Guidelines for Gunshot Residue Distance Determinations

1.0 Objective

The purpose of this document is to set forth guidelines to examiners conducting gunshot residue distance determinations.

2.0 Introduction

A laboratory shall have policies in place to provide the firearms examiner with a comprehensive protocol and examination sequence in conducting examinations for the detection of gunshot residues and the physical effects due to gunshots.

The examination of items for projectile defects, impact sites, and subsequent range determination of a firearm-to-target distance can include the evaluation of gunpowder, lead residue pattern/wipe and copper wipe.

When a firearm is fired, gunshot residues in the following forms are discharged from the firearm:

- Unburned and/or partially burned gunpowder particles
- Soot and/or vaporous lead
- Nitrite residues
- Other particulate metals

These gunshot residues along with the morphology of the bullet defect can be used to determine the possible muzzle to target distance.

3.0 Procedures

3.1 Materials

3.1.1 Suggested Equipment: Stereomicroscope; alternate light sources; clothing test material; protective gloves; photography scales; measuring devices; safety glasses; copper and lead controls, nitrite treated cotton swabs; bullet puller; etc.

3.1.2 Chemical reagents include, but are not limited to: Alpha-Napthol, Marshall's, Dithiooxamide (DTO), 2-Nitroso-1-Naphthol (2-NN), Sodium Rhodizonate, Acetic Acid, Hydrochloric Acid, Methanol, Sodium Nitrite, Potassium Chloride, deionized water. Chemical formulas and MSDS sheets should be available in the laboratory for reference.

3.1.3 Evidence related items typically include garments or other objects, autopsy photographs/reports, actual firearm and similar ammunition. The outer clothing is required for distance determination.

3.2 Controls

3.2.1 Nitrite cotton swabs are used for the positive control for Griess/Modified Griess reagent.

3.2.2 A copper standard is used as the positive control for the DTO and 2-NN tests.

3.2.3 A lead standard is used as a positive control for the Sodium Rhodizonate Test (NaRho).

3.2.4 Negative controls (adjacent area of the positive control) should also be obtained.

3.2.5 Lot numbers of reagents and control tests results should be documented in the examiner's notes.

3.3 Examination Sequence

A procedural sequence must be followed for the Griess/Modified Griess Test, DTO or 2-NN Tests, and the Sodium Rhodizonate Test to prevent chemical interference. The Griess/Modified Griess Test always precedes the DTO/2-NN Tests and Sodium Rhodizonate Test.

3.4 Visual and Microscopic Examination of Evidence

3.4.1 The initial examination pertains to the presence of observable physical characteristics and residue on the clothing. All observations shall be documented.

3.4.2 The microscopic examinations are generally performed with a stereoscope. The examiner should also consider other means of detection such as infrared or other alternate light sources.

3.4.2.1 Indicative of/consistent with a contact shot:
- 3.4.2.1.1 Ripping, tearing (stellate)
- 3.4.2.1.2 Burning, singeing
- 3.4.2.1.3 Melted synthetic fibers
- 3.4.2.1.4 Heavy vaporous lead residues (smoke)

3.4.2.2 Indicative of/consistent with the passage of a bullet:
- 3.4.2.2.1 A hole in an item
- 3.4.2.2.2 A visible ring around the perimeter of the hole (bullet wipe)

3.4.2.3 Consistent with the discharge of a firearm:
- 3.4.2.3.1 Vaporous lead (smoke)
- 3.4.2.3.2 Particulate lead shavings or solidified droplets
- 3.4.2.3.3 Unburned gunpowder
- 3.4.2.3.4 Melted, adhering gunpowder

3.5 Chemical Processing

3.5.1 After microscopic examination is completed, certain chromophoric tests may be conducted, as appropriate, for the various types of gunshot residues.

3.5.2 Prior to any chemical testing, the examiner should have a procedure in place to address factors such as blood, dirt and other masking materials that may hinder chemical testing results.

3.5.3 The Griess/Modified Griess Test is a chemical test specific for the detection of nitrite deposits (unburned or partially burned gunpowder deposited around suspected bullet holes).

3.5.4 The DTO and 2-NN Tests are specific for the detection of copper residues from the passage of a copper jacketed bullet.

3.5.5 The Sodium Rhodizonate Test is specific for the detection of lead residue related to the passage of a bullet. This includes vaporous lead (smoke), particulate lead and "bullet wipe".

3.5.6 The results of these tests should be thoroughly documented with narratives, sketches, and/or photographs in the examiner's notes.

3.6 Interpretation of Results

Gunshot residue distance determinations are a result of residues detected on an item of evidence. The absence of residues is not a basis for expressing a distance determination. The examiner should understand that shooting events are dynamic and must consider the possibility of intervening objects when determining a maximum (drop-off) distance for gunshot residue deposits.

The results of the Sodium Rhodizonate Test should be consistent with the results of the Griess/Modified Griess Test at a particular muzzle-to-target distance and with any physical effects present.

3.6.1 Contact Shot: A contact shot is based on the presence of characteristic ripping and tearing (stellate), the burning and singeing of cloth, the melting of synthetic fibers, and the heavy vaporous lead (smoke) deposits around the suspected bullet hole. In certain instances, the firearm may not be needed.

3.6.2 Nitrite Residues: Patterns of detectable nitrite residues around a suspect bullet hole vary in size and density. When a pattern of nitrite deposits is detected, it may be possible to reproduce this pattern using the submitted firearm and ammunition in combination.

3.6.3 Copper Residues: Particulate and vaporous copper are chemically detectable utilizing the DTO or 2-NN Tests. Copper bullet wipe is consistent with the passage of a bullet and cannot determine distance.

3.6.4 Vaporous Lead/Lead Residues: Vaporous lead deposits are typically deposited at close ranges and are detected utilizing the Sodium Rhodizonate Test. Such residues are produced to an approximate maximum distance, which can be determined by testing the suspect firearm and ammunition at known distances. Lead bullet wipe is consistent with the passage of a bullet and cannot determine distance. In certain circumstances, the use of lead free ammunition may preclude a positive reaction with this detection method.

3.6.5 The results of these tests must be documented in the examiner's notes in the form of narratives, sketches and/or photographs.

3.7 Distance Tests

3.7.1 When reproducing residue patterns (powder particles or vaporous lead), it is essential that the suspect firearm and similar ammunition be used for the distance tests to accurately reproduce residue patterns. Factors affecting the pattern of residues include, but are not limited to, ammunition, barrel length, caliber, and powder type/charge.

For the majority of situations, white cotton twill cloth is suitable as a test target media. However, there may be instances where the characteristics of the evidence item are unusual enough to preclude meaningful test patterns with the cotton twill cloth. In such cases, it may be necessary to duplicate the evidence material, or to utilize a portion of the evidence item for firing known-distance tests.

3.7.2 When reproducing patterns of residues, it is appropriate to fire known distance targets that will produce patterns both smaller and larger than the residues found on the evidence item. This method allows a range of distance of the evidence pattern to be established. Such a bracket should be wide enough to account for differences expected in commercially manufactured ammunition and variations normally expected from shot-to-shot. It is recommended that more than one panel at the suspected distance be fired to demonstrate reproducibility.

3.7.3 When residues are not found, it may be necessary to find the maximum distance (drop-off) from which residues are discharged from a firearm. Protocols should be in place to determine the distance at which the residues are always observed, and the distance at which residues are not observed at known distances. This forms a bracket or range for the maximum distance that particular type of residue will be deposited.

3.8 Limitations

The Griess/Modified Griess, DTO/2-NN, and Sodium Rhodizonate Tests yield reactions to nitrite, copper, and lead residues, respectively. As shooting events are dynamic and often complicated, residue testing results shall be weighted according to the scenario and the condition of the evidence.

4.0 Documentation

The above tests are generally considered destructive to the evidence and the examiner must document the examination and evaluation including photography and standardized worksheets.

5.0 Safety

Standard safety procedures set forth should be followed. When firing known-distance tests, the safety protocols and range rules will be followed.

Appendix 1 - References

1. Bashinski, JS, Davis, JE, Young, C. Detection of Lead In Gunshot Residues On Targets Using The Sodium Rhodizonate Test. AFTE Journal 1974 Aug; 6(4):5.

2. Thompson, RC. The Effects of Wind Velocity on Gunshot Powder And Residue. AFTE Journal 1977 Jul; 9(2):139.

3. Stone, IC, Di Maio, VJM. Metallic Residues in Gunshot Wounds. AFTE Journal 1977 Jul;9(2):31.

4. Wecht, CH, Perper, JA. The Forensic Examination of Gunshot Wound Fatalities. AFTE Journal 1980 Jan;12(1):11-18.

5. Doyle, JS. Griess Test Modification. AFTE Journal 1987 Apr;19(2):165-66.

6. Shem, RJ. A Simplified Griess and Sodium Rhodizonate Test. AFTE Journal 2001 Feb;3(1):37-39.

7. Dillon, Jr., JH. A Protocol for Shot Pattern Examinations in Muzzle-To-Target Distance Determinations. AFTE Journal 1991 Feb;23(1):511-21.

8. Allen, DE. Effects of Blood on Gunshot and Gunpowder Residue. AFTE Journal 1983 Apr;15(2):102-3.

9. Horvath, MA. Interpretation of Gunshot Residue Patterns Using Infrared Microscopy. AFTE Journal 1981 Jan;13(1):21-31.

10. Veitch, VM. An Examination of The Variables That May Be Encountered In Gun Shot Residue Patterns. AFTE Journal 1981 Apr;13(2):35-54.

11. Campbell, PA. Antazoline Hydrochloride vs. the Griess Test, Detection of Nitrites In Gunshot Residues. AFTE Journal 1982 Apr;14(2):87-109.

12. Lekstrom, JA, Koons, RD. Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test. Journal of Forensic Sciences 1986 Oct;31(4):1283-91

13. Haag, MG. 2-Nitroso-1-Naphthol vs. Dithiooxamide in Trace Copper Detection at Bullet Impact Sites. AFTE Journal 1997 May;29(2):204-9.

14. Schous, CE. A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues. AFTE Journal 1999 Feb;31(1):3-8.

15. Haag, MG, Wolberg, G. Scientific Examination and Comparison of Skin Simulants for Distance Determinations. AFTE Journal 2000 May;32(2):136-42.

16. Nichols, RG. Gunshot Proximity Testing: A Comprehensive Primer in the Background, Variables and Examination of Issues Regarding Muzzle-to-Target Distance Determinations. AFTE Journal 2004 Aug;36(3):184-203.

17. Haag, MG. Trace Bullet Metal Testing for Copper and Lead at Suspected Projectile Impacts. AFTE Journal 2006 Nov;38(4):301-9.

18. Giroux, BN. Non-Destructive Techniques for the Visualization of Gunshot Residues. AFTE Journal 2006 Nov;38(4):327-38.

Appendix 2 – Document History

Date	Section	Changes
02/18/2013	1.1.2	Alpha-Napthol and 2-Nitroso-1-Napthol (2-NN) were added to the list of chemical reagents
02/18/2013	1.2.2, 1.3.1, 1.5.4, 1.6.3, 1.8	2-NN Test was added to sections
02/18/2013	1.2.1, 1.3.1, 1.5.3, 1.6, 1.8	Griess Test was added to sections
02/18/2013	Appendix 1-References	References 13 and 17 were added
04/13/2013	All sections	Reformatted to the standardized format to include the addition of the objective statement, 2.0 Introduction heading, 3.1 Materials heading, reformatting numbering scheme