A168 Reference Bullets and Cartridge Cases for Automated Ballistics Inspection Systems

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The goals of this presentation are to describe the physical properties of the National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) 2460 and 2461 and how they may be acquired and to outline the procedure for using the SRMs to test optical identification systems in crime laboratories

This presentation will impact the forensic science community by showing how SRMs 2460 and 2461 will help crime laboratories to: (1) verify that automated optical equipment for bullet and cartridge case image acquisition and correlation is operating properly; (2) establish ballistics measurement traceability; and, (3) achieve accreditation.

NIST SRMs 2460 and 2461 are physical standards that provide replica tool markings of fired bullets and a fired cartridge case, respectively. SRM 2460, the standard bullets, were certified and first distributed in 2006. SRM 2461, the standard cartridge cases, were certified in July 2012.

Each unit of SRM 2460 is a copper pellet in the shape of a 9mm bullet, which contains six Land Engraved Areas (LEAs) fabricated using an ultra-precision, numerically controlled diamond turning machine. The machined profile of each LEA is a replica of a profile measured on a fired bullet. Six different profiles were used from six different firearms, three from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) and three from the Federal Bureau of Investigation (FBI). Because of the highly-repeatable manufacturing process, all units of SRM 2460 are essentially identical.

Each unit of SRM 2461 consists of a circular electroformed nickel plate, replicated from the head of a fired master cartridge case, which contains the surface topography of a breech face impression, a firing pin impression, and an ejector mark. The electroformed plate is cemented to a brass cylinder holder so that the assembly resembles a real fired cartridge case. The master cartridge case was fired at the National Laboratory Center of ATF. The SRM cartridge cases produced from that master by electroforming have virtually the same surface topography signatures. The surface topography of each SRM unit produced was measured at NIST to confirm the similarity of the tool marks.

The key property of the SRMs is the similarity of the tool marks on different SRM units, enabling comparisons and quality control of measurement results obtained at different sites. In a controlled system, images of different units taken by the same model inspection instruments, in different places, at different times, and by different operators should be highly similar. This similarity can be easily quantified if the different inspection tools share common databases, such as the National Integrated Ballistics Information Network (NIBIN) developed and coordinated by the ATF in collaboration with local crime laboratories. NIBIN includes approximately 200 ballistic inspection systems linked together into regional databases and having common software for acquisition and correlation testing. The NIBIN incorporates two models of ballistics inspection instruments. Individual laboratories can assess whether their identification process is in control by comparing SRM measurement results with the control limits developed under a project known as the National Ballistics Imaging Comparison.

The SRMs may also be used to test systems that directly measure surface topography of cartridge cases and bullets. Topography images acquired on such systems can be compared with reference images obtained at NIST and available on the website, pml.nist.gov/srm2461. For SRM 2461, two parameters are used to quantify the similarity of the cartridge case surface topography images: the maximum value of the areal cross correlation function, $ACCF_{max}$, and the relative signature difference D_s. When two correlated cartridge case signatures are exactly the same (point by point), D_s must be equal to 0 and $ACCF_{max}$ must be equal to 100%.

The surface topography of all SRM 2461 units and three reference units were measured with a confocal microscope at NIST. The topography images were processed using band pass filtering to minimize noise, form and waviness, thus emphasizing the fine roughness features of the tool mark topographies. The SRM unit topography images were then correlated with those of the three reference units. For the breech

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face, firing pin, and ejector mark regions of the distributed SRM units, a lower limit for $ACCF_{max}$ and an upper limit for D_s, each with a 95% confidence level are reported in the SRM certificates. Similar statistics are reported for SRM 2460.

Standards, Topography, Ballistics

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