I. Scope

Establishing the distance from which a particular shooting took place can provide critical information to aid in the reconstruction of a series of events regarding the shooting. Establishing the distance from which a particular shot or series of shots occurred can help to refute or corroborate witness accounts. These guidelines establish a standard approach for the determination of the muzzle-to-target distance when clothing or other evidence material and suspect firearm(s) are submitted.

II. References

Bureau of Alcohol, Tobacco, Firearms and Explosives National Firearms Examiner Academy Gunpowder and Gunshot Residue Manual

Dillon, J. "A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations." *AFTE Journal*. 22(3), July 1990, pp. 257-274.

Dillon, J. "A Protocol for Shot Pattern Examinations in Muzzle-to-Target Distance Determinations." *AFTE Journal.* 23(1), January 1991, pp. 511-521.

Dillon, J. "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrite Compounds in Gunshot Residues." *AFTE Journal*. 22(3), July 1990, pp. 243-250.

Dillon, J. "The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead in Gunshot Residues." *AFTE Journal.* 22(3), July 1990, pp. 251-256.

Haag, M. and Wolberg, G. "Scientific Examination and Comparison of Skin Simulants for Distance Determinations." *AFTE Journal*. 32(2), Spring 2000, pp. 136-142.

Haag, L. "A Microchemical Test for Copper-Containing Bullet Wiping." *AFTE Journal.* 13(3), July 1981, pp. 22-28.

Nichols, R. "Expectations Regarding Gunpowder Depositions." *AFTE Journal.* 30(1), Winter 1998, pp. 94-101.

Nichols, R. "Gunshot Proximity Testing: A Comprehensive Primer in the Background, Variables and Examination of Issues Regarding Muzzle-to-Target Distance Determinations." *AFTE Journal.* 36(3), Summer 2004, pp. 184-203.

III. Safety Precautions

See ATF-LS-FT8 Firearms Safety Guidelines. Range protection equipment, laboratory coat, eye protection, rubber gloves, fume hoods, MSDS sheets, and acid spill kits.

NOTE: *Some chemical analyses used to examine for the presence of GSR result in the formation of azo dyes, which are highly carcinogenic. Any chemically processed material(s), other than the submitted evidence, do not need to be retained and may be destroyed. However, the results of all chemical tests must be documented with color photos containing a scale to show any significant analytical observations i.e. – positive controls and any observed reactions of analysis.*

Apparatus/Reagents

Apparatus and equipment include: ammunition, target material, target supports, tape measure, range protection equipment, iron, sprayer, fume hood, filter paper or Bench Kote, pre-treated photograph paper, and blow dryer.

Reagents – amounts can be adjusted to ensure the ratios are equivalent

1. Sodium Rhodizonate Solution
    1. To be prepared fresh
    2. Saturated aqueous(distilled/purified water) solution of Sodium Rhodizonate

2. 5% Hydrochloric Acid Solution
    1. Can be prepared ahead
    2. Add 5mL of concentrated Hydrochloric Acid to 95 mL distilled/purified water

3. Buffer Solution
    1. Can be prepared ahead
    2. Dissolve 1.9 grams Sodium Bitartrate and 1.5 grams Tartaric Acid in 100 mL of distilled/purified water

4. 15% Acetic Acid Solution
    1. Can be prepared ahead
    2. Add 15mL of Glacial Acetic Acid to 85 mL of distilled/purified water

5. 5% Acetic Acid Solution
    1. Can be prepared ahead
    2. Add 5mL Glacial Acetic Acid to 95 mL of distilled/purified water

6. Dithiooxamide (DTO) Solution
    1. To be prepared fresh
    2. Dissolve 0.2 gram of DTO in 100 mL of ethanol

7. Ammonium Solution
    1. Can be prepared ahead
    2. Add 20 mL of ammonium hydroxide to 50mL of distilled/purified water

8. Modified Griess Film Treatment Solution and Photo Paper Treatment
    1. Can be prepared ahead
    2. Dissolve 0.75 gram Sulfanilic Acid in 150 mL distilled/purified water
    3. Dissolve 0.42 gram Alpha-naphthol in 150 mL of methanol
    4. Mix the sulfanilic acid and alpha-naphthol solutions in a clean tray
    5. Saturate photo paper in the solution and allow to dry

9. Nitrite Reagent for Cotton Test Swabs and Swab Treatment
    1. Can be prepared ahead
    2. Dissolve 0.6 gram sodium nitrite in 100 mL distilled/purified water
    3. Saturate cotton swabs in solution and allow to dry

IV. Procedures

See ATF-LS-FT9 Firearm and Toolmark Examination and Documentation for minimum required documentation and supplemental documentation depending on the purpose for which the firearm was submitted for examination.

General Procedure

1) Assess and document any physical (damage) effect and/or residue pattern present on evidence as a result of a bullet (gunshot) strike. The following are aspects of the physical effect(s) and pattern(s), as well as related evidence that shall be considered:
    a. Presence of burned gunpowder
    b. Presence of and, if possible, type of unburned powder
    c. Presence of soot and/or smoke
    d. Size (diameter) and relative density of the GSR pattern (including burnt and/or un-burnt gunpowder)
    e. Presence of particulate materials (shavings of lead, copper, brass, etc.)
    f. Location of holes in the item
    g. Presence of ripping or tearing around any holes of an item
    h. Presence of melted, adhering gunpowder
    i. Presence of a visible ring around the perimeter of holes (bullet wipe)
2) Other aspects that may be considered:
    a. Presence of burning, singeing or melting
    b. Presence of possible masking effects (variables)
    c. Pattern of artifacts surrounding holes
    d. Pellet pattern size
3) Based on experience, training and relevant literature, an approximation or estimate a potential range of distances from which the shot may have been fired.
4) Using target material that is suitable for the evidence and pattern to be produced, conduct a series of distance tests in an attempt to replicate the pattern(s) observed on the evidence. The following considerations are important:
    a. The suspect firearm must be used

b. The suspect ammunition should be used. However, use of ammunition of similar manufacturer, caliber, bullet weight, shot size, powder type, etc. is acceptable.
c. Target material generally consists of white cotton. For critical powder pattern assessments, target material similar in all respects to evidence material should be used. For pellet pattern estimation, heavy paper is suitable.

5) Using visual examination of pattern elements and chemical testing (see below) for gunshot residues where appropriate, compare the evidence pattern(s) to distance tests. Features of comparison can include:
   a. Pattern diameter
   b. Pattern density
   c. Results of chemical tests
   d. Overall appearance of pattern
6) Using visual examination of any physical (damage) effects, an assessment as to firearm muzzle contact or greater than contact proximity to the target evidence could be made. Assessment features include:
   a. Stellate type ripping or
   b. Stellate type tearing of a hole
7) Those observations that were made and used to form the basis of conclusions shall be documented in case notes.
8) Estimate range of muzzle-to-target distance for the evidence pattern based on test patterns. Conclusions may offer:
   a. Range between which it is likely evidence shot was fired
   b. Maximum distance at which residues are deposited
   c. Presence of lead wipe with no residues
   d. No residues found

Chemical Testing

If multiple chemical tests are to be performed on a target or other bullet impact site, they are to be performed in the following order:

1. Modified Griess Test for nitrites (and reverse Modified Griess Test)
2. Dithiooximide for copper
3. Sodium Rhodizonate for lead (and Bashinski Transfer Method)

Modified Griess Chemical Test Procedure

1) Write lab case number, exhibit number, date and examiner initials on treated photo paper.
2) Test corner of photo paper with nitrite swab soaked in 15% acetic acid.
3) Note orange color reaction.
4) Place evidence/distance test (EV/DT) question side down on photo paper.
5) Index seams, buttons, buttonholes, or suspect bullet holes, etc., with pencil.
6) Place cheesecloth soaked in 15% acetic acid solution on (EV/DT).
7) Press cheesecloth with hot iron.
8) Note orange color reaction pattern on photo paper and let dry.
9) Take color photographs, with a scale, of significant analytical observations to include: reaction of controls and results of analysis.

Reverse Modified Griess Chemical Test Procedure

1) Write lab case number, exhibit number, date and examiner initials on photo paper.
2) Tape filter paper to back of desensitized photo paper and test corners with nitrite swab soaked in 15% acetic acid solution.
3) Note orange color reaction.
4) Index seams, buttons, button holes, or suspect bullet holes, etc., with pencil.
5) Wipe treated emulsion side of photo paper with cheesecloth soaked in 15% acetic acid solution or spray with 15% acetic acid solution.
6) Place photo paper on (EV/DT).
7) Press hot iron on filter paper taped to back of the photo paper until 15% acetic acid solution dries.
8) Note orange color reaction pattern on photo paper and let dry.
9) Take color photographs, with a scale, of significant analytical observations to include: reaction of controls and results of analysis.

Dithiooximide (DTO) Chemical Test Procedure

1) Test DTO solution by saturating a clean cotton swab with ammonia solution and rubbing against a piece of known copper. Process swab with DTO solution.
2) Note dark, greenish gray color.
3) Moisten a small area of filter paper or Bench Kote with ammonia solution sufficiently to cover area of bullet hole/impact site.
4) Place the moistened area against the bullet hole/impact site and cover with filter paper.
5) Press and rub with moderate pressure for approximately 5 seconds.
6) Remove filter paper and test paper. Process test paper with DTO by applying approximately 3 drops of DTO solution to the area in contact with the bullet hole/impact site.
7) Note dark, greenish-gray color (positive for copper) or blue-violet color (positive for nickel) and allow test paper to dry.
8) Take color photographs, with a scale, of significant analytical observations to include: reaction of controls and results of analysis.

Sodium Rhodizonate Chemical Test Procedure - Direct

1) Using a known lead sample run control test with filter paper and chemicals to be used on evidence.
2) Spray appropriate area with saturated aqueous solution of sodium rhodizonate
3) Spray the same area with buffer solution to eliminate the yellow background color and establish a 2.8 pH environment - pink color may appear.
4) Spray the same area with 5% hydrochloric acid solution - only lead will produce a blue-violet color reaction.
5) Take color photographs, with a scale, of significant analytical observations to include: reaction of controls and results of analysis.

Bashinski Transfer Method

1) Using a known lead sample run control test with filter paper and chemicals to be used on evidence.
2) Place filter paper or Bench Kote over test area and index seams, buttons, button holes or suspect bullet holes, etc. with pencil.

3) Dampen filter paper with 15% acetic acid solution.
4) Cover dampened filter paper with several layers of dry filter paper. Press with hot iron.
5) Spray appropriate area of filter paper with saturated solution of sodium rhodizonate in distilled/purified water.
6) Spray the same area with buffer solution to eliminate the yellow background color and establish a 2.8 pH environment - pink color may appear.
7) Spray the same area with 5% hydrochloric acid solution - only lead will produce a blue-violet color reaction.
8) Take color photographs, with a scale, of significant analytical observations to include: reaction of controls and results of analysis.

V. Quality Control

Use of measuring devices that are properly calibrated, reagents that are properly prepared and functioning properly with controls, use of proper ammunition, use of similar target material as the evidence, and proper assessment of pattern elements (smoke, soot, powder) will ensure reliable results.