



ATF-LS-FT16 Shooting Trajectory Analysis	Published Online: March 2018
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I. SCOPE

These procedure guidelines establish a minimum standard to identify, reconstruct and document the three-dimensional (3-D) paths of fired projectiles.

II. REFERENCES

ATF-LS-Quality Manual

ATF-LS-FT5 Muzzle-to-Target Distance Determination

ATF-LS-FT8 Firearms Safety Guidelines

ATF-LS-FT12 Trace Evidence Preservation and Collection

ATF-LS-FT15 Firearm and Tool Mark Report Wording

Barr, D. "Modification to the Common Trigonometric Method of Bullet Impact Angle Determination", Association of Firearms and Tool Mark Examiners (AFTE) Journal, Volume 33, #2, Spring 2001, pp. 116-121.

Bunch, S.G., "Some Proposals for Standardizing Trajectory Analysis and Reporting", AFTE Journal, Volume 30, #2, Summer 1998. p.482

DiMaio, V.J.M., Gunshot Wounds: Practical Aspects of Firearms, Ballistics and Forensic Techniques, 2nd Edition, CRC Press, 1999, pp. 109-113.

Garrison, Jr., D.H., Practical Shooting Scene Investigation: The Investigation & Reconstruction of Crime Scenes Involving Gunfire, Universal Publishers, 2003.

Garrison, D.H., "Reconstructing Drive-By Shootings from Ejected Cartridge Case Location", AFTE Journal, Volume 25, #1, January 1993, pp.15-20

Garrison, D.H., "Shooting Reconstruction vs. Shooting Reenactment", AFTE Journal, Volume 25, #2, 1993, pp.125-127

Garrison, D.H., "Reconstructing Bullet Paths with Infixed Intermediate Targets", AFTE Journal, Volume 27, #1, 1995, pp. 45-48.

Garrison, D.H., "Field Recording and Reconstruction of Angled Shot Pellets Patterns", AFTE Journal, Volume 27, #3, July 1995, p.204.

Garrison, D.H., "The Effective Use of Bullet Hole Probes in Crime Scene Reconstruction", AFTE Journal, Volume 28, #1, January 1996, pp. 57-63

Garrison, D.H., "Crown & Bank: Road Structure as it Affects Bullet Path Angles in Vehicle Shootings", AFTE Journal, Volume 30, #1, Winter 1998, p.89.

Haag, L.C., Shooting Incident Reconstruction, Elsevier, Inc. 2006.

Hueske, E.E., Practical Analysis and Reconstruction of Shooting Incidents, CRC Press, 2006.

Trahin, J.L., "Bullet Trajectory Analysis", AFTE Journal, Volume 19, #2, April 1987, p. 124.

Scientific Working Group for Firearms and Toolmarks (SWGgun), [Projectile Path Reconstruction Essential Elements Guideline](http://www.swggun.org/swg/index), website address: www.swggun.org/swg/index

III. Safety Precautions

Refer to requesting agency's field processing safety guidelines. Also refer to ATF-LS-FT8 and ATF-LS-FT5 to include personal body protection, such as eye glasses, gloves, acid spill kits, etc., if necessary.

IV. Apparatus/Reagents

Rulers, calipers, protractors, magnifiers, trajectory rods, single and/or dual axial lasers, as well as possible chromophoric chemical reagents.

V. Procedures

- Identify target type. Note potential target(s) and type. These are generally classified as:
 - Stationary
 - Non-stationary
 - Thin substrate

On anatomical targets where the trajectory could only be determined by the internal body wound track, the trajectory should be established by an individual(s) participating in the autopsy.

In documenting the target(s) at a scene, the literal or exact description can be used instead of the general classifications above.

- Projectile/Bullet Strike Analysis (PSA/BSA), Recognition of marks, holes and other physical

features produced by the impact of a projectile.

- Documentation of visible characteristics associated with marks and holes produced by a projectile strike.
- Trace evidence associated with the marks, holes or projectiles should be considered. If trace of potential value noted, follow appropriate agency crime scene or laboratory guidelines for collection and preservation.
- Chemical tests can also be used to recognize, identify and/or verify projectile strike marks or holes, as well as direction of fire. These test tests may include:
 - Nitrite testing, e.g. Modified Griess (Direct & Reverse Method)
 - Copper and/or nickel residue testing, e.g. dithiooxamide (DTO)
 - Lead residue testing, e.g. sodium rhodizonate (Direct & Reverse Method)
- Determine coordinate system(s) to establish frame of reference, and define spatial relationships of other objects at the scene.
- Path determination: Determine projectile path by utilizing any of the methods below:
 - Visual alignment
 - Physical projection
 - Laser projection
 - Mathematical calculation
 - Computer reconstruction or animation.

Path determination can be accomplished by using any of the above-listed methods in combination.

Path determination can also be accomplished by using one or all of the above methods in conjunction with supplemental electronic coordinating systems, such as Total Data Station or 3-D Scanners.

- Angle Determination
 - Angle determination including both vertical and horizontal angles.
 - Direct measurement can be performed using a variety of tools. -
 - Mathematical formulae, such trigonometric functions, could be used to calculate angles where complete projectile strike characteristics can be measured or where linear dimensions have been properly calculated and documented.

- Documentation

A variety of methods can be used, separately or in combination, to document the projectile path relative to fixed locations, or relative to evidence items. These may include:

- -Sketching
- -Measurements
- -Photographic
- -Audio or video recording
- -Computer Assisted Design Programs
- -Computer Assisted Software.

VI. Interpretation(s)/Conclusion(s)

- Reporting of results should correspond to the policy in ATF-LS-FT15; in that, the method(s) used and basis for conclusions and/or significant findings should be included the report.
- Assessing the nature and location of the projectile impact site(s) on a target and the relative spatial relationship to other objects, items, and/or physical barriers, the following are types of conclusions that possibly could be made:
 - The direction of travel of a fired projectile.
 - The path at which an intervening or intermediate target was located at the time of firing.
 - The trajectory angle of incidence.
 - The direction or estimated angle of departure of an impacted projectile.
 - The path upon which a firearm (and/or a target) was positioned or located at the time of firing.
 - The portion(s) of a path where the firearm (and/or target) could have been positioned or located at the time of firing.

Quality Control

Reliable results are ensured when equipment used is properly calibrated and maintained, and chemical reagents are prepared and/or tested before each scene use.