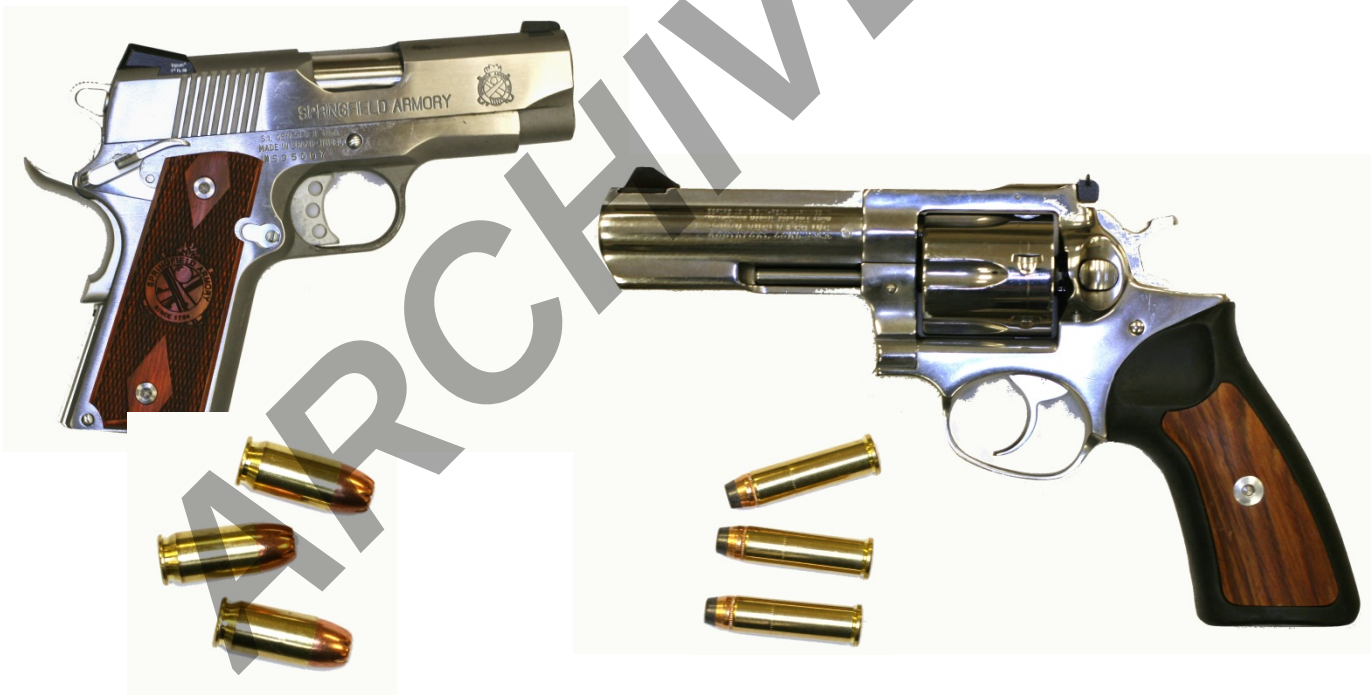
Las Vegas Metropolitan Police Department
Forensic Laboratory
5605 W. Badura Ave. Ste. 120B
Las Vegas, NV 89118

Firearms/Toolmark Technical Manual



LVMPD FORENSIC LABORATORY
TECHNICAL OPERATIONS MANUAL
FIREARMS / TOOLMARKS DETAIL

Title: **PREFACE**

The Firearms/Toolmarks Detail is responsible for the examination of firearms as related to criminal matters and the examination and comparison of ammunition components with the goal of identifying the particular firearm used to discharge a crime scene bullet or cartridge case. Ancillary subjects include toolmark examinations and comparisons; serial number restorations; proximity analysis (muzzle to target distance determination); and National Integrated Ballistic Information Network (NIBIN) entries.

The goal of the Firearms Examiner is to provide information to the Detective or Requesting Officer to aid in the investigation of the criminal matter, to examine and compare physical evidence impartially, and to present evidence in courts of law thereby allowing a jury to reach a verdict based upon scientific information.

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Title: **STATEMENT of PURPOSE**

The purpose of this manual is to provide the forensic Firearm/Toolmark Examiner / NIBIN Technician with a set of useful procedures for the examination of physical evidence. This manual is not designed to be an all-inclusive collection of every possible procedure or variation of procedure which might be used in forensic Firearm/Toolmark cases.

It is expected that deviations in methodology will occur at the discretion of the individual examiner as set forth in the LVMPD Forensic Handbook Technical Requirements Manual 5.4.1.1. Due to the wide variety of evidence received by the examiner, a great deal of ingenuity is required in the analytical approach. This may require the modification of a technique or the search for a new one in order to accomplish the task of thorough evidence examination. The procedures presented in this manual are intended to provide a sound framework upon which to build.

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1.01 Title: INTRODUCTION TO ADMINISTRATIVE PROCEDURES

1.01 / 01 General Administrative Procedures

The methods and procedures presented in this manual are designed to act as guidelines to assist in the proper examination of firearm and toolmark evidence. The examiner/technician is additionally assisted by appropriate technical references maintained within the Forensic Laboratory**,** as well as private references and communications.

This technical manual is subject to continual review and procedures may be updated or replaced with new methodology after approval.

The examiner/technician responsible for firearm and toolmark examinations will conform to accepted methods and procedures. Proper ethical and professional standards will be maintained as an employee of the Forensic Laboratory.

To be permitted to perform casework, the examiner/technician must have completed an appropriate and approved training program, and have successfully completed a practical competency test, a competency exam (written or oral) and a moot court. Upon successful completion of competency testing, the examiner/technician will be issued an authorization certificate in the specific category of testing covered by this process. .

Each procedure in this manual requires certain safety practices that must be adhered to at all times.

Although many of the procedures in this manual are recognized internationally as standard methods, all of them must follow a quality assurance program involving technical review. Procedures for technical review are outlined in the *LVMPD Forensic Handbook*, Technical Requirements Manual section 5.9.4.

Case documentation is an important part of the analytical process. Documentation will occur at all phases of the examination process and must be consistent with the LVMPD Forensic Handbook. Worksheets/note pages will be used to ensure inclusion of all pertinent facts pertaining to this process and the submitted evidence. Refer to the Unit Record Details in the LIMS or Qualtrax for examples of worksheets used within the Firearms/Toolmark Unit. The analysis start date will be the date data is first entered into a worksheet. This date is automatically generated in the LIMS when a worksheet is created. If an analysis is started prior to the creation of a worksheet, the “Exams Started” date within the Details tab of the Unit Record in the LIMS will be modified to reflect the actual date the analysis was started.

The critical issues of quality, training, and technical review require that a Firearm/Toolmark section be staffed with no less than two qualified examiners. If a Firearm/Toolmark section falls below this standard, a reasonable effort should be made by the Forensic Laboratory Director to bring that section up to minimum staffing.

1.01 / 02 Proficiency Testing

Proficiency testing is recognized as an important adjunct to technical review, and together they function as critical elements of the overall quality assurance program.

Every Firearm/Toolmark Examiner must complete at least one annual proficiency test in each category of testing in which they perform casework: firearms, toolmarks and distance determinations.

Every Firearm/Toolmark Examiner/Technician must complete at least one Serial Number Restoration proficiency test if qualified in that category of testing.

Every Technician/Investigative Aide/NIBIN Squad Member (Police Officer) performing NIBIN entries will complete an annual NIBIN (Individual Characteristic Database) proficiency test.

Every Technician/Investigative Aide/NIBIN Squad Member (Police Officer) test firing firearms for NIBIN entry will complete an annual firearm test fire proficiency test.

Internally created proficiency tests will be subjected to quality control checks to verify the validity of the test prior to issuance. The criteria for these checks and expected results will be outlined in the specific test.

1.01 / 03 Testimony Monitoring

The testimony of each examiner/technician will be monitored and reviewed annually by an equally qualified member of the Detail or Manager. A testimony review form is available in Qualtrax.

1.01 / 04 Reporting Guidelines

Reports will be written in accordance with the policies outlined in the Forensic Lab Handbook. In addition to these policies, Firearm/Toolmark reports will include the following when applicable:

- Testing Dates
  For reporting and documentation purposes, the testing dates will begin with the date a worksheet is opened in LIMS and end with the date the report is issued in LIMS.

- NIBIN
  Entry of crime scene and/or test fired cartridge cases into NIBIN will be reported.

  Associations from one event to one or more other events will be reported. Note: Associations within an event are exempt from this requirement.

- Methodologies
  The methodology used to reach a reported conclusion will be reported.

- Conclusions
  Conclusions will be clearly delineated as such in the report.

- Inconclusive Explanation
  The reason(s) for non-conclusive results will be reported. See “Range of Conclusions” in Section 2.01

- Simplified Reports
  A simplified report format can be used for NIBIN entry reports. These reports will include the make, model, caliber, type and serial number of the firearm examined and the name(s) of the technician(s) performing the DNA swabbing (if applicable), test firing and NIBIN entry. Lab number(s), package number(s), and impound number(s) do not have to be included in these reports. Note: Additional evidence items received will be included in the case notes but not listed in simplified reports.

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1.02 Title: **EVIDENCE CONTROL AND FLOW**

1.02 / 01 Evidence from LVMPD

Evidence handling practices pertaining to ordering, receipt and return/transfer of evidence will follow policies and procedures detailed in the *LVMPD Forensic Handbook*, Technical Requirements Manual Section 5.8.

The following details the handling of evidence in the Firearms/Toolmarks Detail of the Forensic Lab:

Upon receipt of the evidence, the assigned examiner/technician shall store the evidence in their evidence safe/locker, the Armory, or the NIBIN Squad/ Evidence Storage Room until the time of analysis. The proximal container will be marked with a unique identifier consisting of: the Lab (Case) Number, Lab Item Number and the examiner/technician's initials. Items of evidence may be marked with all or a combination of the above as deemed appropriate by the examiner/technician.

Due to obvious and easily distinguishable physical characteristics, the potential for sample switching with firearms evidence is innately low. To further reduce the potential for sample switching, the following steps are taken:

- Only one case is open on the bench and being worked on at a time.
- As packages are opened, the item description is recorded in the notes, the item may be photographed, and the item (if possible) and/or the proximal container are marked with the appropriate identifier.
- The items of evidence and proximal containers should be marked in such a manner as to prevent inadvertent "rubbing off" of the marks.
- Ammunition used for test firing is engraved prior to firing.
- Evidence examinations are not "batched". Cartridge cases and bullets are marked, examined and compared one item at a time, one case at a time.
- Items of evidence are kept in their original containers or other suitably marked secondary containers when not being examined.
- Per the examiner's preference, test samples are always mounted on the same side stage and the evidence is mounted on the other stage for all examinations. This same mounting convention is used if the comparison involves evidence to evidence comparisons where one evidence component is designated the "master".
- As the comparisons are completed, the test designator and item identifier from the items themselves are recorded along with the conclusion.
- The use of a different brand of ammunition for test firing other than that represented by the evidence, while not always feasible, aids in preventing sample switches.
- All identifying information will be verified prior to sealing the evidence.

Upon completion of the analysis the evidence will be transferred to the Forensic Lab Evidence Vault until it is transferred out of the Forensic Lab back to the LVMPD Evidence Vault.

1.02 / 02 Evidence from Other Jurisdictions

Evidence from other jurisdictions will be handled in the same manner as above in that the evidence will first be brought to the Evidence Vault and then transported to the Firearms Section.

1.02 / 03 Exceptions

Court ordered examinations will be examined by the Firearms Examiner only if a copy of a Court Order is presented. If necessary, a representative of the District Attorney's Office may transport the evidence to the Firearms Section and take receipt of the evidence upon conclusion of the examination.

Other exceptions such as hand to hand delivery of the evidence to the Firearms Examiner shall not occur without approval of the Laboratory Manager or Laboratory Director. When this is necessary, every effort will be made to use the assistance of an Evidence Technician.

1.02 / 04 Transportation of Evidence for Off-Site Examination

Certain examinations may require that evidence be removed from the laboratory and transported to an off-site facility for testing. This practice is permissible as long as the evidence remains in the custody and control of the examiner/technician while it is outside the laboratory. Note: This section does not apply to evidence forwarded to outside laboratories for analyses involving expertise beyond the scope of the Forensic Laboratory (see section **5.8.1, "*Evidence Ordering, Receipt, Processing, Return and Release*"** of the Forensic Lab Handbook for further details).

1.02 / 05 Documentation and Reporting of Evidence Received

All items of evidence received by the examiner/technician will be recorded in the case notes regardless of whether or not that evidence will be examined. With the exception of a simplified report (see Section 1.01 / 04), all evidence items will be listed on the report. A notation will be made for those items not examined.

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1.03 Title: PRECAUTIONS FOR HANDLING EVIDENCE

1.03 / 01 Precautions of Biological Evidence

Firearms and bullets which bear biological material are often encountered. In such instances, the presence of the material on the item will be noted and where appropriate, collected by the examiner/technician (see 2.04 / 01 DNA Evidence for collection procedures) or a member of the Biology/DNA Detail and may be submitted to the Biology/DNA Detail for analysis. The evidence will be handled with gloves with precautions taken to prevent infection of the examiner/technician with bloodborne pathogens.

If biological material is located on an item of evidence but is determined to be of no forensic value, the item may be cleaned in a 10% solution of bleach or other appropriate disinfectant prior to handling by the examiner/technician.

1.03 / 02 Precautions with Loaded Firearms

On occasion, the Firearms Examiner will be presented with a firearm which cannot be easily checked or unloaded. This situation may occur if the firearm is malfunctioning or rusted to the point where the action cannot be opened to check or unload. The Firearms Examiner in these cases will render the firearm safe by dismantling the firearm, discharging the contents, or by neutralizing the ammunition.

1.03 / 03 Precautions Using Chemicals and Reagents

Chemicals and reagents may be utilized by the Firearms Examiner. Chemicals and the reagents prepared from those chemicals will not be used beyond the Manufacturer's expiration/use by date in the Firearms/Toolmarks Unit. All chemicals are stored and handled according to the Chemical Hygiene Plan as set forth in the *LVMPD Forensic Handbook* Safety Manual Section 3.4.

1.03 / 04 Precautions Using Energy Dispersive X-Ray Fluorescence Spectrometer [ED-XRF]

The Innov-X hand-held ED-XRF emits ionizing radiation [x-rays] which may pose a health risk. The ED-XRF will only be operated by approved users. For safety guidelines see the *LVMPD Forensic Handbook* Safety Manual Section 3.1.6, Ionizing Radiation.

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1.04 Title: **FACILITIES**

The Firearms Detail consists of two designated areas accessed by entry/exit doors with manual/electronic keypad type locks. Note: These locks will be coded different than the locks to the other areas of the lab.

The Detail is divided into the following eight areas:

1.04 / 01 Firearm/Toolmark General Exam Area
This general examination area consists of desk and work areas for the use of computers, comparison microscopes, stereo microscopes, cameras, reference materials, reference standards, reference collections and the examination of evidence. Also in this area are gun safes assigned to the Firearms Examiners/NIBIN Technician(s) for short term evidence storage.

1.04 / 02 Armory
A separate room within the Firearm/Toolmark General Exam Area, the Armory is adjacent to the above Examination Area and is secured with a fob/proximity card sensor and separate alarm system. The purpose of this area is to house the reference collections of guns and ammunition. Large items of evidence may be stored in this area as needed.

1.04 / 03 Ballistics Lab
A separate room within the Firearm/Toolmark General Exam Area, the Ballistics Lab is used for the purposes of test firing. The Lab houses a stainless steel water-filled bullet recovery tank, dual bullet traps and test equipment all enclosed in a ballistically secure "Quick Range". This "Quick Range" is ventilated and designed to contain non-armor piercing bullets up to 3600 feet per second. The LVMPD or other ranges may also be used for test firing purposes if necessary. See Appendix Section 8.06 for Ballistics Lab clean-up procedures.

1.04 / 04 GSR Room
A separate room within the Firearm/Toolmark General Exam Area, the GSR room is used for the examination of evidence and test materials during gunshot distance determinations. This room houses a fume hood, sink, and exam areas. The door should remain closed as to limit contamination.

1.04 / 05 NIBIN BrassTrax/Matchpoint Room
Located in a separate room within the Firearm/Toolmark General Exam Area is the National Integrated Ballistic Information Network (NIBIN) computer with associated exam and desk areas.

1.04 / 06 Gun Cleaning / Work Alcove

A separate area within the Firearm/Toolmark General Exam Area houses exam areas, equipment, a sink and a snorkel type fume hood for serial number restorations, gun cleaning and repair, trigger pull measurements and other related tasks.

1.04 / 07 NIBIN Squad General Exam Area

This general examination area consists of desks and work areas for the use of the NIBIN Squad and is shared with the Trace Evidence Unit. This area is separate from the Firearm/Toolmark General Exam area

1.04 / 08 Evidence Storage Room

Located within the NIBIN Squad / Trace Evidence General Exam Area is an access controlled room for short term evidence storage.

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1.05 Title: **EQUIPMENT**

1.05 / 01 Microscopes

Forensic comparison microscopes are provided for use by the Firearm/Toolmark Examiner. These microscopes are used for examination and comparison of fired bullets and cartridge cases and toolmark comparisons. A stereoscopic microscope is also provided and is used by the examiners/technicians for examination of evidence.

1.05 / 02 Hand Tools

Numerous hand tools are used by the examiner/technicians including, pliers, cutters, hammers, screwdrivers, wrenches, drills, saws, drifts, punches, files, brushes, gauges, inertia bullet pulling equipment, hand magnifiers, measuring devices, trigger pull apparatus and other hand tools.

1.05 / 03 Camera Equipment

Camera equipment utilized by the examiners includes digital cameras and digital microscope cameras. A high speed monochrome video imaging system is available when fleeting events need to be recorded for playback in slow motion or for measuring the timing of a string of gunshots such as when determining the cyclic rate of fully automatic firearms.

1.05 / 04 Measuring Equipment

Calipers, micrometers, thickness gauges, rulers, tape measures, electronic scales and weights are used by the examiners to take appropriate measurements of evidentiary items. A chronograph is available for measuring the velocity of projectiles.

All measuring equipment will be handled carefully to avoid damage that may affect its accuracy. This equipment will be used at or near room temperature. If a piece of equipment becomes damaged so as to affect its accuracy, it will be removed from service and replaced.

1 inch and 1 mm gauge blocks are available to check the accuracy of the calipers, micrometers and thickness gauges used in the unit. Stage micrometers (2) are available to check the accuracy of the digital software measuring tool on the comparison microscopes. These items are stored in a drawer in the GSR room of the Firearms Detail. Care should be taken when using these items to ensure they are not damaged and will be immediately removed from service if they are damaged in a manner that may affect their accuracy.

NIST traceable rulers are available for critical measurements (barrel length and overall length of firearms.) Care will be taken when using the rulers to ensure they are not damaged during use. Any NIST traceable ruler will be immediately removed from service

if it becomes damaged in a manner that may affect its accuracy. The rulers are stored in the General Exam Area of the Firearms Detail.

Non-NIST Traceable rulers and gauges such as feeler gauges which are sold by reputable vendors are deemed to have accuracy and precision sufficient for our purposes and they may be used as received. The gauges will be replaced if they show wear or damages. A Firearm/ Toolmark Examiner may check feeler gauges with an appropriate calibrated caliper or micrometer if desired.

The calibration and/or performance check of calipers, micrometers, measuring rods, balances and trigger pull weights is detailed in the Appendix 8.04 -Quality Control Plan.

Calipers, gauge blocks, micrometers, rulers, and trigger pull weights are considered critical supplies and will be purchased from and/or calibrated by vendors (prior to use) who meet the criteria in **4.6.4.1- Critical Services** in the **Management System Manual.**

A software 'measuring tool' is available which, when used in conjunction with the digital microscope cameras, allows measurement of features being viewed through a microscope. If the software is not integrated with the microscope, care will be taken to ensure the correct objective is in use. The calibration of the software is detailed in the Appendix 8.04 -Quality Control Plan [see Leica Measuring Tool under Other Instrumentation].

A Type I Sound Level Meter is available when sound levels are of interest [as in Suppressor testing]. A Class I Sound Level Calibrator is to be used according to the Sound Level Meter's manufacturer's instructions. See the Appendix 8.04 -Quality Control Plan for information on Sound Level Calibrator calibration.

A PACT Shooting Timer is available for measuring the timing of a string of gunshots such as when determining the cyclic rate of fully automatic firearms.

Certain analyses may require the transportation of test/measuring equipment to facilities outside of the Forensic Laboratory. When this is necessary, the manufacturer's operating manual should be referred to regarding the handling, usage, transportation and storage of the following equipment:

- PACT Timer
- Oehler Chronograph
- Redlake hi-speed video camera
- Larson-Davis sound meter
- Innov-X EDXRF

Care will be taken to ensure these devices are not damaged during transport. This equipment should be stored in their assigned carrying cases (if applicable) during transport and when not in use. Prior to use, the recommended QC checks will be performed and documented.

1.05 / 05 Bullet Recovery Tank / Bullet Trap

A stainless steel, water-filled recovery tank is used for the purpose of test firing firearms and retrieving the test fired bullets and test fired cartridge cases. A ventilated, rifle rated

modular small arms range may be used when it is not necessary to recover the fired bullets.

1.05 / 06 Ear / Eye Protection

Ear muff and ear plug hearing protectors and a plastic eye shield are provided for use during test firing.

1.05 / 07 Reference Guns, Ammunition, Books and Other Materials

Numerous reference materials including firearms, books, and ammunition samples are used by the examiner/technicians for the purpose of dismantling, repairing and checking for modifications to firearms, locating serial numbers on confiscated guns and identifying types, calibers and manufacturers of ammunition.

The Firearms/Toolmarks Detail maintains an inventory of reference guns and ammunition. Reference guns and ammunition are uniquely identified and stored in a secure location.

See Section 2.8.3 Firearms Inventory in the Forensic Laboratory Handbook Administrative Manual for specific information and procedures regarding the use of the reference firearms.

1.05 / 08 Ammunition

Ammunition obtained by the Firearms Detail is either purchased from retail stores, online distributors, LVMPD supply, or it is received from the Evidence Vault destruct ammunition. The packaging should be marked with the source and date obtained.

Action proving or “Dummy” cartridges [should] be available in all common “calibers” for safe testing of firearm function and training.

1.05 / 09 Portable X-ray Fluorescence Spectrometer

A portable Energy Dispersive X-ray Fluorescence [ED-XRF] Spectrometer is available for the use of laboratory staff who have completed the requisite safety training. The ED-XRF is used to determine qualitatively what elements are present on or near the surface of the material. As configured, the system can detect and identify elements above atomic number 13 [Al]. The instrument produces ionizing radiation and will ONLY be operated by individuals who have received safety training. [See *LVMPD Forensic Handbook* Safety Manual; Section 3.1.6 Ionizing Radiation].

Operation and standardization will follow the manufacturer’s instruction manual supplied with the instrument. Standardization of the ED-XRF is detailed in the Appendix 8.04 – Quality Control Plan.

To Use:

1. The user must have their individually assigned dosimeter device (ring) on before continuing.
2. Turn on the power on the ED-XRF.
3. Turn on the power on the iPAQ.
4. Check the date on the iPAQ as this is how the reading is recorded in the system.
5. From the start menu, select the Innov-X software.

6. Select the “Alloy Analysis – Analytical” mode of analysis
7. Use the standardization Coupon or Clip composed of 316 Stainless Steel for calibration.
8. Place the sample in front of the window. If using while in the stand, the cover must be in place. If using as a hand held unit, insure that there is no portion of the user’s or another person’s body in front of the window during testing.
9. At minimum, a record of the date and reading number will be recorded in the case notes and the standardization screen shot will be included in the case file.

1.05/10 Ultrasonic Firearm Cleaning and Lubrication System

An ultrasonic firearm cleaning and lubrication system is available for the examiner/technicians to clean, disinfect and lubricate firearms when deemed necessary. The cleaner will be operated according to the manufacturer’s instruction manual. Cleaning, disinfecting and lubrication reagents utilized will be compatible with the manufacturer’s recommendations.

1.05 / 11 General and Clerical Equipment

Computers, pens, paper and other stationery supplies are used daily by the Firearms Unit for note taking, report writing, evidence sealing etc.

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1.06 Title: **REQUEST FOR ANALYSIS**

Property Connect or the form LVMPD 63 are the primary methods used for requests for analysis which concern the Firearms Detail.

Impounded evidence firearms and crime scene cartridge cases may be automatically examined for NIBIN entry and do not require a formal request prior to entry. In addition, outside jurisdictions may use a “NIBIN List” for the submission of firearms and cartridge cases into NIBIN.

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2.01 Title: INTRODUCTION TO FIREARM EXAMINATION PROCEDURES

The procedures in this section require the skills of a trained Firearm Examiner See Section 1.01).

To ensure the accuracy and completeness of case documentation and for reporting purposes, the AFTE glossary and appropriate manufacturers' nomenclature should be used for definitions and describing firearms parts.

The standard method for associating suspect firearms with fired ammunition components is comparison microscopy. Comparisons are typically made from about 5x to 60x using fluorescent, incandescent or LED lights. Any analytical conditions deemed by the examiner to be critical to the particular examination will be recorded in notes.

The criteria for identification is an acquired skill based on experience and training in observing patterns of individual and class characteristics which result in the formation of an opinion. The counting of individual characteristics will not be required for an identification.

Evidence items will be examined and evaluated to determine the class and individual characteristics of any markings present on the item(s) and the suitability of these markings for use in the comparison process. The results of this initial evaluation will be recorded in the examination notes.

When examining a firearm which possesses the same class characteristics as the evidence, the examiner should carefully evaluate factors such as weapon history, variability of test firings and the possible effect of ammunition variation before eliminating the firearm.

The examiner will follow these basic procedural techniques in order to facilitate examinations:

a) Ensure that the comparison microscope is properly adjusted for equal magnification at both stages.

b) Adjust the illumination to fully visualize the microscopic details.

c) Compare the test-fired components to ensure reproducibility of class and individual characteristics prior to microscopically comparing them to the evidence components. Record these comparisons in the case notes.
Note: This step is not necessary for eliminations based on differences in class characteristics.

d) Adopt a consistent procedure for the handling and documenting of comparison evidence. Photographs of comparisons will be clearly marked to indicate evidence items and test items.

e) During the comparison, documentation of the phase orientation (index) of test-fired and evidence components is recommended.

f) Documentation of conclusions must include depictions or descriptions of the agreement or disagreement of individual and/or class characteristics to the extent that another qualified examiner, without the benefit of the evidence itself, can review the case record, understand what was compared, and evaluate why the examiner arrived at the reported conclusion. The supporting documentation of one comparison may be used for additional evidence within a case, provided the agreement described or depicted is representative of the additional comparison(s).

The following was adopted by the Association of Firearm and Tool Mark Examiners in 2011 and pertains to the comparison process followed by the members of the Firearms/Toolmarks Detail.

1. The theory of identification as it pertains to the comparison of toolmarks (includes bullets and cartridge cases) enables opinions of common origin to be made when the unique surface contours of two toolmarks are in "sufficient agreement."

2. This "sufficient agreement" is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours. Agreement is significant when the agreement in individual characteristics exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool. The statement that "sufficient agreement" exists between two toolmarks means that the agreement of individual characteristics is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.

3. Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

Verifications will be performed for all comparisons of evidence items with similar class characteristics (identification, inconclusive and/or elimination). Verifications will be conducted by laboratory members authorized to perform examination in the specific area of testing covering the verification request. Verifications do not have to be performed on items of no comparison value or insufficient microscopic detail; or eliminations based on significant differences of the class characteristics. Verifications are not considered to be examinations and are normally completed in the presence of both examiners.

Therefore, they do not require evidence moves in ACE or marks on the items or packages by the verifier. If the verifications cannot be completed in the presence of both parties or require overnight storage by the verifier, evidence transfers in ACE will be performed. The conclusions of the consulting examiner will be noted in the primary examiner's case notes in the comments field of the Verification Review window in the LIMS. The verification documentation will include the identity of the consulting examiner, the date the verification was performed and the Lab Item numbers of the items verified.

During the verification process, if the reviewing examiner does not agree with the case examiner on a result/conclusion, it will be documented in the comment/note section of the Verification window in FRED prior to discussing the results with the case examiner. If the case examiner and reviewer reach a consensus on the result/conclusion, the case examiner can simply document the results of the discussion and update the notes and/or report with the revised conclusion(s), if any, and the date.

If the case examiner does not concur and a more comprehensive discussion is needed to achieve a consensus, the Forensic Laboratory Manager/Supervisor will be notified. The Forensic Laboratory Manager/Supervisor will determine the appropriate course of action. If resolution cannot be reached, it will be brought to the attention of the Laboratory Director.

If an actual error in conclusion and/or interpretation is noted which may indicate a deficiency in the training or abilities of the examiner, the report will be submitted to the respective Forensic Laboratory Manager. The Forensic Laboratory Manager will evaluate the situation and determine the needed course of action. See section **4.9 - *Control of Nonconforming Testing and/or Calibration Work*** of the Forensic Laboratory Management System Manual for further details.

Range of Conclusions

Identification
Agreement of all discernible class characteristics and sufficient agreement of a combination of individual characteristics where the extent of agreement exceeds that which can occur in the comparison of toolmarks made by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.

Elimination
Significant disagreement of discernible class characteristics and/or individual characteristics.

Inconclusive

a) Agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification.
b) Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, damage, or lack of reproducibility.

c) Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

Unsuitable
Unsuitable for examination.

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2.02 Title: **USE OF PHOTOGRAPHY**

Representative photomicrographs documenting identifications will be taken at the discretion of the examiner. Identifications are not made from these photomicrographs; hence, it is recognized that photography is primarily for recording purposes and generally documents only selected portions of an identification. Photography is inherently limited in its ability to record all of the observed detail.

Firearm/Toolmark Examiners do not use photomicographs to reach conclusions because:

a. A photograph is a two dimensional image of an object that is three dimensional.

b. Photographs often contain insignificant detail which may confuse people not trained in microscopic comparison.

c. A photograph is still and freezes the cursor (hairline). An actual comparison is very dynamic, and continuous movement of the cursor is an integral part of the examination process.

d. Photographs can be falsified or altered.

e. Photographs provide an incomplete representation of the entire comparison process.

f. Visual data in photographs, particularly when magnified, can be misinterpreted by people not trained in firearm/toolmark examination.

g. The incorrect interpretation of a photograph may endanger the accused, particularly on a probable identification.

General Evidence Photography
Photography can be a useful addition to note taking and evidence documentation. Good forensic practices such as the use of scales, special lighting or filters may be employed. Notes should reflect significant techniques used.

Digital Photography
Digital photography and electronic image capture and processing can be used in the same way standard photography is used. The ability to enhance or otherwise edit images accomplishes the same things that can be done to traditional photographs in a darkroom but with greater control, speed and convenience.

It is inappropriate to edit an image with the intended purpose of misrepresenting the evidence or the results of comparisons or examinations of the evidence. When digital images are used for purposes other than simple documentation of the appearance of an item of evidence, an unedited, full digital image file should be retained in addition to the edited files. These digital image files will be stored in the Unit Record Object Repository. Edited, enhanced or composited image files may also be stored with the unedited file. Digital images inserted in a LIMS worksheet should be saved as a JPEG or PDF file.

LVMPD FORENSIC LABORATORY
TECHNICAL OPERATIONS MANUAL
FIREARMS / TOOLMARKS DETAIL

2.03 Title: **SAFE FIREARM HANDLING IN THE LABORATORY**

2.03 / 01 Introduction

Firearm evidence in the laboratory is not dangerous if handled correctly and treated with respect. Occasionally, loaded firearms are received in evidence for a particular examination. These, of course, need very special handling and will be discussed later. All firearms will be treated as though they are loaded, until the examiner proves they are not! This rule cannot be overstressed and must be followed at all times, whether it is at an evidence reception area, in the vault, firearms section, range, or court. Safe gun-handling here corresponds exactly with safe gun-handling in general. Prevent accidents by practicing safety at all times.

A rule that needs strict adherence is to keep the muzzle pointed in a safe direction at all times! Some firearms are received containing live ammunition and, therefore, this precaution is extremely important and makes common sense.

2.03 / 02 Laboratory / Firearms Section Safety Rules

- No one will be down range/in front of the examiner while a firearm is being loaded, unloaded or fired.
- Firearms will be loaded and unloaded in the test firing area.
- Ear and eye protection must be worn by all persons present during live firing.
- Appropriate notice (i.e., verbal) shall be given prior to test-firing.
- Questions of safety have to be resolved prior to the procedure continuing.
- No loaded firearms will be placed or stored in the Evidence Vault or returned to any agency.
- The shooting area is equipped with video surveillance which is to be checked prior to entering the Ballistics Lab and monitored during shooting to quickly detect any injury or problem.
- The use of the Ballistics Lab will be limited to the Firearms Examiners and NIBIN Technician(s). Other qualified individuals are permitted to use the Lab only under the direct supervision of a Firearms Examiner after approval of the Detail Manager or Laboratory Director.

- No projectiles exceeding the specified limits of the range bullet trap [3600 fps, no steel cored, no armor piercing ammunition] will be fired into the trap.

2.03 / 03 Pre-Firing Safety Check

It is the responsibility of the examiner/technician to ensure that appropriate safety function checks are performed on a firearm prior to test-firing. The following is a list of safety checks which may be considered. The examiner/technician should be mindful that individual situations may require more extensive safety checks than that which are listed here. Examiners/technicians are reminded to be careful not to lose or destroy trace potential evidence while performing the safety check.

FOR ALL FIREARMS:

1) Is the firearm unloaded? (Check tubular magazines carefully.)
2) General Examinations
   - Is the chamber/bore clear?
   - Are there any loose, damaged or missing parts?
   - Are there any dangerous modifications?
   - Is the barrel bulged, obstructed or loose?
   - Are there any loose or missing screws?
     CAUTION: Movement or replacement of parts may make the firearm safer, but may also significantly alter the operational characteristics.
   - Are there any firearm recall notices that should be considered?
3) Trigger Function
   - Does trigger return reliably?
   - Does the trigger function as designed?
4) Hammer
   - Will it push off?
   - Does the half cock notch catch? (if applicable)
   - Will the hammer fall from the half cock notch when the trigger is pulled?
   - Does the hammer rebound when the trigger is pulled?
   - Are there any false seating positions?
   - Will the hammer/striker release when the bolt is closed?
5) Firing Pin
   - Is it free to retract and not binding?
6) Safeties/Types of Safeties
   - Do they operate? (Check each safety independently.)
7) Feeding (Check with dummy ammunition.)
8) Drop/Impact (jar off) testing is a recognized procedure (See ANSI/SAAMI Z299.5-1996)
9) Examination and restoring evidence firearms to safe operating conditions is a recognized procedure.
10) Examination/Disassembly of damaged/altered firearms for operating condition is a recognized procedure

FOR REVOLVERS:

1) Cylinder
   - Is the cylinder secure when closed?
   - Do the chambers align with the barrel?

- Is the cylinder bulged?

2) Cylinder Rotation
   - Does the cylinder bind?
   - Does it lock up in both single action and double action?
   - Does it skip chambers with partial trigger return?
   - Does the chamber align correctly with the forcing cone?

FOR NON-REVOLVER FIREARMS:

1) Disconnector
   - Is one present?
   - Is it functional?
2) Lock-up
   - Does the slide/bolt engage tightly?
   - Will it fire out of battery?
3) Magazine
   - Does it seat properly?
   - Is the magazine operable?

AMMUNITION

- Is it reloaded? As a general policy, reloads will not be used unless necessary and if so, remote firing is strongly recommended.
- Was the firearm designed for the ammunition to be used (i.e., re-chambering, wildcat cartridges, +P rounds)?
- Was the firearm originally designed for black powder loads (i.e., Damascus barrels)?
- Are there any ammunition recall notices that should be considered?

2.03 / 04 Rendering Firearms Safe

Per Department Manual 5/210.02, a Firearms Examiner will assist in rendering a firearm safe prior to impound. This should be completed in a timely manner. The preferred method would be to receive the firearm unsealed to allow unencumbered access to the firearm. The firearm will be unloaded and serial number obtained if easily accessible during this process. All other examinations requested may be addressed at a later time or at the direction of the Firearms Detail Manager.

A memo containing the following information will be generated if loaded firearms brought in by department personnel require extensive handling to render it safe (beyond standard mechanical manipulation),

- Who the firearm was obtained from
- Make, model and serial number of the firearm
- The general steps necessary to render the firearm safe
- What PPE was worn
- Who and/or where the firearms was released to

This memo will be uploaded to OnBase and will be kept in the Object Repository of the Unit Record.

Normal Business Hours

Firearms under CSA custody
Crime Scene Analysts may request assistance from a Firearms Examiner by bringing the firearm directly to the Firearms Detail to be unloaded. Once the firearm has been rendered safe, it should then be returned to the Impounding CSA or to the Crime Scene Analyst Supervisor to be secured and returned to the impounding CSA.

Firearms under Police Officer's custody
If the Officer can remain on premises, then refer to Firearms under CSA custody above. If the Officer cannot be present, then he/she must leave a completed Impound Report, evidence label or tag and the firearm with the Firearms Examiner.* Once the firearm has been rendered safe, the applicable steps should be taken:

- Any ammunition will be removed from the chamber or cylinder
  - Place ammunition in a package and label "removed from… by initial"
  - Add the ammunition to the Officer's Impound Report (initial line item(s)) and write "REVISED" at the top of the form
  - Add the ammunition to the package label and initial
- Package and seal the item(s)
  - The chain-of-custody does not need to be signed as the memo will reflect who sealed the package
- Relinquish the package and Impound Report to the Forensic Lab Vault to be data entered and sent to the Main Vault.

  *Note: the items in the package should only contain firearm related items. i.e. a glove used to store ammunition is okay, but a glove found with the gun should be packaged separately.

Firearms under Other Jurisdiction custody
The Other Jurisdiction (OJ) personnel will work with the Evidence Technician to enter the firearm into ACE and submit a lab request. This lab request will be forwarded to the appropriate LEST to be entered into FRED. The Firearms Examiner may take possession of the firearm during this time to begin the unloading process. Once the firearm has been rendered safe, the applicable steps will be taken:

- Any ammunition will be removed from the chamber or cylinder
  - Place ammunition in a package and label "removed from… by initial"
  - Add the ammunition to the package label and mark with your initials and "LVMPD Lab"
- Package and seal the item
- Sign the package chain of custody
- Relinquish the package to the Evidence Technician and inform them if it should be placed in the "OJ-In" or "OJ-Out" location. OJ-In is for evidence that has outstanding forensic requests. OJ-Out is for evidence that does not need any further forensic testing.

A lab report will be issued in lieu of a memo.

After Business Hours

The Crime Scene Analyst Supervisor will be notified and follow CSI procedures for a loaded firearm.

CSA Custody

The Firearms examiner will obtain the firearm from CSI. Once the firearm has been rendered safe, the firearm will be returned to a Crime Scene Analyst to be secured and returned to the impounding CSA.

Police Officer

The Police Officer will leave a completed Impound Report, evidence label or tag, and the firearm with the Crime Scene Analyst Supervisor. Once the firearm has been rendered safe, the applicable steps will be taken:

- Any ammunition will be removed from the chamber or cylinder
  - Place ammunition in a package and label "removed from… by initial"
  - Add the ammunition to the Officer's Impound Report (initial line item(s)) and write "REVISED" at the top of the form
  - Add the ammunition to the package label and initial
- Package and seal the item(s)
  - The chain of custody does not need to be signed as the memo will reflect who sealed the package
- Relinquish the package and Impound Report to the Forensic Lab Vault to be data entered and sent to the Main Vault.

OJ Personnel

The OJ personnel will leave a completed evidence package (unsealed), the firearm and a Forensic Laboratory Request with the Crime Scene Analyst Supervisor. The Evidence Log For Outside Agencies (LVMPD form ISD22) will also be completed. Once the firearm has been rendered safe, the applicable steps will be taken:

- Any ammunition will be removed from the chamber or cylinder
  - Place ammunition in a package and label "removed from… by initial"
  - Add the ammunition to the package label and initial with 'LVMPD Lab'
- Package and seal the item
- Sign the package chain of custody
- Relinquish the package to the Evidence Technician and inform them if it should be placed in the 'OJ-In' or OJ-Out" location. OJ-In evidence that has outstanding forensic requests. OJ-Out evidence that does not need any further forensic testing.

A lab report will be issued in lieu of a memo.

LVMPD FORENSIC LABORATORY
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2.04 Title: **DNA AND TRACE EVIDENCE**

Firearm evidence is often submitted with debris that may cover its characteristics and which may have other significance to the case. In order to determine class characteristics or compare individual characteristics of the firearm evidence, this debris may have to be removed. This debris may consist of blood, tissue, paint, fibers, glass, etc. The value of this debris as trace evidence should be considered during this examination. The examiner/technician is cautioned that this type of evidence may present a health hazard.

The biological or trace material should be removed and collected to protect the integrity of the material and packaged appropriately. Mark the package as to the type of material removed and from which item it was removed. If the packaged material can be returned to the original packaging, do so. If the material cannot be returned to the original packaging or needs to be examined by another Detail, follow the evidence handling guidelines detailed in the Forensic Laboratory Technical Requirements Manual Evidence Intra-Lab Transactions and Splits, 5.8.1.1.1.

2.04 / 01 DNA Evidence

The following procedure will be followed when collecting DNA evidence, including bloodstains, saliva, semen, skin cells, and additional biological material. DNA evidence swabbing will occur prior to any latent print processing.

When swabbing for DNA, the work area must be clean to prevent cross contamination. Clean the work area with 10% diluted bleach or a suitable commercial disinfectant solution, and place the evidence on a clean sheet of bench/butcher paper. The examiner/technician will use swabs moistened with Molecular Grade Water (MGW) provided by the Biology/DNA Detail for collecting possible DNA material from firearms evidence.

Firearms evidence wrapped in an item that will contaminate the firearm will not be swabbed for DNA and will be noted in the case file (for example, a sock or clothing item that has been worn in which the firearm is placed).

Gloves, mask and lab coat will be worn during this process

1. Biological stain - collect the sample with one moistened swab, concentrating the stain on one area of the swab. Use additional swabs if necessary.

2. Firearms (Possible DNA material)- collect a DNA sample with one or two moistened swabs from the entire exterior surface of the firearm

3. Magazines (possible DNA material)- collect a DNA sample with one moistened swab from the exterior surface of the magazine

If latent print processing will be required swab only the following areas:

a. Revolvers- One moistened swab from the trigger, hammer, cylinder release, ridged surfaces on the cylinder, and grip (with the grip sample last)

b. Semiautomatic handguns - One moistened swab from the trigger, slide serrations, hammer, and grip (with the grip sample last)

c. Firearms Magazines - One moistened swab from the bottom of magazine and the feeding area

d. Rifles and Shotguns - One moistened swab from the trigger, stock, and forestock

Swabs will be packaged using a LVMPD Biological Material envelope (LVMPD 523) placed inside a standard evidence envelope. The following additional information will be recorded:

On the Biological Material Envelope, fill in the appropriate fields and add the FRED Lab number below the Event Number field.

On the evidence label on the outer envelope, the description of the item swabbed should include the ACE number, Lab number and Lab Item number of that item in parenthesis at the end of the description.

The examiner/technician will document the pertinent information regarding the swabbing in the case notes. Pertinent information will include the areas swabbed and lot number of the molecular grade water used for swabbing.

A DNA collection statement will be added to the Lab Report listing the items swabbed.
For example: "The pistol and magazine (Lab Items X and Y) were swabbed for DNA prior to test firing and (insert # of swabs) swabs were booked into the evidence vault".

A short note will also be placed in the Lab Case Details Comments field reflecting that the firearm was swabbed for DNA.

The DNA Manager and/or LEST responsible for updating examination requests in the LIMS will be added to the list of Requestors.

2.04 / 02 Trace Evidence

Trace evidence will be collected using generally accepted evidence collection procedures.

After collection or if trace material is determined not to be of forensic value, the item may be cleaned by mechanical means or using the following lists of reagents:

- Methanol
- Ten percent dilution of bleach
- Soap and water
- “Booker Dip”
- Peroxide-Acetic Acid bullet cleaner
- Acetone
- Isopropyl Alcohol
- Dispatch® or other commercial cleaner/disinfectant
- Microcide SQ™ or other commercial cleaner intended for use in an ultrasonic cleaner

Examiners/technicians are responsible for knowing the health hazards involved in the use of the chemicals named above. These chemicals and their hazards can be found in the Material Safety Data Sheets/SDS that are on file in the laboratory.

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2.05 Title: **CASES WITHOUT FIREARMS**

The examiner may be asked to determine the class characteristics of fired ammunition components. Examples of these class characteristics include but are not limited to:

Caliber, weight, type, direction of twist, number of lands and grooves and their widths, extractor/ejector mark locations, and unique breech face signatures. These characteristics should be compared to appropriate data files and lab data in order to generate a list of possible firearms. When a list of firearms is reported, appropriate qualifying statements will be included to reflect any limitations of the data.

Pellet size determination is normally conducted by one or more of the three procedures listed:

a) Direct comparison with known shot sizes.
b) Weighing a specific number of shot in comparison to the same number of known shot sizes, or values established in a reference source.
c) Measuring diameter and comparing to known shot sizes or an established reference source.

Wad gauge determination will be conducted in direct comparison with known standards and/or measure the diameter and compare to values established in a reference source. The direct comparison method may also be used for brand, type, and design identification.

The expended bullets and cartridge cases in a case submission should be compared in order to determine the number of possible firearms involved. “Fastrack” cases (cases submitted for NIBIN entry only) are exempt from this provision.

Expanded hollow point or controlled expansion bullets may have to be straightened/unfolded to observe class and individual characteristics. Documentation through the use of notes and/or photography will be utilized to record the condition of these bullets prior to straightening/unfolding.

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2.06 Title: **CASES WITH FIREARMS**

The examiner/technician will document a case with notes, worksheets, and sketches or photographs noting the condition of the submitted firearm (i.e., safety positions, smoke rings, action position) and fired components.

The examiner/technician will perform appropriate safety tests prior to test-firing (see 2.03/03).

The purpose of test firing a firearm is to obtain exemplars for comparison purposes and/or NIBIN entry and when specifically requested, to test the functional aspects of the firearm. Firearm functionality examinations are case dependent and may include aspects such as operability, trigger pull, magazine capacity, function of safeties, barrel and overall lengths, etc. Test firing performed for NIBIN entry can establish firearm operability (i.e. is the firearm capable of firing) and may satisfy many laboratory requests for function examinations.

Prior to test-firing, the examiner/technician will evaluate the need for the collection of foreign material on or in the firearm.

The examiner should test fire a minimum of two rounds of ammunition so that suitable test components are available for comparison. Prior to being fired, the test components will be engraved with the Lab Item number of the firearm being test fired and a sequential alpha designator (e.g. 1A, 1B, 1C, etc.). After the completion of the case, these test fires will be booked as evidence in accordance with LVMPD policy under the same event number as the firearm. When packaging the test fires, the test fired bullets will be placed in one plastic bag, the test fired cartridge cases will be placed in a second plastic bag and the barrel patch (if collected) will be placed in a third plastic bag or paper bindle.

These plastic bags/bindle (proximal containers) will be labeled as follows:

> Event #XXXXXX-XXXX
> Test fires from Lab #XX-XXXXX Item #X (may be written as XX-XXXXX-X)
> Initials

The Item # is the FRED item number of the gun. These three plastic bags and/or bindles may be placed in one larger clear plastic bag (Note: this larger bag does not need to be labeled if the writing on the interior packages is visible) and then placed in the evidence envelope. The above is the minimum amount of information that must be placed on the plastic bags. It is left to the examiner/technician's discretion to add more.

The examiner should be aware of the dangers of firing down-loaded ammunition and the possible change in stria on these bullets.

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2.07 Title: **SILENCERS (SOUND SUPPRESSORS)**

The examiner will evaluate the device as to structure and design, as well as its effectiveness as a silencer. This includes identifying components and structural configurations which indicate an attempt to diminish the report of a firearm.

Prior to testing, the device shall be examined for prior usage and its suitability for safe testing. This examination will include consideration of:

- The structural integrity of the device
- The proper attachment of the device to the firearm (if submitted)
- The proper alignment and clearance of the device with the bore of the firearm
- The components and material(s) used to fabricate the device and their visible characteristics.

This may include both external and internal examinations using specialized equipment (e.g. borescopes) and chemical testing for trace material (e.g. sodium rhodizonate for lead)

During the examination process, it may be beneficial to x-ray the device in question. If x-rays are desired/needed, the Firearms Detail has a working relationship with the Clark County Office of the Coroner/Medical Examiner (CCOCME) to provide this service. The Forensic Scientist should contact personnel at the CCOCME and arrange a mutually convenient time to have the device x-rayed. The Forensic Scientist will personally transport the device to the CCOCME and maintain custody and control of the device during this process. Copies of the x-rays will be placed in the Unit Record Object Repository in the LIMS.

In testing silencers, it is recommended that testing equipment (such as an impulse noise level meter) be used in determining sound levels (quantitative) although an audible reduction (qualitative) may satisfy most courts.

- Quantitative: The firearm's report is recorded and calculated with an impulse noise level meter with and without the device attached.

- Qualitative: An audible reduction in sound is noted when shots are fired with and without the device attached.

If the device is permanently attached to the firearm, it is acceptable to compare the report of the evidence firearm with the device attached, to a comparable reference firearm without the device. If this is done, every effort will be taken into consideration to

closely replicate the evidence firearm (i.e. make, model, caliber, barrel length, etc…) and ammunition.

After testing is complete, it is an acceptable practice to disassemble these devices to study the design and construction of the internal parts.

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2.08 Title: **FULL-AUTOMATIC FIREARMS AND CONVERSIONS**

The examiner should evaluate the design, and test the mechanical function of the firearm or component to determine the possibility of full automatic function.

Extreme caution should be used in the test-firing of any suspected full automatic firearm. Firearms converted to full automatic modes of fire are susceptible to a wide range of malfunctions.

It is recommended that while test-firing for the collection of samples, no more than two rounds of ammunition be loaded into the firearm. Test-firing for the rate of fire will be conducted at a range adequate to accommodate full automatic fire of the caliber being fired.

It is a recognized practice to disassemble full automatic firearms to study the design and to identify any altered internal parts.

A shot timer and/or a high speed video camera is available for measuring the timing of a string of gunshots such as when determining the cyclic rate of fully automatic firearms as necessary.

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2.09 Title: BARREL LENGTHS AND OVERALL LENGTHS

Introduction
Barrel length is defined as the distance between the end of the barrel (aka: muzzle) and the face of the closed breechblock or bolt for firearms other than revolvers. On revolvers, it is the overall length of the barrel including the threaded portion within the frame but excluding the cylinder.

Overall length of a firearm is defined as the dimension measured parallel to the axis of the bore from the muzzle to a line at right angle to the axis of the bore and tangent at the rearmost point of the firearm. Firearms with collapsible stocks should be measured collapsed and fully extended.

Barrel and overall length normally include compensators, flash hiders, etc., if permanently affixed. However, removable barrel extensions, chokes, flash hiders, compensators, etc., are not part of the measured barrel or overall length. If the muzzle of the firearm is uneven, barrel length is measured using the farthest extending portion of the muzzle.

Procedure
Overall length

- Position the bore of the firearm parallel to a ruler.
- Use a solid surface perpendicular to the certified ruler to establish the tangential line at the rearmost point of the firearm.
- Measure the distance from the butt (or other rearmost point) to the muzzle using the 1/16” scale of the ruler. The reading may be recorded as a simplified fraction. If the length falls between graduations of the 1/16” scale, round up to the nearest graduation.
- A ‘T-square’ or similar object provided for this purpose may be used at the muzzle to ensure a perpendicular reading in relation to the ruler.

Barrel Length (all firearms excluding revolvers)

- With the breech in a closed and locked position, place a non-marring rod down the barrel of the firearm until it contacts the breech face.
- Slide a cursor (stopper) down the rod until it contacts the muzzle.
- Remove the rod from the barrel.

- Using the 1/16" scale of a ruler, measure the distance between the end of the rod that was positioned against the breech face of the firearm and the cursor device or noted muzzle location on the rod.

- Record this measurement as the barrel length. If the length falls between graduations of the 1/16" scale, the examiner will round up to the nearest graduation.

- Alternately, for non-critical measurements, a Hott-Rod™ may be used. The Hott-Rod™ is placed down the barrel until it contacts the breech face and the length to the muzzle can be read directly off the Hott-Rod™. Non-marring unmarked rods may also be used in a similar fashion. The muzzle location is indexed on the rod and the length read against a suitable measuring device.

Barrel Length (Revolvers)

- The barrel length is measured from the rearmost end of the barrel (forcing cone) to the muzzle.

- If possible, the barrel length may be measured without the use of a rod by placing a ruler directly on the barrel. Alternatively, a non-marring rod and cursor device or Hott-Rod™ may be used to measure the barrel length.

Critical Measurements

The barrel length and overall length recorded on the Firearms Worksheet are typically for descriptive purposes and do not require the use of a certified ruler. However, when barrel and/or overall length measurements are made for the purpose of determining whether or not these length measurements meet certain statutory definitions or legal requirements, the use of a NIST traceable ruler is required. The examiner shall use the procedures described above and record the identity of the NIST traceable ruler in the case file.
An uncertainty of measurement was calculated for barrel length and overall length. The study and the results, along with the procedure for determining the uncertainty of measurement when measuring barrel lengths, can be found in the Firearms/Toolmarks Detail's Validation and Uncertainty Binder located in the Detail Manager's office and/or in Qualtrax.

Effective at the time of adoption of this version of the Firearm/Toolmark Technical Manual, the uncertainty of measurement (UoM) for barrel and overall lengths is +/- 1/16 inch at an approximate 95% confidence interval. At a minimum, the uncertainty budget shall be reviewed upon recalibration of a measurement device, replacement of a measurement device, significant changes to the analytical method, or personnel change within the Firearms Detail.

NOTE: When the reported barrel or overall length measurement impacts the evaluation of a statute, legal requirement or is taken upon customer request, the UoM for that value will be included in the formal laboratory report by checking the box "NIST ruler used" in the firearms worksheet.

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2.10 Title: **TRIGGER PULL EXAMINATION**

One of the routine examinations conducted in a firearms examination is determining the trigger pull of a firearm. Trigger pull is defined as the amount of force that must be applied to the trigger of a firearm to cause sear release. This examination can provide important information regarding the mechanical operating condition of the firearm.

The trigger pull examination should normally be conducted after the firearm has been successfully test fired. There is a remote possibility that the firearm may be damaged during this examination. When practical, measuring the trigger pull of a rimfire firearm shall not be performed on an empty chamber. An inert cartridge shall be used. The examiner must also take into consideration the potential for damage of a centerfire firearm during testing and may wish to use an inert cartridge in this instance as well.

Single Action Trigger Pull

a) Ensure that the firearm is unloaded.
b) Cock the firearm.
c) Hold the firearm with the bore perpendicular to the floor with the muzzle pointed upward. Rest the trigger hook of the standard trigger weight hanger on the trigger where the average finger would normally rest. Make sure the hanger is not touching any other part of the firearm and the weights are hanging parallel to the bore of the firearm.
d) Add weights and gently lift the firearm until the sear releases.

Repeat at least once to confirm results, or continue to repeat until a consistent value is obtained. Reset the sear connection after each attempt.

Record the heaviest weight held prior to sear release and the lightest weight required for sear release. Noting any revolver cylinder chamber (or other special circumstance) that results in a different trigger pull value is recommended.

Double Action Trigger Pull

a) Without cocking the firearm, proceed as above, adding weights until the weights pull the trigger through the double action sequence and the sear releases. The trigger system should be reset as necessary.

The results acquired are only an approximation and a different technique may lead to a different trigger pull weight. When using standard trigger weights, the trigger pull value is normally recorded in ¼ pound increments.

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2.11 Title: **BORE AND CHAMBER CASTINGS**

Occasionally, firearms are received with unknown calibers or calibers that may differ from the designation on the weapon and in the literature. In order to gain more information about the firearm and fire test shots that are of correct caliber, it may be necessary to make a bore or chamber cast. Then, by measuring the cast, the correct cartridge can be determined.

Several methods are available which use a variety of casting materials (such as low melting point metals and silicone rubber compounds*). The specific method will be at the discretion of the examiner.

*Mikrosil, Forensic Sil, silicone rubber, and Duplicast or similar products can be used for this process. Follow the manufacturer's mixing instructions for proper usage.

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2.12 Title: **LAND AND GROOVE MEASUREMENTS**

General Rifling Characteristic (GRC) determinations may entail measurements of land and groove widths. Several instruments are available for making such measurements, and the technique of measurement is approximately the same in each. The critical parameters are the points used for beginning and end of a measurement. Use one or more of the methods listed below:

a) Air Gap Method – Comparison Microscope

Mount the fired bullet on one stage of the comparison microscope. Mount the measuring device (micrometer) on the other stage. Both stages must use the same magnification level (objective setting) and be in focus on the top center portion of the micrometer spindle and bullet surface.
Adjust the measurement gap (opening) between the spindle and anvil of the micrometer to align with the reference points of the appropriate land or groove impression. Record the value to the nearest hundredth of an inch (or appropriate measurement.

b) Air Gap Method – Stereo Microscope

Place the fired bullet beneath the stereo microscope. Place the land or groove impression of the fired bullet in the topmost vertical position aligned with the opening of the micrometer or caliper.

Move the micrometer's/caliper's measuring point to the next reference point and record the measured width. Record the value to the nearest hundredth of an inch (or appropriate measurement).

c) Stage micrometer

Mount the fired bullet on one stage of the comparison microscope. Mount the stage micrometer (microscale) on the other stage. Both stages must use the same magnification level (objective setting) and be in focus on the top center portion of the bullet surface and on the stage micrometer (microscale) markings.

Place the land or groove impression of the fired bullet in the topmost vertical position with one of the reference points corresponding with a mark on the stage micrometer (microscale). Record the measured width to the next

reference point. Record the value to the nearest hundredth of an inch (or appropriate measurement).

d) Leica Live Measure Software or software “measuring tool”

Mount the fired bullet on the comparison microscope Ensure proper lighting and orientation and that both objectives are on the same magnification. Use the software to determine land and groove width measurements. Record the value to the nearest hundredth of an inch (or appropriate measurement).

The caliber and GRC (number, width, and direction of twist of the rifling impressions) on a fired bullet can be referenced to a database* of characteristics to produce a list of firearms the bullet may have been fired from. When searching a database for possible firearms, a minimum range of +/- 0.002 inches should be added to the measured land and groove impression widths.

*Commonly referenced database include those available from the FBI and the Association of Firearm and Toolmark Examiner (AFTE)

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2.13 Title: **NIBIN (National Integrated Ballistic Information Network)**

2.13 / 01 NIBIN General Information

NIBIN is an image based database system designed to allow images of cartridge cases to be collected and searched against Open Case Fired Ammunition Files or added to the database.

Procedures and requirements for personnel to make entries into the NIBIN database are controlled and determined by the BATFE (Bureau of Alcohol, Tobacco, Firearms and Explosives). All users must complete the BATFE Integrated Ballistics Identification System Course and be authorized by BATFE to log into the NIBIN system. An online procedure manual for using the system is available on the IBIS computer workstation.

The Forensic Scientists/NIBIN Technician(s) will enter test fired and/or evidence cartridge cases into the NIBIN database at their discretion, knowing that not all ammunition components or firearms will fit the criteria needed to use NIBIN most effectively. Firearms submitted for entry into the NIBIN database will be examined and test fired following the procedures and protocols established in Sections 2.03 SAFE FIREARM HANDLING IN THE LABORATORY and 2.06 CASES WITH FIREARMS.

Anytime a cartridge case is entered and searched in the NIBIN database, it will be noted in the case record along with the date of entry, the date of correlation review and the results of the search. In addition, a statement will be added to the report noting the entry of the cartridge case(s) into NIBIN.

The following criteria will act as a guide in determining which cartridge cases should be entered into NIBIN

- Any firearm of any caliber that ejects the fired cartridge case during its cycle of operation may be appropriate for entry.
- Any cartridge case with a discernible pattern of individual characteristics in the breechface marks and/or firing pin impression may be appropriate for entry.
- Cartridge cases with no visually distinguishable patterns of individual characteristics in the breech face marks and firing pin impressions should not be entered.
- Multiple cartridge cases submitted for NIBIN entry only (i.e."Fastrack" cases):
  The cartridge cases will be visually screened and grouped according to class characteristics. If one or more groups are found to be visually distinguishable from each other, one cartridge case from each group may be entered.*

  * NOTE: Multiple cartridge case screening is performed by Forensic Scientists only.

In addition to the automatic correlation, a manual correlation of the local databases will be launched.

Correlation results in NIBIN will be reviewed by a Forensic Scientist I/II, Forensic Laboratory Technician or the Detail Manager qualified to perform firearm examinations. At a minimum, the top 40 "rank sorted" candidates will be reviewed. Local NIBIN "Hits" will be confirmed through conventional comparison microscopy of the evidence and/or test fired cartridge cases. When practical, the examiner who confirms a hit should use their test fires for the comparison. In the event the firearm is no longer available, previously booked test fires may be used with appropriate notation in the examiner's bench notes. NIBIN hits to other jurisdictions and/or those that cannot be expeditiously confirmed may be reported without "on-scope" confirmation through on the NIBIN entry report or through the NIBIN Hit Notification available in the LIMS.

2.13 / 02 NIBIN Squad Program

To facilitate a shorter turnaround time for the entry of impounded firearms into NIBIN, the Forensic Laboratory utilizes a squad of permanent light duty police officers. These officers are assigned to the NIBIN Squad and are within the chain of command of the Forensic Lab. The primary job duty of the officers on the NIBIN Squad will be to test fire impounded firearms for entry into NIBIN. In addition, they may perform DNA swabbing on guns associated with violent crimes or by request. These officers are considered lab members and are subject to the same accreditation standards followed by the other members of the Forensic Laboratory. As such, they will follow the administrative and technical procedures outlined in Sections 1, 2 and 8 of this manual along with all sections of the Laboratory's Forensic Handbook.

***Note:** The recovery of fired bullets is not necessary for firearms examined for NIBIN entry only.

The process for the test firing of firearms and subsequent NIBIN entry is as follows:

<u>NIBIN Technician - Test Firing:</u>

1. The Unit Record (UR) is assigned to a NIBIN technician.
2. The Technician requests the evidence and reviews the Lab Case Details and UR to check if the evidence needs to be swabbed for DNA or for other issues or notations regarding the analysis.
3. Once the evidence is received, the technician will confirm that the outer package information and the information in FRED are consistent.
4. If DNA swabbing is needed, the technician will swab the firearm and magazine for DNA per the procedure in Section 2.04 /01 of this manual.
5. Complete the NIBIN test fire sections of the Worksheet.
    - Enter in the charge listed on the evidence label to the outer package comments field.
    - Select the items to be examined – it is only necessary to add notes to the Item Notes field if there is an issue with ACE numbers or descriptions, serial numbers, etc. and/or to add comments regarding DNA swabbing.

- If additional items are in the packaging, add under "Items Not Requested." Add a brief description and impound number of the additional items.
- If a cartridge case consult is needed, add the item and request a consult. If the cartridge case is not associated to test fires, enter it using the NIBIN worksheet.
- For the firearms section of the worksheet choose the correct item and fill in the fields regarding:
    - Make
    - Model
    - Caliber
    - Type
    - Serial Number

NOTE: Examination and test firing will be done following the procedures and protocols established in Sections 2.03, 2.05 and 2.13 of this manual.

- For the test fire section of the worksheet fill in the fields regarding:
    - Labeled
    - # Fired
    - Date fired
    - Function
- In the Notes section at the bottom: The P#/initials of the technician performing the test firing.

6. If the firearm is not functional generate a simplified report* regarding non-functionality and submit for administrative review.
7. If the firearm is functional, book the test fired cartridge cases (FTM0 – TEST) and change the discipline code to **20**.
8. Return the firearm evidence to the lab evidence vault

NIBIN Technician - Test Fire Entry:

9. Transfer the UR to the technician responsible for NIBIN entry.
10. Transfer the test fired cartridge cases to the custody of the technician who will perform the NIBIN entry.
11. Enter a test fired cartridge case into NIBIN.
12. Complete the NIBIN test fire section of worksheet:
    - Check the NIBIN entry radio button and add the date of entry
    - In the Notes section at the bottom record the P#/initials of the technician performing the NIBIN entry
13. Change the discipline code to **30**.
14. Return the test fired evidence to vault.

Forensic Scientist – Correlation Review:

15. Transfer the UR to the Forensic Scientist/Technician reviewing the correlations
16. Review the Correlations.
17. Complete the Correlation sections of Worksheet:

- Date of correlation review and if there were any associations. If applicable, upload the NIBIN Hit info sheet(s) into the OR.
- In the Notes section at the bottom record the P#/initials of the Forensic Scientist/Technician reviewing the correlations.

18. Draft a simplified report* and submit for review.

*Simplified Reports: See “Report Guideline Section 1.01 / 04

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3.01 Title: INTRODUCTION TO TOOLMARK EXAMINATION PROCEDURES

Applying the procedures in this section to casework requires the skills of a fully trained Firearm/Toolmark Examiner. To be deemed trained in a particular procedure; the Examiner must have completed an appropriate and approved training program for the procedure and successfully completed a competency test including the issuance of a certificate of competency. Additionally, a trained Examiner must confirm the training was completed and the trainee is able to perform the procedure satisfactorily.

To ensure the accuracy and completeness of case documentation, it is recommended that the AFTE glossary be used for appropriate definitions and appropriate manufacturers' nomenclature for describing tool parts.

The standard method for associating suspect tools with evidence marks is comparison microscopy. Comparisons are typically made using objectives from about 5x to 60x using fluorescent, incandescent or LED lights. Any analytical conditions deemed by the examiner to be critical to the particular examination will be recorded in notes.

Photographs documenting identifications may be taken at the discretion of the examiner for the reasons outlined in the "Firearm Examination Procedures" of this manual.

Prudence will be exercised in the placement of permanent identification marks on tools and toolmarks so that significant evidence is not altered and the probative value is not lessened.

Evidence items will be examined and evaluated to determine the class characteristics of any markings present on the item(s) and the suitability of these markings for use in the comparison process. The results of this initial evaluation will be recorded in the examination notes.

The criteria for identification is an acquired skill based on experience and training in observing patterns of individual and class characteristics which results in the formation of an opinion. The counting of individual characteristics will not be required for an identification.

Verifications will be performed for all comparisons of evidence items with similar class characteristics (identification, inconclusive and/or elimination). Verifications do not have to be performed on items of no comparison value or insufficient microscopic detail; or eliminations based on significant differences of the class characteristics.

Verifications are not considered to be examinations and are normally completed in the presence of both examiners. Therefore, they do not require evidence moves in ACE or marks on the items or packages by the verifier. If the verifications cannot be completed

in the presence of both parties or require overnight storage by the verifier, evidence transfers in ACE will be performed. The conclusions of the consulting examiner will be noted in the primary examiner's case notes in the comments field of the Verification Review window in the LIMS. The verification documentation will include the identity of the consulting examiner, the date the verification was performed and the Lab Item numbers of the items verified.

During the verification process, if the reviewing examiner does not agree with the case examiner on a result/conclusion, it will be documented in the comment/note section of the Verification window in FRED prior to discussing the results with the case examiner. If the case examiner and reviewer reach a consensus on the result/conclusion, the case examiner can simply document the results of the discussion and update the notes and/or report with the revised conclusion(s), if any, and the date.

If the case examiner does not concur and a more comprehensive discussion is needed to arrive at a consensus, the Forensic Laboratory Manager/Supervisor will be notified. The Forensic Laboratory Manager/Supervisor will determine the appropriate course of action. If resolution cannot be reached, it will be brought to the attention of the Laboratory Director.

If an actual error in conclusion and/or interpretation is noted which may indicate a deficiency in the training or abilities of the examiner, the report will be submitted to the respective Forensic Laboratory Manager. The Forensic Laboratory Manager will evaluate the situation and determine the needed course of action. See section **4.9 - *Control of Nonconforming Testing and/or Calibration Work*** of the Forensic Laboratory Management System Manual for further details.

See section 2.01 for Range of Conclusions.

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3.02 Title: **TRACE EVIDENCE**

Toolmark evidence is often submitted with debris adhering to the questioned tool or toolmark. This debris may consist of paint, metallic fragments, glass, wood, biological, etc. The value of the evidence will be evaluated on an individual case basis and, if deemed necessary, will be collected.

Trace material that is collected will be removed and collected to protect the integrity of the material and packaged appropriately. Mark the package as to the type of material removed and from which item it was removed. If the packaged material can be returned to the original packaging, do so. If the material cannot be returned to the original packaging or needs to be examined by another Detail, follow the evidence handling guidelines detailed in the Forensic Laboratory Technical Requirements Manual Evidence Intra-Lab Transactions and Splits, 5.8.1.1.1.

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3.03 Title: **TOOLMARK EXAMINATION**

The following procedure describes the general methods of working toolmark cases. Because these cases can vary extensively, specificity for any one type is not possible; therefore, this generalization will basically apply to all cases.

The determination of class characteristics (i.e., type of mark, number of marks, size, etc.) is necessary for further comparison or elimination of the suspected tools. While examining for class characteristics, quality of individual characteristics also can be noted, choosing the best ones for the first comparisons. Test marks are made in a suitable material (see "Test Marks," 3.04) and marked as to side, edge, or tooth of the tool, direction of application and then compared to the submitted marks.

The examiner will follow these basic procedural steps to facilitate examinations:

a) Ensure the comparison microscope is properly adjusted for equal magnification at both stages.

b) Adjust the illumination to fully visualize the microscopic details of the toolmarks.

c) Compare the test marks to ensure reproducibility of class and individual characteristics prior to comparing them to the evidence marks. Record these comparisons in the case notes. Note: This step is not necessary for eliminations based on differences in class characteristics.

d) Adopt a consistent procedure for the handling and documenting of comparison evidence. Photographs of comparisons will be clearly marked to indicate evidence items and test items.

e) During the comparison, documentation of the phase orientation of test mark and evidence mark is recommended.

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3.04 Title: **TEST MARKS**

In order to compare an evidence toolmark with a suspected tool, test marks are usually made with the tool. An objective while preparing test marks is to attempt to duplicate the manner in which the tool was used to produce the evidence mark. Test marks will be marked or engraved with the Lab Item number of the tool being used and a sequential alpha designator (e.g. 1A, 1B, 1C, etc.)

The initial test media should be soft enough to prevent alterations to the working surface of the tool. Subsequent test marks may require the use of a harder test material to better reproduce the evidence mark.

A systematic approach will be used for the production of test marks. Consideration will be given to: (a) areas of recent use, and (b) the indexing of test marks, including test marks of all significant working surfaces and (c) limitations due to physical constraints of tool, evidence or the scene.

After completion of the case, test toolmarks used for comparison wil be booked as evidence in accordance with LVMPD policy under the same event number as the tool.

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3.05 Title: **MAGNESIUM SMOKING**

Magnesium smoking is a technique for reducing the glare of a shiny object by lightly coating the surface with fine magnesium smoke. Due to eye and fire hazard, safety is a prime consideration. The use of forceps, proper eye protection, and a leather apron is recommended.

a) This process must be done in a properly ventilated area or under a snorkel or hood.

b) Cut short pieces (~1 inch or less) of magnesium metal ribbon off the roll and place the remaining roll in a safe place.

c) This technique will be done over a flame resistant surface.

d) Hold one end of the magnesium strip securely with forceps or pliers.

e) Light the other end with an open flame. The surface oxidation may need to be scraped off to facilitate lighting.

f) Pass the object in question through the smoke.

CAUTION!!!

- **Never look directly at the magnesium flame!** Serious eye damage can occur due to the brilliant white light emitted by the burning magnesium. The magnesium flame is very hot and must be kept away from other combustible/ flammable substances and water. An ABC type fire extinguisher must be kept nearby at all times.

Examiners are responsible for knowing the health hazards involved in the use of magnesium. This chemical and its hazards can be found in the Material Safety Data Sheets/Safety Data Sheets that are on file in the laboratory.

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3.06 Title: **CASTING OF TOOLMARKS**

If an item received for toolmark examination is too large for the microscope's stage, a cast can be made of the mark or marks. It will also be necessary to cast the test mark so that the comparison will be alike (i.e., negative to negative). No matter what type of casting material is used, the casting procedure is done in a similar manner to all the marks being compared. The casting of toolmarks to facilitate comparison is a recognized practice. In addition, casting may be necessary so that the comparison being made is alike (i.e., negative to negative).

Mikrosil, Forensic Sil, silicone rubber, and Duplicast or similar products can be used for this process. Follow the manufacturer's mixing instructions for proper usage.

Casting material can also be used for some physical matches where fracture areas need to be compared on the microscope and the examiner needs to compare two positives or two negatives. This is helpful in cases where the contour is difficult due to one side being the opposite or mirror of the other.

After completion of the case, casts used for comparison will be booked as evidence under the same event number as the item they were made from.

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4.01 Title: INTRODUCTION TO SERIAL NUMBER RESTORATION PROCEDURES

Many items, notably firearms, require that a serial number be present. Numbers which have been deliberately removed to prevent tracing, inadvertently removed due to damage or repair or which may have become unreadable due to corrosion (as in buried guns or guns recovered from bodies of water) may be restored in a variety of ways.

The examiner should be aware of a variety of means by which numbers may be applied and locations where duplicate or hidden, secret numbers may be applied. Reporting such numbers should avoid the use of terms such as “hidden” or “secret” to preserve their utility which is dependent on a lack of public knowledge of their existence.

Serial numbers on most firearms, as well as many other objects, are usually die-stamped. This process produces a compression of the material in the area immediately surrounding and a short distance below the penetration of the die. Even though the number is obliterated by filing or grinding, restoration may be possible if the removal of the material is not past this compression area. If the obliteration is beyond this area, restoration is impossible for die-stamped, as well as etched or engraved numbers.

The most commonly employed procedures involve the use of chemical etching solutions. The recipes for etching solutions used by the Forensic Laboratory are contained in 8.01-RECIPES. Note: These solution may be diluted as necessary. Additional methods, reagents and restoration techniques can be found in the Handbook of Methods for the Restoration of Obliterated Serial Numbers.

The chemical-etching technique is generally the same for all metals, but the reagents differ depending on the type of metal or alloy. The most important step is to thoroughly clean and polish the surface to be restored to a mirror-like finish. (Sometimes this step alone will make part or all of a number visible.) Examination with low magnification and oblique lighting may also be helpful. Materials other than metal may require another technique.

CAUTION: Because the reagents are etching solutions and contain acids or bases, they are potentially dangerous. They should be used under a fume hood, snorkel, or in a well-ventilated area only by qualified, trained personnel. Storage of these reagents when not in use should be in the appropriate chemical storage area.

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4.02 Title: **PROCEDURE FOR CHEMICAL-ETCHING**

a) Make a tape lift of (with black fingerprint powder), and/or photograph the obliterated surface prior to the restoration attempt. This serves to illustrate the original starting condition.

b) Polish the metal surface by hand using a series of abrasives from medium to ultra-fine grade. It is best to polish in one direction. Deep gouges may require the use of an electric wheel fitted with emery paper or similar polishing compound. Take care not to heat the working surface due to friction.

c) The ideal final polished surface should be mirror-like, with cuts and blemishes removed to the extent possible (deep cuts might not be completely removed).

d) The surface may be cleaned with acetone or another solvent.

e) Prior to the application of the etching solution(s), control test(s) will be conducted on an area of the firearm/evidence item (or similar reference material) away from the questioned area. The control area will be prepped in the same manner as the questioned area followed by the application of the appropriate reagent(s). A visible reaction (bubbling, color change, vapors, etc…) will be considered a positive control test. The results of this control test along with the name of the reagent(s) and lot number(s) will be recorded in the examiner's notes.

f) Apply the appropriate solution(s). Observe the etching action of the solution(s) carefully.

g) When numbers appear, wipe off the solution, or rinse the solution off with water. Write down, photograph or otherwise document the numbers as they appear. Sometimes the numbers can be seen better if the surface is moistened with water, glycerin, or oil.

h) If the numbers are not clear, re-polish the surface, and repeat steps f and fg It may take several attempts to adequately restore the entire number. If necessary, steps e-g may be repeated using other suitable etching solutions

i) Photographs should be taken throughout and at the conclusion of the restoration process.

If the restored number is not readily visible and not able to be recorded photographically, the examiner will request a verification of the number by a second examiner. Verifications are not considered examinations; they are normally completed in the presence of both examiners and do not require

evidence moves in ACE or marks on the items or packages. If the verification cannot be completed in the presence of both parties or require overnight storage by the verifier, evidence transfers in ACE will be performed. The conclusions of the consulting examiner will be noted in the primary examiner's case notes in the comments field of the Verification Review window in the LIMS. The verification documentation will include the identity of the consulting examiner, the date the verification was performed and the Lab Item Number(s) of the item(s) verified. During the verification process, if the reviewing examiner does not agree with the case examiner on a result/conclusion, it will be documented in the comment/note section of the verification window in FRED prior to discussing the results with the case examiner. If the case examiner and reviewer reach a consensus on the result/conclusion, the case examiner can simply document the results of the discussion and update the notes and/or report with the revised conclusion(s), if any, and the date.

If the case examiner does not concur and a more comprehensive discussion is needed to arrive at a consensus, the Forensic Laboratory Manager/Supervisor will be notified. The Forensic Laboratory Manager/Supervisor will determine the appropriate course of action. If resolution cannot be reached, it will be brought to the attention of the Laboratory Director.

If an actual error in conclusion and/or interpretation is noted which may indicate a deficiency in the training or abilities of the examiner, the report will be submitted to the respective Forensic Laboratory Manager. The Forensic Laboratory Manager will evaluate the situation and determine the needed course of action. See section **4.9 - *Control of Nonconforming Testing and/or Calibration Work*** of the Forensic Laboratory Management System Manual for further details.

j) Once the procedure is completed, lightly oil the restored surface to prevent rust.

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5.01 Title: **INTRODUCTION TO PROXIMITY ANALYSIS PROCEDURES**

Applying the procedures in this section to casework requires the skills of a trained Firearm Examiner. To be considered trained; the Examiner must have completed an appropriate and approved training program for the procedures in this section along with the successful completion of a competency test including the issuance of a certificate of competency.

To help ensure the accuracy and completeness of case documentation, it is recommended that the AFTE glossary be utilized for appropriate definitions.

Worksheets will be used to ensure recording of all pertinent facts pertaining to the submitted evidence.

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5.02 Title: **MUZZLE-TO-TARGET DISTANCE DETERMINATION**

Introduction

Conclusions concerning firearm-related defects and approximate muzzle-to-target distances involved in a shooting incident are achieved through the examination and evaluation of gunshot residues, projectile defects, and shot pellet distribution patterns on submitted evidence. Patterns created at known distances can be compared to the evidence patterns to determine an approximate muzzle-to-target distance.

When a firearm is fired, gunshot residues in the following forms are discharged from the firearm:

- Unburned and/or partially burned gunpowder particles
- Soot and/or vaporous lead
- Nitrite residues
- Particulate metals and other materials

These gunshot residues, along with the morphology of the bullet defect, can be used to determine the possible muzzle-to-target distance.

Evidence items frequently encountered include clothing, autopsy photographs and/or reports, the actual firearm and ammunition, and other objects. In most cases, the outer-most layer of clothing will be examined.

The basic objectives of performing muzzle-to-target distance determination are to:

- Identify defects caused by the passage of a bullet, pellet(s) or slug.
- Identify gunshot residues and shot patterns.
- Re-create, as closely as possible, the conditions in which the evidence pattern was produced when creating test patterns at known muzzle-to-target distances for comparison. This may involve:
    - Evaluating the firearm and ammunition components
    - Performing microscopic comparisons of the fired ammunition components
    - Obtaining test material similar to the evidence
    - Obtaining permission to test fire the evidence ammunition if deemed necessary

Any deviations from the use of the actual case firearm, ammunition, or target material similar to the evidence when conducting distance determination tests must be documented in the notes.

All distance determinations for ranges other than contact or near contact will be reported using upper and lower limits.

General Procedure

Perform a visual examination of the evidence item. Describe and document the item and any observable physical characteristics (e.g. defect appearance, powder morphology, visible residues, etc…) on the item. A microscopic examination (stereoscope or other magnifier) should also be performed and any further observations documented. Documentation can include notes, sketches, overlays and photographs. If an item of clothing has been cut severely during medical intervention, it may be necessary to "sew" the garment back together. It is acceptable to use staples for this process.

Chemical testing is not required if:

- There is a clearly visible pellet pattern.
- The distance is determined by direct observation to be "contact" or "near contact"

Chemical testing is generally considered destructive to the evidence. Chemical testing may consist of tests for nitrites (Modified Griess) and lead (sodium rhodizonate).

These chemical tests can identify bullet wipe, lead residue patterns, and particulate GSR patterns. Nitrite residues may be detected on items that have interacted with burned gunpowder particles, even if the particles have been removed or dislodged by handling or other processing.

The appropriate sequence of performing the most commonly used tests is:

1. Visual, and microscopic
2. X-ray Fluorescence (optional)
3. Modified Griess
4. Sodium Rhodizonate

A description of the items used (including, but not limited to: firearm, ammunition type and/or source, target material, and reagents) and the muzzle-to-target distances of the test shots will be recorded. A minimum of two separate test shots will be fired at each set distance. The determination of the initial distances at which test targets will be shot can be based on the observations of the evidence item and previous experience with similar firearm and ammunition combinations. These test panels will be examined and processed in the same manner as the evidence item. Chemical test results should also be consistent with one another at a particular known distance and with any physical effects present. Based on the results, additional test shots may be required.

Conclusions may be limited due to the following factors:

- Damage to the evidence item not related to the shooting (cuts due to medical intervention, normal wear and tear, etc…)
- Elongated patterns caused by angled discharges
- Incomplete patterns caused by intervening objects
- Partial patterns caused by other clothing articles (e.g. folds in clothing, rolled up sleeves, etc…)
- Partial patterns caused by the relationship of pattern-to-target (e.g. half pattern caused by an over the shoulder discharge)
- Insufficient evidence information or availability (e.g. specific type of ammunition)

- Interference due to biological contamination*

The absence of gunshot residue is not a basis for expressing a distance determination. Prior to issuing conclusions, the examiner should understand that shooting events are dynamic and must consider the possibility of intervening objects or other limitations when determining a maximum (drop-off) distance for gunshot residue deposits. These limiting factors may be expressed in the report at the discretion of the examiner.

During the verification process, if the reviewing examiner does not agree with the case examiner on a result/conclusion, it will be documented in the comment/note section of the Verification window in FRED prior to discussing the results with the case examiner. If the case examiner and reviewer reach a consensus on the result/conclusion, the case examiner can simply document the results of the discussion and update the notes and/or report with the revised conclusion(s), if any, and the date.

If the case examiner does not concur and a more comprehensive discussion is needed to arrive at a consensus, the Forensic Laboratory Manager/Supervisor will be notified. The Forensic Laboratory Manager/Supervisor will determine the appropriate course of action. If resolution cannot be reached, it will be brought to the attention of the Laboratory Director.

If an actual error in conclusion and/or interpretation is noted which may indicate a deficiency in the training or abilities of the examiner, the report will be submitted to the respective Forensic Laboratory Manager. The Forensic Laboratory Manager will evaluate the situation and determine the needed course of action. See section **4.9 - *Control of Nonconforming Testing and/or Calibration Work*** of the Forensic Laboratory Management System Manual for further details.

* Pre-processing of blood soaked clothing

The presence of blood can obscure the visual components of the gunshot residue pattern and interfere with the chemical processing for nitrite compounds and lead. In these instances the following method should be used to remove the blood from the item of clothing:

- Soak the item of clothing and the test panels fired from a known distance in separate containers of cold tap water for approximately six hours.
    - Change and gently agitate the water every two hours.
- Allow the item of clothing and the test panels to air dry.
- Process for GSR utilizing the procedures outlined in section 5.03- *Chemical Processing of Clothing for Distance Determination* in this manual.

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5.03 Title: **CHEMICAL PROCESSING OF CLOTHING FOR DISTANCE DETERMINATION**

This technical supplement is to provide the Firearm Examiner with a reference for using the Modified Griess and Sodium Rhodizonate Tests. The Modified Griess Test is a color test for the nitrite containing compounds produced as a combustion product of smokeless powder. The Griess Test does not chemically interfere with the Sodium Rhodizonate Test for lead residue. The Griess Test must be performed first, since the converse is not true.

In general the chemical reactions that occur in the Griess Test involve converting the nitrite compounds on the garment to an orange dye. These dye pigments are preserved in a medium (desensitized photographic paper) for future side-by-side comparisons with test patterns of known distances.

The process of converting the nitrites is done by exposing the compounds to vaporous acetic acid using an acid solution and heat (dry iron) to form nitrous acid. This nitrous acid then combines with sulfanilic acid in the test media (photographic paper) to form a diazonium salt of sulfanilic acid. The diazonium salt then binds with alpha-naphthol (1-naphthol), also in the test media, to form the orange azo dye.

The Sodium Rhodizonate Test uses a reagent (sodium rhodizonate) to react with any lead or other heavy metals present on the garment producing a pink color. The specificity for the lead is to apply an additional acid solution (5 % hydrochloric acid) to the area. If lead is present then the pink areas will change to a blue-violet color. The chemistry involved is thought to be a chelating of the metal to the rhodizonate molecule and that the blue color is a molecular complex consisting of lead rhodizonate and hydrochloride.

The following instructions are for reagent and test media preparation for the Modified Griess Test for nitrite residues and the Sodium Rhodizonate test for lead. Good laboratory practice dictates the use of appropriate precautions to preclude inhalation, ingestion, or skin contact with chemicals. The use of a hood/proper ventilation, protective gloves, and hand washing after handling chemicals are required. Prepared chemicals and test media should be stored in closed/covered containers until needed.

Many of the procedures which follow involve the spraying of reagents in an aerosol form. This can be accomplished by using spray bottles, cans of compressed gas or an airbrush. All spraying shall be done in a chemical fume hood that has sufficient air flow to prevent back-flow of the reagents into the work area.

The recipes for the reagents used in these processes are listed in Section 8.01 RECIPES, of this manual.

The evidence items and test media along with all positive test results will be thoroughly documented with narratives, sketches, overlays and/or photographs.

After case completion, test and evidence media showing positive results will be booked as evidence in accordance with LVMPD policy under the same event number as the questioned item. Test media relating to negative results need not be retained.

The Modified Griess Test

- It is noted that the desensitized photo paper mentioned below is simply photographic print paper which has been exposed to a hypo solution and thus no longer bears light sensitive silver salts in its surface emulsion. If this material is not available, several varieties of photo type printer paper have been shown to be suitable replacements (see the Firearms/Toolmarks Detail Validation Study "*Modified Griess - Paper Source*" completed February 2015). As a result of this study, the following papers were deemed to have the best contrast and sensitivity for this process:
    1. Epson Premium Photo Inkjet, Product # S042183
    2. Epson Premium Semi-Glossy, Product # S041331
    3. Epson Glossy, Product # S041141
    4. HP Advanced Photo Paper, Product #Q7852A

In addition to the validation of replacement papers, this study demonstrated that the preparation and processing of the paper test media should be performed contemporaneously with the examination process.

1. **Processing of desensitized photographic or inkjet paper**
    a. Pour the Griess reagent into a non-reactive photo processing tray and briefly dip the paper into the tray. Simply submerge the sheets completely and remove them.
    b. Set the sheets aside on an uncontaminated surface or hang to dry.
    c. Note: In lieu of desensitized photographic paper, ordinary laboratory filter paper may be processed in the same manner for use in the Modified Griess Test.

2. **Procedure for a Modified Griess Test**
    a. Positive and Negative control testing shall be performed prior to testing the evidence or known-distance test items. Place a nitrite treated swab/filter paper square on each of the four corners of the emulsion-coated side of the chemically treated photographic paper. Cover with a piece of filter paper and then 15% acetic acid soaked cheesecloth and iron as described below (step "d"). An orange color should appear at each corner, confirming nitrite sensitivity (positive control) and no other orange reactions should be present (negative control).
    b. Place the evidence or known-distance test questioned side down on the emulsion-coated side of the treated photographic paper. Index seams, buttons, button holes, rips, pockets, suspected bullet holes, tears, cuts, etc., for possible future reference in court by marking with a lead pencil.

DO NOT USE INK at this point because it may transfer back onto the tested item.

c. Nitrite controls will be used on the treated photographic paper used for evidence testing. This can be done by placing a nitrite test swab/treated filter paper square on at least one corner of the treated photographic paper (under the evidence/test item) or by dabbing an acetic acid moistened square or swab on a corner of the paper and observing a positive reaction.
d. Soak a piece of nitrite-free cheesecloth in the 15% acetic acid solution (in a large beaker) and wring it out. Place the cheesecloth on the questioned item or known-distance test as the third layer on the "sandwich". Cover the cheesecloth with filter paper and press the "sandwich" with a hot iron. On many irons the setting for "cotton" is appropriate. Note: That nitrite-contaminated cheesecloth will cause a generalized orange background coloration. Although undesirable, this is not a fatal flaw as long as individual point reactions are still visible against the background.
e. Discard the cheesecloth and separate the questioned item or known-distance test-firings from the photographic paper. Any orange indications on the paper are the result of a chromophoric reaction chemically specific for the presence of nitrite residues. Note that such reactions for nitrite residues may indicate visible nitrite sources (partially burned gunpowder), nitrite deposits which cannot be visually observed, or nitrite-coated unburned powder particles. While it is also possible that in a given case a spurious source of nitrite residues (not firearms-related) could be introduced. It is unlikely that it would alter the meaning of the total array of point reactions around a suspected bullet hole. Often such spurious nitrite sources are manifested as background haze in the test media as opposed to an array of point reactions. In view of these factors, it is normally not productive and often not possible to attempt to relate a given positive point reaction on the test medium to a corresponding visible point source on evidence items.
f. Document any photographic paper showing positive results as a part of the raw data for inclusion in your notes. When dry, the photographic paper shall be marked appropriately in ink with your initials and case/file number.

3. Procedure for a reverse Modified Griess Test for thick or otherwise non-porous materials through which the acetic acid solution "steam" will not penetrate

a. Tape a piece of filter paper or other appropriate nitrite-free substitute to the back of a piece of desensitized and treated photographic paper. Test as usual using the nitrite test swabs/treated filter paper squares.
b. Place the photographic paper emulsion side down on the questioned surface and use a pencil to index seams, buttons, suspected bullet holes, pockets, rips, tears, cuts, etc., for possible future courtroom reference.
c. Wipe the emulsion-coated side of the photographic paper with a piece of cheesecloth saturated with a 15% acetic acid solution. Apply the solution to the entire surface, but lightly. Too much will cause indistinct or hazy results due to pigment migration.

d. Immediately place the photographic paper emulsion side down on the questioned surface. Apply a hot iron to the back of the photographic paper. Note that the back should be covered by filter paper or an appropriate substitute; otherwise the paper may stick to the iron.
e. Separate the photographic paper and the questioned item. Any orange indications on the photographic paper are the result of a chromophoric reaction chemically specific for the presence of nitrite residues.
f. When dry, mark and document any positive results as in the previously described normal Modified Griess Test.

The Sodium Rhodizonate Test

1. **Preparation of the Sodium Rhodizonate Solution**
   a. Mix a small amount of sodium rhodizonate in water in an appropriate container to make a saturated solution approximately the color of strong tea. The solution is saturated if a slight sediment is noted on the bottom of the container. Make only enough solution for immediate use and do not store the solution. The shelf life beyond immediate use is currently unknown.

2. **Procedure for a Sodium Rhodizonate Test - Direct application to an item of evidence**
   a. Positive and Negative control testing shall be performed prior to testing the evidence or known-distance test items. Use a lead standard to "mark" a blank piece of filter paper and treat as described below (steps b-d). A blue-violet should appear at the "mark" confirming the presence of lead (positive control). No other color reactions should appear (negative control).
   b. Spray the appropriate area of the questioned item with a previously prepared saturated solution of sodium rhodizonate in water.
   c. Spray the same area of the questioned item with the previously prepared tartaric acid/sodium bitartrate buffer solution. This solution will eliminate the general yellow background color caused by the sodium rhodizonate, establish a local pH of 2.8, and turn any lead and a few other metals which may be present to a pink color. Document any positive result.
   d. Test or treat a representative area with 5% hydrochloric acid solution. The presence of lead is specifically determined wherever the previous pink color fades out and leaves a blue-violet color in its place. This indicates lead and only lead. Be aware of the fact that a positive (blue-violet) result may abruptly fade. Document the reaction immediately after applying the dilute hydrochloric acid solution.

3. **Procedure for the Bashinski transfer method (for dark-colored items which would mask the blue-violet coloration of a positive test result)**
   a. Place a piece of filter paper over the appropriate area of the questioned item.
   b. Index the filter paper relative to the garment or other item to indicate the location of suspected bullet holes, seams, buttons, button holes, pockets, rips, tears, etc. for possible future reference in court. Indexing in pencil is

preferable in that this will preclude the bleeding of ink pigments during the application of reagents.

c. Uniformly dampen the filter paper while on the questioned item by spraying with a 15% solution of acetic acid. As previously noted, if the Modified Griess Test is performed, it must be done before the Sodium Rhodizonate Test.
d. Cover the dampened filter paper with several layers of dry filter paper. Apply a hot iron to the filter paper and iron until the paper is dry.
e. Remove the filter paper which was in direct contact with the evidence item and process it as in the direct application method. Note that any positive (blue-violet) indications are a “mirror image” of the deposition on the questioned item.
f. Note what is indicated by the positive result: vaporous lead, particulate lead, “bullet wipe”, or a combination of these lead residues. Prompt documentation is essential in that sometimes positive results can/do fade rapidly and unpredictably. When dry, this filter paper will be appropriately marked in ink for future identification with your symbol or initials and case/file or other identifying numbers.

4. **Procedure for a Sodium Rhodizonate test - Standard transfer method (normally a last resort)**
    a. Process the questioned item with sodium rhodizonate. .
    b. Blot the appropriate area of the questioned item using untreated filter paper.
    c. Note and document any positive results.

NOTE: For the Sodium Rhodizonate test, whichever of the above methods (2-4) is deemed most appropriate for the particular evidence being processed shall be applied to the test media as well.

The reagents, test media preparations, and procedures for these tests are outlined in the references listed in Section 8.05

Examiners are reminded that they are responsible for knowing the requirements and safety practices outlined in the LVMPD Forensic Laboratory Handbook Safety Manual Chemical Hygiene Plan 3.4. Examiners are also responsible for knowing the health hazards involved in the use of the chemicals named above. These chemicals and their hazards can be found in the Material Safety Data Sheets/Safety Data Sheets that are on file in the laboratory.

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5.04 Title: **SHOTGUN RANGE DETERMINATION**

In order to perform a muzzle-to-target distance determination involving a shotshell pellet pattern, it is necessary to produce pellet patterns similar to that present on the evidence item. This is accomplished by shooting test patterns at varying distances for comparison to the pellet pattern present on the evidence item. It is an essential prerequisite that the evidence firearm, and ammunition consistent with the evidence ammunition, be utilized for production of the test patterns. The following steps will be followed for this examination:

- Tests will be shot one pattern per piece of target media.
- The test media for shotshell pellet test patterns is an appropriately sized cardboard target backer, paper, poster board or similar material which visualizes the actual pellet pattern in a safe reproducible manner.
- A minimum of two test shots should be made at each distance to account for variability in shot-to-shot pattern size.
- Test patterns will be shot in increasing or decreasing range increments until a distance is established, both shorter and longer, than that which produces a pellet pattern similar to that on the evidence item.
- This bracketing technique is necessary to determine at what distance a smaller known pattern is consistently produced and at what distance a larger known pattern is consistently produced.
- Comparison of pellet patterns can be done using one or more of the following methods:
    - Visual (side-by-side) comparison of test and evidence pellet patterns Note: Overlays and scaled photographs can also be used for the side-by-side comparisons
    - Comparison of measured pattern sizes
    - Use of the "performance envelope" of the shotgun/ shotshell combination. This can be done by a graphical analysis of the data collected from the test-firing process.
- Document all observations and conclusions in the case notes. Documentation of the evidence patterns will include: notes, and photographs or overlays. Documentation of the test patterns will include notes; photographs and/or overlays; tables and/or graphs.
- The distance determination conclusion will be reported as a minimum and maximum distance based on the bracketed test patterns noted above.

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5.05 Title: **CARTRIDGE CASE EJECTION PATTERNS**

A cartridge case ejection pattern examination is used to determine where a particular firearm ejects the fired cartridge cases under specific test conditions. Variables affecting the ejection pattern of fired cartridge cases include, but are not necessarily limited to, the firearm, the type of ammunition, the shooter's grip on the firearm, the location and orientation of the firearm, and the surface on which the cartridge case lands.

PROCEDURE FOR PERFORMING A CARTRIDGE CASE EJECTION PATTERN

- The same firearm and ammunition represented in the shooting scenario should be used in the testing.
- The firearm must be fired from the same location for each shot. The firearm must also be fired in the same direction for each shot toward a reference point, with the barrel parallel to the ground.
- X-Y coordinates can be laid out on the ground for subsequent plotting of either the impact point or final resting point of each expended cartridge case, or to determine the angle of ejection from the point of aim and the distance the cartridge ejects from the pistol.
- A minimum of two full magazines or ten shots will be fired to generate an ejection pattern.
- If needed, multiple series of shots can be carried out varying one parameter at a time, such as height of the gun, firm vs. loose hold on the gun, pointing the firearm in a different orientation, speed of firing shots, or varying the surfaces (e.g., pavement vs. grass). The use of a tripod or similar device is recommended for maintaining position of X, Y and Z coordinates.
- The limiting factors in a cartridge case ejection pattern determination may be included in the report at the discretion of the examiner.

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6.0 Title: **REFERENCE COLLECTION**

Reference collections are required to assist the Firearm /Toolmark Examiners and NIBIN Technicians to properly accomplish the mission of providing the examination and analysis of submitted evidence. These collections include the firearm reference collection and the ammunition reference collection

The firearms reference collection is tracked using the Departments WASP based inventory tracking system.

The ammunition / reference collection is tracked with barcode labels utilizing a database located on the H:drive.

The reference collections will be maintained, updated and evaluated by the members of the Firearms Detail.

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7.0 Title: **TRAINING**

The following guidelines will be used for technical training at the Forensic Scientist Trainee level or when current lab employees are transferred to the Firearms Detail.

All other training issues will follow the guidelines set forth in the LVMPD Forensic Laboratory Handbook Technical Requirements Manual section 5.2.2 Training and Travel.

It is recommended that the training of a Firearm/Toolmark be conducted and supervised by an Examiner qualified in all of the procedures of this manual.

Training programs and outlines should be flexible and attempt to address the infinite variables involved in modern forensic firearm/toolmark identification.

To ensure the accuracy and completeness of training, the following recommendations are made:

a) The use of the AFTE glossary for appropriate definitions.

b) The use of appropriate manufacturers' nomenclature for describing firearm/tool parts and ammunition components.

c) The use of an established training manual.

d) Documentation of completed training to be retained by the laboratory and trainee.

e) Peer review of the training prior to completion by an examiner other than the primary trainer at regular established intervals with the following goals:
   - To ensure documentation is complete.
   - To evaluate strengths and weaknesses in a timely manner.
   - To evaluate testimony.
   - To determine if the trainee has reached an acceptable level of performance.

f) The training goals are:
   - To provide the Firearm/Toolmark Examiner trainee with a high level of confidence in his/her ability to perform the job procedures.
   - To ensure the laboratory system that the trainee is producing a high quality verifiable work product.
   - To ensure the judicial system benefits from professional, ethical, and honest interpretation and reporting of firearm/toolmark evidence.

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8.01 Title: **RECIPES**

Fill in the blank recipe forms for the following reagents are available in the Firearms/Toolmarks Forms folder located in Qualtrax. These forms include preparation instructions and define the expiration date for each reagent. Note: The reagents used in the Firearms/Toolmarks Detail do not require special storage conditions and are stored in appropriate containers at room temperature. Quality control checks for these reagents are performed at the time of use.

8.01 / 01 Cleaning

Booker Dip
25 mL ammonium hydroxide
25 mL oleic acid
450 mL water

Peroxide-Acetic Acid Bullet Cleaner
10 mL acetic acid
2 mL hydrogen peroxide (30%)
70 mL water

8.01 / 02 Distance Determination

Griess Reagent
Prepare a solution of 0.5 grams of sulfanilic acid in 100 mL of deionized water (Solution "A").
Prepare a solution of 0.28 grams of alpha-naphthol in 100 mL of methanol (Solution "B").
Combine the equal volumes of the above solutions at the time of testing.
Expiration date: two months from the reagent preparation date (combined A & B)

Preparation of nitrite test swabs/filter paper

1. Prepare a solution of 9.3 grains (0.6 grams) of sodium nitrite in 100 milliliters of distilled water.
2. Soak the cotton-tipped ends of six inch swabs or filter paper in the solution.
3. Set the swabs/filter paper aside to dry. Once dry, cut the filter paper into small squares. Store the swabs/filter paper in a sealed container.

2.8 pH BUFFER - Na Bitartrate/Tartaric Acid
Dissolve 1.9 grams of sodium bitartrate and 1.5 grams tartaric acid per 100 mL of deionized water. This usually requires both heat and agitation to complete in a reasonable period of time.

5% HCl
5 mL concentrated hydrochloric acid
95 mL deionized water

15% Acetic Acid
150 mL of glacial acetic acid
850 mL of deionized water

8.01 / 03 Serial Number Restoration Solutions for Acid Etching

Steel

Heyn's Solution

Cupric ammonium chloride	1 gram
Con. Hydrochloric acid	12 mL
Deionized water	12 mL

Fry's Solution

Cupric chloride	90 grams
Con. hydrochloric acid	120 mL
Deionized water	100 mL

Alternative solutions:

Cupric chloride	5 grams
Ethanol	25 mL
Con. hydrochloric acid	40 mL
Deionized water	30 mL

Ferric chloride	6 grams
Deionized water	100 mL

Ammonium persulfate	10 grams
Deionized water	100 mL

Cast Iron

Heyn's solution (as above)
Ammonium persulfate (as above)

Stainless Steel

Ferric chloride	5 grams
Con. hydrochloric acid	50 mL
Deionized water	100 mL

Alternative Solution:

Ferric chloride	25 grams
Con. Hydrochloric Acid	25 mL
Water	100 mL

Zinc Alloys

Solution #1	
Phosphoric acid (85%)	98 mL
Con. nitric acid	2 mL

Solution #2	
Con. nitric acid	5 mL
Water	95 mL

Solution #1 is applied for 10 seconds, then wiped off. Solution #2 is then applied and the number should appear within 30 seconds. See the AFTE article written by Mike Knowles of ATF.

Aluminum

Sodium hydroxide	5 grams
Deionized water	100 mL

Alternative Solution:

Heyn's solution (as above)	1 part
Deionized water	5 parts

Copper Alloys

Nitric acid from concentrated to various dilutions with water. (Depends on the rate of reaction for the particular alloy.)

Nickel Alloys

Con. nitric acid	5 mL
Deionized water	95 mL
Accelerated by DC voltage	

Brass

Sodium sulfate	1.5 grams
Chromic acid	20 grams
Deionized water	100 mL

Lead Alloys

Molybdic acid	100 grams
Ammonium hydroxide	140 mL
Deionized water	240 mL
filter then add	
Con. nitric acid	60 mL

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8.02 Title: **WASTE DISPOSAL PROCEDURE**

The Firearms Detail strives to comply with safe environmental practices by adhering to the following:

- Dispose of liquid waste in the appropriate container that is stored under the chemical hood in the GSR Room.
- Keep used swabs separated (those used with acids from bases) and dispose of the swabs in the correct **solid** waste bin located in the Chemical Storage Room, attaching a disposal sheet as necessary.
- New waste bottles must be marked either “Base Waste” or “Acid Waste” and indicate the first date that waste is added.
- Mark the appropriate chemical or reagent on the appropriate disposal sheet.
    - Current disposal sheets should be taped to the glass of the chemical hood.
    - Sheets are located under the hood or can be printed from H:\Criminalistics\Forensics\General\SAFETY DETAIL INFO\Safety\Waste Logs
    - Reagents or chemicals can be added to the printed disposal list as needed.
- Waste bottles must be disposed of within a year from the start date by placing it in the appropriate liquid waste bin in the Chemical Storage Room, along with the current disposal sheet.

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8.03 Title: **ABBREVIATIONS**

The firearms industry is notable in its use of acronyms and abbreviations. Many are common and can be considered universally understood within the field. When abbreviations are used in reports, they should always be defined at their first appearance.

Abbreviations are used in note taking. A number of commonly used abbreviations are listed here for convenience. Other new or not readily discernible abbreviations will be defined in notes.

#(R/L)	number of lands & grooves and direction of twist (right/left)
AFTE	Association of Firearms and Tool Mark Examiners
Amb/ambi	ambidextrous
amt	amount
AP	armor piercing
approx.	approximate
Assoc	association
auto	automatic
bbl	barrel
bc or b/c	bar code
BEB	brass enclosed base
BF	breech face
bk	back
bl	blue/blued
blk	black
BLS	blood-like substance
BM	bunter mark
BP	black powder
BT	boat tail
bu	bullet
cal	caliber
cap	capacity
cart	cartridge
cc	cartridge case
char	characteristics
cl	class
CM	chamber marks
CMS	consecutive matching stria
comp	comparison/compare
const.	construction
cont	contain, contained, containing
CW or C/W	consistent with
DA	double action
DAO	double action only
dbl	double

dia.	Diameter
e-tape	evidence tape
ejr	ejector
elim	elimination
env	envelope
epm	ejection port mark
EV#	Event number
evid	evidence
exp	exposed
ext	extractor
fm	feed marks
FA	Firearm(s)
FRED	Forensic Request and Examination Database
FMJ	full metal jacket
Fp	firing pin
fpi	firing pin impression
frag	fragment
frt	front
FTE	failure to eject
FTF	failure to fire
GDHP	Gold Dot Hollow Point
GI or GIMP	groove impression
GIW	groove impression width
gp	gunpowder
gr	grain
GRC	general rifling characteristics
GSR	gunshot residue
hemi	hemispherical
HP	hollow point
HS	headstamp
IBIS	Integrated Ballistics Identification System
ID	identification
ifo	in front of
imp	impression
inc	inconclusive
ind or indiv	individual
insuff	insufficient
int	interior
inv	inventory
JHP	jacketed hollow point
JKT	jacket
JSP	jacketed soft point
K	knurled
L	land or left or long
lf or lft	left
LI or LIMP	land impression
LIMS	Laboratory Information Management System
LIW	land impression width
LLM	Leica Live Measure Software
LR	long rifle
LRN	lead round nose
mag	magazine or magnum
ME	manila envelope
mfg	manufactured or manufacturer

NaRho	sodium rhodizonate
NCV	no comparison value
NFE	no further examination
NIBIN	National Integrated Ballistic Information Network
OA or O/A	overall
OAL	overall length
obsv	observed
OD	outer diameter
OIS	Officer Involved Shooting
OJ	outside jurisdiction
OR	Object Repository
PPB	paper bag
PC	Property Connect
pkg	package or packaging
pl	plastic
POI	Person of Interest
poly	polygonal especially as to bore/rifling
R or rt	right
rec'd	received
ref	reference
rel'd	released
ret'd	returned
rf	rim fire
RFLE	Request for Forensic Laboratory Examination
RNA	Received, not analyzed
RNL	round nosed lead
rxn	reaction
S	smooth or short or sealed
SA	single action
Sgp	smokeless gunpowder
sig	significant
sim	similar
SJHP	semi jacketed hollow point
slt	slight
SN	serial number
sngl	single
soln	solution
SP	soft point
spl	special
STHP	silver tip hollow point
stc	said to contain
std	standard
stk	stack
suff	sufficient
supp	supplemental
SWC	semi wad cutter
T	tracer or test
TC	truncated cone
TF	test fired or test fire(s)
tg	trigger guard
TM	toolmarks
TMJ	total metal jacket
trig	trigger
tw	total weight

und	under or underneath
UR	Unit Record
vis	visible
vs	versus
WC	wad cutter
w/in	within
WS	worksheets
wt	weight

Additional common abbreviations from NCIC, common units of measurement, manufacturer's designations, standard chemical and mathematical abbreviations and symbols, as well as common government abbreviations may be used without being listed above.

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8.04 Title: **QUALITY CONTROL PLAN**

	Instrument	Frequency	Criteria	Corrective Action
Balances	FA # 3 Dillon Precision D-Terminator Grain Scale #1019101050299 FA # 4 Dillon Precision D-Terminator Grain Scale #1019101050166 FA # 5 Dillon Precision D-Terminator Grain Scale #1019101050074 FA # 6 Dillon Precision D-Terminator Grain Scale #1064840970440 FA # 7 Dillon Precision D-Terminator Grain Scale #1093310790062 FA # 8 Dillon Precision D-Terminator Grain Scale #1088500590274	**External:** Annually Precise Weighing Systems (661) 250-9044 Mettler Toledo, inc. 1-800-523-5123 ASTM 1 weight sets are available to laboratory personnel if they wish to check the balances at any time	Meet external vendor criteria Vendor certificates for all balances are kept in Resource Manager	If a balance is not operating properly: 1. Tag out of use 2. Advise Lab Manager to arrange for repair 3. Document problem on a Corrective Action Report if needed

	Instrument	Frequency	Criteria	Corrective Action
Fume Hood	FA # 2 Labconco Model: 722801003726 Serial # 981160459	**External:** Annually For annual certification: Vendor Options: Controlled Environment Management (480) 836-4144 For repairs and maintenance: Vendor Options: Thomas and Mack 896-7035	Meet external vendor criteria Vendor certifications are kept for all fume hoods in the "Fume Hoods" binder in the Quality Manager's office or in Resource Manager.	If a fume hood is not operating properly: 1. Tag out of use 2. Advise lab manager
Calipers & Micrometers	FA # 2 Mitutoyo Calipers (manual)	**External:** Annually **Critical Service** For annual calibration: Vendor options: CAL-LABS 1-800-373-1759 Heusser Neweigh, LLC 1-925-798-8900 Integrated Service Solutions, Inc. 1-610-287-3433	Meet external vendor criteria. Vendor certificates are kept in Resource Manager	If the calipers or micrometers do not meet criteria: 1. Tag out of use 2. Replace 3. Document problem on a Corrective Action Report if needed
	FA # 3 Aerospace Calipers (manual) #0708085			
	FA # 5 Mitutoyo Calipers (electronic) #0263086			
	FA # 7 Mitutoyo Thickness Gauge #353770			
	FA # 8 Mitutoyo Thickness Gauge #249081			
	FA # 10 Mitutoyo Thickness Gauge #7304S; FBK 161			

	Instrument	Frequency	Criteria	Corrective Action
	FA # 11 Mitutoyo Thickness Gauge #7304S; FBK 100			
	FA # 12 Starrett Digital Micrometer #ST057494			
	FA #13 Starrett Digital Micrometer #ST0703001			
	FA # 14 Starrett Digital Micrometer #ST0652024			
	FA # 15 Mitutoyo Thickness Gauge #73045			
	FA # 16 Mitutoyo Digital Caliper #07089475			
	FA # 17 Mitutoyo Digital Caliper #05065572			
	FA # 18 Starrett Digital Micrometer #96430557			
	FA # 19 Mituoyo Electronic Caliper #07379766			
	FA #20 VWR Electronic Caliper #111604360 (Formerly Trace #1)			

	Instrument	Frequency	Criteria	Corrective Action
Measuring Devices	Starrett 48” Steel Rule Model # C404R-48 Serial # 13432092 NIST Test # 683/282436	**External:** Every five years **Critical Service** Steel Rules will be calibrated or replaced every five years Vendor Options: Transcat www.transcat.com 800-800-5001 Starrett www.starrett.com 978-249-3551 Heusser Neweigh, LLC 1-925-798-8900 CAL-LABS 1-714-522-8915 Integrated Service Solutions, Inc. 1-610-287-3433 No internal calibration or maintenance is performed	Must meet external criteria for NIST Traceability QC information is maintained for the NIST Traceable Steel Rule in the in Resource Manager in LIMS	If the Steel Rule appears to be damaged or exhibit any characteristics that may affect accuracy: 1. Tag out of use 2. Replace
	Mitutoyo 6” Steel Rule #PY1297			
	Mitutoyo 6” Steel Rule #PY1298			
	Mitutoyo 6: Steel Rule #PY1299			
	Mitutoyo 6” Steel Rule #PY1300			
	Mitutoyo 6” Steel Rule #PY1301			
	Mitutoyo 6” Steel Rule #PY1322			
	Mitutoyo 6” Steel Rule #PY1323			
	Starrett 18” Steel Rule #PY1315			
	Starrett 18” Steel Rule #PY1316			
	Starrett 18” Steel Rule #PY1317			
	Starrett 18” Steel Rule #PY1318			
	Starrett 18” Steel Rule #PY1319			

	Instrument	Frequency	Criteria	Corrective Action
	Starrett 18" Steel Rule #PY1320			
	Starrett 18" Steel Rule #PY1321			
Gauge Blocks	FA #2 1" Mitutoyo Gauge Block (Micrometer Standard)	**External:** Every five years **Critical Service** Micrometer standards will be calibrated or replaced every five years Vendor Options: Mitutoyo (through VWR) CAL-LABS 1-800-373-1759 Heusser Neweigh, LLC 1-925-798-8900	Must meet external criteria for NIST Traceability QC information is maintained for the NIST Traceable Micrometer standards in the Resource Manager in LIMS	If the Micrometer standard appears to be damaged or exhibits any characteristics that may affect accuracy: 1. Tag out of use 2. Replace
	FA #3 1mm Mitutoyo Gauge Block (Micrometer Standard)			
Reference Weights	FA # 2 Lyman 50 gram weight	**Internal:** One time, performed with NIST certified weight sets	**Internal:** These weights are considered a reference only, there are no legal issues concerning data obtained QC information is maintained in the Resource Manager in LIMS	If the reference weight appears to be damaged or exhibits any characteristics that may affect accuracy: 1. Tag "Out of use" 2. Replace
	FA # 3 RCBS Grain weight set			
	FA # 4 Dillon 50 gram weight (with balance FA # 3)			
	FA # 5 Dillon 50 gram weight (with balance FA # 4)			
	FA # 6 Dillon 50 gram weight (with balance FA # 5)			

	Instrument	Frequency	Criteria	Corrective Action
	FA # 7 Dillon 50 gram weight (with balance FA # 6) FA # 8 Dillon 50 gram weight (with balance FA # 8) FA # 9 Dillon 50 gram weight (with balance FA # 9)			
	Trigger Pull weight sets .25 lbs to 5 lbs FA #1 (red) FA #2 (yellow) FA #3 (blue)	**Critical Service** **External:** Every five years Note: Any event leading to significant/visible damage of the weights requires an internal performance check of the affected weight(s) on a calibrated balance. Use "Trigger Pull Weight Verification Log" Form found in H:\LaboratoryForms\ QC Checks Heusser Neweigh, LLC 1-925-798-8900 Quality Control Services, Inc. 1-800-843-1237	**External/Internal:** +/- 2% External vendor certificates are kept in Resource Manager	If the trigger pull weights do not meet criteria: 1. Repeat test 2. Adjust/repair if possible 3. Tag out of use 4. Document problem on a Corrective Action Report if needed
Microscopes	FA # 1 Meiji Techno Model: EMZ-8TR Serial # 410234 FA # 2 Meiji Techno Model: EMZ-TR LVMPD # 32549 Serial # 58334	**External:** Annually McBain Systems (805) 581-6800 Western Scientific Company, Inc. (WESCO) 1-661-295-5040	Meet external vendor criteria Vendor certificates for all microscopes are kept in the Quality Assurance Standards binder in the Quality Manager's Office or in Resource Manager	If a microscope is not operating properly: 1. Tag out of use 2. Advise Lab Manager to arrange for repair

	Instrument	Frequency	Criteria	Corrective Action
	FA # 3 Meiji Techno Model; EMZ-TR LVMPD # 30851 Serial # 58276			
	FA # 5 Meiji Techno Model: EMZ-8TR Serial # 410232			
	FA # 6 Meiji Techno Model: EMZ-TR LVMPD # 30871 Serial # 49128			
	FA # 7 Meiji Techno Model: EMZ-TR LVMPD 3 30853 Serial # 58253			
	FA # 8 Meiji Techno Model: EMZ-TR Serial # 71447			
	FA # 9 Leica Model: FSC LVMPD # 51694 Serial #11581051/284670			
	FA # 10 Leica Model: FSC LVMPD # 51690 Serial #11581051/283092			
	FA # 11 Reichert Model: K2700LF LVMPD # 26091 Serial # 144			
	FA # 12 Leica Model: K2700 LVMPD # 34005 Serial # 319			

	Instrument	Frequency	Criteria	Corrective Action
	FA # 13 Leica Model: K2700 Serial # 332			
	FA # 15 Leica Model: FSC LVMPD # 10838 Serial # 319553			
	FA #16 Leica Model: S6E / KL1500LCD Serial # 241984			
Other Instrumentation	Innov-X Energy Dispersive X-ray Spectrometer Model α4000SL Serial #6845	**Internal:** Before each use and every four hours while in use Additional standardization is at the user's discretion	Must meet the manufacturer's recommendations as outlined in their documentation	If the ED-XRF will not standardize after following all software and manufacturer's instructions, the user should: 1. Contact the Innov-X service center for assistance 2. Tag out of service 3. Advise the lab manager to arrange for repair 4. Document problem on a Corrective Action Report if needed
	Larson-Davis Sound Level Meter Model 820SLM Serial #1622	**Internal:** The sound level calibrator will be used before each series of sound level measurements. Its use is described in the Sound Level Meter Reference Manual	See the model 820 User's Manual, Chapter-Calibration Original certificate of Calibration and Conformance maintained by the Quality Manager or in Resource Manager	When the Sound Level Meter will not calibrate properly: 1. Follow the instructions in the Reference manual on adjusting the meter 2. Tag out of service 3. Advise the lab manger to arrange for repair 4. Document problem on a Corrective Action Report if needed

	Instrument	Frequency	Criteria	Corrective Action
	Larson-Davis Sound Level Calibrator Model CAL200 Serial #5124	**External:** Annually Vendor: Larson Davis (888) 258-3222 or (801) 375-0177	To meet external vendor's criteria Certificate of Calibration and Conformance maintained by the Quality Manager or in Resource Manager	
	Leica measuring tool (software)	**Internal:** Upon installation of the software Annually It will also be checked after microscope maintenance or repair, after software reloads or at the analysyt's discretion	The measuring tool must give the correct measurement within specified tolerances when using the calibration standard (Leica part 11581080)	If the measured result falls outside the specified tolerance: 1. Follow the manufacturer's recalibration / trouble shooting procedures 2. Tag out of service 3. Advise the lab manager to arrange for repair 4. Document problem on a Corrective Action Report if needed

LVMPD FORENSIC LABORATORY
TECHNICAL OPERATIONS MANUAL
FIREARMS / TOOLMARKS DETAIL

8.05 Title: **REFERENCES**

A technical reference library (books, periodicals, etc…) is maintained in the Firearm Detail. In addition, the scientists in the Detail who are members of the Association of Firearm and Tool Mark Examiners (AFTE) have access to the resources available on the Association website (afte.org). Other resources on the internet are available but their veracity must be verified before being considered for use.

In addition, the following specifically mentioned references are available in Qualtrax:

Knowles, Mike - *Instant Recovery of Obliterated Serial Numbers*, AFTE Journal, Vol. 17, No. 3, July 1985;

Dillon, John H., *The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrite Compounds in Gunshot Residues,* AFTE Journal, Vol 22, No. 3, July 1990;

Dillon, John H., *The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead Compounds in Gunshot Residues,* AFTE Journal, Vol 22, No. 3, July 1990;

Dillon, John H., *A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations,* AFTE Journal, Vol 22, No. 3, July 1990.

Dillon, John H., *Graphical Analysis of the Shotgun/Shotshell Performance Envelope in Distance Determination Cases*, AFTE Journal, Vol 21, No. 4 October 1989

Treptow, Richard S., Handbook of Methods for the Restoration of Obliterated Serial Numbers, NASA, January 1978. To order, contact: Stanley G. Young, Project Manager, Materials & Structures Division, NASA Lewis Research Center, Ohio 44135 (Grant NSG 3036 (3030); NASA Contract Report CR-1353)

Manufacturer/Instrument Manuals

The following Manufacturer's/Instrument Manuals are located in Qualtrax:

Innov-X Systems XRF Manual-August 2005/Version 2.1

Crest Ultrasonic Model F1436T Cleaning and Lubricating System - Rev. B 2/23/2007

LAS User Manual - version 3.3/2008 (on CD)

Larson Davis Model 820 Sound Meter - Rev. C/2003

P.A.C.T. Timer & Chronograph - 2005

Oehler Model 35P Chronograph - 1991

CyberNational Bullet Recovery System

Dillion D-Terminator Electronic Scale - V2.0/2002

Leica FSC Operating Manual – 2003

Lightning Bullet Catcher - Kevlar Trap

Perma Gel ballistic gelatin

Stack-On Safe

Presto PL and RL Series Hydraulic Lift Table

Ransom Master Series handgun rest

Minuteman X829 Series Vacuum

Shooting Ranges International Quick Range

Dillon's D-Terminator Electronic Scale V 2.0

Software Versions

Leica Application Suite V 4.6/4.7/4.11
Innov-X-Systems Operating System 2008 version
Redlake Motion Studio V 2.07.10

The AFTE Glossary

*The AFTE Glossary is available at:

https://afte.org/members/afte-manuals

LVMPD FORENSIC LABORATORY
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8.06 Title: **Ballistics Lab Clean-up Procedure**

The Ballistics Lab should be cleaned as needed to minimize lead exposure and to ensure the floor remains clear of firearms-related debris. The proper cleanup procedure will be followed as closely as possible to minimize exposure to lead. Note: The floor shall never be swept because it agitates the settled lead contaminates and increases the potential lead exposure for the person cleaning as well as others nearby.

Use a HEPA Filter (High Efficiency Particulate Air) vacuum. The currently-available Minuteman X829 series model 829116 is located in the Gun Cleaning/Work Alcove of the Firearms Detail. The hoses and tools are stored together inside a cardboard box located in the Armory.

- An appropriate respirator, gloves and disposable Tyvek type coveralls should be worn during this process.
- Range blowers will be turned on.
- While vacuuming, the operator should work in one direction with the vacuum positioned between the operator and the trap end of the range. This will allow the blowers to move the potentially lead contaminated air away from the vacuum operator and therefore minimize potential exposure.
- After completion of cleanup, allow the vacuum to run for approximately 45 seconds to bring remaining lead particulates from the hoses and tools up and into the filter.
- The vacuum and attachments will be returned to their appropriate storage location.
- Any large debris that cannot be vacuumed can be picked up by gloved hands and placed into a plastic bag. The top layer of the contamination control mats can also be disposed of at this time. The plastic bag, contamination mats, gloves and overalls will be placed in an appropriate waste disposal container (not in regular trash).

Appropriate skin cleaning will be done immediately following cleanup. The HEPA Filter vacuum will be cleaned out when needed to minimize exposure, and in accordance with proper lead disposal procedures.

Additional instructions on assembly, disassembly, cleaning, repair and service are available. Please refer to the product manuals which can be found in the Firearms Equipment Manuals folder in Qualtrax.