Forensic Science International 216 (2012) 168–182

Contents lists available at SciVerse ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

The National Ballistics Imaging Comparison (NBIC) project

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ARTICLE INFO

Article history:
Received 11 April 2011
Received in revised form 9 September 2011
Accepted 21 September 2011
Available online 19 October 2011

Keywords:
Forensic science
Ballistics identification
Standard reference material
Standard bullet
Standard cartridge case
NIBIN
NBIC

ABSTRACT

In response to the guidelines issued by the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB-International) to establish traceability and quality assurance in U.S. crime laboratories, a NIST/ATF joint project entitled National Ballistics Imaging Comparison (NBIC) was initialized in 2008. The NBIC project aims to establish a National Traceability and Quality System for ballistics identifications in crime laboratories within the National Integrated Ballistics Information Network (NIBIN) of the U.S. NIST Standard Reference Material (SRM) 2460 bullets and 2461 cartridge cases are used as reference standards. 19 ballistics examiners from 13 U.S. crime laboratories participated in this project. They each performed 24 periodic image acquisitions and correlations of the SRM bullets and cartridge cases over the course of a year, but one examiner only participated in Phase 1 tests of SRM cartridge case. The correlation scores were collected by NIST for statistical analyses, from which control charts and control limits were developed for the proposed Quality System and for promoting future assessments and accreditations for firearm evidence in U.S. forensic laboratories in accordance with the ISO 17025 Standard.

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1. Introduction

In the late 1990s, the National Integrated Ballistics Information Network (NIBIN) was established in the United States [1,2]. At the time of this report there were approximately 200 installations nationwide, in which the Integrated Ballistics Identification Systems (IBIS[1]) [3] are used for ballistics signature acquisitions and correlations. To establish measurement traceability and quality assurance for laboratory assessment and accreditation using the ISO 17025 standard [4], the National Institute of Standards and Technology (NIST) in collaboration with the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) developed Standard Reference Material (SRM) 2460 bullets and 2461 cartridge cases [5]. NIST also developed a two-dimensional (2D) and three-dimensional (3D) Topography Measurement and Correlation System for ballistics signature measurements [5–7]. In response to the guidelines recently issued by the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB-International) to establish traceability and quality assurance in U.S. crime laboratories [8], NIST and ATF have recently completed a joint project entitled the National Ballistics Imaging Comparison (NBIC). The aim of this project is to establish a National Traceability and Quality System using the SRM bullets and cartridge cases for NIBIN's acquisitions and correlations, and to develop a quality assurance system which can be used for detecting and exploring any quality problems which may arising from operators' acquisition procedures, IBIS software and networks, even from the SRM standard itself. In this paper, the NIST SRM standard bullets and cartridge cases project, the NIST 2D and 3D Topography Measurement System and the proposed Traceability and Quality System are introduced in Sections 2–4. The correlation result, statistics analyses, control charts and control limits are described in Sections 5 and 6. Finally, in Sections 7 and 8, quality assurance for NIBIN acquisitions and correlations and future work are discussed.

2. The NIST SRM 2460/2461 standard bullets and cartridge cases project

The NIST SRM 2460 bullets and 2461 cartridge cases were developed as reference standards for ballistics laboratories to help verify that the computerized optical-imaging equipment in those laboratories is operating properly, to establish ballistics measurement traceability and quality assurance, and to promote laboratory assessment and accreditation in accordance with the ISO 17025 standard [4]. The SRM bullets are designed as both a virtual and a

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[1] Certain commercial equipment, instruments, or materials are identified in this paper to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

0379-0738/$ – see front matter. Published by Elsevier Ireland Ltd.
doi:10.1016/j.forsciint.2011.09.016

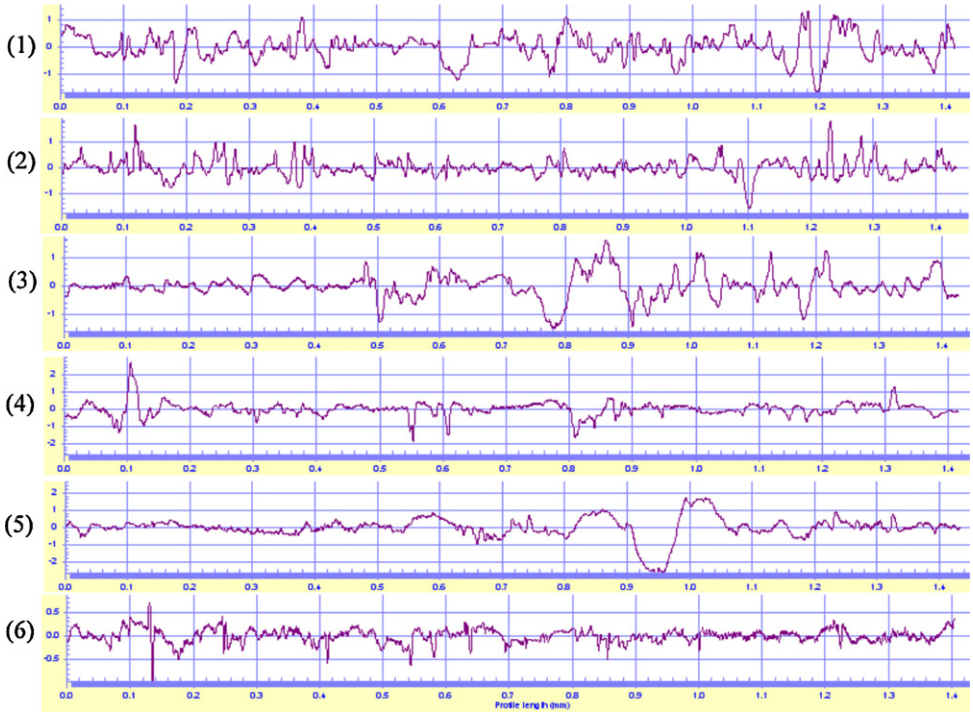

Fig. 1. The virtual bullet signature standard consists of six digitized bullet profile signatures measured by a stylus instrument on six master bullets fired at the ATF and FBI. The virtual standard profiles shown above are modified profiles after curvature removal and Gaussian filtering [9,10] with a short wavelength cutoff of 0.0025 mm and a long wavelength cutoff of 0.25 mm. The vertical scale is in μm; the horizontal scale is in mm.

physical ballistics signature standard [5]. The virtual standard is a set of six digitized bullet profiles (see Fig. 1) used as the reference profiles to machine bullet signatures on the SRM bullets. The virtual standard also serves as the reference standard for measurements of the machined bullet signatures on the SRM bullets, and helps ensure that these measurements are traceable to the SI unit of length. These profiles were originally traced with a stylus instrument on six master bullets fired at the National Laboratory Center of ATF and the Federal Bureau of Investigation (FBI) under standardized shooting and recovering procedures [5]. Each bullet was fired by a different handgun and the profile signature was taken only on one selected Land Engraved Area (LEA). An LEA is a region on the bullet that contains the impression of one of the lands of a rifled barrel. There are several lands in a rifled barrel and, consequently, there will be an equal number of LEAs on a bullet. The virtual standard (six bullet profile signatures, see Fig. 1) was stored digitally and used for control of the tool path of a numerically controlled (NC) diamond turning machine at the NIST instrument shop to machine the bullet signatures onto the SRM bullets [5]. Twenty SRM bullets were manufactured at the same time with each setup; forty SRM bullets have been produced so far. The virtual standard is also available from the NIST website for the Surface Metrology Algorithm Testing System (SMATS) [11]. At this site, the user can download the LEA profiles and directly compare them with the corresponding LEA profiles measured on the SRM bullet with the user's own topography measurement system. Alternatively, the user can compare the surface topography parameters, such as the rms-roughness *Rq* [9,10] of the virtual standard profiles with parameters obtained from the corresponding profiles on the user's SRM bullet.

A SRM bullet is shown in Fig. 2, left. It contains six LEAs, each having a unique bullet signature manufactured by the NC diamond turning machine with a 5° twist, which helps to make the SRM bullet look like a real bullet. The material was made of oxygen-free, high conductivity (OFHC) copper rod with about a 1 mm thick pure-copper coating to avoid the crystal boundary effect in the diamond turning process [5]. After machining, a specially designed chemical etching process was used for roughening the surface of the bullet to improve its glossy reflection without changing the bullet signatures and make the SRM bullet appear like a real bullet when observed under an

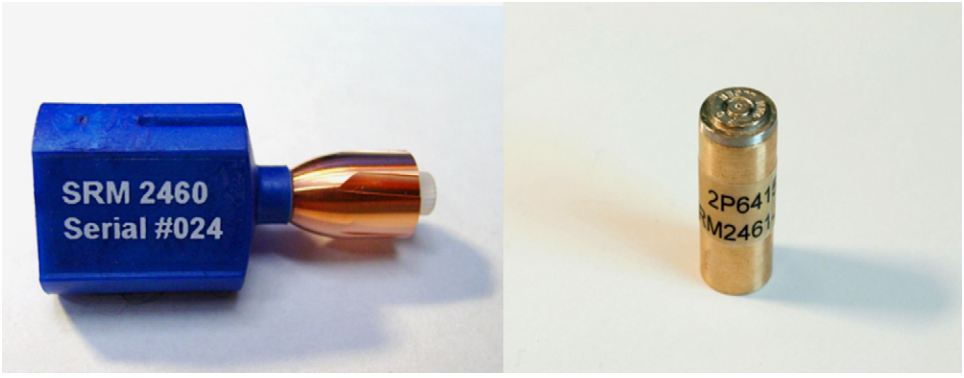

Fig. 2. A SRM 2460 Standard Bullet (left) and a SRM 2461 Standard Cartridge Case (right).