Section 6 Gunshot Residues and Range Determination Procedures.

History Page

Revision #	Effective date	History
0	1/12/07	This is an original procedure this procedure has been completely reformatted and updated from the previous procedure that was adopted from the Washington State Patrol.
1	10/27/14	Removed photography requirement for sodium Rhodizonate positive.

6.0 Scope and background

The residue and range determination procedures are used to determine muzzle to target distance. When a firearm is fired gunshot residues, including primer residues, burned gun powder particles, partially burned gun powder particles, unburned gun powder particles, vaporous lead and particulate metals, are discharged from the firearm. The residues along with the morphology of the bullet hole may be effectively used in determining the possible muzzle to target distance.

6.1.1 Equipment (section 9 deals with the calibration and maintenance of equipment used in firearm and toolmark procedures).

Microscope
Balance
Laboratory glassware
Rulers or Tape measure
Camera
Alternate Light Source
Iron

6.1.2 Reagents

Sensitized Paper
15% Acetic Acid Solution
5% Hydrochloric Acid Solution
Buffer Solution (for Sodium Rhodizonate)
Diphenylamine Solution
Dithiooxamide Solution
Ammonium Hydroxide:Water 2:5
(Water used in solutions may be tap water)

6.1.3 Visual examination

The visual examination of an item for gunshot residue will include the examination and/or consideration of the following.

- The presence of vaporous lead (smoke)
- The presence of particulate metals (shavings of lead, copper, brass)
- The presence of unburned, burned and partially burned gunpowder
- A hole in the item
- The presence of a visible ring around the perimeter of holes
- The location of all holes, tears, etc.
- The presence of burning, singeing or melting.
- The presence of any possible masking effects.

Data regarding these physical effects and visible residues shall be included in the examination notes.

Visual examination may be aided with the use of filtered or IR photography, or an alternate light source.

6.1.3.1 Interpretation of results for visual examinations

6.1.3.1.1 Indicative of/ Consistent with the discharge of a firearm

- Vaporous lead (smoke)
- Particulate metals
- Unburned, burned and partially burned gunpowder
- Melted adhering gunpowder

6.1.3.1.3 Indicative of/ Consistent with a contact shot

- Ripping or tearing
- Burning or singeing
- Melted artificial fibers
- Heavy vaporous lead residues

6.1.3.2 Limitations: Possible masking effects

Dark background color
Blood Staining

6.1.4 Microscopic examination

The microscopic examination of an item for gunshot residue will include the examination and/or consideration of the following:

- The presence of vaporous lead (smoke)
- The presence of particulate metals (shavings of lead, copper, brass)
- The presence of unburned, burned and partially burned gunpowder
- The presence of melted adhering gunpowder
- The presence of burning, singeing, or melting
- The presence of any possible masking effects

6.1.4.1 Interpretation of results for microscopic examinations

6.1.4.1.1 Indicative of/ Consistent with the discharge of a firearm

- Vaporous lead (smoke)
- Particulate metals
- Unburned, burned and partially burned gunpowder
- Melted adhering gunpowder

6.1.4.2 Limitations: Possible masking effects

Dark background color
Blood Staining

6.1.5 Chemical examinations methods

If multiple chemical examinations are going to be performed on an item they must follow a specific order. Modified Griess first, Dithiooxamide second, Sodium Rhodizonate.

6.1.5.1 Modified Griess Test

The Modified Griess test may be used independently and or in conjunction with other tests in range determinations. The Modified Griess test utilizes a color chemistry reaction to help distinguish gunshot residue patterns not visible with the naked eye or the microscope. The test detects nitrites, a product of the incomplete burning of gunpowder, by reacting with acetic acid to form nitrous acid. This acid combines with alpha-napthol and produces an orange-red color.

6.1.5.1.1 Preparation of reagents

(the following may be made in different amounts using appropriate ratios)

Sensitized Paper:

Add 0.75 g Sulphanilic acid to 150 ml water
Add 0.42 g of Alpha Napthol to 150 ml methanol
Mix solutions together in a clean tray
Saturate filter paper, desensitized photo paper or computer photo paper in solution
Dry the paper and store in an airtight plastic container

Acetic acid Solution

Prepare a 15% glacial acetic acid solution.

Nitrite test swabs

Dissolve 0.06 g of sodium nitrate in 100 ml water.
Saturate filter paper or cotton swabs in the mixture. Dry and store in an airtight plastic container.

6.1.5.1.2 Application Procedure

Direct application

6.1.5.1.2.1. Place sensitized paper directly under area to be tested.
6.1.5.1.2.2. Soak a piece of nitrate-free cheesecloth or filter paper with the acetic acid solution, and place this over the reverse side of the evidence.
6.1.5.1.2.3. Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.

Reversed application

6.1.5.1.2.4. Moisten the side of the sensitized paper that will be in contact with the questioned area with the acetic acid solution.
6.1.5.1.2.5. Place the sensitized paper over the area to be tested.
6.1.5.1.2.6. Place a piece of filter paper or nitrite-free cheesecloth over the sensitized paper.
6.1.5.1.2.7. Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.

6.1.5.1.3 Controls

The control for the Modified Griess procedure consists of placing a test mark, utilizing a nitrite test swab, on the edge of each sensitized paper being used. An immediate orange color should appear. The color shift indicates that the sensitized paper is sensitive to the presence of nitrites.

6.1.5.1.4 Interpretation of results

Any orange, orange red indications on the paper are the results of the chemically specific test for the presence of nitrite residues. Positive results shall be documented with photographs, negative results and results of controls need only be noted.

6.1.5.4 Dithiooxamide (DTO)

The DTO test is used independently and/or in conjunction with other tests in range determination. The DTO test utilizes a color chemistry reaction to indicate the presence of copper. This test may be effective in determining physical characteristics of bullet holes including entrance vs. exit holes. A fired bullet passing through clothing or other items often leave traces of copper around the bullet hole. The copper transfer comes from copper-containing bullets, and/or the barrel of the firearm. The transfer may be in the form of minute particles, a fine coating of particles, or a fine cloud of vaporized copper. The copper transfer may be an obvious ring or wipe but is often not visible

6.1.5.4.1 Preparation

Dithiooxamide Solution: 0.2% solution Dithiooxamide in ethanol (w/v).

Ammonium Hydroxide solution: 2 parts conc. ammonium hydroxide to 5 parts water.

6.1.5.4.2 Application Procedure

Place about three drops of Ammonium Hydroxide solution on filter paper.
Place the treated paper over the area to be tested.
Place a second piece of filter paper over the first and apply moderate pressure.
Remove both pieces of paper and place about 3 drops of Dithiooxamide solution to the tested area of the filter paper.

6.1.5.4.3 Controls

A positive control will be run each day the reagents are used and the results of the control will be noted in the examination notes.
A positive control can be obtained by creating a test mark on an appropriate piece of material with know copper, or by wetting 2 swabs with the Ammonium Hydroxide solution and rubbing one on a known piece of copper and then adding the DTO solution to both swabs.

6.1.5.4.4 Interpretation of results

A dark greenish-gray color reaction, corresponding to the area tested, indicates a positive reaction for copper. Results will be noted in examination documentation.

6.1.5.2 Sodium Rhodizonate Test

The Sodium Rhodizonate test is used independently and/or in conjunction with other tests in range determinations. The Sodium Rhodizonate test utilizes a color chemistry reaction that is specific for lead and can effectively be used in determining the physical characteristics of bullet holes including the determination of entrance vs. exit holes. Fired bullets passing through clothing and/or other objects often leave traces of lead around the bullet hole. The lead transfer comes from the surfaces of the bullet, the barrel and/or the primer residue. This lead transfer can be in the form of minute particles, a fine coating of powder particles or a fine cloud of vaporized lead. At times this lead transfer is an obvious ring or wipe around the hole but is more often not visible.

6.1.5.2.1 Preparation of reagents

(These reagent may be prepared in different quantities with the appropriate ratios.)

Sodium Rhodizonate saturated solution: Saturate water with sodium rhodizonate.

Hydrochloric Acid Solution: Prepare a 5% HCl solution (5 mls conc. HCl in 95 mls of water).

Buffer Solution: Dissolve 1.9g sodium bitartrate and 1.5 g tartaric acid in 100ml of di water. The may require heat and agitation.

Acetic Acid Solution: Prepare a 15% acetic acid solution (15 mls glacial acetic acid in 85 mls of water).

6.1.5.2.2 Application procedures

Kashinsky Transfer Technique

6.1.5.2.2.1. Uniformly dampen a piece of filter paper with Acetic Acid solution.

6.1.5.2.2.2. Place the treated filter paper over the hole/area to be tested.

6.1.5.2.2.3. Place a second piece of paper over the first and apply moderate pressure or apply a hot iron for approximately 5 seconds.

6.1.5.2.2.4. Remove both pieces of filter paper and spray the Sodium Rhodizonate solution on to the tested area of the filter paper.

6.1.5.2.2.5. Spray the tested area of the filter paper with the Buffer solution

6.1.5.2.2.6. Spray the tested area of the filter paper with the Hydrochloric acid solution.
6.1.5.2.2.7. Repeat this process on all hole/area to be tested. Both sides of the hole should be tested if there is question of direction.

Direct Application
6.1.5.2.2.8. Apply Sodium Rhodizonate solution on to the questioned area.
6.1.5.2.2.9. Apply the Buffer solution to the questioned area
6.1.5.2.2.10. Apply the Hydrochloric acid solution to the questioned area.
6.1.5.2.2.11. Repeat this process on all hole/areas to be tested. Both sides of a hole should be tested if there is question of direction.

Swab Technique
6.1.5.2.2.12. Dampen a swab with Acetic Acid.
6.1.5.2.2.13. Swab the area of interest.
6.1.5.2.2.14. Apply Sodium Rhodizonate solution to swab.
6.1.5.2.2.15. Apply Buffer solution to swab.
6.1.5.2.2.16. Apply Hydrochloric Acid solution to swab.

6.1.5.2.3 Interpretation of results
A violet or purple colored ring, corresponding to the margin of the hole, or a violet or purple colored stain, corresponding to the area tested constitutes a positive reaction for lead. Results will be noted in examination documentation.

6.1.5.2.4 Controls
A positive control will be run each day before the reagents are used to ensure they are working properly. A positive control may be prepared by placing a test mark with a piece of lead on an appropriate material or by wetting a swab with a 5% solution of HCl and swabbing a piece of lead with it.

6.1.5.3 Diphenylamine test
The diphenylamine test utilizes a color chemistry reaction to indicate the presence of nitrates and/or nitrites. Diphenylamine reacts with the nitrates or nitrites to give a dark blue color reaction. Some gunpowder particles may be deposited on surrounding objects or clothing. This test can effectively identify an area in which a firearm was discharged through the examination of vacuum sweepings or clothing.

6.1.5.3.1 Preparation (may be mixed at different quantities with using appropriate ratios.)

Diphenylamine Solution: add 0.3g diphenylamine to 20ml conc. sulfuric acid. Add this mixture to 10ml glacial acetic acid.

6.1.5.3.2 Application Procedure
Examine evidence macroscopically and microscopically.
Separate potential gunpowder particles based on size, color and shape.
Place Diphenylamine reagent in empty spot test well then add unknown particles.

6.1.5.3.3 Interpretation of results
A dark blue color reaction with an unknown particle indicates the presence of nitrates or nitrites. Results will be noted in examination documentation.

6.1.5.3.4 Controls
A positive control of known gunpowder will be tested each day the reagent is used and the results will be noted in the examination documentation.

6.1.6 Test Pattern Methods
In muzzle to target determinations if observations support the findings of a "contact shot" no comparison is necessary. If the observations do not support a "contact shot " finding, a hypothesis will be formed based on observations and use the comparison procedures described in 6.1.6.1 or 6.1.6.2.

6.1.6.1 Non-shot pellet test pattern production
It is an essential prerequisite that the suspected firearm and ammunition consistent with the suspect ammunition be utilized.

6.1.6.1.1 Preparation
Attach appropriate sized piece of an appropriate test material to nitrite-free cardboard backing board.

Tests should be shot in increasing or decreasing range increments until a distance is established both shorter and longer than, that which reproduces the gunshot residue patterns on the suspect item.

If the test patterns are obtained outside, they must be obtained during appropriate weather conditions. It must not be raining or have strong winds present.

6.1.6.1.2 Interpretation of results
By utilizing the suspect firearm and appropriate ammunition it is possible to obtain a reproduction of a gunshot residue pattern present on a suspect

item. Therefore one can ascertain the approximate distance that a particular firearm's muzzle was from the suspect item when it was shot. The witness sheets will be stored centrally in the lab. The location of the sheets will be documented in the case notes.

6.1.6.2 Shot pellet test pattern production

It is an essential prerequisite that the suspect firearm and ammunition consistent with the suspect ammunition be utilized.

6.1.6.2.1 Preparations

The test media for shot pellet test patterns is an appropriate sized piece of poster board, heavy paper or cloth attached to cardboard.

Tests should be shot in increasing or decreasing range increments until a distance is established, both shorter and longer than that which reproduces the shot patterns on the suspect item.

If the test patterns are obtained outside, they must be obtained during appropriate weather conditions. It must not be raining or have strong winds present.

6.1.6.2.2 Interpretation of results

By utilizing the suspect firearm and appropriate ammunition it is possible to obtain a reproduction of a shot pattern present on a suspect item. Therefore one can ascertain the approximate distance that a particular firearm's muzzle was from the suspect item when it was shot. The witness sheets will be stored centrally in the lab. The location of the sheets will be documented in the case notes.

6.2 Safety

These procedures involve hazardous materials. It is the responsibility of the user of these procedures to establish appropriate health and safety practices. Proper caution to include adherence to test firing rules and the use of personal protective equipment must be considered to avoid exposure to potential hazards. Consult the appropriate MSDS for each chemical prior to use.

6.3 Possible Results for Range Determinations

There are many possible results relating to muzzle to target distance and the reporting of residues and shot patterns. This section is included as a guide for the most frequently reported results. It should not be construed as all-inclusive or limiting to the examiner in reporting examination results.

- Item XXX was examined and found to exhibit holes consistent with the passage of projectiles in the XXX (area of target).
- Item XXX was examined and found to exhibit no damage that was consistent with having been produced by the passage of a projectile.
- Visual and chemical examination of the holes and areas surrounding the holes revealed a gunshot residue pattern.
- Visual and chemical examination of the holes and areas surrounding the holes failed to reveal a gunshot residue pattern.
- Portions of XXX were used in distance determination testing.
- The damage found in item XXX is consistent with a contact gunshot.
- Based on tests using the firearm submitted in item XXX and the ammunition submitted in or similar to item XXX, it was determined that the gunshot residue pattern found on item XXX is consistent with a muzzle to target distance greater than XXX but less than XXX.
- The absence of a gunshot residue pattern on Item XXX precludes the determination of a muzzle to target distance.
- The absence of gunshot residue on Item XXX indicates a muzzle to target distance greater than XXX.

6.5 References

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