8. BULLET TRAJECTORY ANALYSIS

A. Introduction

Bullet trajectory analysis is critical in regards to determining the path of a bullet and tracing its trajectory. The purpose is to determine approximately where the bullet(s) originated. Proper measurement and documentation are critical for reconstruction of the crime scene at a later time. If a protrusion rod is inserted into an apparent bullet hole to demonstrate trajectory of a bullet, an opinion may be rendered as to the direction of travel based on training, knowledge, and prior investigative experience and will be documented in the case notes and report. If an opinion is not rendered the rods will be utilized as a demonstrative representation of the trajectory.

B. Equipment

(1) Trajectory/protrusion rods

(2) Digital Protractors

(a) Determines horizontal angles

(3) Digital Angle Finder

(a) Determines vertical angles

(b) Determines slope

(4) Laser

(5) String

(a) Adhesive tape

(b) Bubble or torpedo level

(6) Photographic fog or a white card

(7) Tripod

(8) Adhesive identifying markers

(9) Digital camera and remote sync cord

(10) Measuring devices

(a) Tape measure

(b) Survey rod

(11) Plumb Bob

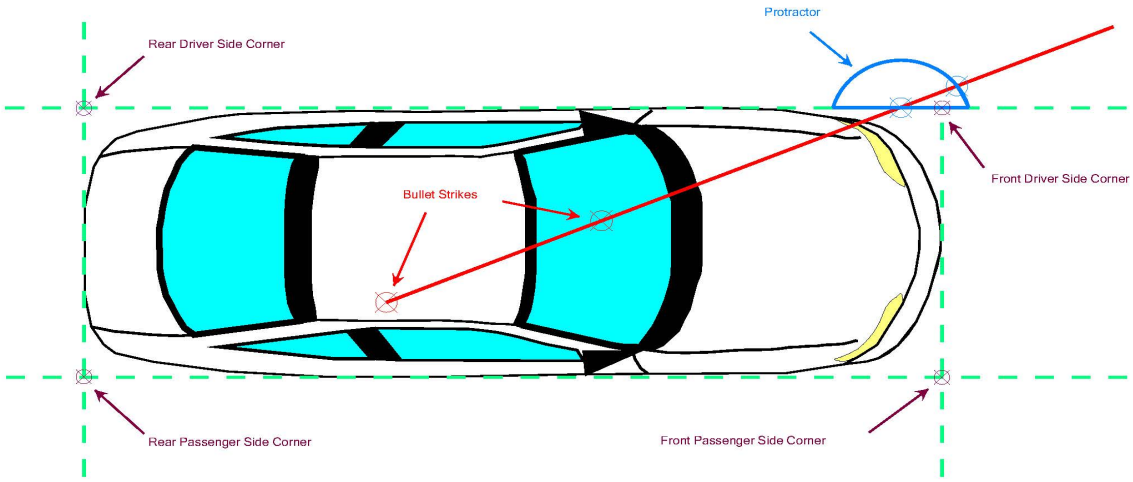
C. Procedure

(1) A bullet impact test could be conducted on a minimum of one (1) of the apparent bullet strikes/holes which will be used for the trajectory analysis.

(2) If applicable, measure the apparent bullet holes (including height) using a fixed reference point utilized during the crime scene investigation.

(3) If performing trajectory analysis on a vehicle, best practice would be to measure the apparent bullet holes from a fixed point on the vehicle (e.g. tire axle, exterior front/side/rear of vehicle, etc.). If the vehicle is on an angled surface it would be appropriate to obtain trajectory measurements at the location as well as obtain the angle measurement of the surface where

the car is located. The vehicle will be squared off, utilizing string or another reference line, in order to obtain accurate measurements for the locations of the strikes as well as the specific angles. Angle measurements will only be obtained when there is a clearly defined trajectory path that can be delineated from the other apparent strikes. If surrounding surfaces are struck in the vicinity of the strikes to the vehicle it would be best practice to conduct the trajectory analysis while at the location. Trajectory analysis can be completed on a vehicle at any time, but it may be more appropriate to conduct the analysis at the location in which the vehicle was struck. Below is an example of trajectory on a vehicle.



(4) Place a rod through the apparent bullet hole.

(5) Photograph the rod in place.

(6) Measure the horizontal angle deviation

(a) Describe directionality (e.g. left to right, right to left, east to west, north to south, front to back etc.).

(b) Use the digital protractor, ensuring that the protractor is properly aligned with the rod in the apparent bullet hole. If applicable, use a plumb bob.

(c) Record the measurement to nearest whole number using normal rounding procedures.

(d) When recording the horizontal angle deviation, it will not be described as being over 90 degrees

(7) Measure the vertical angle deviation

(a) Downward or upward using a digital angle finder.

(b) Record the measurement to nearest whole number using normal rounding procedures.

(8) Photograph each measurement angle

(9) If using string to demonstrate trajectory in a large area

(a) Use adhesive tape to attach string to the rod and maintain same angles.

(b) Attach the other end of the string to a fixed surface along the trajectory path.

(c) Maintain a taut string to avoid any sag in the string which can cause errors in the trajectory.

D. Photography

(1) Camera position

(a) The camera lens must be at the same height as the trajectory rod or string line that is being photographed.

(b) The camera lens must be perpendicular to the vertical plane in which the line or rod is located.

(2) General photographs

(a) Take overall, perspective, and specific photographs of the apparent bullet hole.

(b) Photograph the apparent bullet hole or strike with the evidence item number/letter placard or scale in the photograph. If possible, add a vertical reference tape, ruler or survey rod.

(c) Align number/letter placards facing north, upward or forward if possible.

(d) Take close-up or macro photographs with the scale or number/letter in the photograph.

(3) Laser Photography-Initial Procedures

(a) Attaching a laser to the trajectory rod allows for a longer distance of the trajectory to be documented.

(b) Laser photography will need to be performed with enough darkness that allows for the laser to be visible.

(c) Attach a laser to the end of the trajectory rod or a tripod that is positioned with the trajectory angle that has been measured.

(d) The below listed camera setting are recommendations and can be modified based upon the scene conditions.

(4) Using Photographic Fog

(a) Photographic fog is best used indoors where environmental factors can be controlled.

(b) Set up the camera on a tripod to document the trajectory.

(c) Set the camera to either 200 or 400 ISO depending on the lighting conditions and Aperture Priority.

(d) Set the Aperture Priority to 4.0 or 4.5.

(e) Spray the photographic fog around the laser until the laser beam becomes visible.

(f) Take a timed exposure and adjust for the lighting conditions. Ensure the beam is visible, as well as the background of the area that is being photographed.

(5) Using the white card method

(a) The white card method is best utilized outdoors or when environmental factors can't be controlled. This method will require an assistant to complete.

(b) Set up the camera on a tripod to document the trajectory.

(c) Set the camera to either 200 or 400 ISO depending on the lighting conditions and set the camera to Manual with an Aperture of f8 and utilize the Bulb setting.

(d) Place a dark colored object (e.g. paper, notebook cover, etc.) over the lens of the camera.

(e) Have someone place a white colored card in front of the laser with the red dot on the card visible towards the camera.

(f) Lock open the shutter and remove the dark colored object from in front of the camera lens.

(g) Have the person with the white card walk the "line" of the laser beam with the white card until reaching the end point. The red dot on the white card should always be visible towards the camera and the individual should continue walking until reaching the end point of the beam so as not to appear as a ghost in the image.

(h) Once the person has completed walking the "line" of the beam, close the shutter. If multiple laser trajectories are being documented repeat these steps while keeping the shutter open and covering the lens between white cards to show multiple lasers on one image.

E. Safety

(1) Do not point laser directly at eye or indirectly off reflective surfaces.

(2) Photographic fog is a flammable aerosol, may explode if heated, and may be fatal if swallowed.

(3) Wear appropriate PPE when utilizing the photographic fog and laser.

F. References

(1) Fisher, B.A.J., *Techniques of Crime Scene Investigation*, 7th ed. Boca Raton, FL: CRC Press, 2004 (pgs 266-267)

(2) Lee, Henry, *Crime Scene Handbook*. San Diego, CA: Elsevier Academic Press, 2001 (pgs 310-314)