FIREARMS & TOOLMARK EXAMINER TRAINING MANUAL

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Revision History

Revision #	Description of Changes
1	Converted to Qualtrax

1.0 Introduction

The following training plan will allow you as an examiner trainee to guide yourself through the various areas of knowledge integral to the field of firearms/toolmark identification. This training plan is generic in its layout and allows some modification by the individual, Discipline Leader/on-site trainer or lab manager to meet local conditions. It is paramount that you keep before you the primary and ultimate objective of this training period: to independently and completely examine and compare evidence relating to firearms and toolmark identification; to independently and competently render an opinion and reach conclusions relating to your examinations and comparisons; and to give expert testimony in court in matters encompassed within the broad definition of firearms/toolmark identification and to do this in a professional, competent and impartial manner. The obligation is yours to maximize on the effectiveness of the training period as an opportunity to learn everything possible in this field. The extent to which you exert yourself during this training and evaluation period will bear directly on the quality of your performance in the laboratory and on the witness stand. Note that your technical abilities and your testimony will, in turn, bear directly on the future situations of accused persons, and especially in the discipline of firearms/toolmark identification, the lives of accused persons can hang in the balance. You have a moral and ethical obligation to prepare yourself technically and professionally during training in order to be able to perform according to the most rigid standards.

You will be expected to carry out a study of all pertinent lab equipment, the Analytical Methods, the Safety Manual, as well as the physical reference files.

Your training will be monitored and assisted by the Discipline Leader/on-site trainer, who has responsibility for training matters. You will be expected to meet the standards set by the Discipline Leader/on-site trainer for your successful completion of your training.

The acceptance criteria for verbal/written examinations will require a minimum passing score of 80%. Practical exercises, mock court and competency tests will be reviewed by the trainer and/or technical lead and a pass/fail determination will be made. The trainee should demonstrate the appropriate knowledge, skills and abilities relevant to the practical exercise in order to pass. To pass a competency test the trainee should obtain the expected results with no unexplainable discrepancies. If the acceptance criteria are not met the trainer and/or technical lead will determine any remediation required prior to progressing in the training program.

2.0 Roles and Responsibilities

2.1 Supervisor

2.1.1 The Supervisor should monitor the progress of the trainee.

2.2 Technical Lead

2.2.1 The technical lead will monitor and assist in the completion of the training. The trainer has responsibility for training matters. The trainee will be expected to meet the standards set by the Discipline Leader/on-site trainer for successful completion of training. The Technical Lead will be responsible for final approval on the completion of each training section/module.

2.3 Trainer

2.3.1 The trainer is required to actively participate in the trainees' completion of the required sections of the Training Plan. The Technical Lead will be responsible for assigning training modules and setting the training timeline to be completed by the trainee.

Note: The Supervisor/Technical Leader/Trainer may be the same individual or a designee.

2.4 Trainee

2.4.1 It is recommended that the trainee keep a loose-leaf notebook of study notes on each of the items shown in the training plan for research, discussion, demonstration, study or practical work. This notebook can include handwritten notes, charts, graphs, photographs, brief photocopied material, etc., at your discretion, but it should address and broaden on each of the required items of study set out in the training plan. Organization of your notebook in a format which parallels the training plan is suggested. This notebook will serve as a ready reference in the months and even years following your qualification, and will assist in documenting the trainees' progress during training.

3.0 Administrative Matters and Procedures

3.1 Background and Theory

3.1.1 An understanding of laboratory facilities and procedures both in general and specifically related to Firearms/Toolmark Identification is important to the success of the beginning trainee.

3.2 Objectives, Principles, and Knowledge

3.2.1 Become familiar with facilities and procedures of Idaho State Police Forensic Services in a general sense.

3.2.2 Become familiar with the facilities and procedures of the Firearms section of the Idaho State Police Forensic Services.

3.3 Health and Safety Hazards

3.3.1 None

3.4 Reading and Practical Exercises

3.4.1 Complete ISPFS core training.

3.4.2 Become familiar with the requirements and the facilities available for the secure storage of evidence within the lab. Discuss this with the Lab Manager and an examiner from the lab.

3.4.3 Become familiar with the requirements of lab security in regards to firearms, electrical appliances, evidence while under examination, and lab space security. Discuss this with an examiner from the lab.

3.4.4 Familiarize yourself with the Firearms Reference Collection (FRC):

i. Learn how to locate firearms in the FRC using the FRC printed inventory listings, and obtain up-to-date copies of this inventory for your use.

ii. Know the correct procedure for checking a firearm out of the FRC.

3.4.5 Familiarize yourself with the Range Rules and Safety Rules regarding firearms. To include:

i. Become familiar with the lab's firearms range including its physical dimensions, construction of walls and backstop, and bullet velocity limitations.

ii. Know how to test fire firearms thought to be possibly unsafe.
iii. Become familiar with the use of all the equipment on the range.
iv. Know the range rules and emergency medical treatment procedures.

4.0 Background/History of Firearms Identification and Current Trends

4.1 Background and Theory

4.1.1 Firearms Identification dates back to the beginning of the 20th century and its roots may go back even farther. An understanding of the history of Firearms Identification gives the trainee an idea of the scientific and historical foundation on which the science is based, where the science is presently and what issues it may face in the future.

4.2 Objectives, Principles, and Knowledge

4.2.1 Learn to define Firearms Identification.

4.2.2 Become familiar with the history and scientific foundations of Firearms Identification.

4.2.3 Become familiar with the workings and terminology of Firearms Identification laboratories.

4.3 Health and Safety Hazards

4.3.1 None

4.4 Reading and Practical Exercises

4.4.1 Define the following terms:

i. Firearms identification
ii. Ballistics

4.4.2 Read the applicable sections from the basic references and prepare a report on the history, principles, evolution and scope of firearms identification in its broadest sense. Support your report by data accumulated in your notebook. Discuss this with the Discipline Leader/on-site trainer who will review your report.

4.4.3 Formulate an answer to the following questions:

i. Is firearms identification an art or science?
ii. What are the types of conclusions that can be reached in firearms identification comparisons?
iii. What is the basis for each of the above conclusions?

iv. Can experts in the field of firearms identification disagree regarding their conclusions? Why?

v. How does "probability" relate to firearms identification?

4.4.4 Familiarize yourself with the "Association of Firearms and Toolmark Examiners" (AFTE) to include its history, criteria for membership, committees, the AFTE glossary and the AFTE journal and be able to discuss them.

4.4.5 Research the status of the ongoing initiatives to link shootings using computer imagery such as NIBIN/IBIS. What information can be given to Agencies regarding these programs?

4.4.6 Visit and tour the various laboratories that provide firearms and toolmark examinations within your region. Coordinate this visit with the Lab Manager.

4.4.7 Become knowledgeable about the proficiency testing program administered by the outside independent testing services. Particularly be aware of testing and the results of testing conducted within the field of firearms and toolmark identification by this organization.

4.4.8 Be able to demonstrate a practical working knowledge of firearms terminology using the AFTE Glossary as the standard.

5.0 Firearms & Ammunition Development and Current Trends

5.1 Background and Theory

5.1.1 Firearms were first used almost 900 years ago. Since then they have undergone significant changes and are still changing today. A knowledge of the origins and evolution of firearms and ammunition is important to the trainee's understanding of the firearms and ammunition seen in casework.

5.2 Objectives, Principles, and Knowledge

5.2.1 Knowledge of the history and evolution of firearms.

5.2.2 Knowledge of the history and evolution of ammunition.

5.3 Health and Safety Hazards

5.3.1 None

5.4 Reading and Practical Exercises

5.4.1 Review the history of early firearms and ammunition development up to the advent of metallic cartridges, with particular emphasis on lock mechanisms, early rifling techniques, percussion systems, priming methods and pre-metallic cartridges. Prepare a chronological outline of this early development.

5.4.2 Study the firearms reference collection noting in particular the types of firearms which are representative of commercial and military firearms development since the advent of metallic cartridges.

5.4.3 Trace the evolution of the rimfire cartridge from the mid-nineteenth century to the current generation of modern .22 caliber rimfire cartridges.

5.4.4 Study the history of centerfire cartridge development starting with black powder cartridges to the current generation of modern centerfire cartridges. Make notes to show the chronological history of this development.

5.4.5 Study the Standard Ammunition File (SAF), in particular cartridges and shotshells which are representative of commercial and military ammunition development during the past three decades.

5.4.6 Conduct a study of exterior bullet coatings. Determine how this new technology impacts the examinations conducted as a firearms examiner.

6.0 Manufacture of Modern Firearms

6.1 Background and Theory

6.1.1 Each different manufacturing technique produces its own specific marks. It is important to Firearms Identification to determine if marks produced by these methods will produce marks which are individual and can be used to identify a toolmark back to a single source

6.2 Objectives, Principles, and Knowledge

6.2.1 Examine the different manufacturing methods and the marks they produce.

6.2.2 Determine how these methods are used in firearms manufacturing and if they will produce marks useful for identification.

6.3 Health and Safety Hazards

6.3.1 None

6.4 Reading and Practical Exercises

6.4.1 Numerous techniques are used in the manufacture of modern firearms. Research in detail these processes and set these out in your notes. Include but do not restrict your study to the following machining methods:

i. Shaping
ii. Planning
iii. Drilling
iv. Reaming
v. Turning
vi. Boring
vii. Milling-include both face milling and peripheral (slab) milling
viii. Broaching
ix. Abrasive machining-include honing, lapping, grinding, sanding, and ultrasonic methods
x. Filing
xi. Swaging
xii. Electrochemical machining (ECM)
xiii. Electrodischarge machining (EDM)
xiv. Investment casing
xv. Metal injected molding (MIM)
xvi. Sawing

6.4.2 Become familiar with the basic nomenclature of handguns, rifles, and shotguns.

i. Include, but do not restrict your study, to the following: breechface, breechbolt, bolt, bolt face, extractor, ejector, firing pin, rifling, barrel, lands, grooves, ramp, magazine, clip, ejection port, and receiver.
ii. Point out these parts in several handguns, rifles and shotguns as applicable.
iii. Discuss the manufacturing techniques which would have been used to fabricate and finish each of the parts and note the machining marks on each part.
iv. Point out any "mark of abuse" which could contribute to the uniqueness of each part.
v. Identify areas that machining marks might "carry over" to another firearm.

6.4.3 Research in detail the following rifling techniques:

i. Broach
ii. Button
iii. Hammer forging
iv. hook method
v. scrape method
vi. ECM/EDM

6.4.4 Obtain broaches and buttons for study from the lab training materials. Determine the difference between barrels which have been button rifled and those which have been broach rifled.

6.4.5 Discuss and define the following terms as they relate to firearms manufacture or firearms identification.

i. Chambering
ii. Crowning
iii. Ballizing
iv. Bore slugging
v. Forcing cone
vi. Bore
vii. Choke
viii. Choke tubes

6.4.6 Research the history and current significance of proof marks as they relate to the manufacture of firearms.

6.4.7 *Optional/Funding Dependent*: Visit the manufacturing facilities of at least two firearms and/or barrel manufacturers such as Wilson barrels, Ruger, Smith and Wesson, Mossberg, Marlin and US Repeating Arms.

i. Record notes in training notebook on each visit and produce a written report of the visit. Particular emphasis should be placed on manufacturing and rifling techniques used by each manufacturer, noting methods and procedures which leave unique manufacturing toolmarks on firearms parts which, in turn, produce individual microscopic marks on bullets, cartridge cases and shotshell casings. Coordinate these visits with the Discipline Leader/on-site trainer.

7.0 Manufacture of Modern Ammunition

7.1 Background and Theory

7.1.1 Ammunition is a fundamental to the operation of modern firearms. A working knowledge of ammunition components and manufacturing techniques is important to almost every process in Firearms Identification.

7.2 Objectives, Principles, and Knowledge

7.2.1 Learn terms related to ammunition nomenclature and manufacturing

7.2.2 Determine the purpose of each component of modern ammunition.

7.3 Health and Safety Hazards

7.3.1 None

7.4 Reading and Practical Exercises

Written and Verbal Exercises:

7.4.1 Define in trainees' notebook and know the meaning of the following terms as they relate to modern ammunition and its manufacture:

i. Cartridge
ii. Cartridge case
iii. Primer
iv. Shotshell
v. Shotshell casing
vi. Bottleneck cartridge
vii. rebated-rim cartridge
viii. Rimless cartridge
ix. Rimmed cartridge
x. Semi-rimmed cartridge
xi. Shoulder
xii. Neck
xiii. Mouth
xiv. Head
xv. Headstamp
xvi. Proof cartridge
xvii. Tapered cartridge
xviii. Extractor groove
xix. Gauge
xx. Battery cup
xxi. Brass
xxii. "Rule of 17"
xxiii. Wadding
xxiv. Shot collar
xxv. Crimp
xxvi. Bunter
xxvii. Bullet
xxviii. round-nosed bullet
xxix. "hollow-point" bullet
xxx. bullet sizing
xxxi. wadcutter bullet
xxxii. semi-wadcutter bullet
xxxiii. soft point bullet
xxxiv. spitzer bullet
xxxv. swaging
xxxvi. cast lead bullet
xxxvii. mold marks
xxxviii. truncated cone bullet
xxxix. cannelure
xl. ogive
xli. brass-coated lead bullet
xlii. copper-coated lead bullet
xliii. nylon-coated lead bullet
xliv. "silvertip" bullet
xlv. antimony
xlvi. arsenic
xlvii. chilled shot
xlviii. high brass, low brass
xlix. lubaloy
l. dram equivalent
li. single base, double base

7.4.2 Sketch the cross-section of Berdan and Boxer primers, showing their relationship to the head of the cartridge.

7.4.3 Discuss the purpose and essential ingredients of priming mixture used in modern cartridges.

7.4.4 Know the difference between caliber and caliber type. Illustrate this difference by relating these terms to a discussion of the .22 caliber, .30 caliber and .38 caliber families of cartridges.

7.4.5 *Optional/Funding Dependent*: Visit at least two ammunition-manufacturing facility such as Remington, Federal or Winchester to observe the manufacture of rimfire and centerfire cartridges and shotshells.

i. Make detailed notes of the manufacturing processes and generate a written report. Particular emphasis should be placed on pellet and bullet manufacture, shotshell casing and cartridge case manufacture and the steps involved in the loading of cartridges and shotshells.

8.0 Instrumentation and Equipment

8.1 Background and Theory

8.1.1 Instruction in the care and use of instrumentation and equipment is important to their proper use and maintenance.

8.2 Objectives, Principles, and Knowledge

8.2.1 Proper use of Microscopes used in Firearms Identification.

8.2.2 Proper use and calibration of measuring devices and other equipment used in Firearms Identification

8.3 Health and Safety Hazards

8.3.1 None

8.4 Reading and Practical Exercises

8.4.1 Differentiate between the following:

i. Compound microscope
ii. Stereo microscope
iii. Comparison microscope

8.4.2 Review the instruction manual for our stereomicroscopes.

8.4.3 Review instruction manuals and the mechanical and optical aspects of our microscopes in the lab. Note the differences and similarities in each, both mechanically and optically.

8.4.4 Familiarize yourself with the following types of light sources which are in use in the lab on the comparison microscopes.

i. fluorescent
ii. Fiber optics (with and without filters)

8.4.5 Using each type of light source in the field of view on a comparison microscope, note the differences in the quality of each using the following different surfaces: lead bullets, jacketed bullets, various types of cartridge cases, and various types of surfaces containing toolmarks. Manipulate the above light sources with respect to angle and vary the

intensity of the light source if possible. Gain an appreciation for the effects of varying the angle and intensity for each light source on each type of surface. Discuss this with the Discipline Leader/on-site trainer.

8.4.6 Prepare the microscope for your personal use, including adjustments to your personal vision requirements, and familiarize yourself with each set of objective lenses on your comparison microscope. Become familiar with the various digital camera systems in the lab.

8.4.7 Become familiar with and demonstrate the use of the following equipment:

i. Speed micrometer
ii. Inertia bullet puller
iii. Steel rule
iv. Reticle in ocular lens of binocular microscope
v. Balances and scales located in the lab
vi. Gauge blocks
vii. Barrel rods
viii. Stage micrometer
ix. Water recovery tank, to include cleaning and priming wand
x. Barrel casting materials
xi. Calipers

8.4.8 Review the maintenance and calibration of the balances and other equipment/instrumentation in the firearms lab.

9.0 Examination of Firearms

9.1 Background and Theory

9.1.1 There are a wide variety of firearm manufacturers, types and action. The manufacture, make and model can usually be determined by examining markings on the firearm. Type can be determined by a visual examination as can the action. Firearms should be examined to determine if they are safe to fire before they are test fired

9.2 Objectives, Principles, and Knowledge

9.2.1 Be able to characterize the firearm including manufacturer, make, model and action.

9.2.2 Be able to determine if a firearm is safe to test fire.

9.3 Health and Safety Hazards

9.3.1 Follow all firearm safe handling rules.

9.3.2 Lead exposure

9.4 Reading and Practical Exercises

9.4.1 Define each of the following types of firearms and explain in detail the operation of each type to include the loading of cartridges and the subsequent movement of the cartridge case and/or bullet after firing.

i. revolver, single and double action
ii. auto-loading pistol, single and double action
iii. Derringer and single shot pistols
iv. Bolt-action rifle
v. auto-loading rifle
vi. pump-action rifle
vii. Various single shot rifles
viii. Submachine gun
ix. Assault rifle

9.4.2 Explain and illustrate the differences between a gas-operated and a recoil-operated auto-loading shotgun.

9.4.3 Explain and illustrate the differences between the following types of auto-loading pistols:

i. Blowback action

ii. Delayed blowback action
iii. gas-delayed blowback action
iv. Short recoil action
v. Long recoil action

9.4.4 Discuss with the Discipline Leader/on-site trainer from the unit the protocol to be used in determining whether a firearm "can be made to fire without pulling the trigger".

9.4.5 Research, define, and/or determine the implications of the following terms as they relate to safety in the operation of a firearm.

i. Excessive headspace
ii. Barrel obstruction
iii. barrel bulge
iv. Broken extractor
v. Push off
vi. Trigger shoe
vii. False half-cock
viii. defective safety
ix. high primer
x. rail splitting
xi. hairline cracks
xii. improper timing
xiii. excessive pressure
xiv. dented barrel

9.4.6 Explore the capabilities in restoring an inoperable evidence firearm to operating condition and also know the limitations and reservations which must be considered.

9.4.7 Review and record the references in the lab library which can be used to identify the manufacturer and/or source of a firearm using the following criteria:

i. Proof marks
ii. Inspector marks
iii. Factory numbers and markings
iv. Serial number
v. Part numbers
vi. Company logos

9.4.8 Become familiar with the capabilities and limitations of the lab in regard to these areas:

9.4.9 Marking evidence firearms

i. Determining whether an evidence firearm has been fired since it was last cleaned

ii. Determining the manufacturer of a firearm from an examination of a part from a firearm

iii. Determining the manufacturer of a firearm from a photograph and comparing an evidence firearm to a photograph

9.4.10 Become knowledgeable about how to submit evidence firearms to the laboratory when they have been recovered from water or when they are in a rusted condition. Also become familiar with the capabilities, limitations, and reservations which must be considered when restoring such firearms to operating condition to obtain test specimens from them.

9.4.11 Become knowledgeable about how to conduct an examination to determine if a firearm has been altered to fire full automatic. Using a firearm which has been altered to fire full automatic, conduct this type of examination and verbally report your findings.

Practical Exercises:

9.4.12 For each of the following firearms partially disassemble and reassemble a representative sample, photograph, note differences in operational mechanism and be able to identify major parts by name.

i. representative sample of revolvers
ii. semiautomatic firearms
iii. submachine guns
iv. military and civilian center fire rifles
v. shotguns
vi. rimfire revolvers, pistols and rifles

Using the above firearms:

a. Study the various safety mechanisms employed in each design. Include thumb safety, grip safety, magazine safety, firing pin block, transfer bar, and any other mechanical safety. Illustrate how the firing mechanisms are blocked, interrupted, or otherwise stopped from operating.

b. Demonstrate how to place firearms in a safe condition, how to load and unload each, how to handle and carry these firearms in the laboratory, and how to safely test fire each of these different types of firearms.

c. Familiarize yourself with the lab equipment used for measurement of trigger pull. Determine the trigger pull on at least one firearm from each group of firearms.

d. Demonstrate using one firearm from each group of firearms, how to determine whether a firearm "can be made to fire without pulling the trigger".

9.4.13 Attend Armorer's training offered by various manufacturers of firearms, at their manufacturing facilities if possible. Coordinate these with the Discipline Leader/on-site trainer.

10.0 Serial Number Restoration

10.1 Background and Theory

10.1.1 Stamping a serial number in metal deforms the metal below the surface of the visible number. Under certain circumstances a removed number can be recovered by treating the surface with chemical reagents.

10.2 Objectives, Principles, and Knowledge

10.2.1 Alteration methods.

10.2.2 Recovery methods.

10.2.3 Serial number references.

10.3 Health and Safety Hazards

10.3.1 Safe gun handling procedures.

10.3.2 Lead exposure.

10.3.3 Caustic and acidic chemicals.

10.4 Reading and Practical Exercises

Written and Verbal Exercises:

10.4.1 Read the Handbook of Methods for the Restoration of Obliterated Serial Numbers by Tretow. Prepare a summary on the Theory of Serial Number Restoration.

10.4.2 Sketch the entire stressed area above and below the indentation of a stamped item and depict what remains when the indented area is removed.

10.4.3 Make a list of the various methods used to mark items by private industry. This list should include but not be restricted to: casting, stamping, dot matrix, laser and electrical discharge machining.

i. Determine the effect each of these marking techniques has on the subsurface of the marked area.

ii. Determine how the marking methods used can directly affect the ability of the examiner to restore any obliterated markings and why.

10.4.4 Define the term "plastic deformation" of metal.

10.4.5 Document the difference between cold rolled steel and cast iron metal.

10.4.6 Define and document the effect that the following types of alterations will have on the subsurface of the marked item and how it will impact on the results of the examiner.

i. Grinding
ii. Restamping
iii. Pinging
iv. Gouging
v. drilling
vi. welding
vii. filing
viii. combinations of the above

10.4.7 Determine the telltale signs that can be left by the various alteration methods. Discuss how these signs will determine your specific approach to the restoration attempt.

10.4.8 Determine the different types of lighting (e.g., incandescent and fluorescent) and how they can improve or enhance the restoration results. Document how the angle of incidence of these lighting techniques might vary the results.

10.4.9 Discuss the various methods of surface preparation such as sanding and polishing and how they will affect the results in the restoration attempt.

10.4.10 Determine the chemical reaction that takes place when etching is done and place in your notebook the appropriate chemical formulations for the general reactions of acid with steel and aluminum.

10.4.11 Determine whether the reaction rate for the stressed area is faster or slower than the etching rate of the rest of the surface and why.

10.4.12 Determine the specialized equipment that might be used in number restoration and discuss these with the Discipline Leader/on-site trainer.

10.4.13 Determine the various ways photography can be utilized to document the process of serial number restoration. Also discuss its limitations.

10.4.14 Research the various kinds of magnifying and enhancing equipment used for number restoration and explain when and why each would be used.

10.4.15 Become familiar with the following chemicals:

i. $CuCl_2$
ii. $NaOH$
iii. HCl
iv. HNO_3
v. K_2SO_4
vi. H_2SO_4
vii. $FeCl_3$

10.4.16 Obtain the proper safety equipment (e.g., eyewear, masks, gloves, and lab coats) before attempting any chemical restorations. Review the chemical hygiene policies to insure proper safety precautions are used.

10.4.17 Define and place in your notebook these common chemical terms:

i. Frys Reagent
ii. Turner's Reagent
iii. Davis' Reagent

10.4.18 Become knowledgeable of the numbering systems and methods used by various firearms manufacturers including but not limited to Colt, Ruger, Smith & Wesson, US Repeating Arms (Winchester) and Remington.

10.4.19 Discuss the best chemicals and techniques to use in number restoration of the following firearms:

i. Colt pistol
ii. Smith & Wesson revolver
iii. RG Industries revolver
iv. Ruger stainless steel revolver
v. Winchester rifle
vi. shotgun case hardened receiver
vii. shotgun alloy receiver
viii. chrome/nickel 25 caliber auto-loading pistol

10.4.20 Document how the combination of brief application of $CuNH_4C_{12}$ followed by normal $NaOH$ application can shorten the processing time on aluminum.

10.4.21 Prepare a short summary of why alternating HNO3 and HCl can work so well on chrome or nickel-plated firearms.

Practical Exercises:

10.4.22 Obtain several sample serial numbers from the Discipline Leader/on-site trainer; alter the serial numbers using different methods and then attempt to restore them. Prepare notes and photographs to substantiate your conclusions and results.

10.4.23 Document the methods used and lessons learned during the restoration process.

10.4.24 Obtain several pieces of aluminum that have had stamped numbers removed. Attempt to restore these numbers using various techniques. Prepare notes and photographs to substantiate your conclusions and results.

10.4.25 Research the effect of electricity on the reaction time of the different chemical techniques you have learned. Conduct restorations using this method.

10.4.26 Successfully complete a serial number restoration competency test.

10.4.27 Successfully complete a written or oral examination dealing with serial number restoration.

10.4.28 Successfully complete mock court dealing with serial number restoration.

10.4.29 Successfully complete supervised cases.

10.4.30 Successfully complete technical review training.

11.0 Gunshot Residue Examinations and Distance Determinations

11.1 Background and Theory

11.1.1 When fired a firearm produces smoke, partially burnt powder and vaporous lead. These products can be deposited onto the target in a pattern that changes with distance. This pattern can be reproduced allowing the examiner to determine an approximate muzzle to target distance for the original shot. Shotgun pellet patterns can also be reproduced. The passage of a bullet can leave copper and/or lead wipe which can be chemically tested for.

11.2 Objectives, Principles, and Knowledge

11.2.1 Producing test patterns.

11.2.2 Preparing chemicals.

11.3 Health and Safety Hazards

11.3.1 Safe gun handling procedures.

11.3.2 Chemical hazards.

11.4 Reading and Practical Exercises

Written and Verbal Exercises:

11.4.1 Obtain a copy of and be familiar with the lab protocol for Distance Determination examinations.

11.4.2 Described in detail the chemical reactions which take place in the burning of smokeless powder, the modified Griess test and the Sodium Rhodizonate test.

11.4.3 Read the article entitled "Graphical Analysis of the Shotgun/Shotshell Performance Envelope in the Distance Determination Cases" in the AFTE Journal, October, 1989 issue. Prepare a summary of the significance of the article

Practical Exercises:

11.4.4 Demonstrate your proficiency in preparing the chemicals used in the modified Griess test and the Sodium Rhodizonate test including the test media and the photographic paper.

11.4.5

11.4.6 Demonstrate your proficiency in conducting the following techniques, following appropriate lab protocol.

i. Conventional Griess test
ii. Reverse Griess test
iii. (c) Sodium rhodizonate test
iv. Bashinsky transfer
v. blotting transfer

11.4.7 Perform a competency test conducting "muzzle-to-garment" distance tests, with at least one sample involving the deposition of gunshot residues and one sample involving shot patterns.

11.4.8 Successfully complete a written or oral examination dealing with distance testing.

11.4.9 Successfully complete a mock court dealing with distance testing.

11.4.10 Successfully complete supervised cases.

11.4.11 Successfully complete technical review training.

12.0 Bullet Examinations and Comparisons

12.1 Background and Theory

12.1.1 When a firearm is fired markings are imparted on the bullet by the barrel. These markings include class characteristics from the rifling and individual characteristics imparted by imperfections in the barrel caused by manufacturing methods, wear and damage.

12.2 Objectives, Principles, and Knowledge

12.2.1 Become familiar with terminology.

12.2.2 Be able to characterize a fired bullet and determine what conclusions can be drawn from it.

12.2.3 Become familiar with bullet comparisons.

12.3 Health and Safety Hazards

12.3.1 Safe gun handling procedures.

12.3.2 Lead exposure.

12.4 Reading and Practical Exercises

Written and Verbal Exercises:

12.4.1 Obtain a copy of and familiarize yourself with the lab protocol for the examination of fired bullets.

12.4.2 Define or determine the significance of the following terms/phrases as they relate to the examination and comparison of fired bullets.

i. Slippage
ii. Shaving
iii. Obturate
iv. Leading edge and trailing edge
v. Melting
vi. blow-by
vii. Striation
viii. Individual microscopic marks
ix. Ogive
x. bearing surface
xi. class characteristics
xii. general rifling characteristics
xiii. insufficient individual microscopic marks
xiv. corrosion
xv. leading
xvi. "limited individual microscopic marks"
xvii. “single-action" firing
xviii. "double-action" firing

12.4.3 Know the importance of and limitations of determining the following, as they relate to the examination and comparison of fired bullets or bullet fragments:

i. Weight
ii. Caliber
iii. Manufacturer
iv. Caliber type
v. general rifling characteristics
vi. pitch of rifling
vii. depth of rifling

12.4.4 Become familiar with the Known Specimen File (KSF). Know its location, composition, filing system and uses as a reference file.

Practical Exercises:

12.4.5 Familiarize yourself with the General Rifling Characteristics (GRC) file. Know how to use this file to compile a list of firearms in a "no-gun case". Demonstrate your proficiency in using the GRC file using samples provided by your on-site trainer.

12.4.6 Using provided test bullets and other fired bullets and bullet fragments demonstrate your proficiency in accurately determining caliber, caliber type, manufacturer, and rifling characteristics of these fired bullets. Prepare a list of firearms which could have been used to fire these bullets provided to you. Use the KSF, SAF, and GRC files in conducting these examinations.

12.4.7 Using test bullets fired from polygonal rifled barrels, demonstrate your proficiency in accurately determining the rifling characteristics of these fired bullets. Compile a list of firearms which could have been used to fire these bullets using the GRC file.

12.4.8 Become knowledgeable about the facilities in the lab for the recovery of fired test bullets. Know when and how to use the horizontal recovery tank and fiber box and their limitations. Observe and assist the Discipline Leader/on-site trainer from the lab in the recovery of fired bullets using each of these methods.

12.4.9 Familiarize yourself with the ammunition storage areas in the lab. Know how to locate test ammunition. Know the reasons for using substitute ammunition or down-loading ammunition for test firing. Know the proper procedure for down-loading ammunition for test firing. Under supervision of the Discipline Leader/on-site trainer prepare and fire down-loaded test ammunition.

12.4.10 Microscopically compare test bullets from "consecutively-made" barrels. Observe and document the differences and similarities in the striations.

12.4.11 Using the same .22 caliber firearm, test fire two each of at least three brands of 22 LR caliber ammunition, using both plated (copper and brass washed) and lead bullets. Attempt to identify the test bullets to each other. Take appropriate photographs and notes.

12.4.12 Using the same .357 Magnum caliber revolver, test fire two each of at least three brands of 38 special and .357 Magnum caliber ammunition, using jacketed, plated and lead bullets. Attempt to identify the test bullets to each other. Take appropriate photographs and notes.

12.4.13 With the on-site trainer test fire a 9mm Luger pistol using two each of at least 3 brands of 9mm ammunition, ensuring both jacketed and plated bullets are used. Attempt to identify the test bullets with each other. Take appropriate photographs and notes.

12.4.14 With the on-site trainer test fire a .30 caliber rifle using at least two different brands of ammunition and compare the tests with each other.

12.4.15 With the on-site trainer test fire a .32 S & W caliber revolver using two each of the following cartridges and compare the test bullets with each other.

i. 32 S & W caliber Remington with lead bullet
ii. .32 Auto caliber Remington with full metal case jacketed bullet

12.4.16 With the on-Site trainer test fire a representative sample of Polygonal or Hexagonal rifling profile pistols. Using two test bullets from each pistol, make microscopic comparisons of the test bullets.

12.4.17 Microscopically compare bullets before and after that have been fired from a gun and then the barrel of the gun was cut and the muzzle end was crowned.

Written and Verbal explanations based on Practical Exercises:

12.4.18 Compile a list of reasons as to why bullet identifications cannot be made in some cases, and why some barrels and bullets can preclude or tend to preclude identifications. This list should include, but not be limited to, the results of the above testing.

12.4.19 Read the article in the April 1985 issue of the Crime laboratory Digest concerning "Manufacturing Toolmark Identification on the Base of Jacketed Bullets". Discuss the significance of identifying manufacturing toolmarks on a fired bullet from a victim with those on unfired bullets loaded into cartridges from the suspect.

12.4.20 Determine the feasibility of determining caliber and/or the rifling characteristics of a fired bullet from an examination of a bullet hole in metal. To complete this test:

i. Compare test bullets with each other before and after from a barrel that has been "Slugged"

13.0 Cartridge/Cartridge Case Examinations and Comparisons

13.1 Background and Theory

13.1.1 When a firearm is fired markings are imparted on the cartridge case. These markings include class characteristics and individual characteristics. Class characteristics can be used to determine caliber, make and model of a possible firearm. Individual characteristics can be used to show a common origin.

13.2 Objectives, Principles, and Knowledge

13.2.1 Be able to characterize a fired cartridge case and determine what conclusions can be drawn from it.

13.2.2 Become familiar with cartridge case comparisons.

13.3 Health and Safety Hazards

13.3.1 Safe firearm handling procedures

13.4 Reading and Practical Exercises

Written and Verbal Exercises:

13.4.1 Obtain a copy of and be familiar with the lab protocol for the examination of cartridges and cartridge cases.

13.4.2 Describe "class characteristics" of the markings on a cartridge or a fired cartridge case. Determine the types of marks which can be left on a cartridge case/cartridge during loading/extracting and firing. Review a videotape regarding the slow motion of firing sequences using semiautomatic firearms.

13.4.3 Read the following two articles in the October 1989 issue of the AFTE journal and discuss them with the Discipline Leader/on-site trainer in the lab.

i. "Firing Pin Impressions - Their Measurement and Significance"
ii. "Firing Pin Impressions - Their Relation to Hammer Fall Conditions"

Practical Exercises:

13.4.4 Test fire at least twice 6 semiautomatic firearms.

i. Using the test fired cartridge cases, visually relate the markings imparted to the fired cartridge case with the part on the firearm which produced these markings.

ii. Load and extract at least two cartridges from each of the firearms and visually relate the markings imparted to the unfired cartridges with the part on the firearm which produced these markings.

iii. Microscopically intercompare all of the markings with each other. Include the following types of markings in your microscopic comparisons: firing pin impression, breechface marks, chamber marks, anvil marks, extractor marks, ejector marks, ramp marks, and magazine marks. Photograph the results of your comparisons.

13.4.5 Test fire the following firearms, at least twice with each brand, using comparable CCI, Remington, Federal, and Winchester ammunition of the appropriate caliber type. Select ammunition with both nickel and brass primers. Microscopically intercompare and photograph the markings as completed above.

i. .38 Special caliber Smith & Wesson revolver
ii. .357 Magnum caliber Smith & Wesson revolver
iii. 9mm Smith & Wesson pistol
iv. .22 long Rifle caliber Ruger pistol

13.4.6 Index the cartridges and test fire a .22 Long Rifle caliber Smith and Wesson revolver using the same manufacturers' ammunition. Fire six .22 Long Rifle caliber cartridges, six .22 Long caliber cartridges, and six .22 Short caliber cartridges. Intercompare and photograph the markings imparted to the fired cartridge cases.

13.4.7 Test fire a .30 Carbine caliber U.S. Carbine and compare the test cartridge cases with each other. Compare all of the marks imparted to the fired cartridge cases. Load and extract cartridges from this same firearm. Note and compare all of the marks imparted to the test cartridges.

13.4.8 Explore the possibility of comparing and identifying reloading-type marks on cartridges/cartridge cases. Identify the various types of marks

which may be indicative of reloaded ammunition. Become familiar with the reloading equipment in the lab and the procedures used in reloading cartridges. Reload several cartridges and compare reloading-type marks on these cartridges with each other.

13.4.9 Determine the feasibility of comparing and identifying manufacturing toolmarks on a fired cartridge case from the scene of a crime with cartridges which can be associated with the suspect. Identify the various types of manufacturing toolmarks which may be present on cartridges or cartridge cases.

14.0 Shotshell/Shotshell Component Examinations and Comparisons

14.1 Background and Theory

14.1.1 When a shotgun is fired markings are imparted on the shotshell. These markings include class characteristics and individual characteristics. Class characteristics can be used to determine gauge, make and model of a possible firearm. Individual characteristics can be used to show a common origin.

14.2 Objectives, Principles, and Knowledge

14.2.1 Become familiar with terminology.

14.2.2 Become familiar with characterizing shotshell components and fired shot.

14.2.3 Shotshell comparisons.

14.3 Health and Safety Hazards

14.3.1 Safe gun handling procedures.

14.3.2 Lead exposure.

14.4 Reading and Practical Exercises

Written and Verbal Exercises:

14.4.1 Determine what type of examinations can be conducted and what conclusions can be reached from an examination of the following components. Discuss this with the Discipline Leader/on-site trainer.

i. shot, deformed and undeformed
ii. Fired card or fiber wads
iii. Fired plastic wads
iv. Fired shotshell casings
v. Unfired shotshells
vi. Shot buffer material
vii. Shot collar and shot cup

14.4.2 Familiarize yourself with the use of the SAF in regard to the determination of gauge and manufacturer of fired shotshell components. Know the limitations in regard to making such determinations. Demonstrate your proficiency in using the SAF to conduct this type of search.

Practical Exercises:

14.4.3 Using a shotgun, saw off a portion of the barrel. Test fire this shotgun using a Remington shotshell with a power piston wad. Recover the test shotshell wads and make microscopic comparisons of marks imparted to the test wads.

14.4.4 Test fire 4 shotguns using at least two test shotshell casings from each shotgun and microscopically compare the marks imparted to these shotshell casings. Include in your comparisons the following types of marks: firing pin impression, breechface marks (primer, battery cup, and head), extractor marks, ejector marks, chamber marks, and any other mechanism marks. Photograph these marks and document the significance of identifying any of these types of marks.

14.4.5 Using a 12 gauge semiautomatic shotgun, using at least two test shotshell casings with a representative sample of 12 gauge shotshell ammunition. Use small size shot, mediums size shot, buckshot and slugs for this test. Also recover a representative number of the fired pellets and fired wadding from each test firing. Compare markings on these test shotshell casings with each other. Examine the fired components which were recovered and compare them to unfired components of the same type. Document the significance of your findings.

14.4.6 Discuss in detail the procedures used in reloading shotshells and familiarize yourself with the shotshell reloading equipment in the lab. Know how to recognize reloaded shotshells from an examination of the shotshell casing and/or its components. Reload shotshells using the shotshell reloading equipment in the lab and examine the reloaded shotshells for reloading-type marks.

14.4.7 Successfully complete a written or oral examination dealing with firearm examination.

14.4.8 Successfully perform a competency test that includes at least one cartridge case comparison, one bullet comparison and a shotshell or shotshell component examination and comparison.

14.4.9 Successfully complete a mock court dealing with firearm examination.

14.4.10 Successfully complete supervised cases.

14.4.11 Successfully complete technical review training.

15.0 Toolmark Examinations and Comparisons

15.1 Background and Theory

15.1.1 Toolmarks can be found at crime scenes from burglary to murder. The marks left by tools can include class characteristic and individual characteristics. Class characteristics can be used to determine the type of tool and to determine if a tool is consistent or inconsistent with the mark. Individual characteristics can be used to show a common origin.

15.2 Objectives, Principles, and Knowledge

15.2.1 Define terminology and types of tools.

15.2.2 Toolmark comparisons.

15.3 Health and Safety Hazards

15.3.1 Sharp edges.

15.4 Reading and Practical Exercises

Written and Verbal Exercises:

15.4.1 Obtain a copy of and familiarize yourself with the lab protocol for the examination toolmarks.

15.4.2 Review your notes in reference to the section entitled "Manufacture of Modern Firearms". Those machining methods are the basis for toolmark identification as they were for firearms identification. However, it should be noted that in the broad definition of toolmarks identification, certain other related types of examinations are also performed.

15.4.3 Define the word "tool" and toolmarks identification in the narrow sense of the expression. Define Toolmark Identification in its broadest sense, and determine the kinds of conclusions which may be reached in the toolmark identification.

15.4.4 Determine and document the significance of examining submitted tools first for foreign deposits and itemize several types of such deposits.

15.4.5 In a case involving a toolmark examination where no tool is submitted, determine the types of conclusions which can be reached. Consider such things as the type of tool, size of tool, action employed by tool, value of toolmark for comparison purposes, and unusual tool features. Discuss the "no tool" case with the Discipline Leader/on-site trainer.

15.4.6 Define the following terms as they relate to toolmark identification and give three examples of tools or methods which could produce each category:

i. Shearing
ii. Pinching
iii. Fracture
iv. scrape mark
v. impression
vi. slicing

15.4.7 Discuss the fact that generally saws, files, and abrasive tools are not identifiable with the marks they produce. Cite any exceptions to this rule.

Practical Exercises:

15.4.8 Define the term "class characteristics" as it applies to toolmark identification. Using the tools of methods selected as examples in the paragraph above, describe their respective class characteristics in detail.

15.4.9 Select at least two tools representative of each category in paragraph 5 above from the lab. Produce toolmarks with each tool and observe the class characteristics of the toolmark. Vary the angle and force with which each tool is used.

15.4.10 Using soft copper wire of approximately 1/4-inch diameter, make cuts through it with the tools which employ a shearing, pinching and slicing action. Make test cuts in lead using the same tools. Attempt to identify the cuts in the copper wire as having been made by the same tool as that which cut the test lead. Support your results with photographs and note

any lighting considerations made necessary by the color difference between copper and lead.

15.4.11 Select a flat-bladed tool such as a screwdriver and a pry bar and make marks in a piece of copper or brass sheeting. Make the same type of marks in lead with both tools. Microscopically compare those in the brass or copper sheeting with the test marks in the lead. Attempt to identify the appropriate marks with the appropriate tool. Photograph your results and comment on the difference in the quality of marks made by each tool.

15.4.12 Using a drive pin punch, produce an impression in a piece of brass sheeting. Produce a set of test marks in lead and intercompare these two marks. Attempt to identify these as having been made by the same tool. Support your results by photographs.

15.4.13 Using a junked doorknob and a serrated-jawed tool, have the Discipline Leader/on-site trainer produce impressions and scrape marks like those produced by an attempt at an entry. Devise a method of obtaining test marks in lead like those produced by the serrated-jawed tool on the doorknob. Microscopically compare the marks on the doorknob with those on the test material. Identify the tool with the marks on the doorknob and reproduce the tool-doorknob orientation and relate each mark to its respective serration on the tool.

15.4.14 Learn the technique of reverse lighting. Obtain a piece of brittle metal as from an automobile bumper or fragment of pot metal and fracture it into two fragments. Attempt to identify the two fragments as having once been a single object. Take notes and support your results by photographs.

15.4.15 Obtain an ax blade which contains numerous defects. Cut a piece of seasoned wood such as a dowel rod with the ax blade and attempt to identify the blade with the cut. Insure that your test cuts are consistent with your "unknown" with respect to the orientation of the ax to the wood and the direction of the grain. Support your results with sketches and photographs.

15.4.16 Obtain a section of large-diameter telephone cable and cut it with the ax used above and study the effects of a slicing action on a multi-stranded cable. Note the quality and extent of microscopic marks of each strand and comment on the problems involved in identifications of this sort. Photograph the sliced end of the cable.

15.4.17 Obtain a used tire and make cuts and stabs into the sidewall with a fixed blade knife. Attempt to make comparisons of the toolmarks produced by the knife. Support your results with photographs and notes. Determine how the results of your examinations might be altered if the knife had been sharpened after making the questioned cuts, or if the knife had been used for an extended period of time after making the initial questioned cuts.

15.4.18 Investigate pressure/contact examinations in regard to objects which may have been in contact with each other for an extended time. Research several cases of this type and set these out in your notes.

15.4.19 Demonstrate making of casts of toolmarks. Discuss the potential of such casts and of photographs alone in making toolmarks identifications.

15.4.20 Successfully complete a written or oral examination dealing with toolmark examination.

15.4.21 Successfully perform a toolmark competency test.

15.4.22 Successfully complete a mock court dealing with toolmark examination. (An additional mock court not required if completed during the Firearms comparison mock court)

15.4.23 Successfully complete supervised cases.

15.4.24 Successfully complete technical review training.

16.0 Supervised Cases

16.1 Background and Theory

16.1.1 Supervised cases allows the trainer to evaluate the trainee's performance on actual case work.

16.2 Objectives, Principles, and Knowledge

16.2.1 To determine if the trainee can apply their training to actual case work.

16.3 Health and Safety Hazards

16.3.1 None

16.4 Reading and Practical Exercises

16.4.1 Upon successful completion of competency testing and the Quality Manager having reviewed and approved the training documentation, the Trainee will be responsible for the analysis of one case under close supervision. Analysis notes for supervised casework will be reviewed by the trainer and documentation of this placed in the case file. Based on this case the onsite trainer will determine if the trainee can work independently or needs to perform additional supervised cases. Upon completion of this required the trainee can begin unsupervised casework.

17.0 Technical Review Training

17.1 Background and Theory

17.1.1 The purpose of technical review is to ensure that the conclusions are supported by the examination documentation, are reasonable, and within the constraints of validated scientific knowledge.

17.2 Objectives, Principles, and Knowledge

17.2.1 To provide the trainee with experience in the technical review process.

17.3 Health and Safety Hazards

17.3.1 None

17.4 Reading and Practical Exercises

17.4.1 The trainee shall technically review for training purposes another analysts cases for a period of six months or 25 cases whichever comes first. These reviews will be submitted to the trainer for evaluation and the results compared to the actual review results. No significant differences should be present. After successfully completing this requirement the trainee can perform casework technical review.

18.0 Basic References:

- Policies and procedure manuals for the laboratory
- Manufacturer's procedure and operation manuals
- "AFTE Glossary" AFTE Standardization Committee
- "Basic Firearms/Toolmarks Course" California Department of Justice
- "Cartridges of the World" BARNES
- "Encyclopedia of Modern Firearms, Parts and Assembly, Vol I." BROWNELL
- "Firearms and Ammunition Fact Book" NRA STAFF
- "Firearms Identification" Vol. I, MATHEWS
- "Firearms Investigation, Identification and Evidence" HATCHER, JURY, and WELLER
- "Gun Digest Book of Exploded Firearms Drawings" MUNTZ
- "Gunshot Wounds" DiMAIO
- "Handbook of Firearms and Ballistics" HEARD
- "Handbook of Forensic Science" FBI
- "Handbook of Methods for the Restoration of Obliterated Serial Numbers" TREPTOW
- "Handgun and Shoulder Arms Assembly" NRA
- "Hatcher's Notebook" HATCHER
- "History and Development of Small Arms Ammunition, Vol 1-3, HOYEM
- "Hodgdon's Reloading Data Manual" HODGDON POWDER CO.
- "Hornaday Handbook of Cartridge Reloading" HORNADAY STAFF
- "Introduction to Tool Marks, Firearms and the Striagraph" DAVIS
- Identification of Firearms and Forensic Ballistics" BURRARD
- "Machine Shop Practice Vol 1 & 2" K. H. MOLTRECHT
- "Military Small Arms of the Twentieth Century" HOGG and WEEKS
- "NRA Firearms Source Book" BUSSARD & WORMLEY
- "NRA Guidebook to Shoulder Arms" NRA STAFF
- "Silencer History and Performance" PAULSON
- "Small Arms of the World" W.H.B. Smith
- "Speer Reloading Manual" SPEER STAFF
- "The Book of Rifles" SMITH & SMITH
- "The Identification of Firearms and Forensic Ballistics" BURRARD
- "The Illustrated Encyclopedia of Handguns" ZHUK
- "The Microscope a Practical Guide", G. H. NEEDHAM
- "The Guide for the Integrated Ballistics Identification System", Forensic Technology