D26 A Study of Batch-to-Batch Handgun Ammunition Propellant Variables and Their Influence on Muzzle-to-Target Distance Determinations

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After attending this presentation, attendees will understand ammunition construction and the variables in propellant composition and morphology that exist between different batches of externally identical ammunition. The impact of these variables on the validity of muzzle-to-target distance determinations will be discussed.

This presentation will impact the forensic science community by affecting the way in which muzzle-to-target distance determinations are performed when a sufficient quantity of identical ammunition is not recovered.

Deceased gunshot wound victims frequently have close range wounds to bare skin that exhibit sooting and/or stippling, to varying degrees. It is common practice for technicians to perform muzzle-to-target distance determinations using the same brand and, when known, loading of ammunition. This presentation illustrates and discusses the variability of propellants (especially propellant geometry/morphology) discovered within different lots of the same brand and loading of premium ammunition. The variability in combustion, stippling, and sooting characteristics were studied in the context of their impact upon the accuracy and validity of muzzle-to-target distance determinations that are based upon these visual indicators. The results and conclusions of the study will impact the way that muzzle-to-target distance determinations are performed when a sufficient quantity of identical ammunition is not recovered.

The degree of sooting, and the maximum range for sooting, vary significantly depending upon the propellant used in the subject ammunition. Typically, propellants manufactured with a greater variety and/or quantity of additives will produce more sooting. For most handgun/ammunition combinations, visible sooting will cease at a muzzle-to-target distance of approximately nine to twelve inches, but it is not uncommon for some "dirtier" ammunition types to leave visible soot deposits out to fifteen inches or more.

Additionally, old propellants or propellants that have prematurely aged due to being inappropriately stored (high temperatures and/or repeated temperature cycling — such as may be encountered in a vehicle, for example) typically produce a greater degree of both sooting and stippling than would otherwise be the case. It is generally accepted that stippling from a handgun will cease at a maximum muzzle-to-target distance of approximately three feet. Occasionally, stippling may occur beyond that three-feet limit, but it is more usual for stippling to cease at a muzzle-to-target distance of approximately two feet; however, the propellant characteristics that most influence maximum range and dispersion of stippling are propellant grain mass, size, and morphology. Propellants used in handgun ammunition typically fall into one of three morphology categories — ball, flake/disk, and cylindrical. It is not uncommon for propellants to be blended, and thereby be comprised of more than one propellant grain geometry type. Clearly, there are implications for the aerodynamic characteristics for each of the three propellant grain geometries cited — a grain of ball propellant will travel further than a grain of flake propellant, for example.

The research conducted for this presentation focused on a practical study of several batches of the same loading of premium defensive handgun ammunition that had been manufactured by a long-established and reputable manufacturer. Disassembly of samples from the different batches revealed that different propellants had been utilized — the primary concern of the manufacturer being to achieve the same batch-to-batch average muzzle velocity, without regard for propellant type. The differing propellants encountered in each batch may have had varying additive content (in terms of both composition and quantity). The propellants were primarily identified and classified merely by their size and morphology. The primary purpose of the research was to investigate the variation in sooting and stippling characteristics between different batches of ammunition of the same brand and loading, given the knowledge that the propellants used differed significantly from batch to batch. The research demonstrated that sooting and stippling characteristics varied widely between different batches of the same brand and loading of ammunition, due to the varying size and morphology of propellant grains used during manufacture. Consequently, it was concluded that a technician who tested for muzzle-to-target distance using a given brand and loading of ammunition, assuming that the results would be representative, may obtain erroneous muzzle-to-target distance results if the ammunition batch were not identical. Current laboratory protocols and generally accepted practices do not consider these ammunition variables.

If a significant quantity of ammunition is recovered for testing, the previously cited problems will be of little concern, assuming a visual examination of propellant samples confirms that it is all identical; however, in cases where only one round or a limited quantity of ammunition is available, it is recommended that it be dismantled and new ammunition procured for testing. The propellant from the new batch(es) of ammunition should be compared to the case sample to ensure propellant similarity and thereby guarantee the validity of any subsequent muzzle-to-target distance determinations.

Propellant Morphology, Propellant Stippling, Distance Determinations