

# **Firearms/Toolmarks Discipline Standard Operating Procedure for Comprehensive Gunshot Residue – Distance Determination Examinations**

## **1 Scope**

This procedure is to provide the Examiner with a protocol and processing sequence in conducting gunshot residue – distance determination examinations and the physical effects due to gunshots. This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Firearms

## **2 Equipment/Materials/Reagents**

- Microscope (stereozoom)
- Camera (infrared capability if possible)
- Lens paper
- Lead and copper bullets
- Nitrite cotton swabs
- Personal protective equipment
- Cotton twill test cloth or equivalent
- Inertia bullet puller
- Fiber tape or equivalent
- Steel tape measure
- Felt marker or equivalent

## **3 Standards and Controls**

Standards are not applicable.

Controls are handled as follows:

- A lead bullet is used as a positive control for the Sodium Rhodizonate Test (SoRho).
- Nitrite cotton swabs are used as the positive control for Modified Griess Test.
- A copper jacketed bullet is used as the positive control for the Modified Dithiooxamide Test (DTO).

## **4 Sampling or Sample Selection**

Not applicable.

## 5 Procedure

### 5.1 Examination Sequence and Flow Chart

The *Gunshot Residues Examination Sequence Chart* (Appendix A) illustrates the procedural sequence of the visual and microscopic examinations and subsequent chemical processing. For the Modified Griess Test, DTO Test, SoRho Test, and the Modified SoRho Test there are decision points which are reached. Note that the Modified Griess Test always precedes the DTO Test and SoRho Test because the SoRho Test has the potential to chemically interfere with the results of the Modified Griess Test.

**5.1.1** If a chemical reagent must be prepared before an examination, the following information must be recorded on the appropriate *FTU Chemical Reagent Log* (Appendix B): FTU Lot number (date the reagent was prepared), initials of preparer, performance check, parent chemical, FBI Laboratory Lot number and barcode (if available).

**5.1.1.1** The FTU Lot number for reagents used during examinations will be recorded on the appropriate *FTD Worksheets* (Appendix D – *FTD Case Assignment, Records, Report Writing and Review*).

### 5.2 Visual and Microscopic Examination of Evidence

**5.2.1** It should be noted that the initial examination is in regard to the observable physical characteristics and microscopic examination for residues which may be present.

**5.2.2** Initially, a visual examination is performed to determine the presence of gunshot residues. A sketch(s) or photograph(s) is taken to record the item being examined and the relative position of hole(s) or gunshot residues is recorded. When visually examining clothing having a dark color or pattern, the use of infrared photographs can assist in the detection of gunshot residues.

**5.2.3** Microscopic examinations are performed using a stereozoom binocular microscope with appropriate lighting. The examiner will be looking for various types of relevant physical effects and residues.

**5.2.3.1** Indicative of/consistent with the discharge of a firearm:

- a. Vaporous lead (smoke).
- b. Particulate lead shavings or solidified droplets.
- c. Unburned gunpowder.
- d. Melted, adhering gunpowder.
- e. Soot

**5.2.3.2** Indicative of/consistent with the passage of a bullet:

- a. A hole in an item.
- b. A visible ring around the perimeter of the hole (bullet wipe).

**5.2.3.3** Indicative of/consistent with a contact shot:

- a. Ripping, tearing.
- b. Burning, singeing.
- c. Melted synthetic fibers.
- d. Heavy vaporous lead residues (smoke).

**5.2.4** Data regarding these physical effects and visible residues will be recorded on the appropriate *FTD Worksheets*.

### **5.3 Chemical Residues and Their Processing**

**5.3.1** After completion of the microscopic examinations, certain chemically specific, chromophoric tests are conducted for the various types of gunshot residues. The initial test, *FTU SOP The Modified Griess Test for Nitrite Residues*, is directed toward the detection of deposits of nitrite compounds from burned or partially burned gunpowder around a suspected bullet hole or patterns of suspected shot pellet holes.

**5.3.2** *FTU SOP The Dithiooxamide Test for Copper Residues (DTO)* is directed toward the detection of copper residues which might be present from the firing of a copper jacketed bullet. These residues include particulate and vaporous copper and “bullet wipe,” a ring-shaped deposition often found around the perimeter of a bullet hole.

**5.3.3** *FTU SOP The Sodium Rhodizonate Test for Lead Residues (SoRho)* is directed toward the detection of any type of lead residue which might be present. This would include vaporous lead (smoke) usually associated with closer ranges, particulate lead and “bullet wipe,” a ring-shaped deposition often found around the perimeter of a bullet hole.

**5.3.4** The results of these tests will be recorded on the appropriate *FTD Worksheets*.

### **5.4 Interpretation of Results**

**5.4.1** 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 results of the SoRho Test should be consistent with the results of the Modified Griess Test at a particular muzzle-to-target distance and with any physical effects present.

**5.4.2** The Contact Shot: A contact shot is based on the presence of very characteristic ripping and tearing of an item, the burning and singeing of cloth, the melting of synthetic fibers, and the heavy vaporous lead (smoke) deposits around the suspected bullet hole.

**5.4.3** Nitrite Residues: With increases in muzzle-to-target distances, patterns of detectable nitrite residues around a suspect bullet hole vary in size and density. When a pattern of nitrite deposits is found, it is possible to reproduce this pattern using the submitted firearm and ammunition in combination. When only scattered nitrite residues are found, it is possible to find the maximum distance to which such residues are deposited, using the submitted firearm and ammunition in combination.

**5.4.4** Copper Residues: Particulate and vaporous copper is characteristically deposited at close ranges and is chemically detectable utilizing the DTO Test. Copper bullet wipe is consistent with the passage of a bullet and cannot determine distance.

**5.4.5** Vaporous Lead/Lead Residues: Vaporous lead deposits are characteristically deposited at close ranges and are chemically detectable utilizing the SoRho Test and Modified SoRho Test. Such residues are produced to a particular maximum distance, which is determined utilizing the suspect firearm and ammunition in known-distance tests. Lead bullet wipe is consistent with the passage of a bullet and cannot determine distance.

## **5.5 Known-Distance Tests**

**5.5.1** When reproducing residue patterns detected on evidentiary items, it is essential that the suspect firearm and ammunition like the suspect ammunition be used in the known-distance tests. Patterns of residues will vary with changes in or to ammunition, barrel length, caliber, and powder charge.

**5.5.2** 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.

**5.5.3** When reproducing test patterns of residues, it is appropriate to fire known-distance targets that will produce test patterns both smaller and larger than the residues found on the evidence item. Using the most similar test patterns, a “bracket” is established to include the evidence pattern. Such a “bracket” should be wide enough, typically a foot<sup>1</sup> in width when outside near contact/contact, to account for differences expected in commercially manufactured ammunition and variations normally expected from shot-to-shot. A reported “bracket” must be verified by a second examiner and supported by known-distance tests performed at the same distances reported.

**5.5.4** When certain types of residues are found, it is necessary to find the maximum distance to which these residues are projected from a firearm. The procedure in these instances is to gather data that can be used to establish the distance at which the particular residue is always

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<sup>1</sup> Dillon, J.H., “A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations,” AFTE Journal, Vol. 22, No. 3, 1990, pp. 266.

found, and the distance at which it is never found in known-distance tests. This forms a bracket for the maximum distance situation for a particular type of residue.

## **6 Calculations**

Not applicable.

## **7 Measurement Uncertainty**

Not applicable.

## **8 Limitations**

The Modified Griess Test, DTO Test, SoRho Test and Modified SoRho Test yield reactions to nitrite, copper and lead residues, respectively, regardless of whether or not these residues are in fact the result of the discharge of a firearm. Distance determinations reached as a result of gunshot residue examinations must be based on residues found to be present, not on the absence of residues.

Distance determinations involving a wound and/or injury are outside the scope of this procedure.

## **9 Safety**

The safety procedures set forth in the Modified Griess Test, DTO Test and SoRho Test procedures should be followed. When firing known-distance tests, the safety protocols and range rules will be followed.

Reagent solutions should be prepared in a manner consistent with current Safety Data Sheet provisions regarding acids and bases. For disposal of the chemicals used for this procedure, refer to the *Hazardous Waste Disposal (Section 5 - FBI Laboratory Safety Manual)*, which is maintained on the Laboratory Division SharePoint site.

## **10 References**

“SWGgun Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. 28 November 2018.

Dillon, J.H., “A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations,” *AFTE Journal*, Vol. 22, No. 3, 1990, pp. 257-274.

Lekstrom, J.A., Koons, R.D., “Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test,” Journal of Forensic Sciences, Vol. 31, No. 4, 1986, pp. 1283-1291.

Schous, C.E., “A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues,” AFTE Journal, Vol. 31, No.1, 1999, pp. 3-8.

FBI Laboratory Quality Assurance Manual, latest revision.

FBI Laboratory Operations Manual, latest revision.

FBI Laboratory Safety Manual, latest revision.

FTD Quality Assurance Manual, latest revision.

“FTU Safety Protocols for Handling of Firearms and Ammunition”, Appendix E, *FTD QAM – Mission Statement, Administrative, and Operational Guidelines*, latest revision.

Rev. #	Issue Date	History
7	04/01/13	Throughout document changed Sodium Rhodizonate to SoRho where appropriate. Section 3 added “FTU Chemical Reagent Log” and clarified documentation for reagent log. Section 6.4.5 redacted “only if”. Section 9 added “Test” for. Section 9 added second paragraph on limitations for wounds. Section 10 added GSR room. Updated references in Section 11 by adding SWGGUN.org. Corrected spelling error in Appendix B FTU Chemical Reagent Logs.
8	03/02/18	Title was updated and muzzle-to-target reference was removed. Scope was updated for clarity and application to FTD personnel. Formatting changes were made to Sections 2 and 3 that included additions of tables. Removed Section 4 titled Calibration, renumbering was completed in remaining sections. Formatting change to Appendix A title reference in Section 5.1 and 5.2.1. Moved chemical reagent preparation instruction under Section 5.1. Added soot to 5.2.3.1 listing. Made reference to FTD Worksheets in Section 5.2.4. Details about the bracket generated and the verification process for a reported bracket were added to Section 5.5.3. Updated procedural reference for chemical disposal in Section 9. Reference section was updated including FTD reference. Updated formatting of Appendix A.
9	04/17/19	Updated Appendix B, specifically the <i>FTU Chemical Reagent Log – Modified Griess Test Media Preparation</i> .

**Approval**

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Firearms/Toolmarks  
 Technical Leader

Date: 04/16/2019

Firearms/Toolmarks  
 Unit Chief

Date: 04/16/2019

**QA Approval**

Quality Manager

Date: 04/16/2019

**Appendix A: *FTU Gunshot Residues Examination Sequence Chart***

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**Appendix B: *FTU Chemical Reagent Log – 1.0 pH Potassium Chloride Buffer Solution***  
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**Appendix B: FTU Chemical Reagent Log – 2.8 pH Bitartrate/Tartaric Acid Buffer Log**  
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**Appendix B: *FTU Chemical Reagent Log – 5% Hydrochloric Acid Solution***

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**Appendix B: FTU Chemical Reagent Log – 15% Acetic Acid Solution**

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**Appendix B: FTU Chemical Reagent Log – Nitrite Positive Control Swabs**

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