119-124.
3. WSP CLD Materials Analysis Technical Procedures Manual (current), section on Vehicle Lamps.

6.4 STUDY QUESTIONS

1. How are vehicle lamp requests submitted?
2. What conclusions may be reached from a vehicle lamp analysis?
3. What information should be included in your notes?
4. What information should be included in a report?
5. Due to various types of Cognitive Bias the forensic community has been called upon to limit the information available to scientists before they analyze evidence in submitted cases. How does this idea fit in with the Vehicle Lamps section of the current WSP Materials Analysis Technical Procedures Manual? How may concerns regarding Cognitive Bias affect the analysis of vehicle lamps?

6.5 PRACTICAL EXERCISES

1. Review at least 3 case files where a vehicle lamp examination was the purpose of the request. A representative file from each vehicle lamp analyst should be included in the mix. Consider requesting files from archives in order to review a sufficient number of case files. Note the

wording of observations, worksheets, and what printouts were included. Note how the conclusion(s) were documented.

2. Work at least 3 vehicle lamp mock cases as if they were real cases. These cases should be realistic in the type of evidence submitted. At least one of the mock cases should include removal of the glass envelope. Follow the requirements of the Technical Manual and include a draft report.
3. Perform at least 3 practice technical reviews. These reviews may be on copies of active vehicle lamp case files prior to the actual case files being technical reviewed by a qualified analyst or on mock vehicle lamp case files created for this exercise.
4. Discuss with other vehicle lamp analysts any court testimony experiences they have had.
5. Observe court testimony in vehicle lamp analysis if possible.
6. Participate in an oral practice session to practice giving verbal answers to court type questions for vehicle lamp analysis.

7 VEHICLE LAMP TRAINING CHECKLIST

Trainee:		Trainer:		
		Trainee Initials/Date	Trainer Initials/Date	Time for Completion
Collection and Preservation of Lamp Evidence				
	Reading			
	Study Questions			
	Exercises			
Opening the Glass Envelope and Safety Concerns				
	Reading			
	Study Questions			
	Exercises			
Lamp Construction				
	Reading			
	Study Questions			
	Exercises			
Examination of Vehicle Lamps from Collisions				
	Reading			
	Study Questions			
	Exercises			
Evidentiary Significance and Mock Casework				
	Reading			
	Study Questions			
	Exercises			
Written Test				
Competency Exam				
Oral Testimony Exam				