



B167 Elucidating the Relative Dependence of Propellant Pattern-Based Muzzle-to-Target Distance Determinations on Variables of Weapon and Ammunition

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The attendee will explore factors that influence the accuracy of muzzle-to-target distance determinations based on target-deposited propellant particle patterns.

Estimates of the distance from the muzzle of a gun to a nearby target at the moment of discharge, based on target-deposited propellant particle patterns (PPP), have figured importantly in shooting investigations for many years. For weapons firing a single projectile, *viz.*, rifles and pistols as opposed to pellet firing shotguns, these estimates are based on an analysis of patterns resulting from the deposit of ammunition derived residues emanating from the muzzle and forcibly deposited on the target. A major part of this pattern is the PPP. For the purposes of this study only the PPP is considered. Metallic deposits such as those contributed by shaved and vaporized lead are not considered. This is also true of deposits due to lubricants and other residues in the barrel. We hypothesize that these non-PPP contributions are too dependent on the condition of the barrel and the nature of the ammunition used for prior shots. The PPP analysis and interpretation require a comparison of the evidence pattern with a series of test patterns produced on a surface or substrate similar to the questioned or evidence surface. Ideally, the test shots are made using the same weapon and ammunition.

In many casework situations no weapon is recovered, although the ammunition used is known or can be ascertained. Here caution may dictate that no attempt be made to estimate the muzzle-to-target distance. However, we postulate that in situations where the ammunition used during the shooting event can be identified and examples acquired, carefully designed test firings can assist in making reliable estimates.

For this paper it was hypothesized that the most critical variable affecting the pattern is the ammunition. It was further hypothesized that nuances in variables related to weapon parameters are relatively less significant. The research in the present paper was designed to test these two hypotheses. Experimentation involving replicate test firings and the digitization of the resulting PPPs produced the data which, was analyzed. Following digitization, each propellant particle pattern was characterized. "Image J," public domain software from the National Institutes of Health was used to determine the Cartesian coordinates for each propellant particle in a pattern. These data were input into the software package Math Cad (Mathsoft®) which was used for the analysis and characterization of the pattern produced by each shot. This enabled the objective comparison of PPPs and allowed any significant pattern differences resulting from the deliberate altering of gun barrel variables to be evaluated in relation to stochastic differences among replicate test shots. The effects of batch-to-batch variations in ammunition were also evaluated preliminarily. Circumstances where reasonable estimates of the muzzle-to-target distances can be made in the absence of the actual weapon used will be described.

Muzzle-to-Target Distance, Propellant Particle Patterns, Gun Shot Residue