

Firearms/Toolmarks Discipline

Technical Procedure for Measurement, Calibration, Performance Checks and Maintenance of Equipment

1 Scope

This procedure establishes requirements for calibration, performance checks, and maintenance of equipment to ensure the accuracy and reliability of measurement results that have an impact on the quality of an examination. This procedure also satisfies the FBI Quality Assurance Manual (QAM) and Laboratory Operations Manual (LOM) requirements, as well as requirements of the applicable accrediting body. This procedure applies to all Firearms/Toolmarks Discipline (FTD) personnel in the Firearms/Toolmarks Unit (FTU) and the Scientific and Biometrics Analysis Unit-Toolmark Group (SBAU-TG) who use the listed equipment to make and record measurements on evidentiary items when those measurements may be utilized to make judgements regarding the further examination, classification, or comparison of an item, or to form conclusions regarding the item.

This procedure does not address Measurement Uncertainty, which is the subject of the FTD Quality Manual document *Estimating Uncertainty for Reported Quantitative Measurements*.

2 Equipment / Materials / Reagents

- Calipers (measurement within ± 0.001 in / 0.01mm.)
- Microscope (stereozoom/comparison)
- Micrometers (measurement within ± 0.001 in / 0.01mm.)
- Balances (measurement within ± 1 grain / ~ 0.065 grams)
- Alicona® Infinite Focus microscope
- GelSight/Cadre TopMatch® Instrument
- GelSight Instrument
- Arsenal weights for trigger pull
- NIST Standard bullet
- National Institute of Standards and Technology (NIST) traceable gauge blocks
- Measuring reticle
- NIST traceable weights
- NIST traceable steel rulers
- Alicona®-IF Verification tools
- GelSight/Cadre TopMatch® calibration tools
- Balance - 10 pound (lb.) capacity
- NIST Standard cartridge case

3 Standards and Controls

All equipment having an effect of the quality of an examination is properly maintained per manufacturer's guidelines and calibrated. The FTD ensures that equipment used for measurement can achieve the measurement accuracy required to provide an accurate result.

3.1 Prior to being placed into service, and when necessary, equipment that has a direct effect on the quality of an examination is calibrated and/or performance checked to verify that it meets any specifications required by the method.

3.2 Personnel in the FTD will handle and operate equipment in accordance with manufacturer's guidelines. Equipment and standards are properly stored when not in use to prevent contamination and damage. Equipment or standards that leave the control of the laboratory are properly packaged, inspected and performance checked and/or recalibrated upon their return.

3.2.1 Due to differences in instrument resolutions, variations from manufacturer's guidelines exist as to how the instruments can be utilized (e.g., camera settings, lenses, calibration standards, etc.).

3.2.2 Personnel in the FTD are not qualified or authorized to make adjustments to calibrated equipment and are prohibited from doing so.

3.3 Damage or changes to equipment or NIST traceable standards will be recorded by written notification to the Calibration and Maintenance Administrator (CMA) of the laboratory/location. The CMA will follow the *LOM Practices for Calibration and Maintenance of Equipment*.

3.3.1 A copy of the notification will be maintained by the CMA.

3.3.2 The CMA will ensure that the replacement item is acquired as soon as practicable and will follow the *LOM Practices for Calibration and Maintenance of Equipment* to place the new item into service.

3.4 Microscopes are serviced annually by qualified maintenance personnel to ensure proper functioning, and to prevent contamination and deterioration.

4 Sampling

Not Applicable

5 Procedures

5.1 Calibration

5.1.1 NIST traceable steel rulers, gauge blocks, and weights are recertified every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.1.1 The NIST traceable steel ruler utilized for measurements of Explosively Formed Projectile (EFP) liners, and Hott Rods[®] and rulers used for barrel and overall length measurements are recertified annually by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certification performed.

5.1.2 Calipers/micrometers and balances are calibrated annually by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the calibration.

5.1.2.1 Calipers/micrometers or rulers that fail calibration are removed from service and replaced.

5.1.2.2 Balances that fail calibration are removed from service and repaired or replaced.

5.1.3 The Alicona[®] IF Verification tool is handled according to manufacturer's specifications. Recertification of the calibration status of the tool will be performed every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.3.1 If the verification tool is damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the verification tool is found to be defective, manufacturer's guidance will be followed.

5.1.3.2 If a verification tool fails to obtain the required measurements based on the calibration requirements, it will be recalibrated or pulled from use.

5.1.4 The Cadre TopMatch/GelSight[®] calibration tool is handled according to manufacturer's specifications. Recertification of the calibration status of the tool will be performed every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.4.1 If the calibration tool is damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the calibration tool is found to be defective, manufacturer's guidance will be followed.

5.1.4.2 The GelSight® system used at the Terrorist Explosive Device Analytical Center (TEDAC) utilizes a standard ball-grid array to “set” the instrument prior to use. If the array is damaged or visibly changed, it will be replaced.

5.1.5 The NIST Standard bullet and cartridge case will be recertified prior to expiration as provided for in NIST guidelines. If damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the NIST Standard bullet or cartridge case are found to be defective, NIST guidance will be followed.

5.2 Performance Checks

5.2.1 Prior to using listed equipment, performance checks must be completed in order to ensure the accuracy and reliability of measurement results that have an impact on the quality of an examination.

5.2.2 Records of performance checks will be included in the examination records, except as provided for in the remainder of this document.

5.2.2.1 Information that is required to be recorded includes:

- the type or name of equipment
- the equipment serial number or other unique identifier
- the Reference item used for the performance check
- the result of the performance check
- the date of the performance check
- the identity of the person performing the performance check.

5.2.3 Any instrument that fails to pass the performance check will be taken out of service and marked as such. See Section 3.3 above.

5.2.3.1 Instruments that are taken out of service due to a failed performance check will be assessed by the CMA to determine if they will be repaired, recalibrated, or replaced.

5.2.4 When making measurements that have an impact on the quality of an examination, stage micrometers must be performance checked on the day of usage.

5.2.5 When making measurements that have an impact on the quality of an examination, balances, micrometers, and calipers must be performance checked on a semi-annual basis.

5.2.5.1 Performance check records for balances will be maintained by FTU and SBAU-Toolmark Group.

5.2.6 Performance check procedures and records for the FTU GelSight/Cadre TopMatch[®] are located at the instrument.

5.2.6.1 Performance checks on FTU 3D instruments are carried out based on the manufacturer's specifications. These records are maintained at the instrument.

5.2.6.2 Performance checks of the calibration on an FTU 3D instrument (referred to as calibration check in the remaining document) will be performed as outlined in the *TopMatch User Manual* (Controlled Document FTU 019).

5.2.6.3 The calibration check interval for a 3D instrument is based on the manufacturer's specifications as outlined the *TopMatch User Manual*.

5.2.6.4 Performance checks of the status of a 3D instrument in FTU will be performed using a suitable NIST SRM. Performance checks of the status of the GelSight 3D instrument in SBAU Toolmark Group will be performed using the GelSight Ball Grid Array.

5.2.6.5 Performance checks of the status of the Alicona instrument at SBAU-Toolmark Group will be performed with a NIST traceable scale. These records are maintained at the instrument.

5.2.7 Arsenal weights will be performance checked annually.

5.2.7.1 Inspect each weight and hanger for damage. Weigh each arsenal weight three times, calculate the average weight and record the average weight in the annual arsenal weight performance check record located in the Maintenance and Calibration binder in the FTU.

5.2.7.2 If an arsenal weight has a difference greater than +/- 0.10 lb. from its designated measured weight, it will be removed from service and labeled as such. The removal will also be recorded on the performance check record.

5.3 Methods for Measuring General Rifling Characteristics (GRCs) of bullets

5.3.1 Air gap method: The fired bullet is mounted on one stage of the comparison microscope. A micrometer/caliper is mounted on the other stage. Both stages must be at the same magnification level and in focus. Measure the land or groove impression using the micrometer/caliber and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.2 Stereo microscope-micrometer/caliper method: The fired bullet is either held or mounted on a steady surface beneath the stereo microscope. Measure the land or groove impression using the micrometer/caliper and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.3 Stereo microscope–grid method: The fired bullet is either held or mounted on a steady surface beneath the stereo microscope. Measure the land or groove impression using the ocular alignment grid and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.4 Comparison microscope with built-in micrometer: The fired bullet is mounted on the stage with a built-in micrometer. Align the horizontal edge of the crosshair at one of the anchor points for a land or groove impression, move the horizontal edge of the crosshair to the corresponding anchor point. Measure the land or groove impression and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.5 3D Toolmark Topographical Instrument: See the *FTD Technical Procedure Class Characteristic Database Entries and Searches* for guidance on the use of the Alicona[®] instrument for obtaining scans and performing measurements.

5.4 Methods for Measuring Toolmarks (items or casts of toolmarks)

5.4.1 Visual method: For items that are large enough to be viewed by the naked eye, align the edges of a scale/micrometer/caliper with opposing edges of the toolmark and record the measurement using appropriate units.

5.4.2 Stereo microscope-micrometer/caliper method: Hold the toolmark or cast, or mount on a steady surface beneath the stereo microscope. Using a micrometer/caliper, measure the appropriate dimensions of the toolmark and record the measurement(s) using appropriate units.

5.4.3 Comparison microscope with built-in micrometer: Mount the toolmark or cast on the stage with the built-in micrometer. Align the horizontal edge of the crosshair at one edge of the toolmark, move the horizontal edge of the crosshair to the opposite edge of the toolmark, and record the measurement using appropriate units.

5.4.4 Instructions for using the Alicona[®] Infinite Focus are located at the instrument.

5.4.5 Instructions for using the GelSight/Cadre TopMatch[®] are located at the instrument.

5.5 Method for Measuring Trigger Pull of Firearms

5.5.1 Instructions for measuring the trigger pull of firearms are found in the *FTD Technical Procedure Firearm Examinations*.

6 Records

6.1 Records of calibrations that are to be maintained in Forensic Advantage Resource Manager are specified in the *FBI LOM Calibration and Maintenance of Equipment*.

6.2 For FTU, calibration certificates are maintained by the Unit and via digital upload onto the Forensic Analysis Support Unit (FASU) Sharepoint site. For SBAU-Toolmark Group, hard copies of calibration certificates are maintained by SBAU-Toolmark Group via the SBAU-Instrument Operations Group (IOG), and via digital upload onto the FASU Sharepoint site.

6.3 Performance check records are maintained in examination documentation.

6.3.1 Performance check records for the Alicona Infinite Focus microscope and GelSight Cadre TopMatch instruments are maintained at the instruments.

6.3.1.1 Performance and/or calibration check records for a 3D instrument will be maintained and stored within the system and/or externally by the FTU.

6.3.2 Performance check records for arsenal weights are maintained in the arsenal weight performance check record in the Balances and Trigger Pull Binder in the FTU library.

6.4 Records of damaged or changed equipment are maintained in FA Resource Manager.

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

Not Applicable.

10 Safety

Not Applicable.

11 References

FBI Laboratory Quality Assurance Manual, latest revision.

FBI Laboratory Operations Manual, latest revision.

ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories, International Organization for Standardization, Geneva, Switzerland, 2017.

ISO/IEC 17025:2017 – Forensic Science Testing and Calibration Laboratories Accreditation Requirements (AR3125), ANAB, Milwaukee, WI, April 29, 2019.

Alicona Infinite Focus microscope, User's Manual.

GelSight GSCapture Users' Guide for the GelSight Benchtop Scanner, Jan 2018, SBAU Controlled Document #SAU-1

TopMatch-GS 3D: Software and Hardware Manual v0.9.19, Cadre Research Labs, September 2017, FTU Controlled Document 019

TopMatch-GS 3D: High Capacity Software and Hardware Manual v 1.4.1, Cadre Research Labs, December 2020.

| Rev. # | Issue Date | History |
|--------|------------|--|
| 0 | 03/02/20 | Original issuance. Created from multiple FTD SOPs. |
| 1 | 04/15/21 | Updated document title. Added Gelsight to list of equipment. Updated equipment that is performance checked on the day of usage in section 5.2.4. Removed 5.2.6 and renumbered. Delineated equipment in sections 5.2.6 through 5.2.6.4 by adding unit acronym. Added section 5.2.6.5. Added equipment to section 5.4.1. Corrected numbering in section 5.4.3. Updated procedure title throughout document. Removed SBAU Controlled Document #SAU-2 and added High Capacity Manual. |

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Acting Unit Chief

Date: 04/15/2021

Scientific & Biometrics
Analysis Unit Chief

Date: 04/15/2021

Firearms/Toolmarks
Technical Leader

Date: 04/15/2021