

This document is being made available so that the forensic science community and interested stakeholders can be more fully aware of the efforts and work products of the Organization of Scientific Area Committees for Forensic Science (OSAC). This document is a DRAFT which represents a work still in progress and is intended for future development into a web application. Therefore, please consider the content of the current version of the Trace Materials Crime Scene Investigation Guide but disregard the format, as the format will necessarily be overhauled upon adaptation of the document into a web application.

Trace Materials Crime Scene Investigation Guide

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Introduction

Trace evidence is a subset of forensic evidence that is scientifically analyzed to explore possible associations between people, places, and objects. Trace evidence can provide pertinent information and be utilized by investigators to help solve crimes, corroborate statements, and/or determine the sequence of events. This type of evidence is typically small, highly variable, and easily transferable from one location to another. As such, it can be difficult to recognize and may not always persist.

This guide was prepared to assist the crime scene investigator by providing guidance on a) recognizing, b) collecting, and c) packaging suspected trace evidence. To this end, this guide begins with a quick reference table [\(insert hyperlink\)](#) that contains a summary of collection details for many of the more commonly encountered types of trace evidence. This is followed by detailed, illustrated chapters that each focus on a specific type of evidence. These sections include information about the potential value of a given type of evidence, details specific to the collection of that type of evidence, and approaches to appropriate sample packaging. Also, included is an outline of types of trace evidence to collect at different types of crime scenes with potential laboratory examinations.

Please note, the focus of this guide is trace evidence and is not intended to be inclusive of all types of evidence found at crime scenes. It remains important to recognize and collect trace evidence without jeopardizing the integrity of other evidence. While this guide focuses on some of the more commonly encountered forms of trace evidence, it is critical to remember that almost any imaginable substance could be encountered as trace evidence. If your laboratory does not have the capability to support the examination of a given type of evidence, please note that there are numerous public and private laboratories that can provide additional assistance. If questions arise, please contact the laboratory that typically supports your jurisdiction.

Collection and Packaging

Please note the following:

1. Submit the entire item for known and questioned evidence when practical.
2. Collect known samples that best represent the color and condition of the questioned material being submitted for comparison, as close in time to the incident as possible.
3. Package each known and questioned item separately.
4. Dry, wet or bloody items over paper prior to packaging. Once dry, place paper and items in a paper bag or box. Exceptions include ignitable liquid residues, explosives, and suspicious liquids (e.g., bleach, acid), which should be packaged in airtight containers.
5. Tape seams of envelopes and bags to ensure trace evidence is not lost. Additionally, use paper folds and/or sticky note to hold evidence within a larger container and prevent loss.
6. Always utilize new and/or clean packaging materials and collection tools to prevent contamination of the evidence.

Specimen	What to Collect?		Wrapping & Packaging	Remarks
	Known/Standard	Unknown/Questioned		
Broken Objects (Physical Fits)	As much of the broken object as possible.	All recovered pieces.	Protect edges from further damage. Place in a sturdy container.	Do not attempt to fit them together prior to submission. This may alter the edges or cause a transfer of materials.
Explosives	Materials that could be used to construct a device from scene or suspect.	All potential pieces and parts of an exploded device and associated debris from in/around the explosion.	Pre-blast: Static seal in plastic bag or airtight container (e.g., screw tight vial, unused metal paint can). Post-blast: Seal in airtight container.	Render pre-blast devices safe before submission to the laboratory. Only submit 1-2 grams of suspected explosive to the lab. Ship all items in accordance with local, state, and federal law.
Fabric Damage and Fabric Impressions	All outer clothing from potential source.	Weapon that caused damage; object containing the damage and/or impression. If object cannot be collected, use electrostatic lifting, dusting and lifting with lifting tape, gel lifters, or casting (e.g., for 3-D impressions).	Protect the impression against loss through abrasion and protect trace evidence on weapons (e.g., secure to box).	Take examination quality photographs of the impression prior to processing or packaging. Submit photos with impression. If fibers are observed within a fabric impression, carefully collect them prior to collecting the impression to prevent loss.
Clothing, Fabric, Fibers	All potential fiber/fabric sources - clothing, bedding, carpet, towels, samples of upholstery, etc.	Loose fibers, objects containing fibers, tape lifts of areas with possible transferred fibers, or vacuumed material from areas of interest.	Place each item of clothing in a separate paper bag. Recover visible fibers and place them in a paper fold or inside a folded sticky note then inside an envelope. Place	Avoid using plastic bags. If any paper was placed beneath the item while it dried, submit the paper along with the item. Collecting tape lifts of the decedent's clothing and/or body prior to transport will

			tape lifts on clear plastic sheets and then place into an envelope.	reduce the possibility of contamination or loss of trace materials.
Cordage	Collect the entire rope, twine, or cord.	Bindings, ligatures.	Place each item in a separate paper bag.	Cut in an area away from the knot and clearly mark the cuts made at the scene. Untying a knot can cause the loss of trace evidence.
Fire Debris	Ignitable liquids found at scene, wicks from Molotov cocktails.	Fire debris from around the area of origin, preferably porous material.	Airtight containers, such as unused paint cans or heat-sealed nylon bags.	Freeze soil samples as soon as possible because volatile ignitable liquids can evaporate quickly. DO NOT USE paper bags and envelopes.
Footwear and Tire Impressions	Footwear and tires.	The objects containing the impressions. Examination quality photographs, lifts, casts, etc. of questioned impressions at scene.	Package footwear in a paper bag. Submit questioned images on a CD-R, DVD-R, or in another write protected format.	Take examination quality photographs of the impression (i.e., fill the frame, taken at 90 degrees and with a scale) prior to processing or packaging. Submit photos with impression.
Geological Materials/ Soil	At least 2-3 tablespoons per sample. For surface samples, collect from the top layer at or near scene. Collect at least 5 surface samples to represent an area. For burials, collect individual samples from distinct layers. Avoid body fluids.	Entire item containing soil. Collect soil evidence intact to preserve layer structure if present.	Submit known samples in rigid plastic containers. Place each questioned item in a small padded container.	Package known and unknown items separately.
Glass	Collect at least 1 square inch from each broken glass object. For windows, take from frame rather than from the ground.	Objects or tools used to break glass, any recovered glass fragments, clothing (including hats and shoes), bullets, hair combings, etc.	Use puncture-resistant packaging such as boxes or rigid plastic containers with all edges sealed. Avoid paper or glass containers.	Document condition of glass prior to manipulation or transportation. Place tape on glass to keep it intact during packaging and transport if a physical fit is possible.

	For multilayer/pane glass (e.g., windshields), collect all layers.		Submit clothing in paper bags or boxes. Keep each source separate. Protect the area of interest on a tool (e.g., by taping a paper bag around the end) and sealing in a sturdy container.	Contact your forensic laboratory prior to collecting or moving the broken item if shot sequence determination is necessary.
Gunshot Primer Residue	Occasionally, the weapon, ammunition, and fired cartridges from the scene may be submitted for comparison.	Clothing (outer layer) GSR Collection Kit: -Adhesive Lifters (Stubs) from the hands. -GSR Information Form with the following information: <ul style="list-style-type: none"> ● Collected from what surface/hand? ● Who collected the evidence? ● Time/Date of shooting ● Time/Date of collection ● Was subject injured? ● Last activity of the subject (handwash) ● Occupation and hobbies 	Place adhesive lifts and information form in the GSR kit. Submit clothing separately in paper bags.	Collect as soon as possible after the incident and before transportation in a law enforcement vehicle. Wear gloves when collecting to reduce the possibility of contamination. Avoid having officers who have recently fired or handled their service weapon collect GSR evidence.
Hair	A total of 25 - 50 combed and pulled hairs from the head and/or pubic area. Collect victim, suspect, and any elimination samples. Package samples from each body area separately in separate containers.	Loose hairs, objects containing hairs, tape lifts of areas with possible transferred hairs, or vacuumed material from areas of interest.	Place each item of clothing in a separate paper bag. Recover visible hairs and place them in a paper fold or inside a folded sticky note and then inside an envelope. Place tape lifts on clear plastic sheets and then inside an envelope.	A representative known sample consists of hairs from all areas of the head and/or pubic area. Facial hair may also be comparable. Collecting tape lifts of the decedent's clothing and/or body prior to transport reduces the possibility of contamination or loss of trace materials.
Lamps/Bulbs	Lamps (containing filaments) from area of damage.	Any broken pieces from the scene.	Place in a sturdy container and protect from further damage (e.g., use Styrofoam	Do not turn on lamps at the scene. All information regarding the incident is helpful. Photograph

			cups to protect filament area).	damaged area(s) on vehicle. Collect bulbs from undamaged areas for reference.
Paint	Entire potential paint source (e.g., spray paint can, tool, automotive panel). If not possible, collect a small portion of the larger painted object (enough to cover an area approximately one square inch; include all layers and the substrate which paint is on).	Collect objects with smears or damage, victim/suspect clothing (whether smears are present or not), transferred paint, etc.	Use metal canisters or paper fold and then place inside an envelope with all the edges sealed. Protect the area of interest on a tool (e.g., by taping a paper bag around the end) and seal in a sturdy container.	Do not use tape or plastic bags to collect. Collect known samples from an area very close to, but outside of, the damage. If automotive, collect known samples from each damaged panel. Package samples from different areas of a vehicle separately.
Tape	Potential sources of tape (e.g., rolls of tape or objects with tape).	Tape from scene, bindings, threatening packages, etc.	Place rolls in a box or paper bag. If possible, place questioned tape pieces on clear plastic sheets (i.e., transparency sheets) to prevent wadding. Place wadded tape in a plastic bag or paint can.	Never unwrap bindings; rather, cut bindings (away from torn tape ends) to remove. Label the cut ends clearly. If sticky, do not place tape pieces on paper, in a paper bag, or on cardboard. Place tape on acetate sheets or non-stick aluminum foil, or package sticky side up inside a box.

PAPER FOLD for EVIDENCE

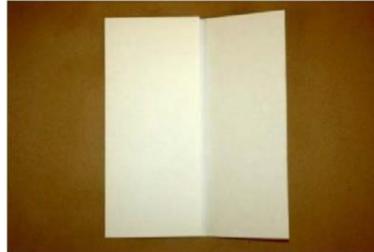
Properly folded, the paper evidence fold is a leak-resistant container that may be used for small quantities of any dry substance such as hairs, paint chips, fibers or powders that may leak from envelopes or paper bags.

The paper fold (or post-it note) should then be placed into a larger envelope or evidence bag which is labeled and sealed. If more than one evidence fold is to be placed into a larger container, each should be labeled to describe its contents.

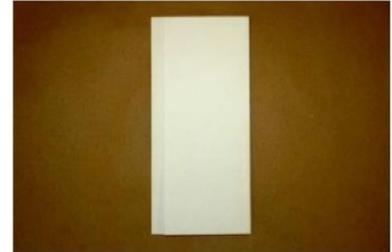
Directions



1. Fold a clean, unused sheet of paper into thirds and place evidence in middle section



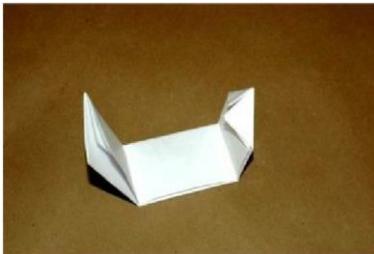
2. Fold one third over middle section



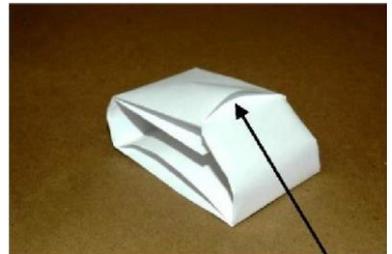
3. Fold the other third over middle section



4. Fold in half in the same direction as the thirds were folded. THIS IS THE CRITICAL STEP IN MAKING THE PACKAGE LEAK-RESISTANT



5. Fold the ends up, making one into a point for easier insertion into the other



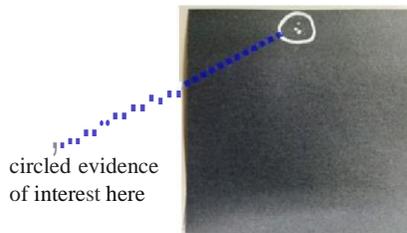
6. Insert the pointed end into the OUTERMOST opening of the straight end



7. If it appears the final fold may not stay closed, use ONE small piece of tape to secure the closure. Only tape if necessary.

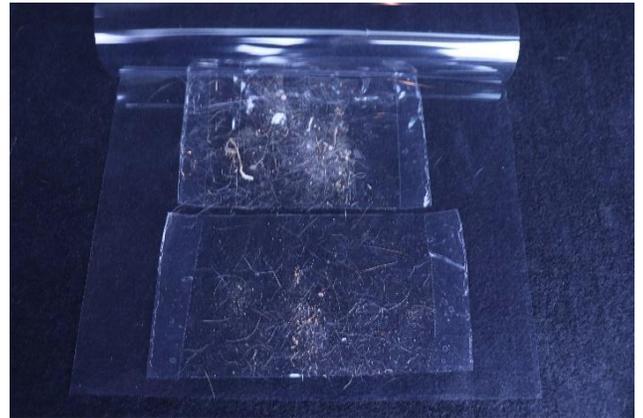
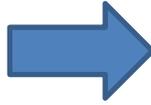
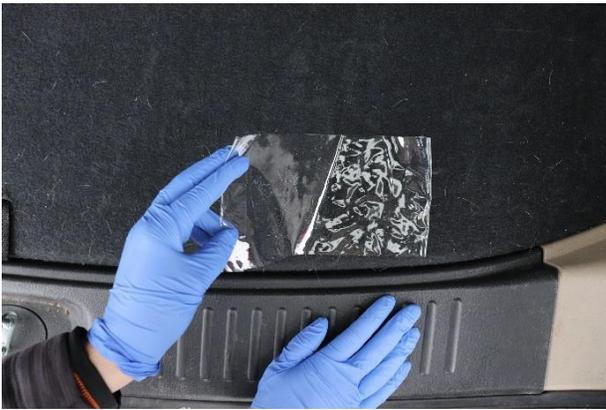
In lieu of paper folds, small fragments of glass, paint, fibers or other trace evidence can be attached to the sticky portion of a post-it note. If practical, circle the evidence of interest.

Fold the note partially over to protect the evidence and label in the area at the bottom of the note with case/evidence information.



Use tape lifts to collect hairs, fibers, and other debris from areas of interest

(e.g., furniture, vehicles, etc.) Do not use tape lifts to collect paint.



Place tape lifts on clear acetate (transparency) sheets. DO NOT PLACE ON PAPER.

Protect areas of objects/tools that may have been used to pry open doors, break windows, open safes, etc. by wrapping a paper bag around the end. Secure it to a box to prevent the loss of evidence.



Wrap broken objects to protect edges and minimize movement



Place bulbs in the bottom of Styrofoam-type cup. Cut the bottoms out of several more cups and stack them on top. Finally, place another cup (with bottom intact) on top and tape them all together.



Collection of Glass or Paint Reference Samples



Trace Evidence Vacuuming



Airbag Contact

Overview

- ◆ The examination of deployed automotive airbags and the clothing of vehicle occupants can establish that a suspect was inside a vehicle at the time of vehicle impact and/or determine the position of vehicle occupants prior to airbag deployment.
- ◆ Front driver side and passenger side airbags inflate when very hot gas is produced by a chemical reaction of a solid propellant. The hot gas can leak through the seams of the airbag and singe the clothing of the occupants in a pattern consistent with the seams of the airbags. The driver side airbag is round, producing an arc-shaped singe pattern while the passenger airbags are typically square or rectangular, producing a straight-lined singe pattern.
- ◆ The chemical reaction that inflates the airbags produces a particulate residue that has been shown to be deposited on the hands and/or clothing of the vehicle occupants. The particles produced by the driver and passenger side airbags can differ in chemical composition.



Detection & Recognition

Singe patterns, which appear as a series of dark dots in a line or arc, may be observed on the clothing of front seat occupants when they contact a deployed airbag. Singe patterns are more likely to be seen on clothing of unrestrained occupants, on lighter colored clothing, or on clothing made of cotton or silk. Airbag residue particles can be found on the vehicle occupants, regardless of whether seatbelts were used.



Collection & Packaging

Remove the driver side airbag by unbolting the nuts or screws on the back of the steering wheel and disconnecting the wiring. As an alternative, the driver side airbag and the passenger side airbag can be cut out. Be cautious not to lose any trace materials that may be on the outside or inside of the airbags. Mark the airbags for orientation prior to removal and package in separate paper bags or boxes.

Collect airbag residue particles on the hands of a suspect using stubs from a Scanning Electron Microscopy Gunshot Residue (SEM/GSR) kit, following the same directions for collection.

Precautions for Loss & Contamination

- ◆ Collect clothing from the suspected driver and/or passenger as soon as possible after the airbag deployment to prevent any loss of trace evidence material.

- ◆ Collect SEM/GSR samples within five (5) hours of the airbag deployment. That type of residue will be lost from the hand surfaces over time due to normal activity.
- ◆ Package all items in separate paper bags or boxes.

Forensic Laboratory Capabilities & Limitations

The seam patterns, size, and location of vent holes on the airbag can vary from one to another, by make, model and year, resulting in class characteristic differences, but not individual characteristics. Other evidence examinations including lubricant identification, fiber transfers, hair and biological material transfers, seatbelt transfers, and thermoplastic fusion transfers can also be used to help determine occupant locations in a vehicular crash.

Airbag residue testing cannot be used to determine occupant locations in a vehicular crash due to the residue being released into the entire interior of the vehicle. However, it can be used to establish the occupant's presence at the time of deployment.

Some passenger side airbags use a percussion primer as part of the chemical reaction used to inflate the airbag. As a result, particles produced by this type of airbag may be similar to primer gunshot residue. If a shooting incident also includes airbag deployment, collection of the airbags may be needed to ensure any gunshot primer residue test results are not a false positive result due to airbag deployment.

Applicable Scene Types

- ◆ Death Investigations
- ◆ Hit-and-Run
- ◆ Drive-by Shootings

Explosives

Overview

- ◆ Forensic examination of potentially explosive materials includes the determination of chemical composition, determination of device functionality or potential functionality, and/or the comparison of questioned and known items to assess whether they originated from the same source (manufacturer). Device components can also be compared to potential source materials recovered from a suspect.
- ◆ Explosives can be classified as commercial, military or improvised in origin. The sensitivity and power of any given explosive depends upon its chemical composition and how it is engineered.
- ◆ Use extreme caution with any intact explosive, particularly explosives that are primary high explosives and/or potentially unstable (e.g., triacetone triperoxide (TATP)).

Detection & Recognition

Intact explosives can be found in various conditions, including contained in their original packaging, stored openly or secretly, when a device fails to function as designed, and/or when a device is rendered safe by a qualified bomb technician. Post-blast residues may be invisible to the naked eye or even under the microscope, but they may be present on the remains of the device as well as on nearby materials. Large post-blast scenes are best handled using a team approach, including criminal investigators, forensic scientists, photographers, and evidence technicians.

Collection & Packaging

The handling, packaging, and shipping of intact explosives must be completed by authorized personnel and in accordance with local, state, and federal law. In post-blast cases, be cognizant of contamination issues when collecting and packaging evidence. Swabbing of large, immovable objects to gather post-blast residue is also possible, however it is critical to use clean, unused swabs that are free of contamination. Package all items for post-blast explosives in an airtight container. If swabbing, also submit a control swab.

Fingerprints, DNA, and other trace evidence can survive a blast and be recovered from post-blast debris. Be aware that swabbing may remove these types of evidence.

INTACT EXPLOSIVES

1 dram glass vial with Teflon-lined screw cap

POST-BLAST DEBRIS –Airtight containers

Metal paint can

Samples

- ◆ Small samples of intact explosives and/or post-blast debris from in/around the explosion.
- ◆ Materials that could be used to construct a device can also be submitted.

Precautions for Loss & Contamination

- ◆ Do not place intact explosives from a suspect/search warrant into the same packaging or shipping container with post-blast debris from a crime scene. These must be kept separate from the point of collection to shipment to analysis.
- ◆ Post-blast debris that is associated with the same small device can be gathered and packaged together in a metal paint can.
- ◆ If a render-safe procedure was used to disrupt a device, submit an exemplar of a disruptor shell or its powder for comparison.

Forensic Laboratory Capabilities & Limitations

Explosives analysis involves visual/microscopical exams, chemical tests, and instrumental methods to identify the explosive that is submitted. The extent of detailed information that can be determined depends strongly on the nature of the explosive, the condition of the material (intact or burned), and the amount of material present (residue or whole powder). In general, explosives examinations proceed from a visual/microscopical level to a variety of instrumental analyses. The identification of an explosive can be used as an investigative lead, as local sources of explosives can be canvassed.

Comparison of two explosives is also possible but is largely limited to intact/unburned samples. Comparisons may include brand identification and/or determination of domestic or foreign manufacture. The significance of questioned and known explosives sharing the same characteristics will vary depending upon many factors, including the extent to which that explosive is widely available.

Note that explosive devices may consist of numerous components other than the explosive. These components can include containers (e.g., pipe), initiation systems (e.g., batteries, igniters, wiring), switches, and other materials such as tape, adhesives, and shrapnel. The examination of these materials can allow for reconstruction of the device as well as associations with materials found in a suspect's possession.

Applicable Scene Types

- ◆ Death Investigations
- ◆ Explosions
- ◆ Theft

Fibers, Fabrics, & Cordage

Overview

- ◆ Fibers are present in a large variety of items including clothing, upholstery, bedding, carpeting, and cordage.
- ◆ Fibers not only vary in type (nylon, cotton, polyester, etc.) but also within a type, exhibiting a range of characteristics that allow for meaningful determinations of whether a fiber association may exist between people, objects, and/or scenes.
- ◆ The examination of fibers and fabrics can provide investigative leads or corroborate statements or events by providing information about the potential end use of an evidential fiber (carpet-type), the type of damage present on a garment or fabric (cut, tear, puncture, etc.) and/or by indicating colors of fibers or fabrics to target during investigative searches.

Detection & Recognition

Fibers may be found at a variety of crime scenes, adhering to almost anything (such as clothing, weapons, and/or adhesive materials). Fibers are often too small to be easily detected with the naked eye, so great care must be taken to recognize items with potential fiber evidence at the crime scene. Changing the angle of lighting or using an alternate light source (ALS) may assist in detecting foreign fibers in the field. In some cases, fibers can be visible at the crime scene. Tufts of fibers or sections of fabric may be found on a broken window, attached to a wire fence, or on a knife or other weapon. Thermoplastic fusions may be found adhering to damaged areas of the exterior (or interior) of a vehicle involved in a collision, which can be valuable in associating an individual to a location on or in the vehicle. Considering you may not always be able to see transferred fibers without the aid of a microscope or ALS, it is best to submit the entire item for laboratory examination. If that is not possible, collect fibers from the item prior to laboratory submission as outlined below, taking care to protect other potential evidence on the item (e.g., DNA, latent prints).

Collection & Packaging

QUESTIONED FIBERS:

Generally, questioned samples include loose fibers, objects with adhering fibers, tape lifts of areas with potentially transferred fibers, or vacuumed material from areas of interest. Collect the entire item to which fibers may have been transferred (e.g., clothing, bedding, weapon, etc.) and package according to the guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- Use tweezers or gloved fingers to collect loose visible fibers. Place the fibers in a paper fold or on the adhesive section of an unused sticky note. Fold the paper fold or sticky note and then seal inside an envelope.
- Use tape lifts to collect the loosely adhering debris (e.g., from a vehicle seat or headrest). A low-tack tape will work well because fibers can later be removed easily for analysis. Before collecting, always discard a full layer of roller sheets or tape to avoid contamination. Also, use multiple separate tape lifts for larger areas to avoid loss of adhesive tackiness. Once collected, place the adhesive side of the lift onto an acetate sheet (e.g., transparency) or within a colorless plastic bag, and package in a sealed envelope.
- Use single-use vacuum canisters specifically designed for crime scene collection.

KNOWN FIBERS:

Generally, known samples include clothing, bedding, carpet, vehicle upholstery, ligatures/cordage. Submit the entire item for fiber sampling in the laboratory and package according to the guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- ◆ Remove a small portion of the larger carpeting or upholstered object using a scalpel blade and/or tweezers, taking care to obtain a representative sample (including all colors, patterns, fiber types, wear areas, and from areas where contact may have occurred).
- ◆ Collect known fibers in a paper fold or on the adhesive section of an unused sticky note. Fold the paper fold or sticky note and seal inside an envelope.

Precautions for Loss & Contamination

- ◆ As many fibers are not readily visible, be aware that dusting for latent prints or swabbing for DNA may cause fibers in that area to be lost.
- ◆ Submit clothing items with minimal movement or shaking to minimize loss of trace evidence.
- ◆ If fiber evidence could be lost during transport of the item, use the techniques described above to recover fibers at the scene and protect them during transport to the laboratory.
- ◆ Improper packaging can cause fiber evidence loss. Do not place fiber evidence directly into an envelope or plastic bag without packaging it first in a paper fold or on sticky notes as fibers can be lost from the unsealed corners of envelopes or due to static electricity.
- ◆ Once an item of evidence is packaged, do not remove the item unless necessary (e.g., drying is required).
- ◆ Items recovered from victims, suspects, and scenes must be packaged separately to prevent contamination.
- ◆ Use disposable collection materials when possible or clean collection materials thoroughly prior to use.
- ◆ Dry wet materials in a clean, controlled area prior to packaging. Place paper beneath an item while drying to preserve any trace evidence that may fall off during the drying process. Submit the paper along with the item. Do not heat items during drying, as this may destroy biological evidence.
- ◆ Secure weapons within cardboard boxes to minimize movement and seal the corners and openings of the box to prevent loss of fibers that could become dislodged from the surface of the weapon during transport.

Forensic Laboratory Capabilities & Limitations

Fiber comparisons cannot result in a single source identification to the exclusion of all others, as fibers are mass-produced and do not contain individualizing characteristics.

Investigative leads can also be provided regarding the original source of the fibers, to include product type (e.g., carpet, upholstery, clothing) or classification (e.g., natural, synthetic). Fibers and fabrics can also be submitted for a comparison between a questioned sample and a known source. A trace evidence analyst will compare fibers based on their physical properties (e.g., diameter, color, shape) and chemical composition to determine if a questioned fiber could have originated from the known source. Fibers have many different types, colors, sizes, and shapes. An association in which the known sample and the questioned sample share the same physical properties and/or chemical composition indicates that they may have originated from the same source.

Fabric:

FABRIC DAMAGE AND IMPRESSIONS:



Clothing or other textile materials can be damaged during an assault or other criminal activity. A fabric damage examination may be important to clarify the types of damage visible in the fabric (e.g., cut, torn, and/or punctured). Fabric damage can indicate a type of weapon or can help explain the victim's injuries. In shooting cases, examination of bullet holes in clothing can yield valuable information about entrance vs. exit and/or approximate muzzle to target distance. A comparison can be performed between an area of fabric damage and test damage created in the lab using an evidentiary knife or other implement that attempts to recreate the likely scenario(s) in the case. Additionally, knives or other sharp implements may contain fibers that can be compared to the damaged textile.

When two or more pieces of fabric are compared, a physical fit of the torn/cut edges of the fabric sections can determine if the pieces were once joined. When the yarns align across a woven or knit section and any patterning on the fabric also aligns, then the pieces can be concluded to have been once joined as a single item (see *Physical Fit*).

Thermal fabric damage can be encountered in arson and explosion cases, as well as motor vehicle collisions. For example, in a motor vehicle versus pedestrian accident, the observation of melted or singed edges on a damaged item of clothing could indicate a high-friction impact with a vehicle, versus the torn edges of fabric that might be caused by asphalt or broken glass. Alternatively, fibers can be thermally deposited or fused *onto* a vehicle or other surface during an impact (thermoplastic fusion).

In addition to thermoplastic fusions, an impact between a vehicle and a pedestrian can produce an impression of the pattern of the clothing fabric in the dust, dirt, paint, etc. on the surface of the vehicle. A comparison can be performed between a fabric impression and a test impression created in the lab using the clothing submitted as evidence. While a fabric impression cannot identify a specific fabric source, additional fiber comparisons from impacted fibers that may be present in the impression may support the connection.

- ◆ Package damaged textile materials in a similar manner to other clothing (e.g., in a paper bag).
- ◆ Package potential implements that may have caused the damage in a manner that reduces the potential for fibers on the surface to be lost or for the implement to cut through the packaging (e.g., tied down in a cardboard knife box).
- ◆ Take examination quality photographs of potential impressions or fusion marks prior to collecting or packaging for transport. Submit the examination quality photos along with any impression evidence.
- ◆ Collect the entire item containing the damage or fabric impression.
- ◆ When it is not possible to collect the entire item, collect fabric impressions at the scene by electrostatic lifting, dusting and lifting with lifting tape, gel lifters, or by casting (e.g., for 3-D impressions). If fibers are observed within a fabric impression, carefully collect them prior to collecting the impression to prevent loss.
- ◆ For items that may contain a thermoplastic fusion or fibers adhering in a fabric impression, submit the smallest portion of the vehicle that can be isolated (e.g., just the hood of the car, a bumper).
- ◆ When individual parts of a vehicle cannot be separated and the whole vehicle is being transported, it is important to protect the region of the impression from potential loss of trace material by then covering more than the area of interest with paper and taping in an area that does not interfere with potential impression evidence.

Cordage:



Evidence in the form of cordage (e.g., ropes, twines, and cords) can be found in several crime scene situations, often as bindings or ligatures. Examination of cordage involves comparing the overall construction, as well as the fiber color and composition. Cordage can be associated, but since they are typically mass-produced, a single source cannot be identified following a comparison unless there is a physical fit of the ends or core material. Cordage can also provide valuable investigative leads in the form of possible sources and/or end uses.

- ◆ Photograph the item in place prior to collection.
- ◆ Collect the whole item when possible and place in a paper bag.
- ◆ If a knot is present, do not untie it as there could be trace evidence held within and/or a knot exam or comparison may be performed; however, if the item cannot be otherwise removed, cut the rope in a location away from the knot and clearly mark where it was cut.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Sexual Assault
- ◆ Burglary

Fire Debris

Overview

- ◆ The basic role of an investigator at a fire scene is to determine the origin of the fire and what caused the fire to start at or around that location.
- ◆ When an investigator suspects that a fire might have been deliberately set using ignitable liquids, submit debris from the scene to the laboratory for analysis to determine if such products are present.

Detection & Recognition

Point of origin of a fire should be located by an experienced arson investigator. Ignitable liquids may be poured in more than one place, and multiple areas of origin are typical. Signs of arson include evidence of separate and unconnected fires, the use of “trailers” to spread the fire from one area to another, evidence of severe burning on the floor as opposed to the ceiling, and the discovery of an ignition device.

Collection & Packaging

The selection of the appropriate container depends on the physical state and characteristics of the sample. The container used must be airtight to seal in any volatile ignitable liquid vapors and prevent cross-contamination between samples. Do NOT air-dry any evidence prior to submission for fire debris analysis. Examples of airtight containers include heat-sealed nylon bags, unused metal paint cans and glass jars with airtight lids. Common consumer plastic bags, paper bags and cardboard boxes are not airtight and therefore are NOT acceptable. If biological materials or latent prints may exist on an item of evidence, contact the laboratory immediately to discuss collection and packaging of the evidence.

Questioned Samples:

Solids (e.g., wood, plastic, carpet, clothing):

Do not fill containers beyond two-thirds and avoid packing down materials within the container. Close the containers securely to prevent loss of volatile vapors.

Liquids (e.g., standing pools, container contents):

Typically, 1oz. or 5mL of liquid is sufficient for analysis. Secure liquid samples in jars or small screw cap bottles. Then secure the bottle inside of an unused can. Use paper towels to protect the bottle inside of the can. If only a small amount of liquid remains, collect with sterile cotton balls or gauze pads. If a cotton ball or a gauze pad is used, a control must be submitted in a separate container. If it is necessary to use a cotton swab (i.e., a Q-tip), package the swab in a 2oz. glass jar with a Teflon-lined lid, then place the jar inside a 1qt. can and use appropriate packaging materials to prevent breakage.

Soil (e.g., dirt, sand, leaves, grass, and foliage):

Soil readily absorbs and retains ignitable liquid residues, which makes it a good source for laboratory analysis. Soil contains bacteria which will destroy hydrocarbon products. Freezing of the sample will preserve the integrity of the evidence.

Precautions for Loss & Contamination

- ◆ Avoid using fuel-powered tools and equipment, which present potential contamination sources.
- ◆ Use disposable gloves for collecting items of evidence. Change gloves between collecting unrelated items of evidence. Do NOT place gloves inside cans.
- ◆ Use clean or previously unused/disposable tools for collecting items of evidence from different locations within a scene.
- ◆ Place evidence in airtight containers and seal immediately.
- ◆ Package liquid samples to prevent leakage.

Forensic Laboratory Capabilities & Limitations

The forensic laboratory will examine debris from fire scenes and attempt to identify any ignitable liquid(s) which may be present. While the laboratory is not able to determine the exact brand or manufacturer of ignitable liquids which may be present, it can provide a classification and a range of the products that are present, if any. Many common materials such as furniture, clothing, building materials, and household products are composed of polymers that are derived from the same petroleum products that are found in many ignitable liquids. Submit comparison samples of unburned substrates such as carpets, upholstery, wood, etc., as they may contribute to the residues detected.

The identification of an ignitable liquid residue does not necessarily mean that a fire was incendiary in nature. Further investigation may reveal a legitimate reason for the presence of ignitable liquid residues. Similarly, the absence of ignitable liquids does not preclude the possibility that ignitable liquids were present at the fire scene. Ignitable liquids, are volatile, and could have evaporated prior to collection;, they could have been consumed in the fire; they could have been washed away during firefighting efforts; they may be, present in an amount too low for detection limits;, or evidence may have been collected from an inappropriate area.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions

Footwear and Tire Impression Evidence

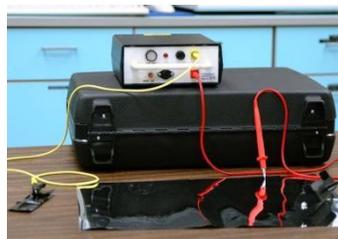
Overview

- ◆ Almost every crime scene has the potential to yield footwear and tire impression evidence.
- ◆ Document and photograph footwear and tire impressions prior to subsequent collection. Collect the original impression itself (such as when it is on a piece of cardboard). If the impression itself cannot be removed, or if it is impractical to remove it from the crime scene, then collect it by casting or lifting. Recovery of footwear and tire impressions may also involve enhancement by chemical or physical means.
- ◆ Crime scenes where tire impressions are found can potentially yield vehicle track measurements (e.g., track width, wheelbase, turning diameter).

Detection & Recognition

Footwear and tire impressions may be visible or latent. Latent impressions are located using lighting techniques (e.g., oblique lighting) and/or enhancement methods (e.g., electrostatic lifter, chemical methods). Thoroughly search obvious areas like points of entry and exit.

Collection & Packaging



PHOTOGRAPHY

Where practical, photography precedes all other methods of recovering footwear and tire impressions evidence.

After general crime scene photographs have been taken, place the camera on a tripod or quadrapod to take examination quality photographs. Position the camera so that the focal plane is parallel to the impression. This may require the use of leveling devices. It also may be necessary to shield the impression from sunlight or other ambient light sources.

Use a camera lens of an appropriate focal length to capture the impression and be free of distortion. Capture the image in a lossless format (e.g., TIFF or RAW). Normal perspective lens of 35mm-55mm (depending on the sensor size) to reduce barrel distortion is recommended.

Place a flat, rigid scale as much as practically possible on the same plane as the impression. A 300 mm L ruler is the recommended type of scale for footwear impressions and sections of tire impressions. When placing an L ruler over a tire impression, run the short leg of the L across the impression and the long leg alongside it. The ruler can be

destructive to the impression, so take great care in its placement. Place a tape measure alongside a long section of a tire impression when documentation requires multiple overlapping photographs.

Capture the impression at a minimum resolution of 300 ppi for a 1X image. This means that depending on the camera's resolution, the impression may need to be photographed in overlapping segments. To calculate maximum image area that can be captured, divide the pixel dimensions of the camera sensor by 300 (e.g., If the camera sensor is a 10 megapixel with pixel dimensions of 3972 X 264, then the largest area that can be photographed is 13.2" X 8.8").

Use the lowest native ISO available on the camera. The lower the ISO the less grain will be visible in the image so the lowest native ISO setting available on the camera should be used when possible.

The F-stop should be set at F8 or greater depending on the depth of the impression. The greater the depth the higher the F-stop should be used to increase the depth of field.

Using manual focus mode may result in a better result than relying on the camera's autofocus.

Take one photograph with the flash on camera and then a minimum of three oblique lighted photographs at varied positions around the impression. The oblique lighted photographs are taken with the flash held off camera usually four to six feet away to prevent hot spots in the image. The optimal angle of the flash will be between 0 to 45 degrees from the ground and is dependent on the depth of the impression.

Lighting should be controlled with the shutter speed. If additional light is needed in the image, decrease the shutter speed. It is essential to use a tripod and remote shutter release for longer exposures to reduce shake that will cause the image to be blurry.

When photographing tire impressions, lay a long ruler such as a retractable tape measure alongside the entire track and do not move it until the examination photographs of that tire impression are complete. This ruler is not to substitute for the scale but is used in addition to it. Overlapping examination photographs along the length of the tire track will include this ruler in them. This ruler will serve to orient the examination photographs and aid in reconstructing the entire tire impression.

Submit questioned images on a CD-R, DVD-R, or another write-protected format.

CASTING

After examination photographs of the impression are taken, three dimensional impressions are cast with dental stone.

Dental stone may be pre-weighed into suitable containers (e.g., resealable bag) to which the appropriate amount of water may be added. A two-pound portion of dental stone is an appropriate amount for most footwear impressions. Tire tracks will generally require seven or more pounds of dental stone depending on the size of the tire impression.

Ten ounces of water is a good starting point to add to the two-pound portion of dental stone. Vigorously agitate the water and dental stone to ensure a proper mix and resultant quality cast. The exact amount of water added may need to be adjusted depending on the product used. The resultant product should have the consistency of a heavy cream. Fragile shallow impressions may require a thinner mix of dental stone to prevent damage to the impression.

Start pouring the dental stone on an area just outside the impression, allowing the dental stone to flow into the impression. Do not allow the dental stone to fall directly on the impression.

Casts that are very thin may require an additional pour of a heavier mix of dental stone over it to reinforce it.

Allow the dental stone to set before any attempts at lifting. This will require a minimum of 20 minutes. In cold or damp weather, a longer period is necessary. As the dental stone begins to set, it becomes warm to the touch.

The dental stone cast will require 48 hours to dry completely and achieve full strength. Therefore, do not clean the cast until the 48 hours have elapsed. Carefully remove loose clumps of soil and debris prior to packaging the cast in a breathable bag, such as a brown paper bag.

Dental stone can be used to lift residue impressions from concrete and road surfaces. The dental stone is mixed thicker than normal, and an edge of the cast must be poured over some means of releasing the hardened cast, such as a sturdy wood strip.

Snow impressions should, when feasible, be casted using sulfur for increased detail. If sulfur casting is not available dental stone may be used.

LIFTING

After examination photographs are taken, two dimensional impressions are lifted by means of electrostatic lifter, gelatin lifts, or adhesive lifts.

Electrostatic lifts are most effective on impressions formed from dry residue and have poor results lifting impressions that were at one time wet but will not harm impressions that are not successfully lifted. Thus, it is a preferred initial method with which to attempt recovery. Secure electrostatic lifts and store in folders or boxes with dust free surfaces. Seal the packaging around the edges to prevent dust from entering and adhering to the lift.

Electrostatic lifts in larger rolls can be rolled out over suspected areas of the crime scene for searching for latent impressions. These larger size lifts may be carefully rolled and secured for transport and storage.

Gelatin lifts are effective for both dry residue and impressions that were at one time wet. When the protective cover is removed from a gelatin lift, the lift may be stretched from the force that was applied. Allow the gelatin lift to "rest" prior to it being placed on the impression so it can return to its original dimensions.

It is preferable if the gelatin lift can be transported carefully secured in a dust free container with the protective cover off. If this cannot be accomplished, then replace the protective cover carefully. Do not trap air bubbles which can create artifacts on the lift.

Precautions for Loss & Contamination

Take examination quality photographs before any other attempts at recovery in the event that the impression is damaged in the recovery process.

Do not clean casts prior to allotting 48 hours for complete drying. Never package casts in plastic bags or other non-breathable material as this can result in degradation to the cast.

Prior to packaging an electrostatic or gelatin lift, photograph the lift with an oblique light source to minimize the risk for damage/degradation of detail in the lift.

Forensic Laboratory Capabilities & Limitations

Footwear and tire impressions are compared with known items of footwear or tires to determine if the known items were responsible for making them. The examiner will express an opinion on a scale ranging from identification to

exclusion. Impressions recovered from crime scenes may also contain details that can be used to determine the brand, model or size of the footwear or tire. When tire track measurements are taken, they may be used to include or exclude a particular vehicle as the source of the tracks.

Geological Materials

Overview

Soil is commonly encountered as trace evidence at crime scenes and can be easily transferred during contact between people and materials. Other examples of geological materials include minerals, clay, sand, gravel, and rocks. This guide summarizes methods for the collection and preservation of soils found associated with evidence items (e.g., questioned samples) and from known sources that may be associated with the questioned samples (e.g., samples from the crime scene or other site).

Detection & Recognition



Soil can be found on a variety of items that could be associated with a crime scene including vehicles, shoes, shovels, and tools. Maintain soil evidence present on an item intact to preserve any layers that may be present. Collect and package the soil evidence in a sealed rigid container that is impervious to corrosion to preserve the soil evidence in its original state.

Collection & Packaging

This brief [video](#) contains information about the collection and preservation of forensic soil samples at the crime scene.

QUESTIONED SOIL

- Common locations to collect questioned soil from motor vehicles include wheel wells, truck beds, floor mats, pedals, and undercarriage.
- Tools, digging implements, footwear and other clothing may also contain relevant questioned soil samples.
- Look for intact soil pieces (clods) and keep them intact whenever possible.

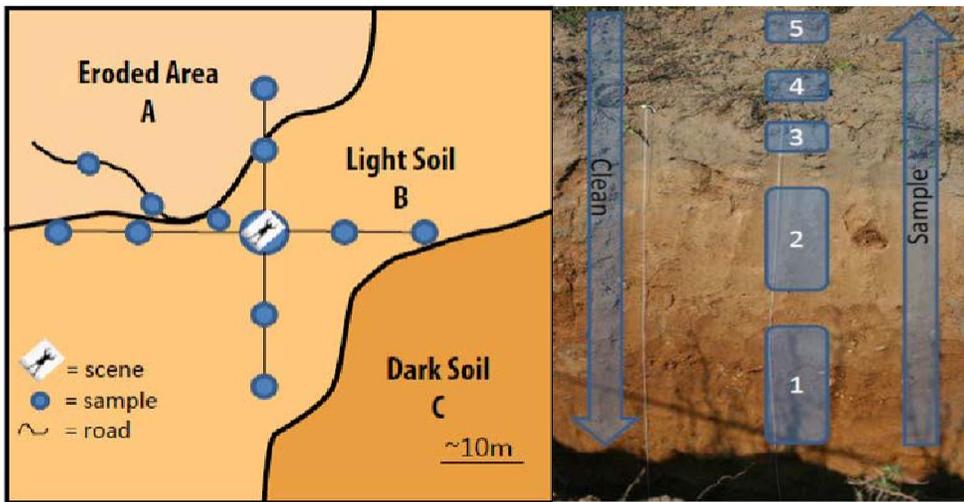
KNOWN SOIL

Surface Sampling:

- Top layer only, at/near scene
- Avoid body fluids
- Along N-S-E-W grid at ~30-foot intervals
- Along egress point(s), e.g., dirt road
- Collect at least 2-3 tablespoons/sample including soils that are different in color and particle size
- Collect at least 5 samples for each area

Burial Sampling:

- Excavate to depth of body at a horizontal distance from the body where no body fluids are present
- Clean (gently brush/wipe) the soil pit wall from top to bottom and remove loose soil from the bottom of the pit
- Collect at least 2-3 tablespoons/sample
- Collect individual soil samples from the layers that look distinct (different colors or particle size) from bottom to top of soil pit



Numbers 1-5 represent sample locations

<http://www.wi.nrcs.usda.gov/technical/soil/soiljudging/Greencosite1.html>

Soil Collection Tools

Select tools which are clean and free of corrosion, thereby minimizing contamination from either the tool itself or a previously collected sample. Examples of suitable materials for tools include hardened or stainless-steel tools (for harder materials) or plastic tools (for softer materials). Select the shape and size of the tools used for collections to enable the isolation and preservation of small, discrete samples where necessary. Some tools commonly used are dental picks, forceps, tweezers, spatulas, spoons, pallet knives, pointed trowels, spades and soil corers.

Soil Packaging



- Fill a plastic container having a tightly sealed closure.
- Package intact soil clods into small padded containers to prevent clods from breaking.
- Do not pack soil materials in containers such as paper folds, envelopes, or bags, as evidence can be easily lost.
- Properly document location and depth as appropriate, include GPS coordinates or latitude/longitude.

Precautions for Loss & Contamination

- Use containers that seal tightly for packaging and to prevent loss or cross-contamination of samples.
- Dry wet materials prior to submission. Air dry them in a clean, controlled area. Remove the lid and cover with filter paper to prevent contamination. When dry, reattach the lid tightly and seal the container.

Forensic Laboratory Capabilities & Limitations

A forensic soil comparison involves the determination of class characteristics that may associate questioned soils with soils from a known location, but it is important to note that there may be other locations with similar soil. The examination of a questioned soil can also be conducted to constrain or determine its possible origin. Laboratory methods include color comparisons, polarized light microscopy, and a variety of physical, chemical, and elemental techniques such as x-ray diffraction and SEM-EDS.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Sexual Assault
- ◆ Burglary

Glass

Overview

- ◆ The variation of chemical, optical, and physical properties in glass from different sources are measurable and usually much greater than the variation within a single glass object.
- ◆ The trace evidence analyst can compare unknown particles of glass from various sources to known pieces of broken glass from a potential source, characterize the cause and nature of breakage (fractography), and determine end use (e.g., container).
- ◆ Glass from multiple unknown sources can also be compared to each other (e.g., glass from a broken window can be compared to glass fragments from clothing).
- ◆ The examination of glass can provide investigative leads, corroborate statements or events, and determine if an association potentially exists between people, objects, or scenes.

Detection & Recognition

When a glass object breaks, fragments can be thrown in all directions and transferred to anything nearby. It can also be transferred through contact with previously broken glass. Glass can become embedded in tools and objects used to break it. Broken glass fragments can be microscopic, so even if glass is not observed on casual inspection, it may be present and recoverable. Glass fragments are commonly recovered from clothing (including shoes), hair combs, tools used to break glass, and vehicles.

Collection & Packaging

QUESTIONED GLASS:

If possible, submit the entire item to which the glass may have been transferred (e.g., clothing, tools) and package according to the guidelines in Section 1.3.

- ◆ Secure glass fragments in leak-proof packaging, such as rigid plastic containers with tight-fitting lids. Avoid paper or glass containers.
- ◆ Package articles of clothing in well-sealed containers.
- ◆ Collect suspect's outer clothing and shoes as soon as possible after the offense. The suspect should disrobe over paper to preserve any trace evidence that may fall off during the undressing process. Submit the paper along with the clothing. Package all items separately.
- ◆ Hair can be combed to collect possible glass fragments. Perform the combing over paper to preserve any trace evidence that may fall off during the combing process.
- ◆ Photograph condition of glass prior to manipulation or transportation.
- ◆ If fracture examination is desired: submit all broken glass; label any glass in frames or removed from frames to indicate top, bottom, left, right, inside, outside. Package securely to avoid shifting and further breakage during transport. Place tape on glass to keep it intact during packaging and transport. Contact your forensic laboratory prior to collecting or moving the broken item if shot sequence determination is necessary.

KNOWN GLASS:

It is imperative that the known samples of glass are collected from the actual window that was broken. Glass fragments collected from the ground near a broken window are not considered known samples.

Submit the entire item to the laboratory (e.g., window, glass bottle) and package according to the guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- ◆ If possible, collect at least one square inch of glass from the broken object.
- ◆ For multilayer/pane glass (e.g., windshields), collect all layers. Label each layer (e.g., inside, outside).

Precautions for Loss & Contamination

- ◆ Broken glass fragments can be small, sharp, and easily lost. Package items that may have glass carefully in leak-proof containers. Clean collection materials prior to use. Avoid paper or glass containers.
- ◆ Package and transport/ship known glass samples and questioned items in completely different containers.
- ◆ Dry wet materials prior to packaging. Dry them in a clean, controlled area. If any paper was placed beneath the item while it dried, submit the paper along with the item.
- ◆ Once an item of evidence is packaged, avoid removing the item unless necessary (e.g., drying is required).

Forensic Laboratory Capabilities & Limitations

Glass comparisons are performed using class characteristics that may associate fragments with a group of objects with similar properties, but never to a single broken glass object without a physical fit. Only when two or more broken glass fragments physically fit together can it be said that they were once part of the same object (see *Physical Fit*). The laboratory may be able to determine the cause of glass breakage, the direction and angle of the breaking force for mechanical breakage, and the sequence of breaking events.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Burglary

Gunshot Residue

Overview

- ◆ Primer Gunshot Residue (GSR) particles are created when the firing pin strikes the primer cap of a cartridge, detonating the primer components, which then deposits on nearby surfaces (e.g., hands, hair, and clothing).
- ◆ The primer gunshot residue particles differ from those produced by cartridge gunpowder which is used for distance determination.
- ◆ GSR is collected with an adhesive lifter by pressing the stub to the surfaces of interest, usually the hands of a suspected shooter and/or cuffs and sleeves of a suspected shooter's clothing.
- ◆ The examination of GSR can provide investigative leads, corroborate statements or events, and associate a person with the discharge of a firearm.

Detection & Recognition

Primer GSR may be found on any item that is in close proximity to the discharge of a firearm. GSR particles cannot be seen with the naked eye; therefore, adhesive lifters must be employed so that they can be searched using a scanning electron microscope.

Collection & Packaging

Suspected Shooter Hand Stubs:

- ◆ Follow the directions of your kit.
- ◆ Press the adhesive lifter to the web area first, then the entire back and/or palm of hand, depending on the type of kit (number of stubs). Adhesive lifters are dabbed (NOT swiped or rubbed) against the hand multiple times until the tackiness of the adhesive is dissipated.
- ◆ Use a separate lifter for each hand or area sampled.
- ◆ Avoid bloody, wet, soiled, and/or oily areas, if possible.
- ◆ Any reference material (from spent cartridge case and gun (barrel, cylinder/chamber), bullet holes (wound or fabric), and/or the bullet itself can be helpful to assess the detected particle population (GSR from primer, memory effects, bullet contribution).
- ◆ Fill out a form with known facts/details:
 - ◆ Collected from what surface/ hand?
 - ◆ Who collected the evidence?
 - ◆ Time/Date of shooting
 - ◆ Time/Date of collection
 - ◆ Was subject shot?
 - ◆ Last activity of the subject
 - ◆ Occupations and hobbies
 - ◆ What type of ammunition and weapon?

Inanimate objects:

Press an adhesive lifter to the appropriate area of interest (e.g., for clothing it may include the cuffs, sleeves, and front) at the scene to minimize the loss of GSR due to activity during transport or packaging. Otherwise, collect the entire item to which the GSR may have been transferred (e.g., outer layer clothing) and separately package items according to guidelines in Section 1.3.

Precautions for Loss & Contamination

- ◆ It is imperative that the person collecting the samples wash their hands and wear disposable gloves prior to collection. Do NOT allow an officer who recently handled their weapon to be the person collecting this sample.
- ◆ Avoid heavily soiled or bloody areas. These materials could potentially mask the GSR.
- ◆ Collect GSR as soon as possible after the incident. Please note, different laboratories may have different time restrictions.
- ◆ Perform collection at the scene, as there is a potential risk of contamination or loss during transport in police vehicles. If sampling at the scene is not possible, bag the hands or clothing using paper bags and sample as soon as possible.

Forensic Laboratory Capabilities & Limitations

The analysis involves the search for microscopic particles formed when a firearm cartridge is discharged. These molten particles cool in the air quickly and fall in the near vicinity. The adhesive lifts are searched using a high-powered microscope which allows the observation of particle shape and provides the elemental composition.

The GSR on a person's hand can indicate that a person recently discharged a firearm, was in the vicinity of a firearm when it was discharged, or came into contact with a surface containing primer residue. The examination itself cannot determine how the GSR particles were deposited. The absence of GSR on a person's hands does not eliminate that person from having discharged a firearm. Reasons for not finding GSR include, but are not limited to, no discharge of a weapon, GSR particles may have been deposited, but were removed (e.g., hands were washed, too much time has elapsed between shooting and collection), and/or there was an intervening object between the hand and firearm.

Applicable Scene Types

- ◆ Death Investigations
- ◆ Assault
- ◆ Drive-by shooting
- ◆ Robbery

Hair

Overview

- ◆ Hairs are naturally shed, may be forcibly removed from people and animals, are easily transferred and as a result hairs are routinely encountered as evidence.
- ◆ Hairs may be present on a wide variety of items including clothing, upholstery, bedding, flooring, cordage, weapons, and points of entry.
- ◆ Hair comparisons are meaningful due to the range of macroscopic and microscopic characteristics among individuals.
- ◆ The examination of hairs can provide investigative leads, corroborate statements or events, and determine if an association potentially exists between people, objects, or scenes.

Detection & Recognition

Hairs may be found at a variety of crime scenes, adhering to almost anything, such as clothing, bedding, upholstery, weapons, and/or adhesive materials. Locating hairs can sometimes be difficult, so submit the entire item to the laboratory for further examination when possible.

Collection & Packaging

QUESTIONED HAIRS

Collect any loose hairs, objects containing hairs, tape lifts of areas with possible transferred hairs, or vacuumed material from areas of interest. Collect the entire item to which the hairs may have transferred (e.g., clothing, bedding, etc.) and package in paper according to guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- ◆ Use tape lifts to collect most recently deposited loosely adhering debris (e.g., from a vehicle seat or headrest).
- ◆ Use tweezers or gloved fingers to collect loose visible hairs and then place them in paper folds or on sticky notes.
- ◆ Place tape lifts onto a clear plastic sheet and into an envelope or place tape lifts into a clear plastic bag.
- ◆ Use single-use vacuum canisters specifically designed for crime scene collections.

KNOWN HAIRS

Collect known hair samples from any person who may have potentially transferred hair (e.g., suspect, victim, family member, significant other) for comparison and elimination of potential source.

- ◆ When collecting a known hair sample, comb the area of interest (head, pubic region or facial) first. Individually package and label combings. To ensure a range of variation is present, pull 25 to 50 hairs as a known sample from the region of interest (head, pubic region or facial). It is important that known hair samples be pulled rather than cut.
- ◆ If there is more than one region of interest (e.g., head and pubic), label known hair samples from each body area and package separately.
- ◆ During the collection process, obtain a representative hair sample from all areas of the region to reflect the range of characteristics present within the individual's hair (e.g., color, length, degree of curl).
- ◆ Package hair standards in a paper fold and then seal within an envelope or zip-closed bag.

Precautions for Loss & Contamination

- ◆ Package items from different individuals and scenes separately to prevent cross-contamination. Completely seal each package.
- ◆ Ensure collection materials are cleaned prior to use.
- ◆ When possible, submit the whole clothing item with minimal movement or shaking to minimize loss of trace evidence.
- ◆ Improper packaging can cause loss of hair evidence. Do not place questioned hair evidence in an envelope without packaging it first in a paper fold or on the lightly adhesive area of sticky notes as hairs can be lost from the unsealed corners of envelopes.
- ◆ Once an item of evidence is packaged, do not remove the item unless necessary (e.g., drying is required).
- ◆ Dry wet materials prior to packaging. Dry them in a clean, controlled area (e.g., drying cabinet). Submit any paper placed beneath the item while drying along with the items of evidence.

Forensic Laboratory Capabilities & Limitations

A microscopical hair analysis can provide information about whether the hair is human or non-human; the area of the body that the hair originated from; characteristics of ancestry; hair treatments an individual may have used; presence of disease or hereditary condition; the presence of characteristics to indicate decomposition, crushing, or burning; as well as whether a hair may have been cut, naturally shed, or forcibly removed.

A comparison of a questioned hair from a person, object, or scene to a known hair sample or samples can be performed to determine if they could share a common origin. If no exclusionary differences exist between the samples, an individual may be included as a possible source of the questioned hair; however, such an association is not limited to a single person to the exclusion of all others. Instead, an association would include a group of individuals of undetermined size whose hair could share similar microscopic characteristics. DNA testing of the hairs is recommended following an association by microscopical analysis. If tissue is visibly present at the root end of the questioned hair, then nuclear DNA analysis may be conducted; otherwise, mitochondrial DNA analysis should be conducted. Neither a microscopical nor a mitochondrial DNA examination of hair will lead to an identification of a single person to the exclusion of all others. Instead, the results from a microscopical hair comparison in combination with those from mitochondrial DNA analysis can be more informative than either technique alone.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Sexual Assault
- ◆ Burglary

Lamp Filaments

Overview

- ◆ The examination of lamps with filaments can help determine if a lamp was on or off at the moment of impact and can support witness statements. Lighted lamp filaments will behave differently from unlighted filaments when subjected to the accelerations and sudden stops of a collision.
- ◆ This exam is applicable to any lamp with tungsten filament and has been involved in a collision or has been impacted, such as from vehicles, bicycles, farm equipment, or lighted signs. Therefore, it is not possible to draw a conclusion for light-emitting diode (LED), high-intensity discharge (HID), or fluorescent bulbs.

Detection & Recognition

Remove the entire lamp assembly, mark with identifying information (including the location from which it came) and submit to the laboratory with the lamps inside. If it is not possible to submit the entire assembly, individual bulbs may be submitted. Do not turn the lamp switch on. If the switch is already turned on, be sure to document this in your notes and indicate it to the laboratory.

Collection & Packaging

Lamps and lamp assemblies from the impact area are of greatest import as are lamps from areas adjacent to the damage. For example, if the impacted area was at the front of the vehicle, submit the headlamps, parking lamps, and front side marker lamps. Likewise, if the impact damage occurred at the rear of the vehicle, submit the tail lamps, rear side marker lamps, and the backup and license plate lamps.

Packaging for Lamp Assemblies

Box with sufficient padding to prevent damage or loss.

Packaging for Individual Bulbs



or



Padded in a structured container (box, jar, egg carton).
Mark the bulb so the orientation in the vehicle is known.

Packaging for Bulbs with Broken Glass



Protect exposed, fragile filaments by securing in an enclosure such as stacked paper or foam cups.

A copy of the accident report and photographs of the damaged vehicle may assist in the examination describing the impact and showing proximity of the lamps to that damage. Bulbs from undamaged areas of the vehicle can also be used for reference purposes.

Precautions for Loss & Contamination

- ◆ Appropriately protect lamps to ensure they do not break during transport. For example, do not place more than one unbroken lamp into a single plastic bag for submission without bubble wrapping each lamp.
- ◆ For broken lamps, protective enclosures such as nested cups are necessary to cover and preserve fragile and/or broken lamp filaments.
- ◆ Do not turn on lamps at the scene to see if they work. This could lead to the deterioration or destruction of physical features or characteristics and can cause the filament to burnout.

Forensic Laboratory Capabilities & Limitations

Typically, a lamp examination involves the observation of characteristics with the aid of a microscope. The goal is to find indicators as to whether the filament was hot/lighted or cold/off when, at some time, it was subjected to impact shock. No determination as to when the impact shock occurred is possible. Filament distortion, stretching, oxidization, and melted glass are indicators the filament was lighted. A fractured or burned-out filament indicates the lamp was off. However, there may not always be sufficient information to make a definitive conclusion. No conclusion as to on/off condition of a lamp can be made if the lamp does not have a filament. Lamp examinations generally do not include the inspection or testing of electrical systems or wiring in vehicles.

Applicable Scene Types

- ◆ Death Investigations
- ◆ Hit-and-Run

Paint

Overview

- ◆ Paint is manufactured with many different chemical compositions and colors and often is applied in multiple layers, which increases the number of characteristics to compare. Painted surfaces also tend to be repainted over time, building a characteristic layer structure.
- ◆ The examination of paint can provide investigative leads, corroborate statements or events, and determine if an association could exist between people, objects, and/or scenes.
- ◆ The examination of paint evidence can determine the type of paint, possible make, model, and year of a suspect vehicle, and/or determine if questioned paint could have originated from a known source.

Detection & Recognition

Paint may be found at a variety of crime scenes on various items, including tools, baseball bats, clothing, bicycles, and vehicles. Paint evidence may transfer to an object intact or smeared. Often-times transferred paint chips are very small and not visible to the naked eye. Therefore, paint can transfer without visible smears. Transferred paint is not always visible without the aid of a microscope; it is best to submit the entire item for laboratory examination when possible.

Collection & Packaging

QUESTIONED PAINT

Collect any loose paint chips or smears. Collect the entire item to which the paint may have transferred (e.g., clothing, tools, baseball bats, bicycles) and package according to guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- ◆ Use forceps or tweezers to remove visible loose paint chips.
- ◆ Use a razor blade to remove a smear. If possible, carve down to the substrate on the vehicle to keep the smear structure intact and collect from the area with the most transfer present.
- ◆ Package the transferred paint in a small metal canister or a paper fold and placed into a coin envelope with sealed corners.
- ◆ Avoid using tape to lift or collect paint, as the adhesive may interfere with the paint analysis.
- ◆ Use a different razor blade for the collection of each sample.

KNOWN PAINT

Collect known paint samples from any item that may have come into contact with the questioned item (e.g., vehicle, clothing, safe, tool, baseball bat, windowsill/frame) for comparison to the questioned paint. Submit the entire item or part for paint recovery in the laboratory and package according to guidelines in Section 1.3.

If an entire item cannot be collected and sent to the laboratory:

- ◆ Collect known paint from an area in very close proximity to the damage (i.e., on the same vehicle panel) but not including damage because different types of paint may be present in different areas. If more than one area has been damaged, submit a known from each area, but package separately.
- ◆ Collect a small portion of the painted object by carving down to the substrate with a scalpel or razor blade to ensure all layers of paint are collected. Clean the blade or replace the blade between sampling known paint from different areas.
- ◆ Package known paint into small metal canisters or a paper fold and then place into a coin envelope with sealed corners.
- ◆ Collect known samples no smaller than 1 square inch in size, when possible.

Precautions for Loss & Contamination

- ◆ Package known paint and questioned items separately in sealed containers to prevent cross contamination.
- ◆ Ensure collection tools are cleaned prior to use.
- ◆ Completely seal each package.
- ◆ If items are exposed to the environment, collect any transferred paint as quickly as possible.
- ◆ Package items as soon as possible, with minimal movement or shaking to minimize loss of paint evidence.
- ◆ Once an item of evidence is packaged, do not remove the item unless necessary (e.g., drying is required)
- ◆ Dry wet materials prior to packaging. Dry them in a clean, controlled area (e.g., drying cabinet). Place paper beneath an item while drying to preserve any trace evidence that may fall off during the drying process. Submit the paper along with the item.

Forensic Laboratory Capabilities & Limitations

Paint evidence can be submitted for a comparison between questioned paint and a known source as well as for investigative leads. For investigative leads, it can often be determined if a questioned paint sample is automotive, architectural, maintenance paint, etc. In hit-and-run cases, a laboratory may also be able to assist in determining the possible year, make, and model of an original-finish vehicle using an automotive paint database.

When known paint is submitted for comparison to a questioned paint chip or smear, the physical and chemical properties are compared to determine if they could be from the same source. Although paint is mass-produced and cannot be sourced to a single item without a physical fit (see *Physical Fit*) paint comes in many different colors and compositions, as well as different layer structures which adds significance to an association. The strength of a conclusion comes from the numerous points of comparison.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Robbery

Physical Fit

Overview

- ◆ A physical match or fit occurs when two or more pieces of a material with irregular edges aligned demonstrating that they were at one time joined as a single object.
- ◆ When an object is broken, torn, or otherwise severed, the internal stresses and the force applied to create the separation both contribute to the characteristics of the resulting edges. These features can be used to re-align or physically refit the resultant pieces along these edges to reform a continuous object.

Detection & Recognition

Physical fit evidence may be found at a variety of crime scenes, in various 2-dimensional or 3-dimensional forms. Examples include: Homicide – knife tip left in a body fit back to knife blade; Hit-and-Run – car parts at scene fit back to car; Kidnapping – duct tape pieces used to bind victim fit back to tape roll; Physical Assault – wood pieces fit back to the baseball bat; Arson – match fits back to matchbook; Burglary – glass on clothing fits back to window of entry; Sexual Assault – condom wrappers; Bank Robbery – note or check pieces.



Vehicle lens fragments



Pieces of fabric



Rock



Duct tape

Collection & Packaging

Collect any broken/torn pieces from a scene that may be fit back together in the laboratory. To prevent contamination of any adhering surface material, keep items recovered from different scenes separate. Depending on the type of material involved, various forms of packing material may be used to package and preserve the evidence from further breakage.

Package articles of clothing in well-sealed paper bags or boxes. Secure fragments with sharp edges in leak-proof packaging such as rigid plastic containers with tight fitting lids. For sharp objects, avoid paper or glass containers. Package rigid objects securely to avoid shifting and further breakage during transport.

Collect all recovered pieces from the scene, as well as any possible source(s) of the questioned evidence, either in its entirety or at least a portion which includes the damage or severed edge(s).

Precautions for Loss & Contamination

Do not attempt to fit pieces together prior to submission, as this may alter the edges or cause the transfer of other materials that may be otherwise tested in the laboratory.

Forensic Laboratory Capabilities & Limitations

The physics behind the random force used to break or tear an item creates irregular edges that are not reproducible, resulting in characteristic separation characteristics. The forensic examination of these broken, fractured, or separated pieces with irregular edges often includes physical characteristic comparisons, microscopical examinations, and photography. When a physical fit is not possible, a comparison of the class characteristics of the materials may be undertaken. If found to share physical and chemical properties, an association could still be established, but with less certainty of the source object. Alternatively, a comparison could result in the discrimination of that suspected source.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Hit-and-Run
- ◆ Sexual Assault
- ◆ Burglary

Tape

Overview

- ◆ Tapes consist at minimum of a flexible backing and an adhesive. A variety of tape types are commercially available, such as duct, vinyl electrical, packaging, and masking tape.
- ◆ Overall construction and chemical components will vary among tape types and among tape products of the same tape type.
- ◆ The examination of tape can provide investigative leads, corroborate statements or events, and determine if an association potentially exists between objects or scenes.
- ◆ Questioned tape samples may be submitted with a request to identify possible product information, manufacturing, and retailing sources.

Detection & Recognition

Tapes may be found at a variety of crime scenes, such as wrapped around improvised explosive devices (IEDs), used to bind victims, or on threatening letters or envelopes. Although case dependent, tape pieces and tape rolls are generally easy to recover.

Collection & Packaging

Samples for submission include tape recovered from the scene (bindings, threatening letters, bottlenecks, etc.), tape rolls from which the tape pieces were suspected to have originated, or other tape pieces which may have originated from the same roll as those recovered from the scene.

Packaging for Rolls of Tape

Paper box
Paper bag

Packaging for Loose or Wadded Pieces

Paint can
Plastic bag
Box (sticky side up)

Precautions for Loss & Contamination

- ◆ Submit tape while still adhered to an object to minimize loss of other types of evidence (e.g., latent prints, DNA, fibers, hairs, etc.). If unable to submit the item with tape on it, prevent any further distortion or tearing of the tape during removal.
- ◆ Place loose tape pieces onto a plastic sheet (such as acetate transparency film), or onto non-stick aluminum foil to protect tape ends, prohibit entanglements, and prevent further adhesive exposure. If that is not possible or wadded tape is encountered, place tape into a plastic bag, sealed metal can, or into a box with the sticky side up.
- ◆ Do not attempt to untangle wadded tape.
- ◆ Do not cut tape near torn ends.
- ◆ If the tape is cut during removal, mark cut ends accordingly. Use pinking shears when cutting tape evidence to create edges that are easily differentiated from existing cut edges.

Forensic Laboratory Capabilities & Limitations

Typically, a tape examination involves the comparison of physical and chemical properties of samples to determine if they could share a common origin. An association of tapes means the questioned tape sample (from the scene, generally) may have originated from the submitted known tape (roll or other tape pieces), but not to the exclusion of all others manufactured with the same components and in the same manner. A single source cannot be identified based on a compositional tape comparison alone.

A single-source identification is only possible for tape pieces and rolls if a physical fit is found. See Section 2.12 for more information on physical fits.

Questioned tape samples may be submitted with a request to identify possible product information, manufacturing, and retailing sources. Sourcing of questioned tape can provide valuable investigative lead information. Physical characteristics and chemical compositional data are used for searching reference databases, for technical inquiries to tape manufacturing companies, or comparisons with various brands of tape purchased at local commercial outlets.

Tapes are often excellent retainers of other types of evidence, such as fibers, hairs, DNA, impressions, and more. These additional evidence types provide opportunities for further forensic analyses and more persuasive evidence in combination than any one analysis alone.

Applicable Scene Types

- ◆ Arson
- ◆ Death Investigations
- ◆ Explosions
- ◆ Sexual Assault
- ◆ Burglary

Other Types of Trace Evidence

Overview

- ◆ Trace evidence can extend beyond those more commonly encountered forms of evidence discussed to this point. Given the range of potential circumstances that may be encountered, any material may hold evidentiary significance. Some of the other forms of trace evidence that may be encountered include:
 - Building materials such as wood, drywall, metal, concrete, insulation, bricks, and dust from all these products.
 - Animal parts including animal tissue, feathers, bones, and scales.
 - Botanicals
 - Cosmetics and suspected cosmetic residues
 - Food & gastric contents
 - Lubricants arising from condoms but also industrial, food, and household oils and greases
 - Metals and alloys
 - Dusts which may be composed of mixtures of fine particles of any of the materials listed in this guide
 - Wood and paper products
 - Ink, toner, and other colorants
 - Bank dyes
 - Pepper sprays
 - Plastic bags, other plastics, rubbers
 - Inhalants
 - Acids, bases
 - Adhesives and glues
 - Household products or industrial chemicals
 - Unknown materials
 - Other trace evidence: Almost any type of material may hold evidentiary significance.

- ◆ The above materials can be used to provide:
 - Material identifications. In many instances, the identification of a material may provide evidential value. Materials may be identified to varying extents. For example, a particle of wood may be identified simply as “wood”, as hardwood or softwood, to a genus or species, or as a particular type of product (such as landscaping, wood chips, or other items made of wood).
 - Investigative information. Both the identity of the above components and their physical, elemental, and chemical properties may be used to provide validation of witness statements or to place constraints upon the type and order of actions and events related to their deposition. This information can be ascertained without the presence of a comparison sample.
 - Comparative information. When a potential source or comparison material is available, evidence types such as those listed above may be used to provide a comparison based upon physical, chemical, optical, and elemental properties of a material.

Detection & Recognition

The above types of evidence may be observed in a recognizable form (such as feather fragments) or may be present in the form of unknown dust, deposits, or residues. Whether such evidence is explicitly recognized or suspected as being potentially useful, it may be collected for later laboratory analysis. While not every crime laboratory holds the in-house expertise necessary to analyze every type of evidence, a laboratory should have the capacity to suggest outside expertise when these or other atypical forms of trace evidence are recovered.

Collection & Packaging

The above types of evidence are often found in the form of small particles, dust, and residues. These may be collected and packaged using any of the methods listed in this manual. Trace evidence, whether recognizable or in small particles or dust/residue form, may be collected and packaged using paper folds, small boxes and containers, vacuum filters, and tape lifts are common means of packaging. In some cases, it may be preferable to submit an entire object (such as vehicle parts, vehicle floor mat, bedding, and/or clothing) for specialized collection by the laboratory. Take care when collecting or packaging materials that may not be shelf stable, such as evidence containing food or beverages, biological material (such as tissue), or potentially volatile components (such as oils or lubricants). Improper sample collection may impact the potential value of evidence.

Sample Collection

These miscellaneous forms of evidence do not take on a single common form. For such types of evidence or potential evidence, contact the laboratory for advice on:

- the types of samples to collect
- the way to collect and store samples
- where, how, and the volume of comparison samples to collect
- whether it is appropriate to collect control samples or blanks
- how to store samples prior to submission to the lab

Precautions for Loss & Contamination

- ◆ Apply general evidence collection guidelines. The precautions vary based upon the type of material being collected and its size and form.
- ◆ Photo-documentation may provide the laboratory with additional context for interpreting the significance of such samples.
- ◆ When possible, collect a material on its substrate (e.g., a potential stain on a floor mat or Kleenextissue).
- ◆ For atypical forms of evidence, consult the laboratory for evidence-specific collection guidelines.
- ◆ Cold storage may be necessary for the preservation of potential biological or food/beverage related evidence.
- ◆ Preserve potentially volatile evidence in a sealed, non-reactive container. Submit an empty container as a blank.

Forensic Laboratory Capabilities & Limitations

The above forms of evidence may be subject to analyses for the purpose of identification, comparison, or characterization of specific properties. The extent and the limitations of a given analysis may depend upon the type of evidence, the capabilities and expertise of a given laboratory, and the suspected significance of a particular item of evidence in a case. Not all laboratories accept all forms of evidence. In certain instances, the expertise of an outside laboratory specializing in a particular type of evidence may provide additional information that may further increase its evidentiary significance.

Applicable Scene Types

- ◆ All