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THE EFFECT OF WEATHERING ON BULLET AND CARTRIDGE CASE ANALYSIS AND IDENTIFICATION

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THE EFFECT OF WEATHERING ON BULLET AND CARTRIDGE CASE ANALYSIS AND IDENTIFICATION

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Abstract

Currently, there is a void in the literature concerning the natural weathering of bullets exposed to different types of soils with varying acidity levels, mineral compositions, microorganisms, and oxygen saturation levels. The effect of weathering on bullet and cartridge case surfaces needs to be assessed. This may prove important in case work where ammunition components have been recovered from outdoor crime scenes, particularly after a length of time.

This study examined the deterioration of bullets and cartridge cases exposed to soil near the water of Lake Arcadia in Oklahoma. 230 grain, copper-alloy, full metal jacket bullets fired from a Ruger P90, .45 caliber Semi-automatic were used and cartridge cases from a Hi-Point JCP, .40 caliber semi-automatic pistol were utilized. Microscopic examination of the projectiles was conducted every two weeks for six months to determine if and when the ability to observe individual characteristics was compromised. Examination indicated that prolonged exposure to soil near lake water in Oklahoma caused discoloration, oxidation, and obscured individual characteristics of the bullets resulting in varied conclusions when compared to the control bullet to include identifications and inconclusives. The cartridge cases were not as impacted by prolonged exposure to this soil. Individual characteristics were observed for all cartridges and identifications made for all comparisons to the control.

Key Words: Weathering, Bullets, Cartridge Cases, Firearms Analysis

Introduction

Environmental weathering can affect a firearm and tool mark examiner's ability to analyze the surface of a bullet, observe unique, microscopic characteristics, and to make identifications. Weathering can result from air pollution, extreme temperature conditions, salts, wind, water, and varying soil conditions (Cao et. al, 2003; Hardison Jr., Ma, Luongo, & Harris, 2004; Hernandez-Soriano & Jimenez-Lopez, 2002; Howard & Olszewska, 2011). These factors can all contribute to the deterioration of the metal surface of a casing or projectile. Crusts may also form on the surface of bullets (Ackermann et al., 2009; Cao et al., 2003; Li et al, 2015; Mera, et al., 2015). These crusts vary in composition due to different weather and soil properties and can include goethite, lepidocrocite, cerussite, hydrocerussite, massicot, anglesite, gebhardite, shannonite, and litharge. (Ackermann et al., 2009; Cao et al., 2003; Li et al, 2015; Mera, et al., 2015).

Currently, there is a void in the literature concerning the natural weathering of bullets exposed to different types of soils with varying acidity levels, mineral compositions, microorganisms, and oxygen saturation levels. The majority of the literature addresses deterioration of ammunition obtained from dirt in shooting ranges. The effect of weathering on bullet and cartridge case surfaces needs to be assessed. This may prove important in case work where ammunition components have been recovered from outdoor crime scenes, particularly after a length of time.

This study examined the deterioration of bullets and cartridge cases exposed to soils near the water of Lake Arcadia in Oklahoma and the effect weathering has on an examiner's ability to observe microscopic, individual characteristics. The research utilized 230 grain, copper-alloy, full metal jacket fired from a Ruger P90, .45 caliber Semi-automatic and cartridge cases from a Hi-Point JCP, .40 caliber semi-automatic pistol. The guns were selected based on research and suggestions from a practicing firearms examiner for their marking ability (Millar, 2017, September 22). The .40 caliber Hi-Point JCP semi-automatic was chosen because it leaves significant detail on the cartridge case. The Ruger was selected because it produces a large number of well-defined striae on the bullet (Millar, 2017, May 8). Microscopic examination of the projectiles was conducted every two weeks for six months to determine if and when the ability to observe individual characteristics is compromised. Bullets and cartridge cases were placed at Lake Arcadia to determine if soil exposed to lake water conditions (current, acidity, microorganisms, salt) affects the surface characteristics of bullets or cartridge cases and the ability to visualize individual, identifying characteristics.

Literature Review

Ammunition Manufacturing

The elemental composition of a bullet may have a significant impact on the deterioration of the surface metal of the bullet when exposed to natural weathering. Knowing the bullets elemental composition may assist in determining if elements detected on the surface are intrinsic to the bullet or deposits from the soil and/or the environment.

Bullets are typically composed of a soft lead core and jacketed in a harder metal like copper or brass (Randich et al., 2002). Ammunition manufacturers obtain the lead for bullet production from one of two sources – lead ores or recycled metals (Sjåstad, K., Simonsen, S., & Andersen, T., 2014). The elemental composition of a bullet is pre-determined by the distributor (Randich et al., 2002). The composition is typically not adjusted during the bullet configuration process (Randich et al., 2002). Lead production requires refining processes to remove impurities and unnecessary elements like copper, tin, bismuth, antimony, arsenic, and silver (Randich et al., 2002). These procedures are typically more intensive for lead obtained from recycled metal as they contain more impurities (Randich et al., 2002). Distribution centers have different manufacturing specifications when making bullets and their thresholds vary for how pure the lead must be to be used for bullet production (Sjåstad, K., Simonsen, S., & Andersen, T., 2014). Bullet composition may contain metal alloys that are not removed during the purification process (Randich et al., 2002).

Following refinement, purified lead is distributed to manufacturers for ammunition production (Randich et al., 2002). The lead is melted and cut into bullets of the appropriate size and weight (Peters, 2011). When the bullets are in their final stage of production they are coated with a grease-like substance to prevent oxidation during storage (Randich et al., 2002; Sjåstad et al., 2014). This coating may inhibit the oxidation process and, thus, slow down the deterioration of the bullet during the natural weathering process.

Cartridge case production is time intensive. Brass (70% copper and 30% zinc) is cut into slabs or sheets that get flattened by a roller (Frost, 1990). These sheets are initially two-inches thick and are rolled until they are ½ inch in thickness (Frost, 1990). Casings then go through a variety of different stages and processes to include blank and cup, annealing, pickling, and washing, which occur many times throughout the production process (Frost, 1990). Blank and cup is the first step and involves sheets of brass being impacted by a blanking punch to outline the diameter of the base of the cup (Frost, 1990). A cupping punch impacts the outline created by the blanking punch and pushes through the sheet of brass taking the sheet and drawing it down to form a cup (Frost, 1990). The cupping lubricate is then washed off and the annealing process starts. During the annealing process, the metal is heated so that it can be reworked and then allowed to harden to prevent fractures (Frost, 1990). There are four main purposes for annealing the metal – to refine the grain, induce softness, improve the electrical and magnetic properties, and to improve its machinability (Frost, 1990). During the pickling process the metal is placed in an acidic bath to remove surface impurities and then washed in a water bath to rinse away the acid (Frost, 1990). The cups then go through many dye casts to draw the sides of the cup up to a specific height and sidewall thickness (Frost, 1990). Bunting/heading then occur (Frost, 1990). During this process, the head diameter, head thickness, and priming cavity size and shape are all determined (Frost, 1990). The bunting process for centerfire and rimfire cartridges varies slightly. During the bunting process in centerfire cartridge cases, the bottom is bunted to flatten the surface of the cartridge case so that it is easy to center the pocketing punch for the primer pocket (Frost, 1990). As for rimfire casings, during the bunting process (also called the heading process), the end of the cartridge is flattened, and the metal is compacted to create a thin rim along the outer bottom edges of the casing where the primer is placed (Frost, 1990). The headstamp is also applied from the compression of the heading punch (Frost, 1990) (Figure 1). The rimfire casings are then ready for the final relief anneal to test for cracks in the rim of the casing and also to test for brittleness (Frost, 1990). Lastly, the final pickle, wash, and the drying process is completed so that the casings are ready for priming (Frost, 1990). Centerfire cartridge cases go through additional processing steps such as tapering and necking, trim in length, head turning, mouth annealing, pierce flash hole, and primer seating (Frost, 1990). For centerfire cartridge cases, mouth annealing is completed to restructure the metal and to reduce the brittleness (Frost, 1990). A flash hole is also punched for centerfire casings (Frost, 1990). The

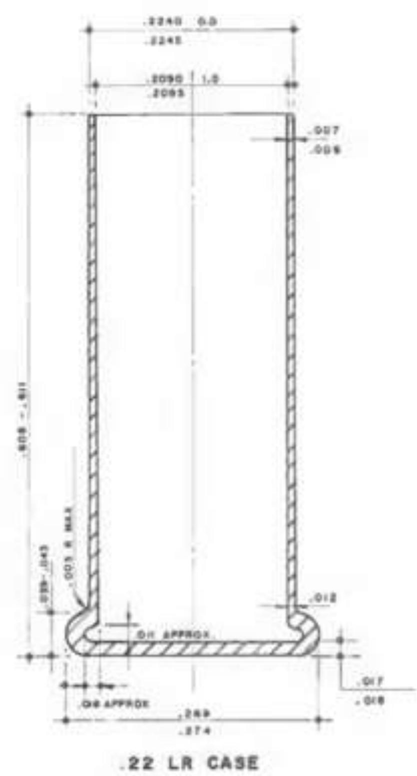

Figure 1: Rim fire cartridge case (Frost, 1990).

flash hole is created so that when the firing pin strikes the primer cup, the powders are ignited and go through the flash hole, propelling the bullet from the casing (Frost, 1990). The primer cup is centered and seating into the casing (Frost, 1990). Placement or seating of the primer cup is very important – if it is pushed in to far the firing pin may not hit it hard enough to ignite the powders; if it not pushed in far enough then it can go off if it is touched or dropped without firing pin activation (Frost, 1990). The primer cup must be seated parallel with the rest of the cartridge to avoid any complications (Frost, 1990).

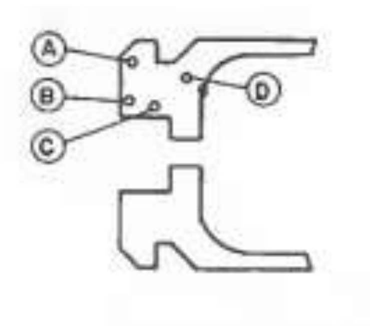

Figure 2: Center fire cartridge case showing where the primer cup sits and the flash hole (Frost, 1990).

The process of jacketing bullets begins by blanking the bullets and then forming them into a cup (Frost, 1990). The bullets then go through annealing, pickling, and washing (Frost, 1990). These processes are performed the same way as previously described for cartridge cases. If the bullet is a full metal jacket, then it gets pointed so that the top of the jacketed bullet is shaped into a point or cone (Frost, 1990). For hollow soft-point bullets, the jacket is trimmed, seated over the bullet, and hollowed out during the pointing process (Frost, 1990). For hollow- or open-point bullets, the core does not fill the bullet (Frost, 1990). Soft-point jackets get adjusted for the proper amount of lead exposure for the finished bullet (Frost, 1990). The last step is for the bullets to be knurled to hold the bullet and the jacket together (Frost, 1990). Full-metal jacketed bullets have enough jacket length past the core to use for the final turnover and closure of the tip of the bullet (Frost, 1990).

A cartridge case holds all the components of a live round of ammunition to include the primer, propellant, and bullet (Frost, 1990). It is composed of four main parts: the outer layer (thin coating), the interlayer, the mantle, and the core (Ackermann, 2009). The bullet is primarily composed of lead, antimony, and iron (Ackermann, 2009). The mantle is made of iron and the core is mostly lead with small amounts of antimony (Ackermann, 2009). The thin layer between the core, the mantle, and the outside layer serves as a coat/ jacket (Ackermann, 2009). Both are typically composed of a copper and nickel mixture (Ackermann, 2009). Other elements may be present depending on manufacturing criteria and thresholds maintained by the manufacturer (Ackermann, 2009). Elemental composition can vary between bullets (Randich et al., 2002). There may be anywhere from three to twenty elements in one bullet to include iron (Fe), lead (Pb), copper (Cu), zinc (Zn), carbon (C), sulfur (S), phosphorus (P), and manganese (Mn) (Larson et al., 2011). Although not being completed in this study, future studies could explore what elements are intrinsic to the bullets and cartridge cases and what is deposited by the soil and/or the environmental conditions after the weathering process. Analysis could be completed by scanning electron microscopy.

Weathering

Metal objects tend to deteriorate at a faster rate when exposed to weathering conditions in natural environments (Mera, M., 2015). According to a study conducted by Mera (2015), bullets immediately begin to oxidize when exposed to soil elements causing the metal surface to transform. Oxidation reactions occur when metals lose electrons and begin to break down (Jorgensen, 1987). Cao et al. (2003) also established that carbonation and hydration reactions can cause the deterioration of bullets.

Jorgenson (1987) analyzed the deterioration of shotgun pellets from shooting ranges that were deposited in the soil and discovered that the pellets all exhibited a white, brown, or gray material on the surface where the pellet corroded. The rapidly degrading lead of the pellets was also visible in the surrounding soil (Jorgenson, 1987). This was also observed in Mera’s (2015) research which focused on the spatial distribution and the compositions of the crusts left on corroded bullets in hunting fields. Certain environmental elements can catalyze the process of weathering like increased oxygen saturation, acidic soil, presence of organic compounds, and even water (Howard et. al, 2011). Different levels of acidity can affect the rate at which certain metals start to oxidize and rust (Cao et al., 2003; Jørgensen & Willems, 1987). For example, lead is more soluble in low pH or acidic conditions than a neutral pH (Xinde Cao et al. (2003).

Soil composition can also impact degradation of metals. Soils with dissolved organic carbon have increased rates of degradation of copper and lead as copper and lead have a high affinity for organic compounds (Hernandez-Soriano and & Jimenez-Lopez, 2012). Howard et al. (2011) studied the effects of “clayey and calcareous soils” on iron. It was found that iron metals deteriorate slower in these types of soils (Howard et. al, 2011). Conversely, in the presence of chloride and sulfate salts the rate of deterioration of iron increases (Howard et. al, 2011). Howard et al. (2011) also found that air pollutants, acid rain, and deicing salts facilitate the corrosion process. Gypsum which is deposited in the soil from plaster or air pollutants containing sulfur is also highly corrosive to metals (Howard et. al, 2011).

In Mera et al.’s (2015) study, bullets exposed to varying soil conditions not only exhibited deterioration, but also formed crusts that covered the bullet surface. These crusts were composed of lead, antimony, iron, titanium, copper, manganese, and zinc (Mera et al., 2015). Lead was present in the highest concentration (Mera et al., 2015). Trace amounts of vanadium, nickel, and chromium were also found (Mera et al., 2015). Cao et al. (2003) studied the effect that a soils pH has on lead and determined that at acidic levels lead is able to be emulsified. Hydrocerussite and cerussite were the predominant elements identified, although there were trace amounts of other elements found (Cao et al., 2003).

Cleaning of Bullets & Cartridge Cases

Ultrasonication is a non-destructive cleaning technique for ammunition that has been used in several studies (Cao et al., 2003; Jørgensen & Willems, 1987; Vantelon et al., 2005). The process utilizes sound waves at a high frequency to agitate and clean fragile, hard to reach surfaces on ammunition (Mears, 2013). Another approach for cleaning corroded bullets uses resin and a polishing technique to allow for visualization of class and individual characteristics (Vantelon et al., 2005; Mera et al., 2015). Ackermann et al. (2009) suggest simply scraping off the corroded crust as a method of cleaning.

Techniques for cleaning firearms were also examined as possible methods for cleaning bullet surfaces. Methods for cleaning firearms that were discussed in the literature included soda blasting, Rust Release™, ultrasonication, and electrolytic rust removal, (Mears, 2013). In Mears' (2013) study, the most effective methods for cleaning firearms were soda blasting and Rust Release™. Soda blasting is a technique that uses a pressurized washer to spray sodium bicarbonate crystals onto a metal object (Mears, 2013). This method can be harmful to soft metals (e.g., lead), but is effective for removing rust (Mears, 2013). The solution Rust Release™ is a non-destructive alternative cleaning method (Mears, 2013). Mears' (2013) study also mentioned ultrasonic and electrolytic rust removal as effective for removing rust. Electrolytic rust remover is a mixture of sodium carbonate and water that initiates a chemical reaction between oxygen and iron causing electricity to break the bonds that hold rust together (Mears, 2013). This technique can be destructive if not handled or used properly (Mears, 2013). As most of these techniques are destructive, they will not be used to clean bullets in this study.

Examination of Bullets & Cartridge Cases

There are a variety of methods to examine bullets and cartridge cases. The least destructive technique involves a visual examination and microscopy. Visual examination of bullets and cartridge cases is typically done first to determine class characteristics. Class characteristics are made on purpose and part of the manufacturing process and shared by multiple items like the number of lands and grooves, width of each land engraved area, bullet diameter, and direction of twist for a bullet and markings like the head stamp, caliber, and manufacturer for cartridge cases (Randich, 2002). After a thorough visual inspection, comparison microscopy is then used to identify individual characteristics (Randich, 2002). Individual characteristics are accidental to manufacturing process and unique to a specific item.

The comparison microscope utilizes two light microscopes to visualize bullets and cartridge cases. These microscopes are connected by an optical bridge that allows bullets, cartridge cases, or tools to be visualized side-by-side and allows them to be rotated 360 degrees and moved left to right or up and down to visualize the entire surface (Doyle, 2014). Bullets are attached to a sticky substance to hold them in place and cartridge cases are placed in a special holder (Doyle, 2014). Images of bullets or cartridge cases being compared are displayed side by side in the examiner's oculars and on a split-screen (Doyle, 2014). These images can be overlaid to help with lining up striations or impressions during analysis (Walz, 2005). The comparison microscope can be used to determine unique, microscopic characteristics on the bullet surface or cartridge case allowing the examiner to make an identification or elimination (Doyle, 2014). Comparison microscopes are also equipped with cameras for documentation (Walz, 2005).

Methodology

Fifty rounds of two–hundred and thirty grain, full metal jackets were fired from a Ruger P90, .45 caliber Semi-automatic pistol into a water tank. Twelve of the bullets were selected for use in this study. These were chosen because they exhibited well-defined striations. These bullets were scribed with number on the tip of each bullet (1-12). Fifty rounds were also fired from a Hi-Point JCP, .40 caliber semi-automatic pistol. Twelve of the cartridge casings from the Hi-Point were selected to be scribed for indexing. These casings were chosen as they exhibited no manufacturing marks or dimples in the primer. The sidewall of each of these twelve cartridge cases was scribed with a number (1-12).

Bullets and casings were initially analyzed for identifiable microscopic striations utilizing a comparison microscope prior to burying them in soil. Areas that were examined on the bullets were the six land engraved areas (LEAs), made by the barrel of the gun, to make sure that there were clear striae. The cartridge casings were examined on and around the primer pocket to make sure that there were no manufacturing marks or dimples on the primer that would skew the results (Millar, 2017, September 29). Results were photographed, cataloged, and documented. Conclusions were made between B1 (Bullet 1 – not buried in soil) and all subsequent bullets and C1 (Cartridge 1 – not buried in soil) and all subsequent cartridge cases based on consistency between class and individual characteristics. Conclusions were based on the AFTE Range of Conclusions and the AFTE Theory of Identification.

The Association of Firearm and Tool Mark Examiners (AFTE) is an international platform for the exchange of information, methods, practices, and further research that is available for practitioners in the field of Firearm and Tool Mark identification (AFTE, 2021). The Association of Firearm and Tool Mark Examiners theory of identification states that a conclusion of identification as it pertains to toolmarks can be made when two toolmarks have "sufficient agreement" in their unique surface contours (AFTE, 2021). Sufficient agreement can be determined by the comparison of the surface contours and the unique sets of patterns two toolmarks have including but not limited to curvature, height/depth, or spatial relationship of the individual peaks, ridges, and furrows (AFTE, 2021). "Agreement is significant when it 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" (AFTE, 2021). Sufficient agreement when comparing two or more different surface contours means that the agreement of individual characteristics has the quantity and quality of detail that would make the likelihood of another tool making the mark a practical impossibility (AFTE, 2021).

The AFTE Range of Conclusions has four different conclusions for toolmark comparisons (AFTE, 2021). Note, that objective observations are important when reporting toolmark examinations (AFTE, 2021). The four conclusions are as follows: identification, inconclusive, elimination, and unsuitable (AFTE, 2021). Identification conclusions occur when all class characteristics and individual characteristics are in agreement (AFTE, 2021). Inconclusive conclusions have three sub-components (AFTE, 2021). Inconclusive I, has agreement of all class characteristics and some individual characteristics, but not enough for an identification (AFTE, 2021). Inconclusive II, has agreement with all class characteristics, but may or may not have individual characteristics due to insufficiency, absence, or they were never reproduced onto the surface (AFTE, 2021). Inconclusive III, has agreement in class characteristics, but the observable individual characteristics disagree (but not enough for an elimination) (AFTE 2021). Elimination conclusions occur when individual and/or class characteristics have significant disagreement (AFTE, 2021). Unsuitable conclusions occur then the toolmark(s) are considered unsuitable for examination (AFTE, 2021).

The bullet labeled 1 and the cartridge casing labeled 1 were used as the controls and were not buried but kept in a controlled environment in the lab in a manila envelope. Prior to depositing the bullets and cartridge cases in the soil near Lake Arcadia, the pH of the lake water was assessed to determine acidity levels. pH strips were used test the acidity. The bullets and casings were then deposited at Lake Arcadia in Edmond, Oklahoma. Eleven bullets and casings were deposited in soil (sand/clay) surrounding the lake water. The bullets and cartridge cases were boxed in construction utility mesh using a tongue depressor as a marker for each bullet and casing and buried approximately 3 inches beneath the soil surface. Every two weeks for six months a bullet and cartridge case were collected for analysis of individual characteristics to determine the effects of natural weathering on the bullet and casing surfaces.

Figure 3: Bullets and cartridge casing buried in the soil at Lake Arcadia.

After the bullets and cartridge cases were retrieved from their location, tap water and a Q-tip were used to clean the surfaces. This method was chosen as it is a fairly non-destructive technique. Cleaning the surfaces was essential for determining the effects weathering and deterioration had on the bullets and cartridge cases and the examiner's ability to observe class and individual characteristics. Following cleaning, the bullets were examined using a comparison microscope to identify class characteristics (number of land engraved areas, diameter, and weight) and individual characteristics (number of striations in the land engraved areas) and photographed with the control, B1. All six land engraved areas were examined to assess individual characteristics and B1 was always on the left side of the picture. The cartridge cases were also examined using the comparison microscope to identify class characteristics (breechface pattern, firing pin shape, headstamp, extractor position, and ejector position) and individual characteristics (number of parallel striations on the primer) and compared with the control, C1. C1 was always on the left side of the picture.

Pictures of bullets were labeled with the authors first initial and last name followed by information pertaining to the control bullet and then information about which bullet it was being compared to. For example, SBrown B1 (LEA 1) to B2 (LEA 1) 28X indicated that land engraved area 1 of the control bullet B1 was being compared to land engraved area 1 of bullet B2 at a magnification of 28X. Each land engraved area was scribed 1-6 prior to being buried. Pictures of the cartridge cases were taken with the firing pin oriented in the upper top portion of the picture (see Figure 4). Which striations were being used for comparison was indicated using "right of the firing pin" or "left of the firing pin." Labeling the image was done using the same format as the bullets. For example, SBrown C1 (L OF FPI) to C2 (L OF FPI) 28X indicated that striations left of the firing pin on the control cartridge C1 were being compared to striations left of the firing pin on cartridge C1 at a magnification of 28X.

Results

Images and detailed analysis of class and individual characteristics can be found in Appendix A.

All bullets and cartridge casings were examined visually after cleaning and then examined using the comparison microscope. The six land engrave areas of each bullet were inspected and photographed to determine if they could be identified to the control bullet B1 based on objective observations of the number of defined striations. Similarly, the primer area of each cartridge case was examined and compared to control cartridge C1. Note, the casings were observed using the firing pin marking as the reference point with the firing pin oriented in the upper/top portion of the picture (Figure 4). Striations to the left and right of the firing pin were documented as individual characteristics. Conclusions were made based on the Association of Firearm and Tool Mark Examiners (AFTE) Theory of Identification and the Range of Conclusions possible. Inconclusive conclusions were defined by parenthesis and the roman numeral (I, II, III) in accordance with which AFTE inconclusive statement it aligned with.

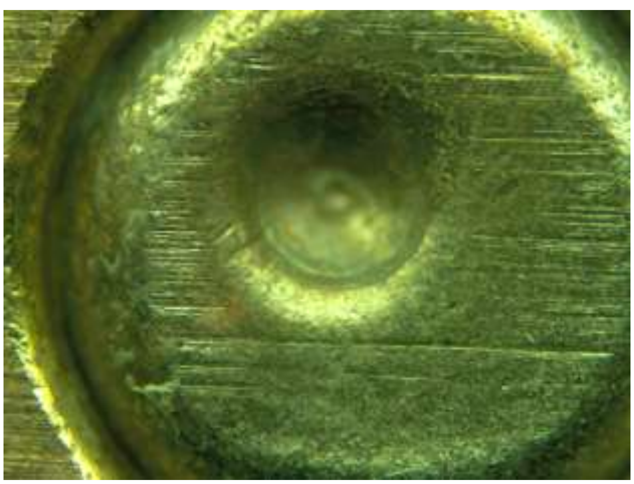

Figure 4: Firing pin impression oriented in the upper/top portion of picture. This orientation was used for all cartridge casings in research.

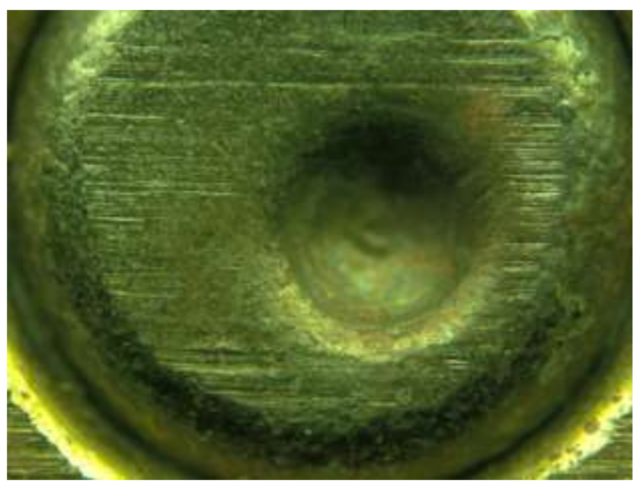

Figure 5: Firing pin impression in the lower/bottom portion of the picture.

Eleven bullets and eleven cartridge cases were buried three inches below the sand/clay soil at Lake Arcadia. A bullet and casing were retrieved from the soil every two weeks. Note, there were a few instances where water levels were too high to pull the bullets and casings and retrieving the materials was slightly delayed. The pH of the lake water was tested and was determined to be between 7-8 (fairly neutral). The soil was also tested by mixing it with neutral water and this yielded a pH of 5-6 (slightly acidic).

The first bullet (B2) and casing (C2) were pulled from the soil after two weeks. The weight of the bullet was 229.4 grains which was essentially the same as its initial weight. Analysis on B2 indicated there was sufficient agreement on LEA (Land Engraved Area) 1, LEA 3, and LEA 4 when compared to B1 (control, not deposited in the soil). LEAs 2, 5, and 6 were considered inconclusive (I) due to there being agreement of all discernible class characteristics and some agreement of individual characteristics. Based on the comprehensive assessment of all land engraved areas for B2 in comparison to B1 the overall conclusion was an identification. The only individual characteristics observed on all cartridge cases were chamber marks and magazine lip marks. No other markings were visible during examination. The comparison between C1 and C2 showed sufficient agreement on individual and class characteristics making it an identification.

After four weeks B3 and C3 were retrieved for comparison. B3 showed signs of decomposition on the underside of the bullet. The lead of the bullet was exposed and the brass finish discolored (which was likely due to oxidation). When compared to B1, B3 demonstrated sufficient agreement of class and individual characteristics on LEAs 1, 3, 4, 5, and 6. LEA 2 would be considered inconclusive (II) as there was agreement on all class characteristics without agreement or lack of disagreement of individual characteristics. Based on the comprehensive assessment of all land engraved areas for B3 in comparison to B1 the overall conclusion was an identification. C3 exhibited discoloration likely from oxidation. However, when compared to C1 there was sufficient agreement on class and individual characteristics making it an identification.

B4 and C4 were retrieved after six weeks. It should be noted that during this time the lake water was relatively high, and the bullets and casings were submerged under water for a period of time. B4 exhibited deterioration on the underside of the bullet. Oxidation also impacted the brass covering of the bullet and some dark spots were observed that interfered with analysis. When compared to B1, there was sufficient agreement of class and individual characteristics on LEA 1, 2, 3, and 6. On LEA 4 and LEA 5 all of the class characteristics and a few individual characteristics demonstrated agreement. The dark coloration caused by oxidation obscured many of the individual characteristics in these areas making them difficult to analyze. The inability to visualize all of the individual characteristics resulted in an inconclusive (II) conclusion. Based on the comprehensive assessment of all land engraved areas for B4 in comparison to B1 the overall conclusion was an identification. C4 had a rough texture, calcification, and oxidation. However, there was sufficient agreement of the class and individual characteristics between C1 and C4 allowing for an identification.

After eight weeks the lake water had receded, and the research materials were no longer under water. B5 had deterioration on the bottom of the bullet and oxidation to the brass finish with some dark spots obscuring the detail. LEA 1 and LEA 2 no longer had striations with well-defined peaks and valleys making individual characteristic analysis difficult and resulting in an inconclusive (II) conclusion for these LEAs. LEA 3 and LEA 4 were affected by oxidation and most of the characteristics were obscured – this was labeled as inconclusive (II). LEA 5 and LEA 6 had sufficient agreement of individual characteristics with striations that exhibited deep valleys and peaks. Based on the comprehensive assessment of all land engraved areas for B5 in comparison to B1 the overall conclusion was inconclusive. C5 had discoloration but demonstrated sufficient agreement of class and individual characteristics when compared to C1 resulting in an identification.

Research samples were not able to be pulled at weeks 10 or 12 due to significant amounts of rain. Lake Arcadia was closed due to flooding. Lake management provided a website to monitor the input and output of the lake and its water levels. Samples 6 and 7 were pulled at 13 weeks. For B6 there was degradation on the bottom portion of the bullet where the lead was exposed to the elements. There was also oxidation to the brass jacket and the brass was dull with no shine. LEAs 1, 2, 3, and 6 all had sufficient agreement of class and individual characteristics and were labeled as identifications. LEA 4 had a few spots where striations were visible but not enough to conduct analysis, so it was labeled unsuitable for examination. LEA 5 was dark with no detail making it also unsuitable for examination. Based on the comprehensive assessment of all land engraved areas for B6 in comparison to B1 the overall conclusion was an identification. C6 showed signs of oxidation. However, it had sufficient agreement with C1 on individual and class characteristics allowing for an identification.

For B7, degradation and oxidation were apparent. LEA 1 was dark due to the oxidation process but had some discernable class characteristics. It was labeled as inconclusive (II). LEA 2 was unsuitable for examination as oxidation obscured all the detail and there was nothing observable to examine. LEAs 3 and 4 had agreement with class and individual characteristics making it an identification. LEA 5 was super dark and had a crusty material on its surface. However, some individual and class characteristics were observed, and LEA 5 was labeled as inconclusive (I). LEA 6 was dark with spots of oxidation and only a few observable individual characteristics. LEA 6 was labeled as inconclusive (II). Based on the comprehensive assessment of all land engraved areas for B7 in comparison to B1 the overall conclusion was inconclusive. C7 showed oxidation but had sufficient agreement of individual and class characteristics with C1.

Bullet B8 and cartridge C8 were retrieved at 14 weeks. LEAs 1, 2, and 6 were dark due to oxidation but had agreement on class and some individual characteristics resulting in a conclusion of inconclusive (I). LEA 3 had agreement with class characteristics and a few individual characteristics making it an inconclusive (II). LEAs 4 and 5 had sufficient agreement with class characteristic and some agreement with individual characteristics resulting in a conclusion of inconclusive (I). Based on the comprehensive assessment of all land engraved areas for B8 in comparison to B1 the overall conclusion was inconclusive. On C8 there was oxidation to the brass and a slight discoloration to the brass, but this had no effect on the ability to observe characteristics or the examination process. There was sufficient agreement of class and individual characteristics between C1 and C8 resulting in an identification.

B9 and C9 were pulled after 16 weeks. For bullet B9, there was oxidation of the brass and degradation of the lead. LEAs 1-6 were hard to visualize and exhibited very few individual characteristics. For LEAs 1-6, the lack of observable details resulted in an inconclusive (II) conclusion. Based on the comprehensive assessment of all land engraved areas for B9 in comparison to B1the overall conclusion was inconclusive. C9 also exhibited oxidation. However, the individual characteristics associated with C9 had sufficient agreement with C1 for an identification.

B10 and C10 were retrieved after 18 weeks. Oxidation and degradation were both observed on B10. LEAs 1, 2, 3, and 5 were labeled as inconclusive (II) as there was agreement of class characteristics, but a lack of agreement of individual characteristics due to absence or insufficiency. LEAs 4 and 6 were inconclusive (I) with sufficient agreement of class characteristics and some agreement of individual characteristics. Based on the comprehensive assessment of all land engraved areas for B10 in comparison to B1 the overall conclusion was inconclusive. C10 had oxidation and what appeared to be rust starting to form on the sidewalls of the cartridge case. The right and left sides of the firing pin on C10 had sufficient agreement with C1 on class and individual characteristics resulting in an identification.

B11 and C11 were retrieved after 20 weeks. B11 exhibited oxidation and degradation. LEAs 1, 3, and 6 were labeled as inconclusive (I) as all of the class characteristics and only some of the individual characteristics were visible. For LEA 2, all class characteristics were visible, however, the individual characteristics were difficult to visualize resulting in an inconclusive (II) conclusion. LEA 4 and 5 were unsuitable for examination. Based on the comprehensive assessment of all land engraved areas for B11 in comparison to B1 the overall conclusion was inconclusive. C11 had some oxidation and rust. The right and left sides of the firing pin impression, however, demonstrated sufficient agreement for an identification to C1.

B12 and C12 were pulled from the ground at 22 weeks. B12 had oxidation and degradation. LEA 1 was inconclusive (I) so there was agreement with all class characteristics and some agreement between the individual characteristics. LEAs 3, 4, 5, and 6 were inconclusive (II) meaning that there was agreement with all class characteristics, but the individual characteristics were difficult to visualize due to oxidation and discoloration. LEA 2 was unsuitable for examination. Based on the comprehensive assessment of all land engraved areas for B12 in comparison to B the overall conclusion was inconclusive. C12 had oxidation but no rust present. The right and left sides of the firing pin impression had sufficient agreement with C1 for an identification.

After all the bullets and cartridge cases had been retrieved, the pH of the lake water was tested a final time and was determined to be between 7-8 (fairly neutral). The soil was also tested a final time by mixing it with neutral water and this yielded a pH of 6 (slightly acidic). The pH levels did not differ from those determined at the beginning of the study.

Comparisons and conclusions of bullets are summarized in Table 1 and cartridge cases are summarized in Table 2. Table 1 indicates if oxidation and discoloration were present on the surface of each bullet. Note, that an “x” indicates a feature was observed. Table 1 also summarizes the AFTE conclusion associated with each land engraved area (LEA) of each bullet and the overall AFTE conclusion for each bullet. Table 2 shows the comparisons and the conclusions for the cartridge cases and indicates whether oxidation, discoloration, and rust was present on the surface of each cartridge case. Note, that there was more of a change in the brass of the cartridge case then around the primer where the examination of the striations was conducted.

Table 1: Examination/Results of Bullets				
	Oxidation	Discoloration	LEA's	Overall Conclusions
Bullet 1 (Control)	N/A	N/A	N/A	N/A
Bullet 2 (2 weeks)	N/A	N/A	LEA 1, 3, 4 = Identification LEA 2, 5, 6 = Inconclusive (I)	Identification
Bullet 3 (4 weeks)	X	X	LEA 1, 3, 4, 5, 6 = Identification LEA 2 = Inconclusive (II)	Identification
Bullet 4 (6 weeks)	X	X	LEA 1, 2, 3, 6 = Identification LEA 4, 5 = Inconclusive (II)	Identification
Bullet 5 (8 weeks)	X	X	LEA 5, 6 = Identification LEA 1, 2, 3, 4 = Inconclusive (II)	Inconclusive (II)
Bullet 6 (13 weeks)	X	X	LEA 1, 2, 3, 6 = Identification LEA 4, 5 = Unsuitable for Examination	Identification
Bullet 7 (13 weeks)	X	X	LEA 1, 6 = Inconclustive (II) LEA 2 = Unsuitable LEA 3, 4 = Identification LEA 5 = Inconclusive (I)	Inconclusive (I)
Bullet 8 (14 weeks)	X	X	LEA 1, 2, 4, 5, 6 = Inconclusive (Ⅰ) LEA 3 = Inconclusive (II)	Inconclusive (I)
Bullet 9 (16 weeks)	X	X	LEA 1-6 = Inconclusive (Ⅱ)	Inconclusive (II)
Bullet 10 (18 weeks)	X	X	LEA 4, 6 = Inconclusive (Ⅰ) LEA 1, 2, 3, 5 = Inconclusive (II)	Inconclusive (II)
Bullet 11 (20 weeks)	X	X	LEA 1, 3, 6 = Inconclusive (Ⅰ) LEA 2 = Inconclusive (II) LEA 4, 5 = Unsuitable	Inconclusive (I)
Bullet 12 (22 weeks)	X	X	LEA 1 = Inconclusive (I) LEA 3, 4, 5, 6 = Inconclusive (Ⅱ) LEA 2 = Unsuitable	Inconclusive (II)
	X = Observed			

Table 2: Examination/Results of Cartridge Cases				
	Oxidation to Cartridge Case	Discoloration to Cartridge Case	Rust to Cartridge Case	Conclusions
Casing 1 (Control)	N/A	N/A	N/A	N/A
Casing 2 (2 weeks)	N/A	N/A	N/A	Identification
Casing 3 (4 weeks)	X	X	N/A	Identification
Casing 4 (6 weeks)	X	X	N/A	Identification
Casing 5 (8 weeks)	X	X	N/A	Identification
Casing 6 (13 weeks)	X	X	N/A	Identification
Casing 7 (13 weeks)	X	X	N/A	Identification
Casing 8 (14 weeks)	X	X	N/A	Identification
Casing 9 (16 weeks)	X	X	N/A	Identification
Casing 10 (18 weeks)	X	X	N/A	Identification
Casing 11 (20 weeks)	X	X	X	Identification
Casing 12 (22 weeks)	X	X	X	Identification
	X = Observed			

Conclusion

There is a noticeable void in the literature regarding the ability of a firearms examiner to analyze bullets and identify unique, microscopic characteristics after exposure to natural weathering. Natural weathering of bullets exposed to lake water soil with varying acidity levels, oxygen saturation levels, microorganisms, salt concentrations, varied pressure/movements from water currents, and other factors needs to be assessed. Previous studies only focused on weathering of bullets collected from shooting ranges or fish tanks.

The current study provides a more authentic representation of how weathering may impact a bullet or cartridge case recovered from a crime scene in a natural setting. Longer exposure to soil near lake water with a neutral pH in Oklahoma causes greater degradation of bullet and cartridge case topography and can obscure individual characteristics. For the bullets in this study, the longer they were exposed to the sand/clay, the more the surface topography was impacted as prolonged interaction with the soil started to create extra markings on the surface. Also, bullets that were buried for longer exhibited increased levels of oxidation and dark spots which in some cases obscured individual characteristics. Some of the LEAs on the bullets also had no markings left to visualize making them unsuitable for examination. This was observed starting with bullet 6 and continued to bullet 12. Comparison of the bullets with the control bullet B1 had varying conclusions to include identification, inconclusive (I-III), and unsuitable for analysis. All the land engraved areas for each bullet were used collectively to determine an overall conclusion for each bullet.

In this study, all of the cartridge cases exhibited sufficient agreement of detail (class and individual characteristics) with the control cartridge C1 for an identification. One issue that was encountered during the examination process and may have impacted results was that on some cartridges sand got into the groove around the primer pocket and obscured some of the lines of striae used for counting purposes.

Results demonstrated that the bullets used in this study (Remington, FMJ, .45 caliber, weighing 230 grains) were more affected by being submerged in soil near lake water with a neutral pH in Oklahoma than the cartridge cases used in this study (Hi-Point JCP, .40 caliber). The bullets seemed to discolor and oxidize faster than the cartridge cases and had more details obscured by the weathering process. The impact of the water and sand/clay was not as harsh on the casings as it was on the bullets. This could be attributed to the striae on the primer pocket being made of a different metal (nickel). Brass seemed particularly susceptible to oxidation and rust. Also, the surface area of the bullets was more readily exposed to the soil than the primer of the cartridge. It should also be noted that the cartridge casing brass seems to be thinner than the jacket on the bullet – although the effect of this on the weathering process is not known.

This research is significant to the forensic science community because it demonstrates that exposure to natural weathering can impact the topography of bullets and cartridge cases and obscure class and individual characteristics. This study also showed that the longer bullets and casings are deposited in these types of conditions the more susceptible they are to degradation and oxidation. Also, the bullets in this study were more affected by natural weathering than the cartridge cases. More research into why cartridge case topography is less impacted needs to be conducted.

Limitations

This study is limited to a specific lake within the state of Oklahoma and is not representative of the effects of weathering on bullet or cartridge case surfaces for anywhere outside of this region. Future research could expand the project to other lakes and regions in

Oklahoma or different areas within the United States with varying natural weathering conditions. Another limitation is that the utility mesh may leech into the surrounding soil affecting the rate of degradation. Finding an alternative method might be necessary. Research could also be expanded to assess effects on different types of ammunition such as pure lead bullets, newer ammunition, and jacketed ammunition. It is also possible that more time might provide additional insight into the degradation process. Also, different weapons of varying caliber could be used to see if there are any significant differences.

References

Association of Firearms and Tool Marks Examiner (AFTE). (2021). AFTE theory of Identification as it relates to toolmarks. AFTE. https://afte.org/about-us/what-is-afte/afte-theory-of-identification

Association of Firearms and Tool Marks Examiner (AFTE). (2021). AFTE Range of Conclusions. AFTE. https://afte.org/about-us/what-is-afte/afte-range-of-conclusions

"About EMPA (electron microprobe analysis)." (n.d.). Retrieved November 19, 2015 from http://probelab.geo.umn.edu/whatisepma.html

Abraham, J., Shukla, S., & Singh, A. (2007). Application of X-ray diffraction techniques in forensic science. *Forensic Science Communications, 9*(2). Retrieved November 18, 2015 from https://www.questia.com/article/1G1-162519770/application-of-x-ray-diffraction-techniques-in-forensic

Ackermann, S., Gieré, R., Newville, M., & Majzlan, J. (2009). Antimony sinks in the weathering crust of bullets from Swiss shooting ranges. *Science of The Total Environment, 407*(5), 1669-1682. doi:10.1016/j.scitotenv.2008.10.059

Cao, X., Ma, L., Chen, M., Hardison Jr., D., & Harris, W. (2003). Weathering of lead bullets and their environmental effects at outdoor shooting ranges. *Journal of Environment Quality*, 32(2), 526-534. doi:10.2134/jeq2003.0526

Doyle, J. (2014). Bullet Identification - FirearmsID.com. Retrieved November 24, 2015 from http://www.firearmsid.com/A_BulletId.htm

Hardison Jr., D., Ma, L., Luongo, T., & Harris, W. (2004). Lead contamination in shooting range soils from abrasion of lead bullets and subsequent weathering. *Science of The Total Environment*, *328*(1-3), 175-183. doi:10.1016/j.scitotenv.2003.12.013

Hernandez-Soriano, M., & Jimenez-Lopez, J. (2012). Effects of soil water content and organic matter addition on the speciation and bioavailability of heavy metals. *Science of The Total Environment, 423*, 55-61. doi:10.1016/j.scitotenv.2012.02.033

Howard, J., & Olszewska, D. (2011). Pedogenesis, geochemical forms of heavy metals, and artifact weathering in an urban soil chronosequence, Detroit, Michigan. *Environmental Pollution, 159*(3), 754-761. doi:10.1016/j.envpol.2010.11.028

Jørgensen, S. & Willems, M. (1987). The fate of lead in soils: The transformation of lead pellets in shooting-range soils. *Ambio, 16*(1), 11–15. Retrieved from http://www.jstor.org.vortex3.uco.edu:2050/stable/4313312

Larrison, R. (2006) Degradation of fired bullets and cartridge cases in different environmental mediums. *AFTE Journal*, Vol 38, No. 3, Summer 2006, pp. 223-230.

Larson, S., Martin, W., Griggs, C., Thompson, M., & Nestler, C. (2011). Comparison of lead dissolution from antique and modern ammunition. *Environmental Forensics, 12*(2), 149-155. doi:10.1080/15275922.2011.572952

Li, Y., Zhu, Y., Zhao, S., & Liu, X. (2015). The weathering and transformation process of lead in China's shooting ranges. *Environmental Science: Processes & Impacts, 17*(9), 1620-1633. doi:10.1039/C5EM00022J

Mears, D. (2013). The restoration of rusted firearms: An evaluation of different methods. *AFTE Journal, 45*(3), 203-221.

Mera, M., Rubio, M., Pérez, C., Galván, V., & Germanier, A. (2015). SR µXRF and XRD study of the spatial distribution and mineralogical composition of Pb and Sb species in weathering crust of corroded bullets of hunting fields. *Microchemical Journal, 119*, 114-122. doi:10.1016/j.microc.2014.11.010

"Micro X-ray Fluorescence (µXRF) – XOS." (n.d.). Retrieved November 18, 2015, from https://xos.com/technologies/xrf/micro-x-ray-fluorescence-µxrf/

Millar, K. (2017, May 8). Thesis. kcrandell@uco.edu.

Millar, K. (2017, September 22). Research. kcrandell@uco.edu.

Millar, K. (2017, September 29). Thesis Project. kcrandell@uco.edu.

Peters, C. (2011). The basis for compositional bullet lead comparisons. *Forensic Science Communications,4*(3). Retrieved from https://www.fbi.gov/about-us/lab/forensic-science-communications/fsc/july2002/index.htm/peters.htm

Randich, E., Duerfeldt, W., McLendon, W., & Tobin, W. (2002). A metallurgical review of the interpretation of bullet lead compositional analysis. *Forensic Science International, 127*(3), 174-191. doi:10.1016/S0379-0738(02)00118-4

Sjåstad, K., Simonsen, S., & Andersen, T. (2014). Lead isotope ratios for bullets, a descriptive approach for investigative purposes and a new method for sampling of bullet lead. *Forensic Science International, 244*, 7-15. doi:10.1016/j.forsciint.2014.07.008

Swapp, S. (2016, December 28). Scanning Electron Microscopy (SEM). Retrieved from http://serc.carleton.edu/research_education/geochemsheets/techniques/SEM.html

Uhlig, J. (2007). X-ray absorption spectroscopy. Retrieved from http://www.chemphys.lu.se/research/techniques/xrayxas/

Vantelon, D., Lanzirotti, A., Scheinost, A., & Kretzschmar, R. (2005). Spatial distribution and speciation of lead around corroding bullets in a shooting range soil studied by micro-x-ray fluorescence and absorption spectroscopy. *Environmental Science & Technology, 39*(13), 4808-4815. doi:10.1021/es0482740

Walz, M. (2005, 12). Eye on forensic microscopy. *Research & Desin, 47*, 33-33,35. Retrieved from https://vortex3.uco.edu/login?url=http://search.proquest.com.vortex3.uco.edu/docview/ 205349775?accountid=14516

Zeiss, C. (2013, June 11). Applications of Scanning Electron Microscopes in Forensic Investigations. Retrieved from http://www.azom.com/article.aspx?ArticleID=552

Appendix A

Charts and pictures prior to placement of bullets and cartridge cases at Lake Arcadia.

Bullet Worksheet		Bullet Comparison:	
Initial Findings		Examiner:	Sheila Brown
Item:	B1 (Control)		
Weight	229.6 gr.	Diameter	0.458"
# of lands/grooves	6	Direction of Twist	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0815"	LEA 4:	0.0795"
LEA 2:	0.0795"	LEA 5:	0.0840"
LEA 3:	0.0805"	LEA 6:	0.0805"
LEA AVG.	0.0809"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

Bullet Worksheet		Bullet Comparison:	B1-B2
Initial Findings		Examiner:	Sheila Brown
Item:	B2		
Weight:	229.5 gr.	Diameter:	0.444"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0825"/53 lines	LEA 4:	0.0810"/28 lines
LEA 2:	0.0755"/26 lines	LEA 5:	0.0810"/15 lines
LEA 3:	0.0820"/18 lines	LEA 6:	0.0800"/45 lines
LEA AVG.	0.0803"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

Figure 6: B1 (LEA 1) to B2 (LEA 1) 28X

Figure 7: B1 (LEA 2) to B2 (LEA 2) 28X

Figure 8: B1 (LEA 3) to B2 (LEA 3) 28X

Figure 9: B1 (LEA 4) to B2 (LEA 4) 28X

Figure 10: B1 (LEA 5) to B2 (LEA 5) 28X

Figure 11: B1 (LEA 6) to B2 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B3
Initial Findings		Examiner:	Sheila Brown
Item:	B3		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0805"/73 lines	LEA 4:	0.0815"/29 lines
LEA 2:	0.0805"/37 lines	LEA 5:	0.0840"/31 lines
LEA 3:	0.0780"/34 lines	LEA 6:	0.0830"/26 lines
LEA AVG.	0.0813"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

Figure 12: B1 (LEA 1) to B3 (LEA 1) 28X

Figure 13: B1 (LEA 2) to B3 (LEA 2) 28X

Figure 14: B1 (LEA 3) to B3 (LEA 3) 28X

Figure 15: B1 (LEA 4) to B3 (LEA 4) 28X

Figure 16: B1 (LEA 5) to B3 (LEA 5) 28X

Figure 17: B1 (LEA 6) to B3 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B4
Initial Findings		Examiner:	Sheila Brown
Item:	B4		
Weight:	229.5 gr.	Diameter:	0.450"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0815"/75 lines	LEA 4:	0.0810"/24 lines
LEA 2:	0.0800"/29 lines	LEA 5:	0.0850"/45 lines
LEA 3:	0.0815"/21 lines	LEA 6:	0.0820"/26 lines
LEA AVG.	0.0818"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

Figure 18: B1 (LEA 1) to B4 (LEA 1) 28X

Figure 19: B1 (LEA 2) to B4 (LEA 2) 28X

Figure 20: B1 (LEA 3) to B4 (LEA 3) 28X

Figure 21: B1 (LEA 4) to B4 (LEA 4) 28X

Figure 22: B1 (LEA 5) to B4 (LEA 5) 28X

Figure 23: B1 (LEA 6) to B4 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B5
Initial Findings		Examiner:	Sheila Brown
Item:	B5		
Weight:	229.7 gr.	Diameter:	0.443"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0820"/46 lines	LEA 4:	0.0805"/24 lines
LEA 2:	0.0805"/26 lines	LEA 5:	0.0830"/36 lines
LEA 3:	0.0805"/30 lines	LEA 6:	0.0815"/33 lines
LEA AVG.	0.0813"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

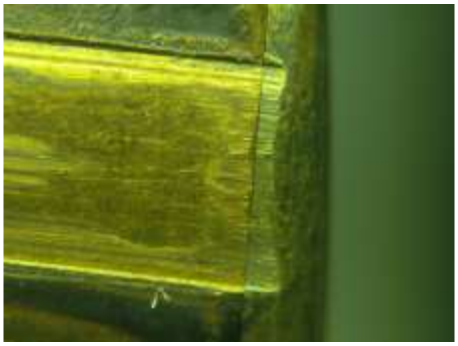

Figure 24: B1 (LEA 1) to B5 (LEA 1) 28X

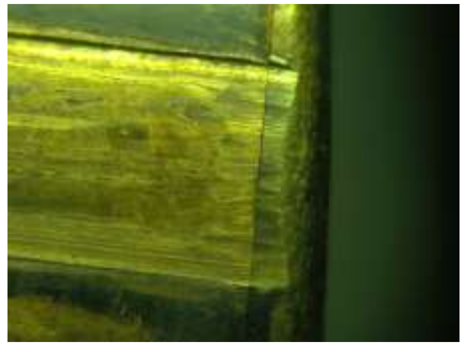

Figure 25: B1 (LEA 2) to B5 (LEA 2) 28X

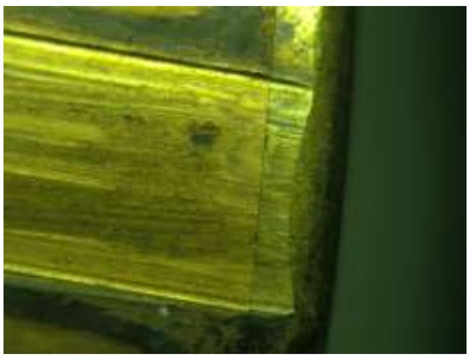

Figure 26: B1 (LEA 3) to B5 (LEA 3) 28X

Figure 27: B1 (LEA 4) to B5 (LEA 4) 28X

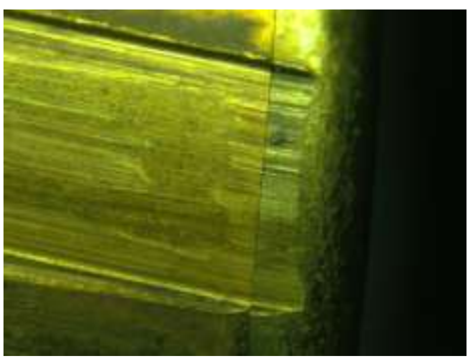

Figure 28: B1 (LEA 5) to B5 (LEA 5) 28X

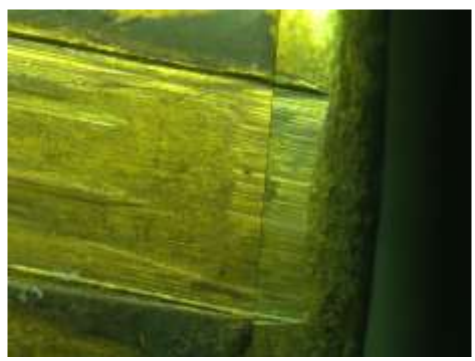

Figure 29: B1 (LEA 6) to B5 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B6
Initial Findings		Examiner:	Sheila Brown
Item:	B6		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0800"/47 lines	LEA 4:	0.0823"/23 lines
LEA 2:	0.0820"/23 lines	LEA 5:	0.0802"/41 lines
LEA 3:	0.0813"/29 lines	LEA 6:	0.0773"/35 lines
LEA AVG.	0.0805"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

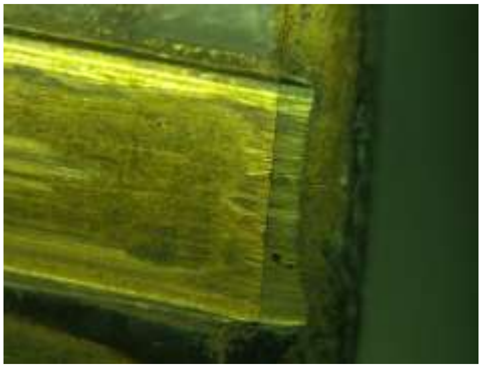
Figure 30: B1 (LEA 1) to B6 (LEA 1) 28X

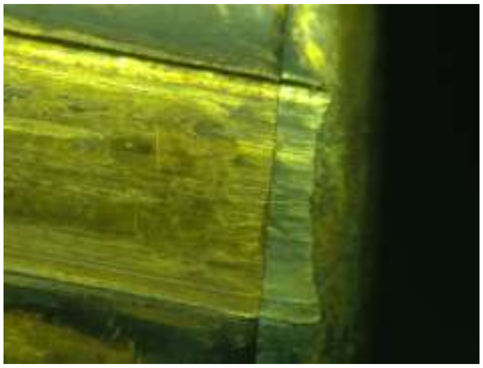
Figure 31: B1 (LEA 2) to B6 (LEA 2) 28X

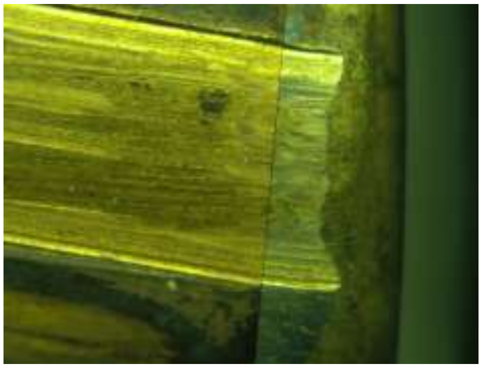
Figure 32: B1 (LEA 3) to B6 (LEA 3) 28X

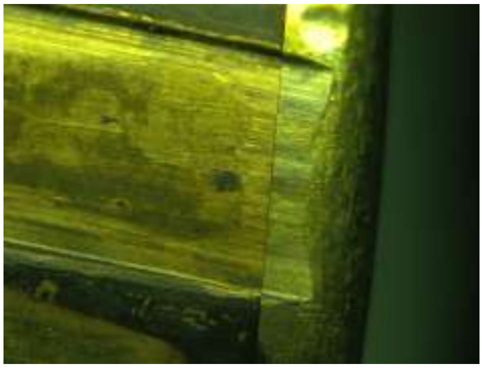
Figure 33: B1 (LEA 4) to B6 (LEA 4) 28X

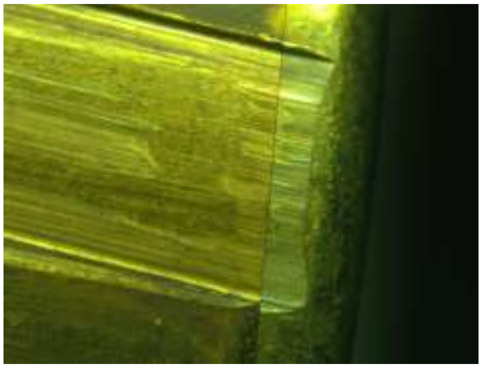
Figure 34: B1 (LEA 5) to B6 (LEA 5) 28X

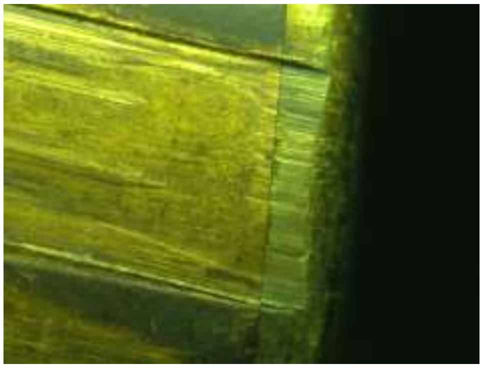
Figure 35: B1 (LEA 6) to B6 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B7
Initial Findings		Examiner:	Sheila Brown
Item:	B7		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0795"/36 lines	LEA 4:	0.0816"/45 lines
LEA 2:	0.0796"/43 lines	LEA 5:	0.0820"/45 lines
LEA 3:	0.0823"/29 lines	LEA 6:	0.0795"/52 lines
LEA AVG.	0.0808"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

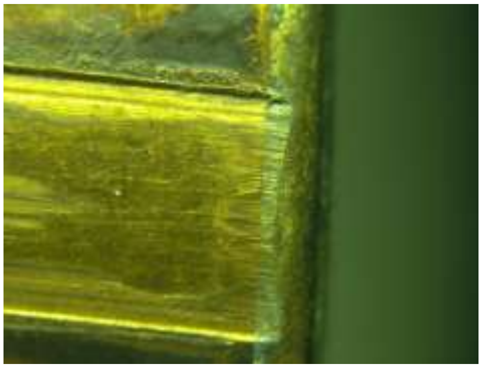
Figure 36: B1 (LEA 1) to B7 (LEA 1) 28X


Figure 37: B1 (LEA 2) to B7 (LEA 2) 28X


Figure 38: B1 (LEA 3) to B7 (LEA 3) 28X


Figure 39: B1 (LEA 4) to B7 (LEA 4) 28X


Figure 40: B1 (LEA 5) to B7 (LEA 5) 28X


Figure 41: B1 (LEA 6) to B7 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B8
Initial Findings		Examiner:	Sheila Brown
Item:	B8		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0800"/72 lines	LEA 4:	0.0816"/42 lines
LEA 2:	0.0800"/30 lines	LEA 5:	0.0845"/41 lines
LEA 3:	0.0790"/40 lines	LEA 6:	0.0810"/56 lines
LEA AVG.	0.0810"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

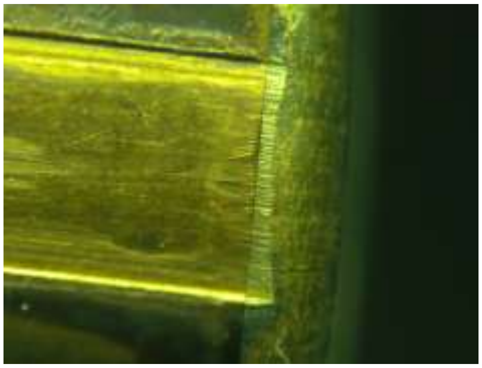
Figure 42: B1 (LEA 1) to B8 (LEA 1) 28X

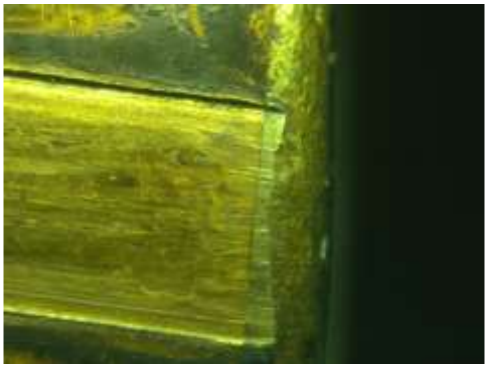
Figure 43: B1 (LEA 2) to B8 (LEA 2) 28X

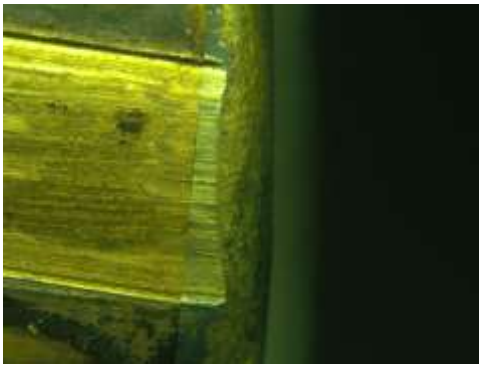
Figure 44: B1 (LEA 3) to B8 (LEA 3) 28X

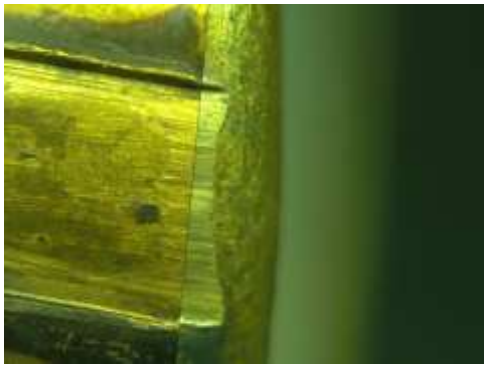
Figure 45: B1 (LEA 4) to B8 (LEA 4) 28X

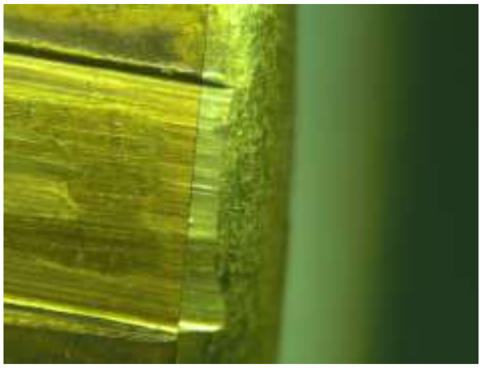
Figure 46: B1 (LEA 5) to B8 (LEA 5) 28X

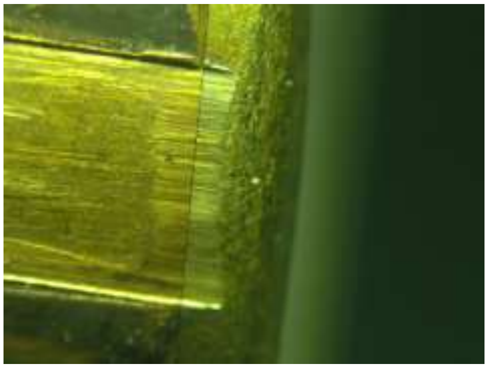
Figure 47: B1 (LEA 6) to B8 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B9
Initial Findings		Examiner:	Sheila Brown
Item:	B9		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0810"/54 lines	LEA 4:	0.0813"/52 lines
LEA 2:	0.0817"/36 lines	LEA 5:	0.0843"/49 lines
LEA 3:	0.0837"/42 lines	LEA 6:	0.0835"/48 lines
LEA AVG.	0.0826"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

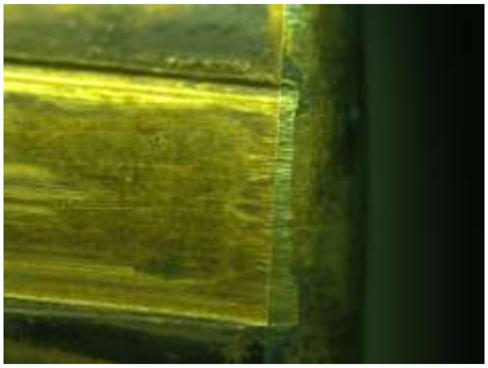

Figure 48: B1 (LEA 1) to B9 (LEA 1) 28X

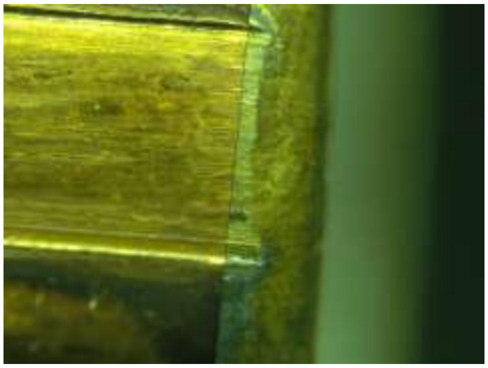

Figure 49: B1 (LEA 2) to B9 (LEA 2) 28X

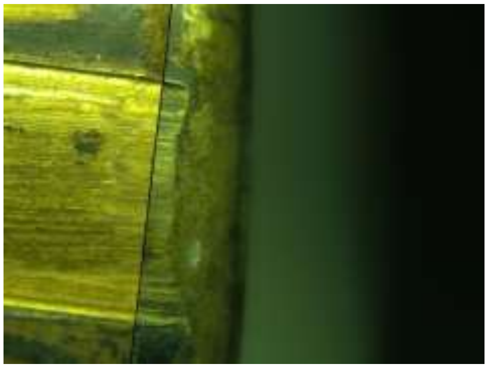

Figure 50: B1 (LEA 3) to B9 (LEA 3) 28X

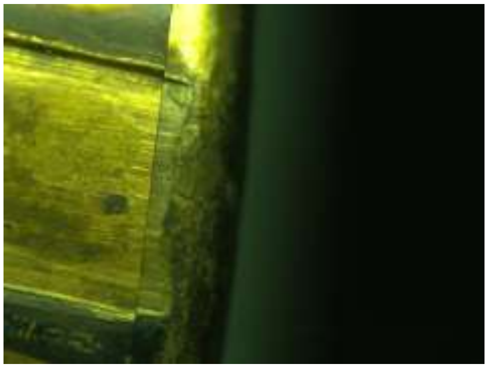

Figure 51: B1 (LEA 4) to B9 (LEA 4) 28X

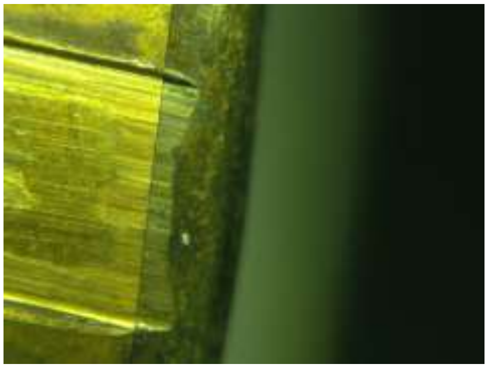

Figure 52: B1 (LEA 5) to B9 (LEA 5) 28X

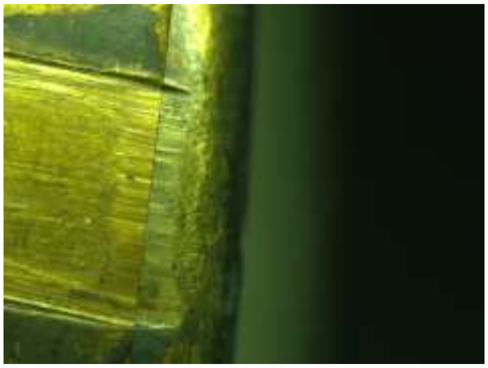

Figure 53: B1 (LEA 6) to B9 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B10
Initial Findings		Examiner:	Sheila Brown
Item:	B10		
Weight:	229.4 gr.	Diameter:	0.446"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0833"/72 lines	LEA 4:	0.0827"/38 lines
LEA 2:	0.0827"/33 lines	LEA 5:	0.0868"/38 lines
LEA 3:	0.0837"/21 lines	LEA 6:	0.0835"/50 lines
LEA AVG.	0.0838"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

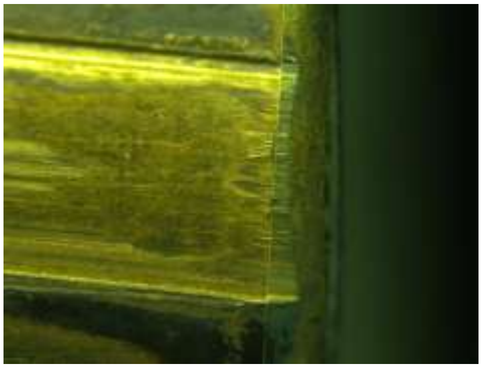
Figure 54: B1 (LEA 1) to B10 (LEA 1) 28X

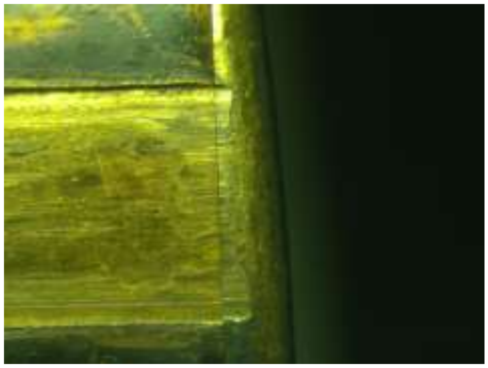
Figure 55: B1 (LEA 1) to B10 (LEA 1) 28X

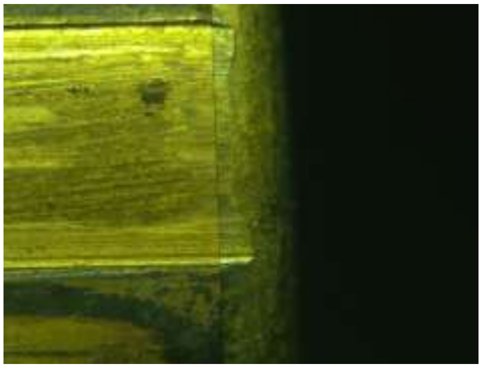
Figure 56: B1 (LEA 3) to B10 (LEA 3) 28X

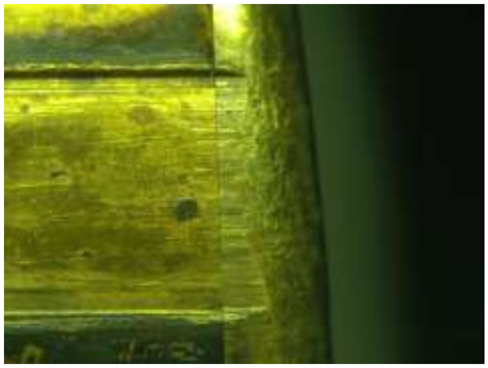
Figure 57: B1 (LEA 4) to B10 (LEA 4) 28X

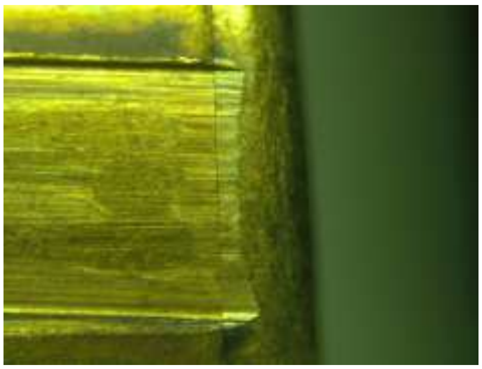
Figure 58: B1 (LEA 5) to B10 (LEA 5) 28X

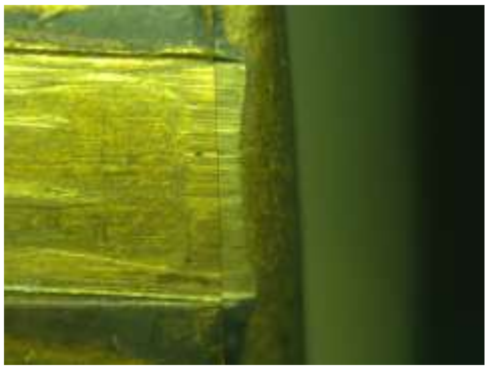
Figure 59: B1 (LEA 6) to B10 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B11
Initial Findings		Examiner:	Sheila Brown
Item:	B11		
Weight:	229.9 gr.	Diameter:	0.442"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0765"/50 lines	LEA 4:	0.0830"/36 lines
LEA 2:	0.0770"/27 lines	LEA 5:	0.0848"/43 lines
LEA 3:	0.0825"/21 lines	LEA 6:	0.0820"/40 lines
LEA AVG.	0.0810"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

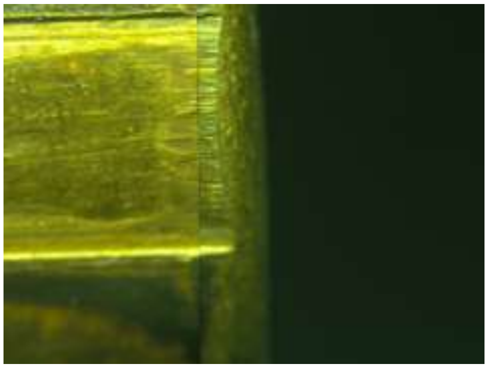

Figure 60: B1 (LEA 1) to B11 (LEA 1) 28X

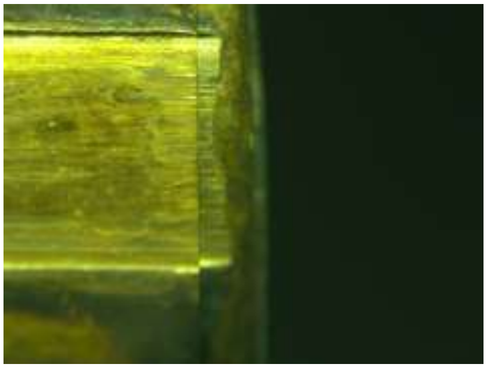

Figure 61: B1 (LEA 2) to B11 (LEA 2) 28X

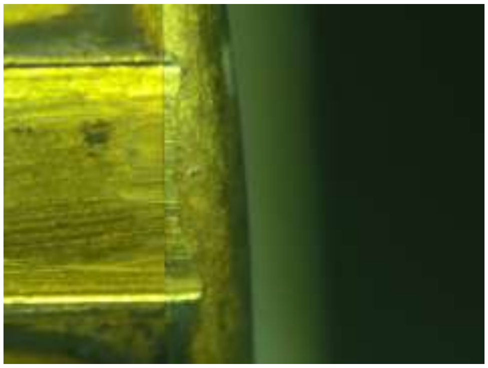

Figure 62: B1 (LEA 3) to B11 (LEA 3) 28X

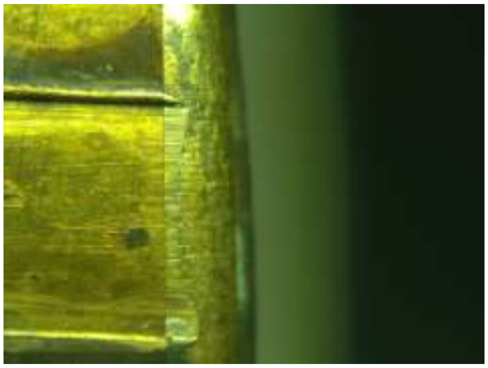

Figure 63: B1 (LEA 4) to B11 (LEA 4) 28X

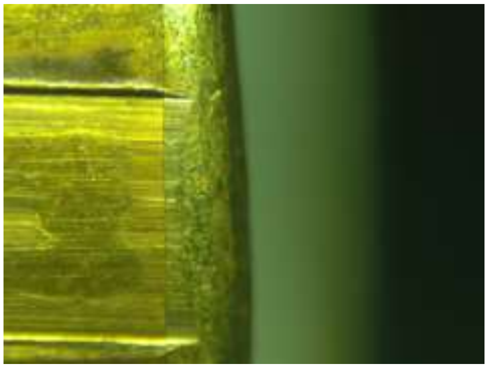

Figure 64: B1 (LEA 5) to B11 (LEA 5) 28X

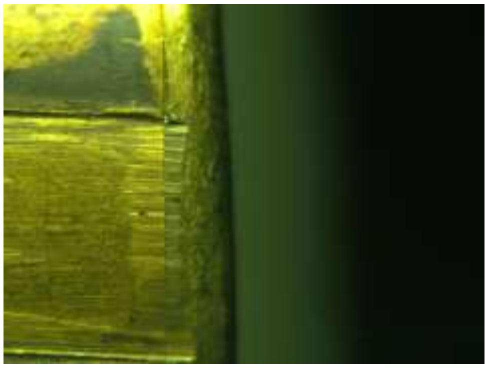

Figure 65: B1 (LEA 6) to B11 (LEA 6) 28X

Bullet Worksheet		Bullet Comparison:	B1-B12
Initial Findings		Examiner:	Sheila Brown
Item:	B12		
Weight:	229.9 gr.	Diameter:	0.443"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0780"/56 lines	LEA 4:	0.0813"/35 lines
LEA 2:	0.0788"/18 lines	LEA 5:	0.0853"/29 lines
LEA 3:	0.0802"/21 lines	LEA 6:	0.0808"/50 lines
LEA AVG.	0.0807"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

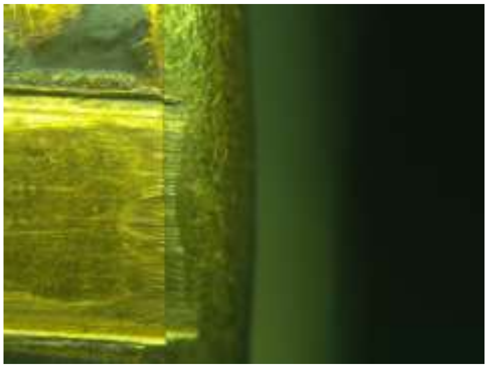
Figure 66: B1 (LEA 1) to B12 (LEA 1) 28X


Figure 67: B1 (LEA 2) to B12 (LEA 2) 28X

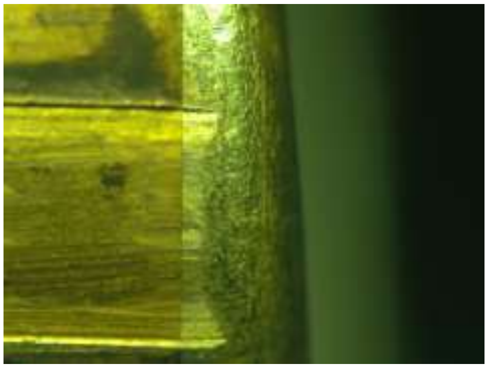
Figure 68: B1 (LEA 3) to B12 (LEA 3) 28X

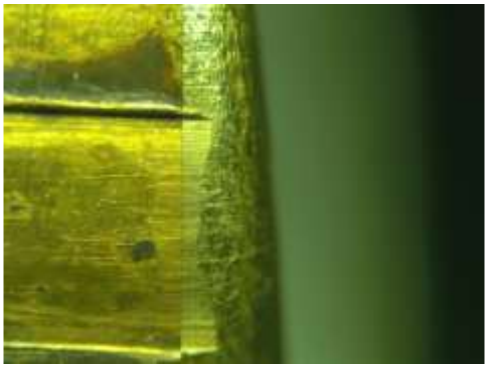
Figure 69: B1 (LEA 4) to B12 (LEA 4) 28X

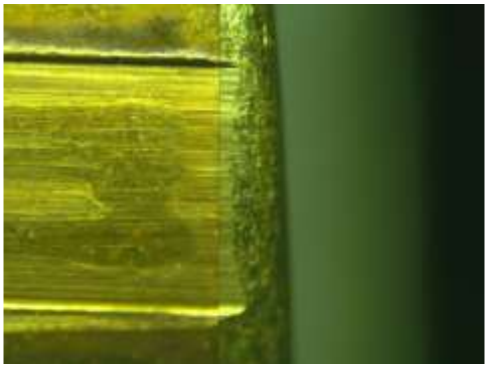
Figure 70: B1 (LEA 5) to B12 (LEA 5) 28X

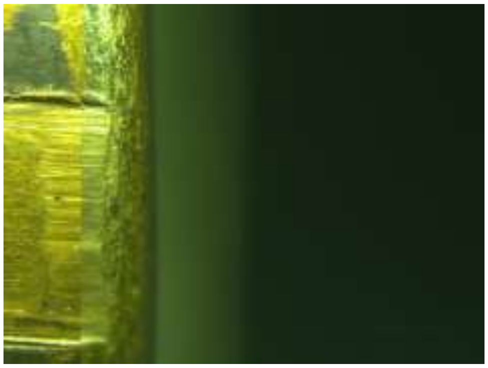
Figure 71: B1 (LEA 6) to B12 (LEA 6) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1
Initial findings		Examiner:	Sheila Brown
Item:	C1		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:			
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

Cartridge Case Work Sheet		Casing Comparison:	C1-C2
Initial findings		Examiner:	Sheila Brown
Item:	C2		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 68 lines	R of FPI: 49 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

Figure 72: C1 (L OF FPI) to C2 (L OF FPI) 28X

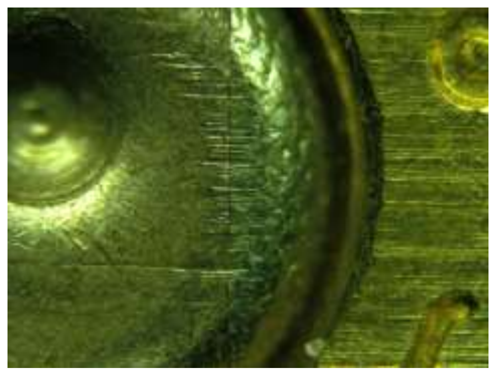

Figure 73: C1 (R OF FPI) to C2 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C3
Initial findings		Examiner:	Sheila Brown
Item:	C3		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 47 lines	R of FPI: 33 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

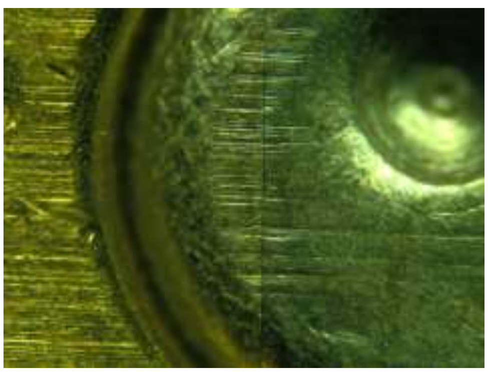

Figure 74: C1 (L OF FPI) to C3 (L OF FPI) 28X

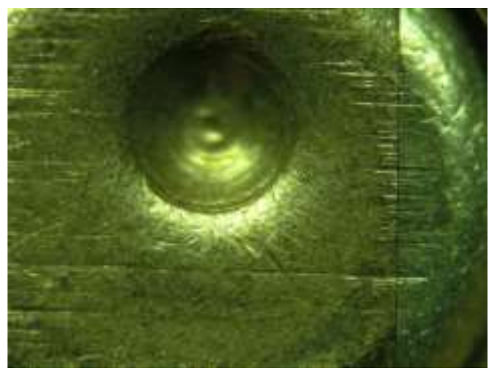

Figure 75: C1 (R OF FPI) to C3 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C4
Initial findings		Examiner:	Sheila Brown
Item:	C4		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 43 lines	R of FPI: 34 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

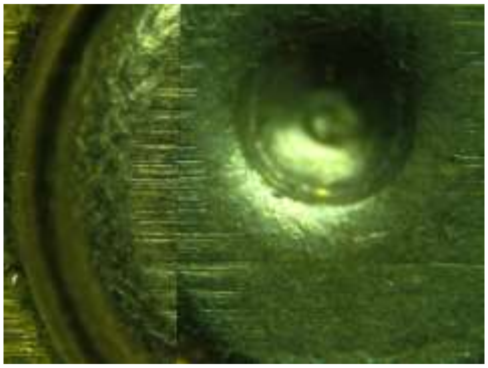
Figure 76: C1 (L OF FPI) to C4 (L OF FPI) 28X


Figure 77: C1 (R OF FPI) to C4 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C5
Initial findings		Examiner:	Sheila Brown
Item:	C5		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 45 lines	R of FPI: 35 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

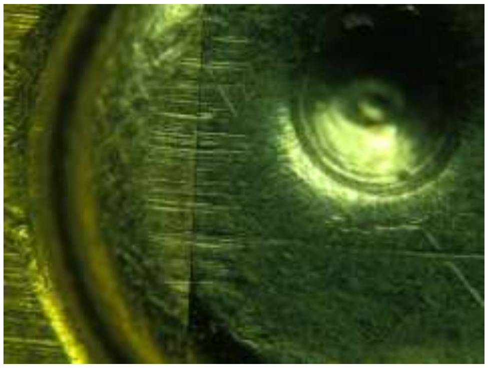
Figure 78: C1 (L OF FPI) to C5 (L OF FPI) 28X

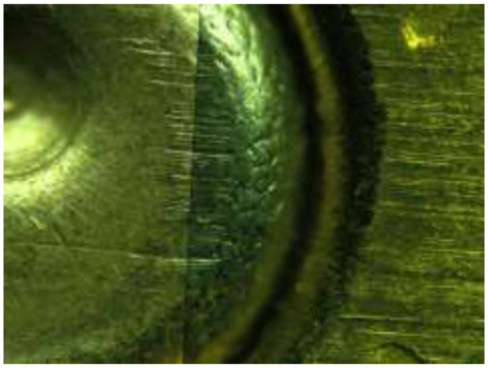
Figure 79: C1 (R OF FPI) to C5 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C6
Initial findings		Examiner:	Sheila Brown
Item:	C6		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 49 lines	R of FPI: 33 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

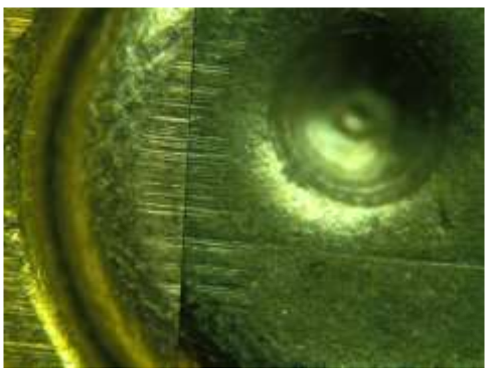

Figure 80: C1 (L OF FPI) to C6 (L OF FPI) 28X

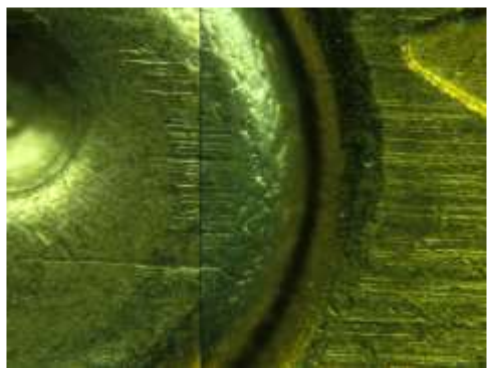

Figure 81: C1 (R OF FPI) to C6 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C7
Initial findings		Examiner:	Sheila Brown
Item:	C7		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 25 lines	R of FPI: 33 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

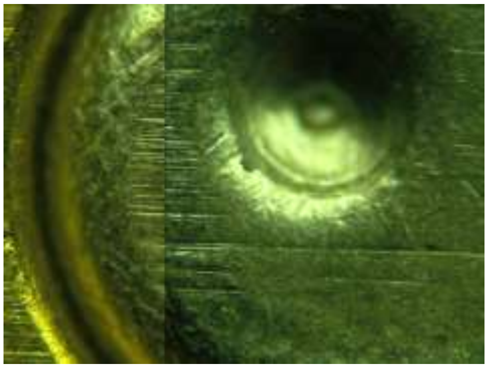

Figure 82: C1 (L OF FPI) to C7 (L OF FPI) 28X

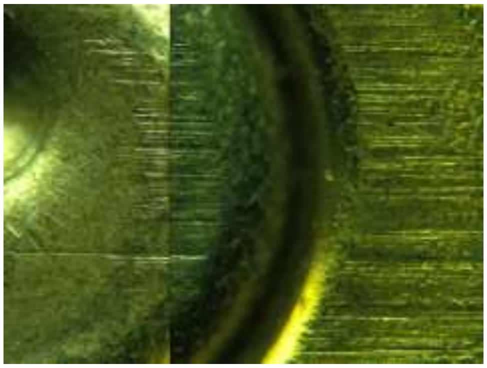

Figure 83: C1 (R OF FPI) to C7 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C8
Initial findings		Examiner:	Sheila Brown
Item:	C8		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 28 lines	R of FPI: 28 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

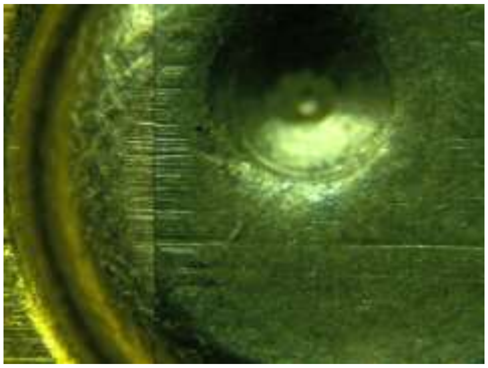

Figure 84: C1 (L OF FPI) to C8 (L OF FPI) 28X

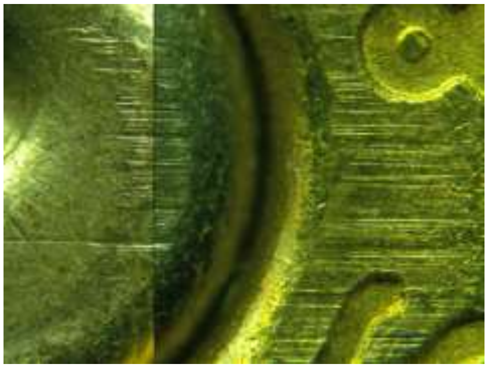

Figure 85: C1 (R OF FPI) to C8 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C9
Initial findings		Examiner:	Sheila Brown
Item:	C9		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 38 lines	R of FPI: 29 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

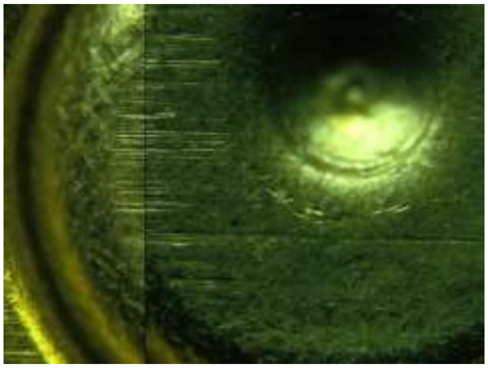

Figure 86: C1 (L OF FPI) to C9 (L OF FPI) 28X

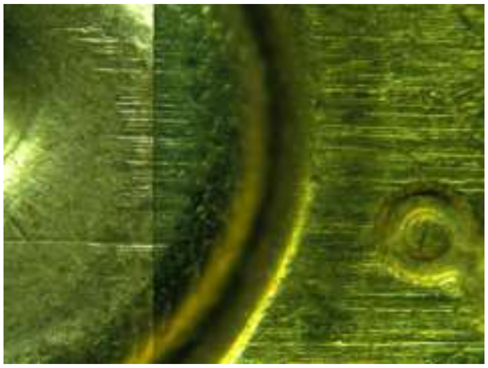

Figure 87: C1 (R OF FPI) to C9 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C10
Initial findings		Examiner:	Sheila Brown
Item:	C10		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 46 lines	R of FPI: 43 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

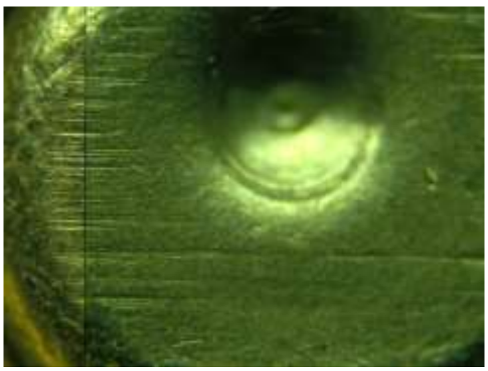

Figure 88: C1 (L OF FPI) to C10 (L OF FPI) 28X

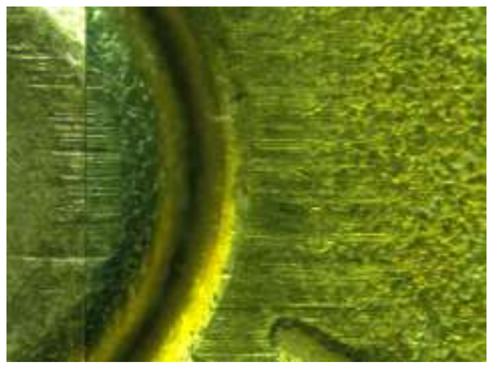

Figure 89: C1 (R OF FPI) to C10 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C11
Initial findings		Examiner:	Sheila Brown
Item:	C11		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 46 lines	R of FPI: 26 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

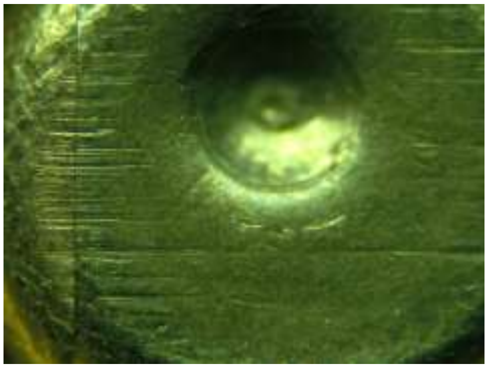

Figure 90: C1 (L OF FPI) to C11 (L OF FPI) 28X

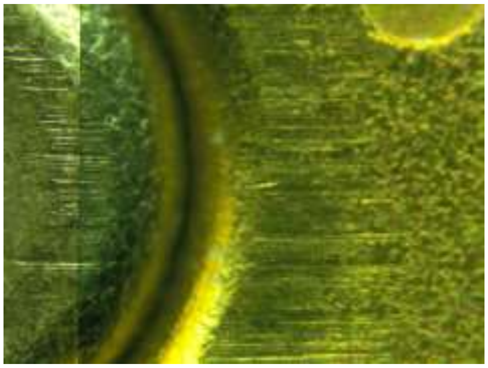

Figure 91: C1 (R OF FPI) to C11 (R OF FPI) 28X

Cartridge Case Work Sheet		Casing Comparison:	C1-C12
Initial findings		Examiner:	Sheila Brown
Item:	C12		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 42 lines	R of FPI: 36 lines	
Conclusions:			
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

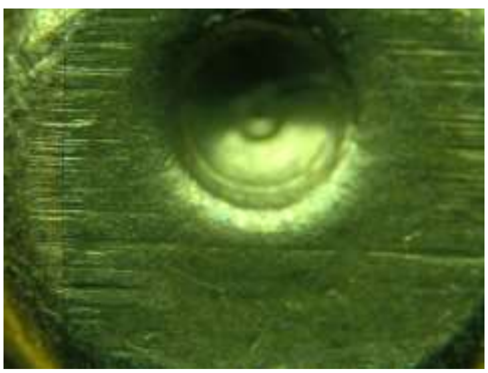
Figure 92: C1 (L OF FPI) to C12 (L OF FPI) 28X

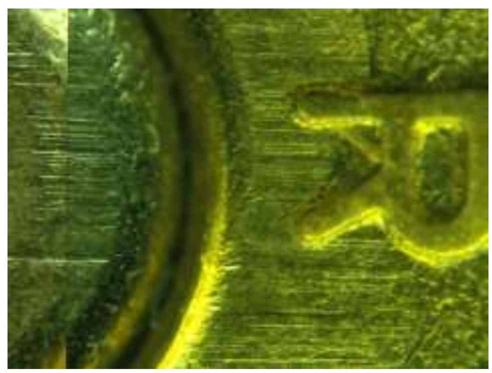

Figure 93: C1 (R OF FPI) to C12 (R OF FPI) 28X

Charts and pictures after placement of bullets and cartridge cases at Lake Arcadia.

Bullet Worksheet		Bullet Comparison:	B1-B2
Final Findings		Examiner:	Sheila Brown
Item:	B2		
Weight:	229.4 gr.	Diameter:	0.451"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0825"/ 18 lines	LEA 4:	0.0745"/ 13 lines
LEA 2:	0.0760"/ 12 lines	LEA 5:	0.0852"/15 lines
LEA 3:	0.0828"/ 9 lines	LEA 6:	0.0840"/13 lines
LEA AVG.	0.0808"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

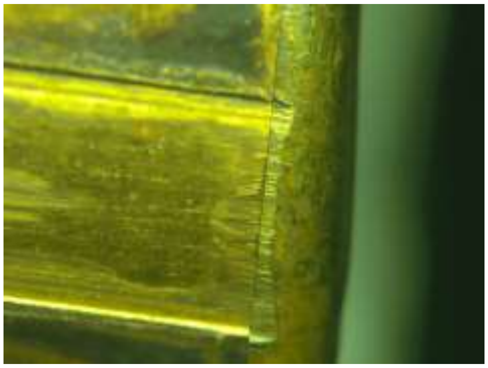

Figure 94: B1 (LEA 1) to B2 (LEA 1) 28X FINAL

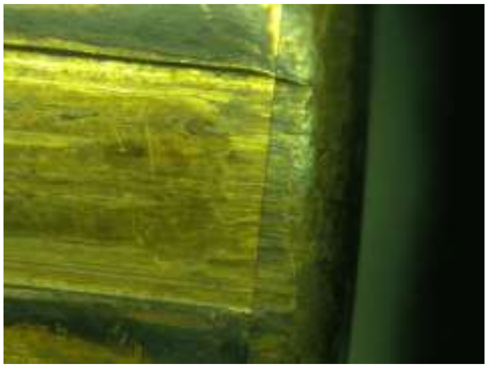

Figure 95: B1 (LEA 2) to B2 (LEA 2) 28X FINAL

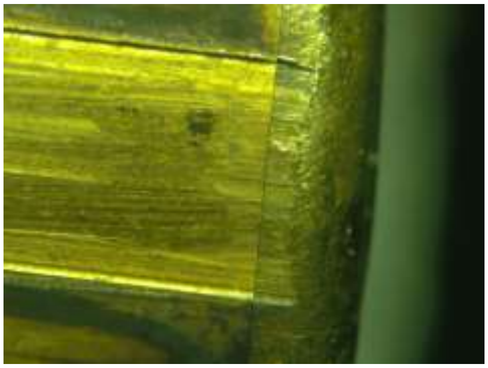

Figure 96: B1 (LEA 3) to B2 (LEA 3) 28X FINAL

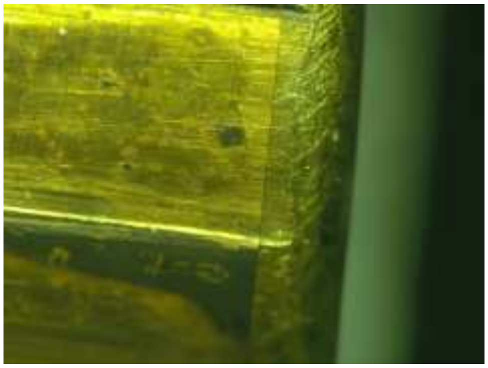

Figure 97: B1 (LEA 4) to B2 (LEA 4) 28X FINAL

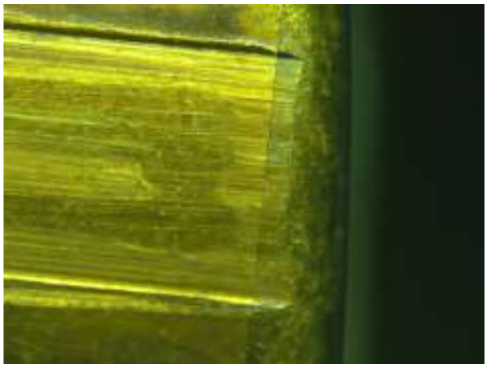

Figure 98: B1 (LEA 5) to B2 (LEA 5) 28X FINAL

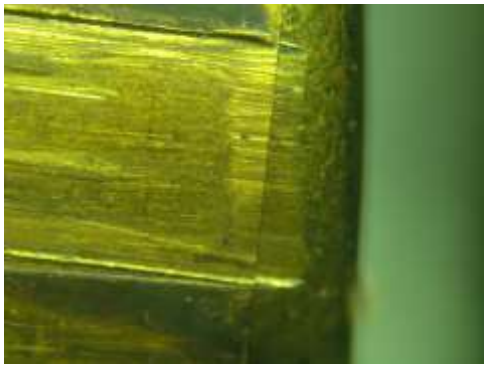

Figure 99: B1 (LEA 6) to B2 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C2
Final findings		Examiner:	Sheila Brown
Item:	C2		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 50 lines	R of FPI: 46 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

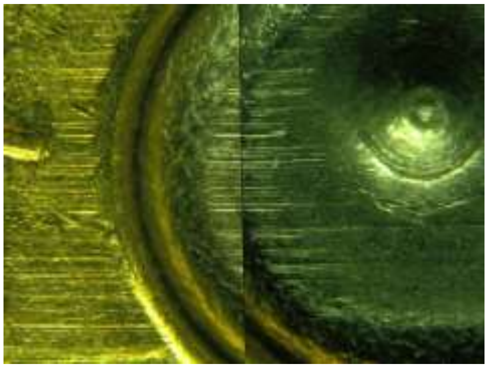

Figure 100: C1 (L OF FPI) to C2 (L OF FPI) 28X FINAL

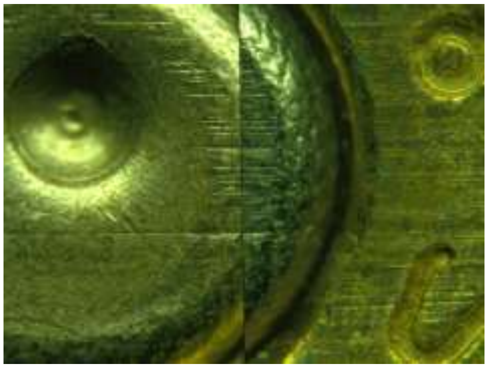

Figure 101: C1 (R OF FPI) to C2 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B3
Final Findings		Examiner:	Sheila Brown
Item:	B3		
Weight:	229.6 gr.	Diameter:	0.453"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0830"/ 33 lines	LEA 4:	0.0827"/19 lines
LEA 2:	0.0837"/16 lines	LEA 5:	0.0860"/14 lines
LEA 3:	0.0842"/19 lines	LEA 6:	0.0838"/21 lines
LEA AVG.	0.0836"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

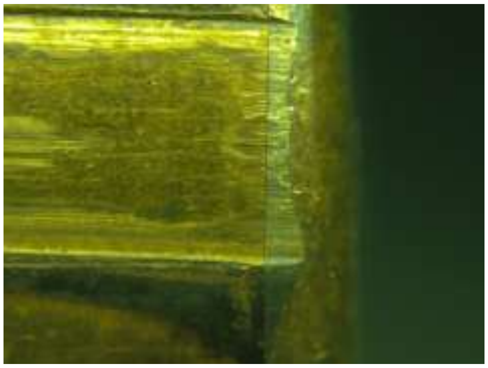
Figure 102: B1 (LEA 1) to B3 (LEA 1) 28X FINAL

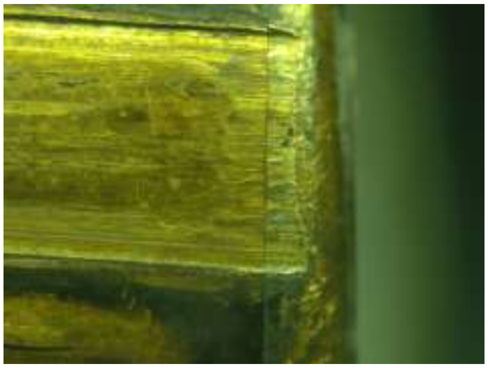
Figure 103: B1 (LEA 2) to B3 (LEA 2) 28X FINAL

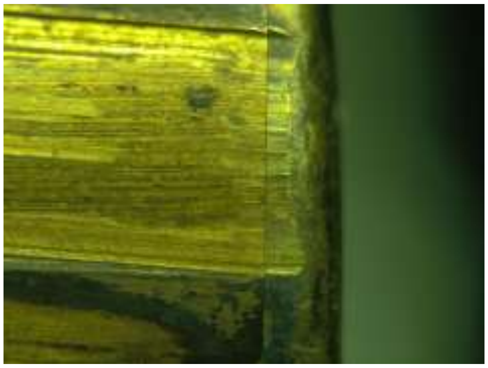
Figure 104: B1 (LEA 3) to B3 (LEA 3) 28X FINAL


Figure 105: B1 (LEA 4) to B3 (LEA 4) 28X FINAL

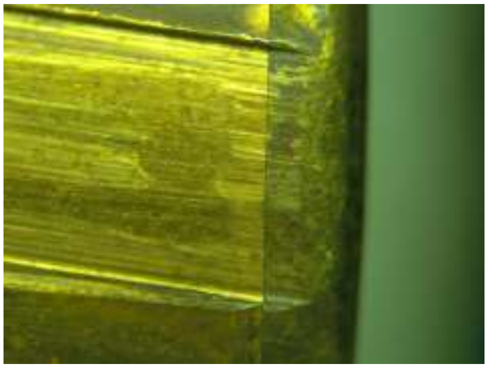
Figure 106: B1 (LEA 5) to B3 (LEA 5) 28X FINAL

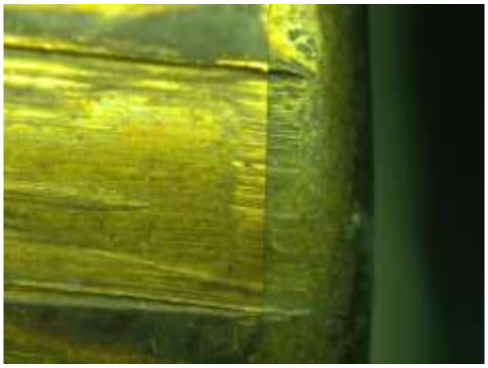
Figure 107: B1 (LEA 6) to B3 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C3
Final findings		Examiner:	Sheila Brown
Item:	C3		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 41 lines	R of FPI: 27 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

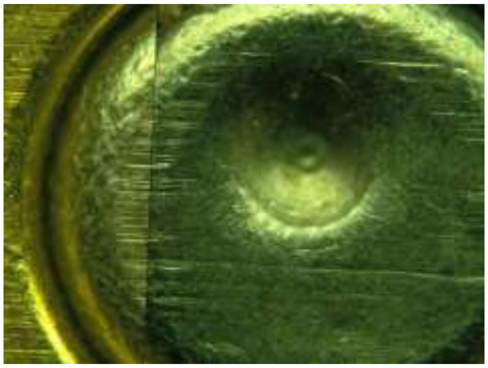

Figure 108: C1 (L OF FPI) to C3 (L OF FPI) 28X FINAL

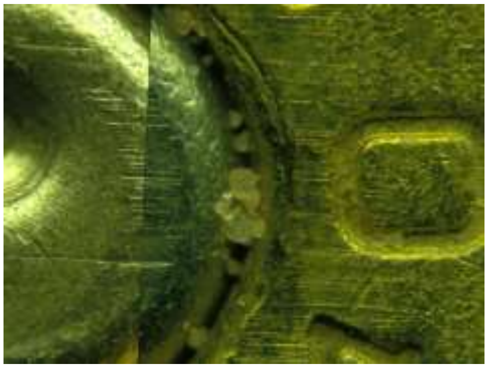

Figure 109: C1 (R OF FPI) to C3 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B4
Final Findings		Examiner:	Sheila Brown
Item:	B4		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0842"/ 50 lines	LEA 4:	0.0862"/ 17 lines
LEA 2:	0.0828"/ 13 lines	LEA 5:	0.0855"/ 20 lines
LEA 3:	0.0843"/ 16 lines	LEA 6:	0.0868"/ 20 lines
LEA AVG.	0.0850"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

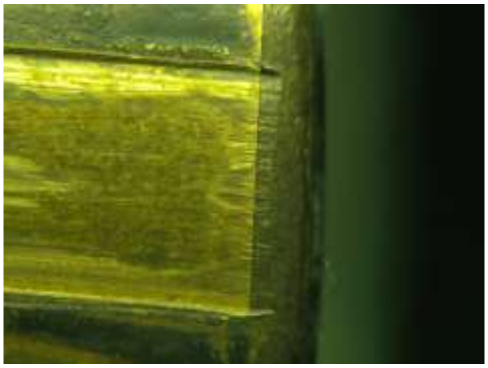
Figure 110: B1 (LEA 1) to B4 (LEA 1) 28X FINAL

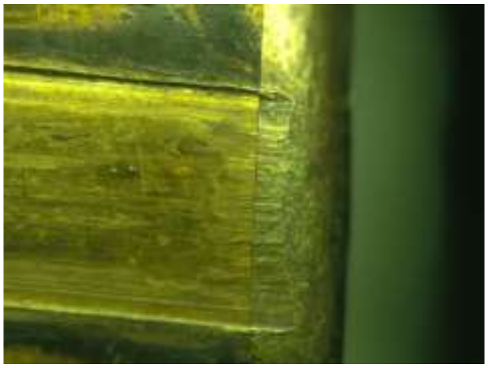
Figure 111: B1 (LEA 2) to B4 (LEA 2) 28X FINAL

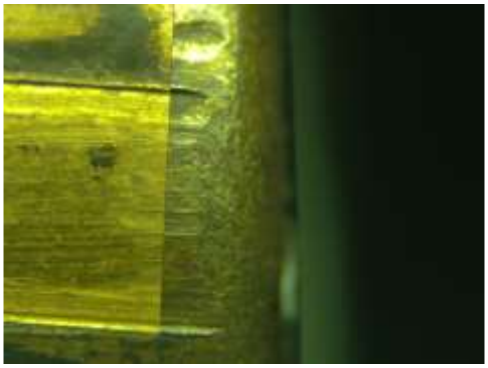
Figure 112: B1 (LEA 3) to B4 (LEA 3) 28X FINAL

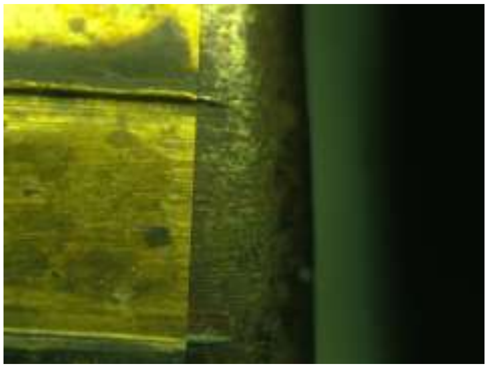
Figure 113: B1 (LEA 4) to B4 (LEA 4) 28X FINAL

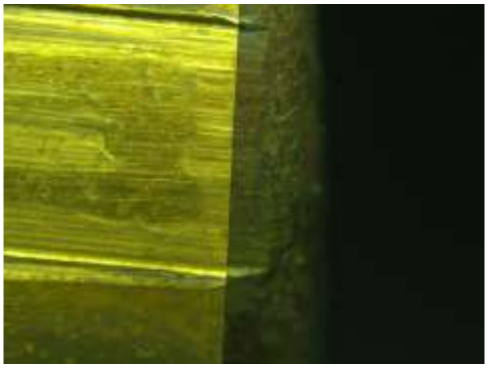
Figure 114: B1 (LEA 5) to B4 (LEA 5) 28X FINAL

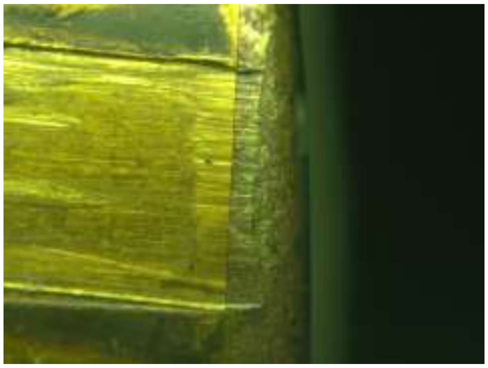
Figure 115: B1 (LEA 6) to B4 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C4
Final findings		Examiner:	Sheila Brown
Item:	C4		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 40 lines	R of FPI: 26 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

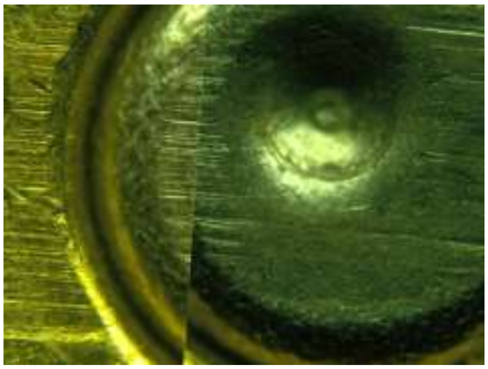
Figure 116: C1 (L OF FPI) to C4 (L OF FPI) 28X FINAL


Figure 117: C1 (R OF FPI) to C4 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B5
Final Findings		Examiner:	Sheila Brown
Item:	B5		
Weight:	229.6 gr.	Diameter:	0.439"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0875"/ 20 lines	LEA 4:	0.0820"/ 7 lines
LEA 2:	0.0875"/ 15 lines	LEA 5:	0.0925"/ 21 lines
LEA 3:	0.0885"/ 13 lines	LEA 6:	0.0877"/ 28 lines
LEA AVG.	0.0876"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

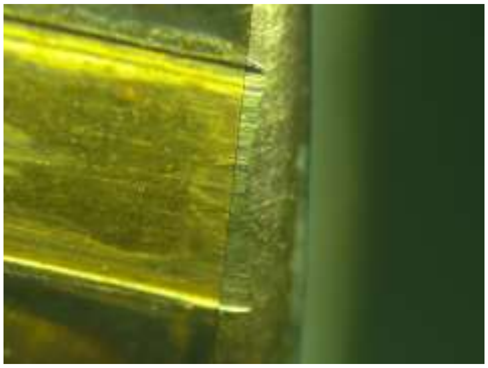
Figure 118: B1 (LEA 1) to B5 (LEA 1) 28X FINAL

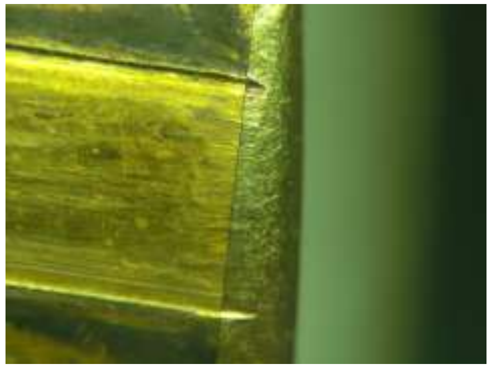
Figure 119: B1 (LEA 2) to B5 (LEA 2) 28X FINAL

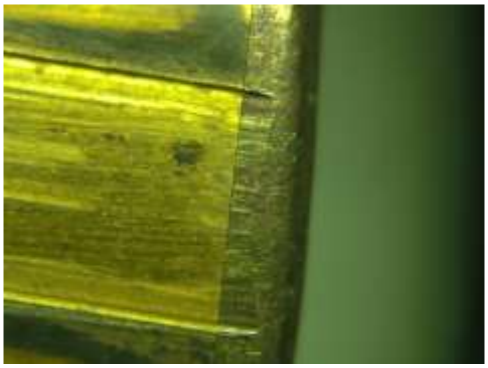
Figure 120: B1 (LEA 3) to B5 (LEA 3) 28X FINAL

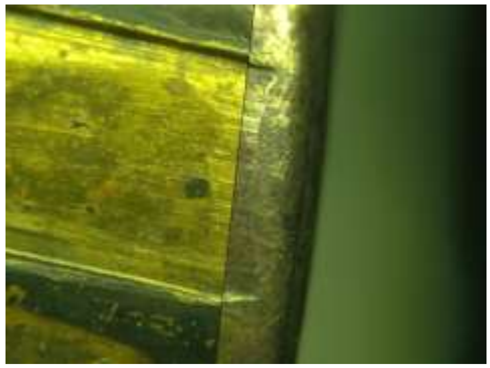
Figure 121: B1 (LEA 4) to B5 (LEA 4) 28X FINAL

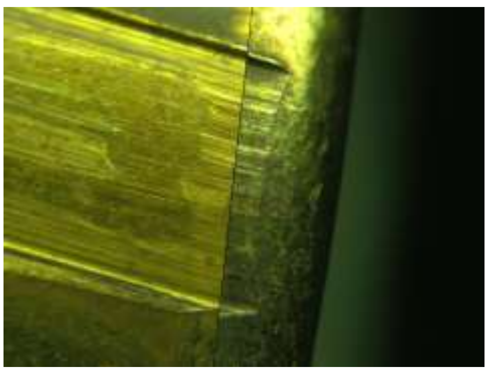
Figure 122: B1 (LEA 5) to B5 (LEA 5) 28X FINAL


Figure 123: B1 (LEA 6) to B5 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C5
Final findings		Examiner:	Sheila Brown
Item:	C5		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 46 lines	R of FPI: 34 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

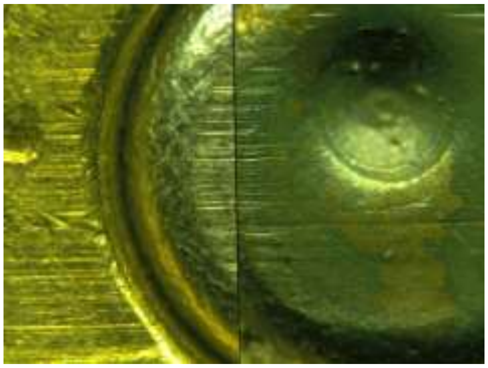

Figure 124: C1 (L OF FPI) to C5 (L OF FPI) 28X FINAL

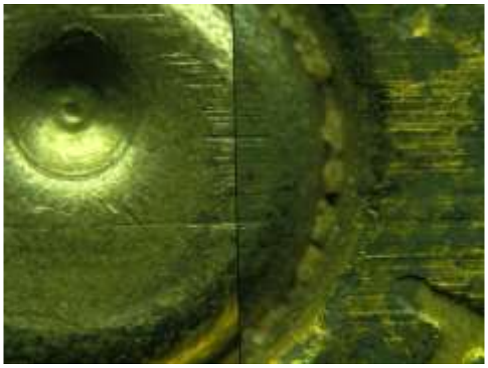

Figure 125: C1 (R OF FPI) to C5 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B6
Final Findings		Examiner:	Sheila Brown
Item:	B6		
Weight:	229.6 gr.	Diameter:	0.449"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0847"/ 53 lines	LEA 4:	0.0818"/ 14 lines
LEA 2:	0.0828"/ 25 lines	LEA 5:	0.0865"/ 4 lines
LEA 3:	0.0793"/ 17 lines	LEA 6:	0.0835"/ 43 lines
LEA AVG.	0.0831"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

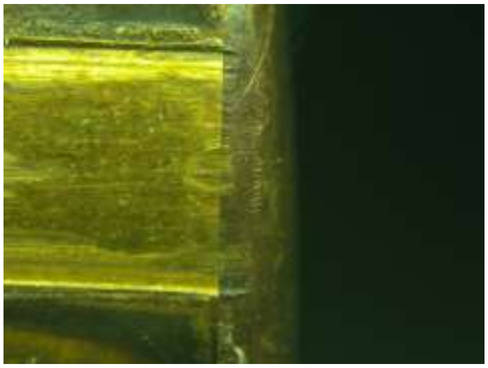

Figure 126: B1 (LEA 1) to B6 (LEA 1) 28X FINAL

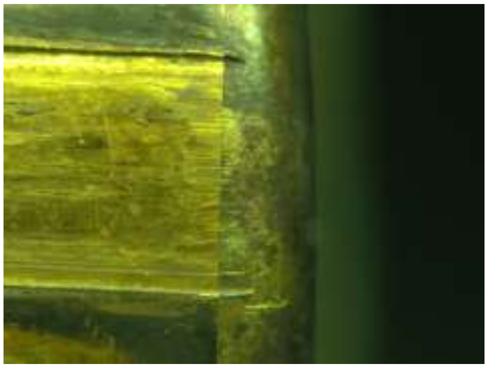

Figure 127: B1 (LEA 2) to B6 (LEA 2) 28X FINAL

Figure 128: B1 (LEA 3) to B6 (LEA 3) 28X FINAL

Figure 129: B1 (LEA 4) to B6 (LEA 4) 28X FINAL

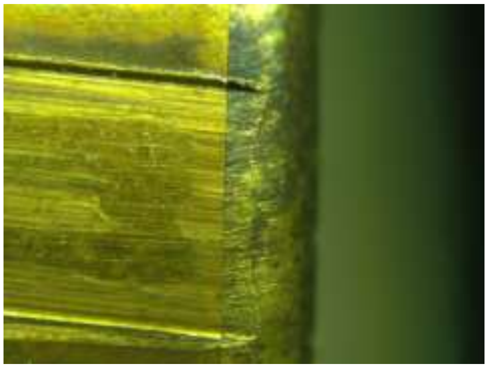

Figure 130: B1 (LEA 5) to B6 (LEA 5) 28X FINAL

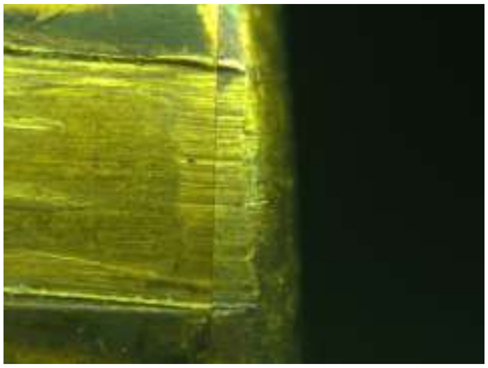

Figure 131: B1 (LEA 6) to B6 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C6
Final findings		Examiner:	Sheila Brown
Item:	C6		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 41 lines	R of FPI: 23 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

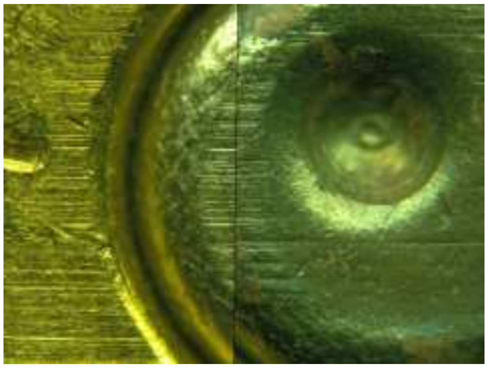
Figure 132: C1 (L OF FPI) to C6 (L OF FPI) 28X FINAL

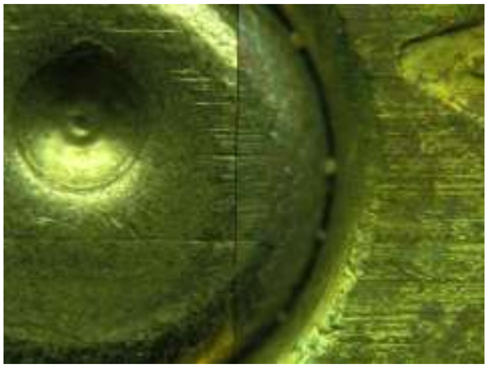
Figure 133: C1 (R OF FPI) to C6 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B7
Final Findings		Examiner:	Sheila Brown
Item:	B7		
Weight:	229.6 gr.	Diameter:	0.450"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0847"/23 lines	LEA 4:	0.0758"/ 33 lines
LEA 2:	0.0833"/ 16 lines	LEA 5:	0.0870"/ 34 lines
LEA 3:	0.0822"/ 15 lines	LEA 6:	0.0832"/ 17 lines
LEA AVG.	0.0827"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

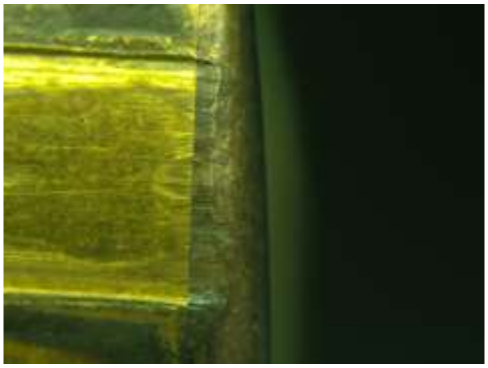
Figure 134: B1 (LEA 1) to B7 (LEA 1) 28X FINAL

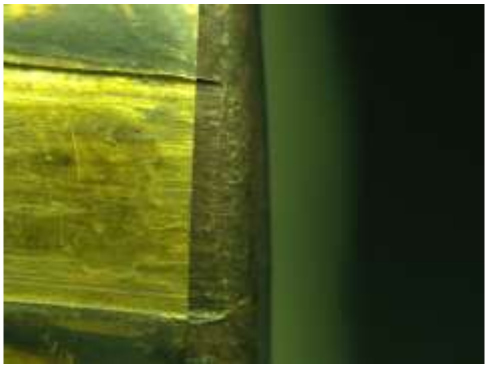
Figure 135: B1 (LEA 2) to B7 (LEA 2) 28X FINAL

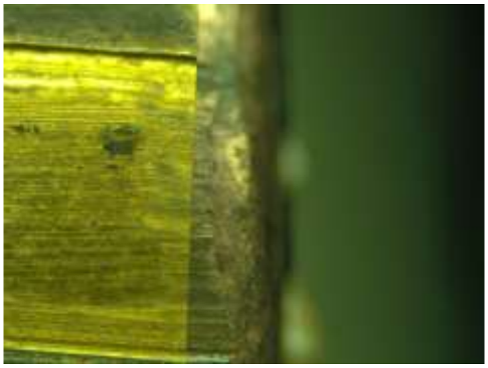
Figure 136: B1 (LEA 3) to B7 (LEA 3) 28X FINAL

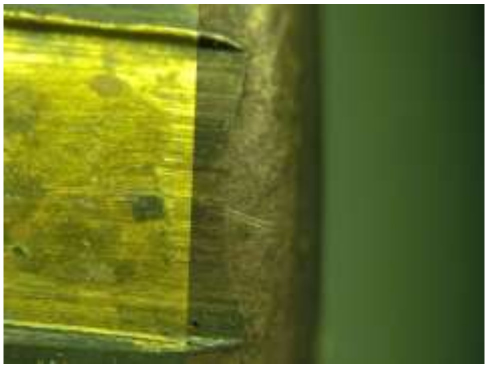
Figure 137: B1 (LEA 4) to B7 (LEA 4) 28X FINAL

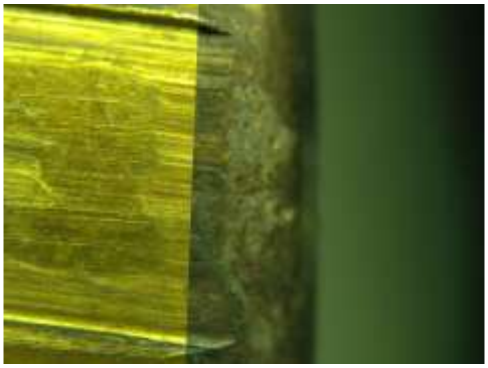
Figure 138: B1 (LEA 5) to B7 (LEA 5) 28X FINAL

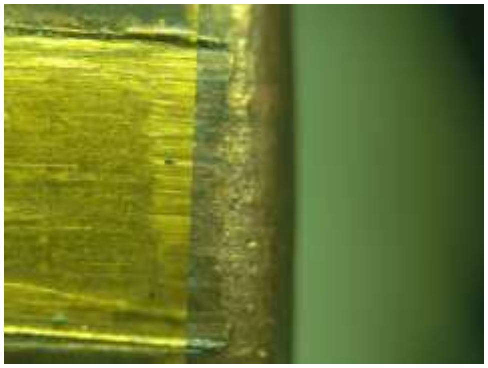
Figure 139: B1 (LEA 6) to B7 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C7
Final findings		Examiner:	Sheila Brown
Item:	C7		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 35 lines	R of FPI: 26 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

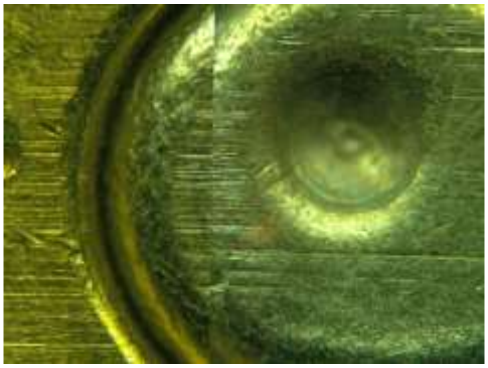

Figure 140: C1 (L OF FPI) to C7 (L OF FPI) 28X FINAL

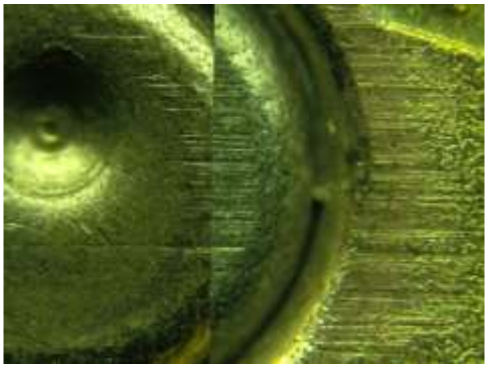

Figure 141: C1 (R OF FPI) to C7 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B8
Final Findings		Examiner:	Sheila Brown
Item:	B8		
Weight:	229.6 gr.	Diameter:	0.449"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0852"/ 48 lines	LEA 4:	0.0843"/ 16 lines
LEA 2:	0.0840"/ 12 lines	LEA 5:	0.0870"/ 18 lines
LEA 3:	0.0847"/ 13 lines	LEA 6:	0.0817"/ 23 lines
LEA AVG.	0.0845"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

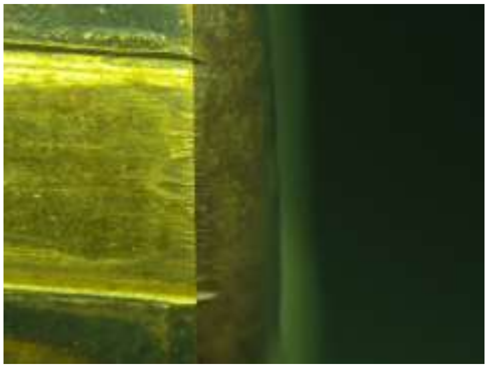
Figure 142: B1 (LEA 1) to B8 (LEA 1) 28X FINAL

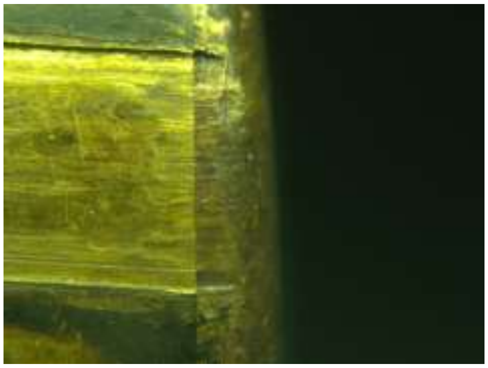
Figure 143: B1 (LEA 2) to B8 (LEA 2) 28X FINAL

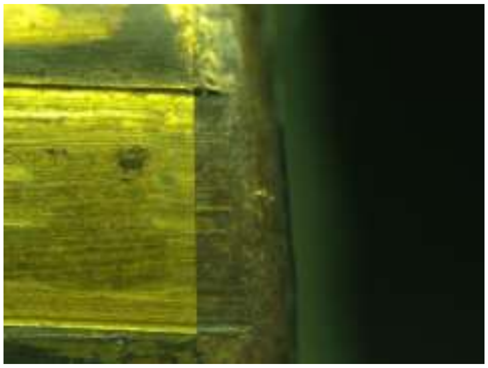
Figure 144: B1 (LEA 3) to B8 (LEA 3) 28X FINAL

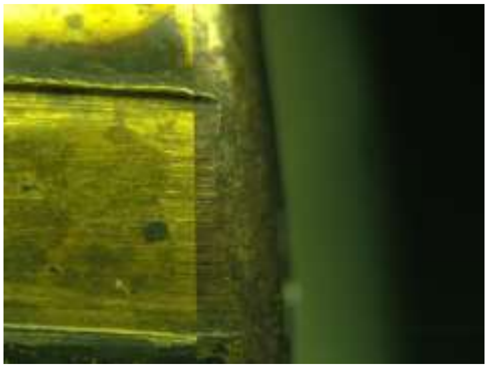
Figure 145: B1 (LEA 4) to B8 (LEA 4) 28X FINAL

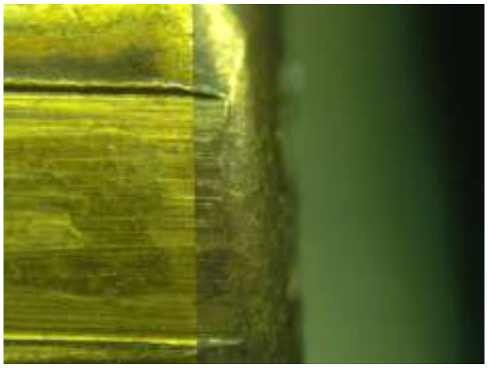
Figure 146: B1 (LEA 5) to B8 (LEA 5) 28X FINAL

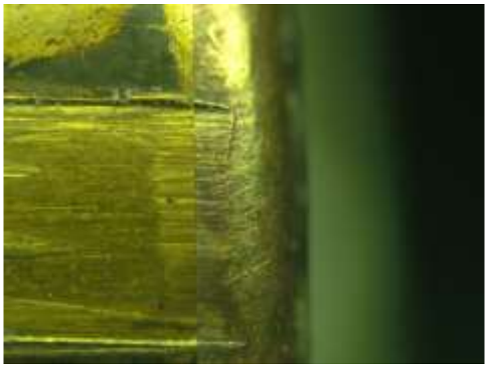
Figure 147: B1 (LEA 6) to B8 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C8
Final findings		Examiner:	Sheila Brown
Item:	C8		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 21 lines	R of FPI: 25 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

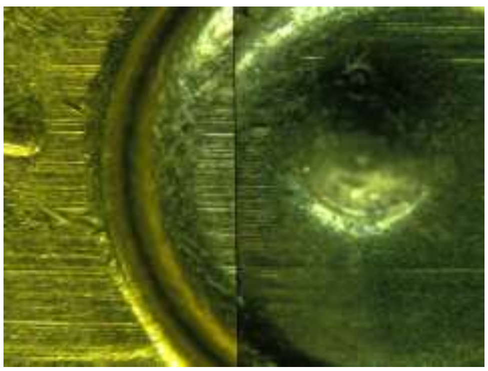

Figure 148: C1 (L OF FPI) to C8 (L OF FPI) 28X FINAL

Figure 149: C1 (R OF FPI) to C8 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B9
Final Findings		Examiner:	Sheila Brown
Item:	B9		
Weight:	229.6 gr.	Diameter:	0.449"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0737"/ 13 lines	LEA 4:	0.0805"/6 lines
LEA 2:	0.0805"/ 7 lines	LEA 5:	0.0862"/ 12 lines
LEA 3:	0.0818"/ 6 lines	LEA 6:	0.0823"/ 4 lines
LEA AVG.	0.0808"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

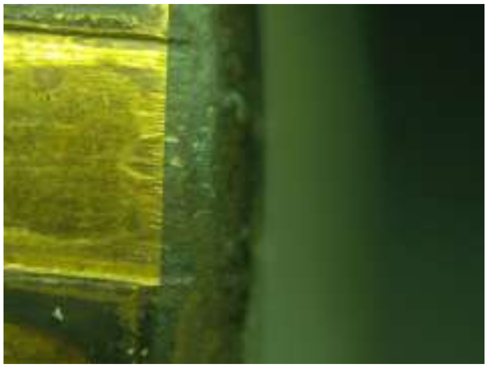
Figure 150: B1 (LEA 1) to B9 (LEA 1) 28X FINAL


Figure 151: B1 (LEA 2) to B9 (LEA 2) 28X FINAL

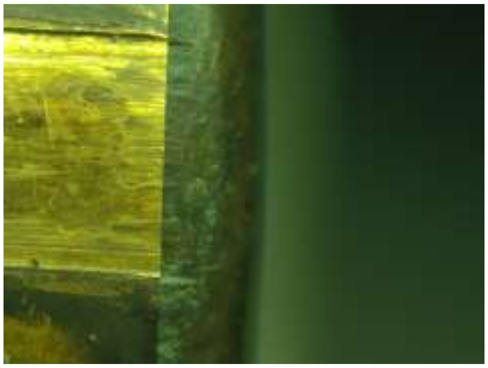
Figure 152: B1 (LEA 3) to B9 (LEA 3) 28X FINAL

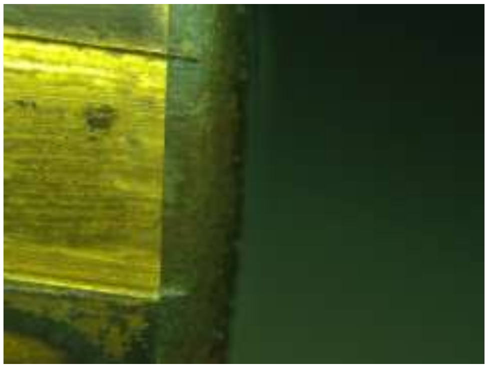
Figure 153: B1 (LEA 4) to B9 (LEA 4) 28X FINAL

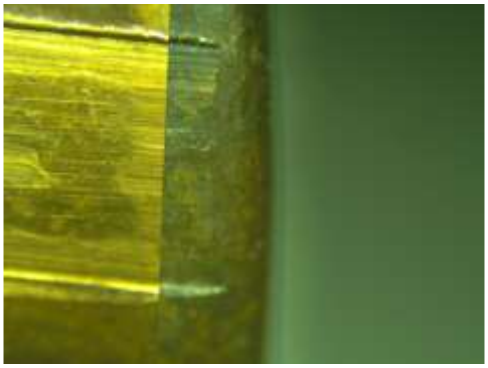
Figure 154: B1 (LEA 5) to B9 (LEA 5) 28X FINAL

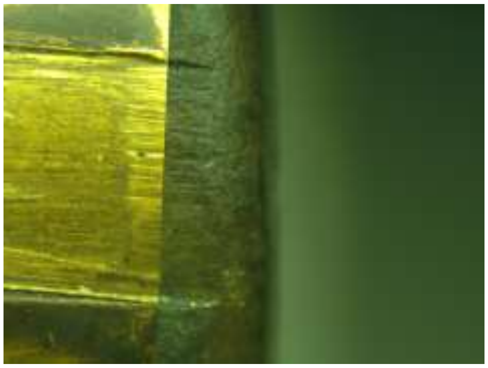
Figure 155: B1 (LEA 6) to B9 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C9
Final findings		Examiner:	Sheila Brown
Item:	C9		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 42 lines	R of FPI: 20 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

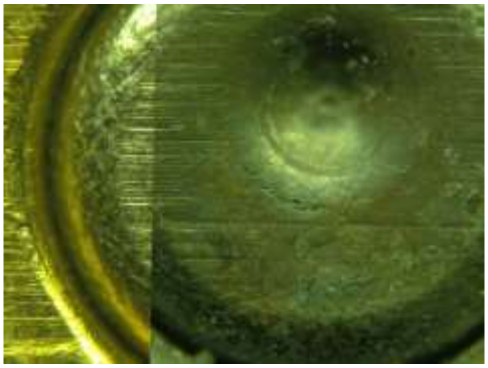
Figure 156: C1 (L OF FPI) to C9 (L OF FPI) 28X FINAL


Figure 157: C1 (R OF FPI) to C9 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B10
Final Findings		Examiner:	Sheila Brown
Item:	B10		
Weight:	229.6 gr.	Diameter:	0.456"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0850"/ 8 lines	LEA 4:	0.0845"/ 18 lines
LEA 2:	0.0835"/ 2 lines	LEA 5:	0.0835"/ 22 lines
LEA 3:	0.0850"/ 9 lines	LEA 6:	0.0833"/ 18 ines
LEA AVG.	0.0841"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

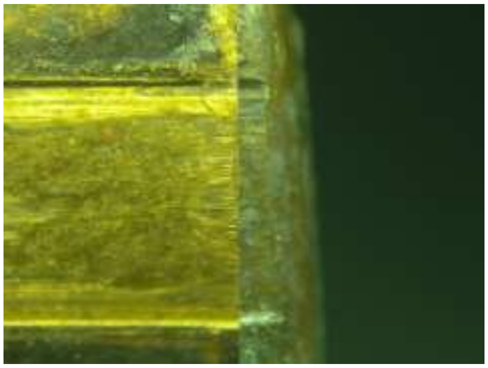
Figure 158: B1 (LEA 1) to B10 (LEA 1) 28X FINAL


Figure 159: B1 (LEA 2) to B10 (LEA 2) 28X FINAL

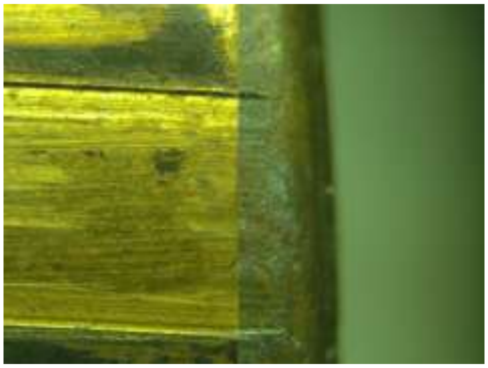
Figure 160: B1 (LEA 3) to B10 (LEA 3) 28X FINAL

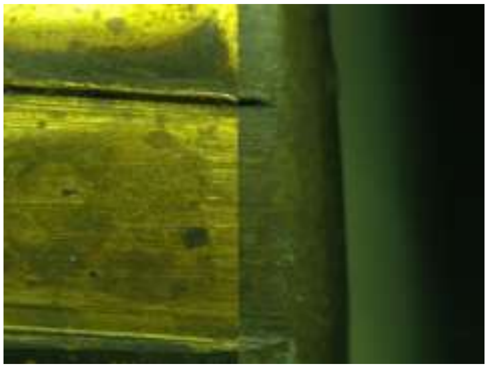
Figure 161: B1 (LEA 4) to B10 (LEA 4) 28X FINAL

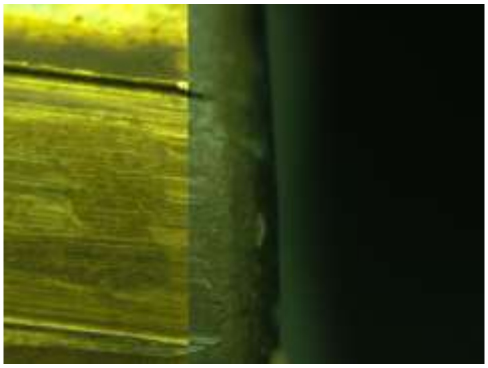
Figure 162: B1 (LEA 5) to B10 (LEA 5) 28X FINAL

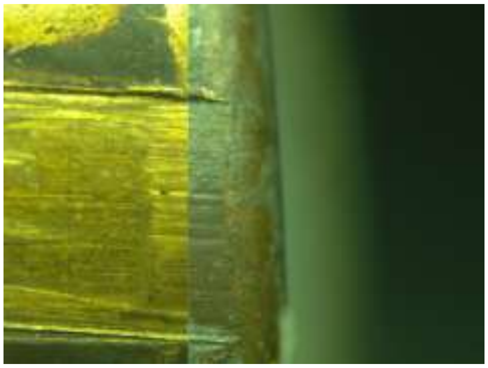
Figure 163: B1 (LEA 6) to B10 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C10
Final findings		Examiner:	Sheila Brown
Item:	C10		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 42 lines	R of FPI: 42 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

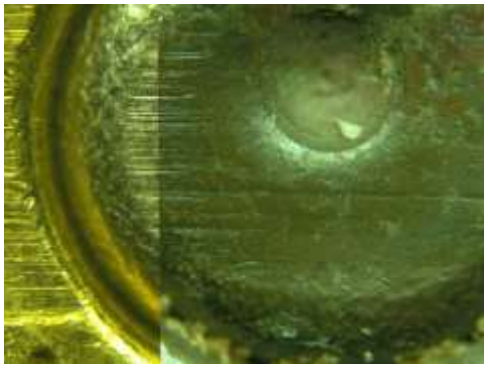

Figure 164: C1 (L OF FPI) to C10 (L OF FPI) 28X FINAL

Figure 165: C1 (R OF FPI) to C10 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B11
Final Findings		Examiner:	Sheila Brown
Item:	B11		
Weight:	229.6 gr.	Diameter:	0.447"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0848"/ 27 lines	LEA 4:	0.0842"/ 1 lines
LEA 2:	0.0845"/ 13 lines	LEA 5:	0.0860"/ 7 lines
LEA 3:	0.0853"/ 6 lines	LEA 6:	0.0835"/ 21 lines
LEA AVG.	0.0847"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

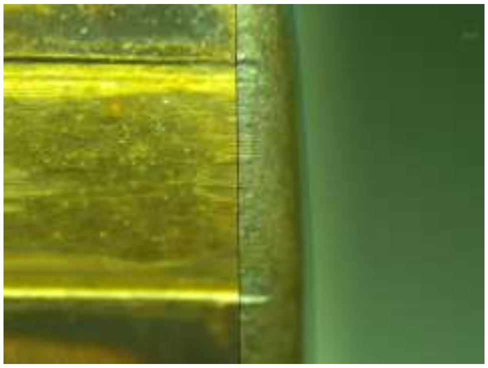
Figure 166 B1 (LEA 1) to B11 (LEA 1) 28X FINAL

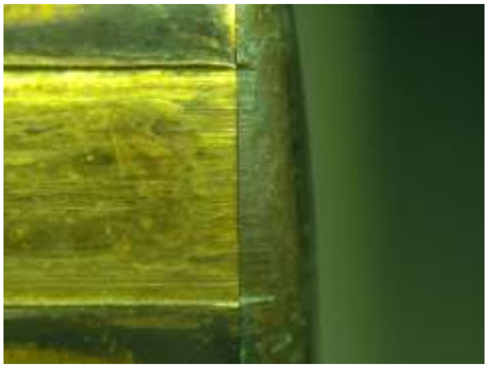
Figure 167: B1 (LEA 2) to B11 (LEA 2) 28X FINAL

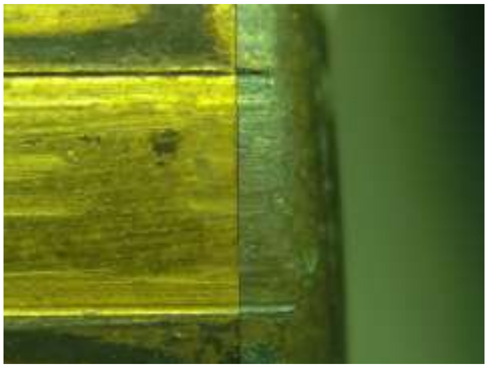
Figure 168: B1 (LEA 3) to B11 (LEA 3) 28X FINAL

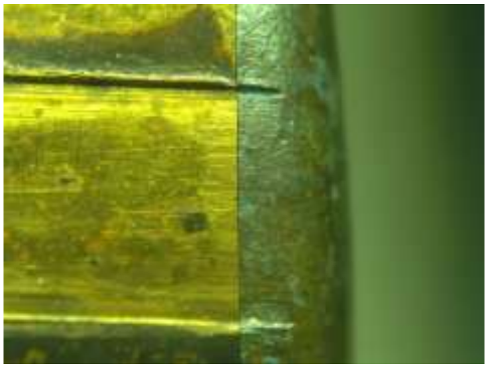
Figure 169: B1 (LEA 4) to B11 (LEA 4) 28X FINAL

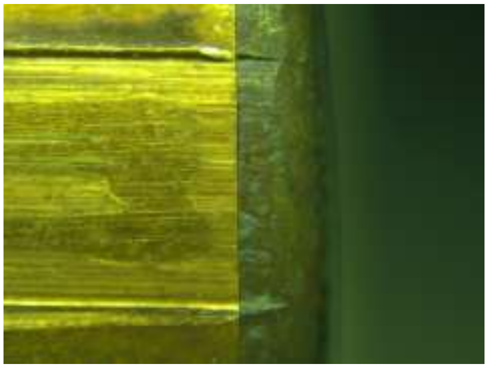
Figure 170: B1 (LEA 5) to B11 (LEA 5) 28X FINAL

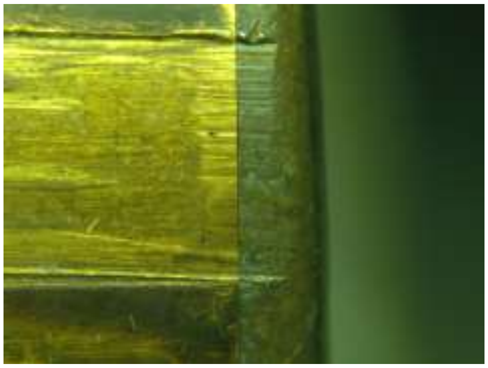
Figure 171: B1 (LEA 6) to B11 (LEA 6) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C11
Final findings		Examiner:	Sheila Brown
Item:	C11		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 36 lines	R of FPI: 23 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

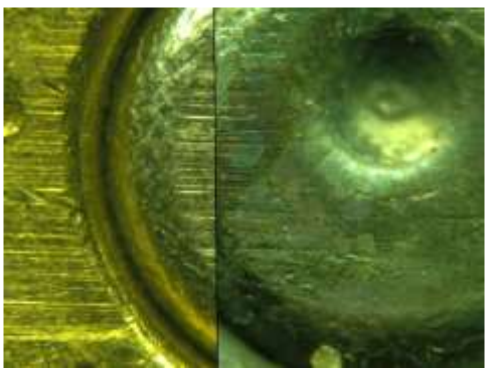

Figure 172: C1 (L OF FPI) to C11 (L OF FPI) 28X FINAL

Figure 173: C1 (R OF FPI) to C11 (R OF FPI) 28X FINAL

Bullet Worksheet		Bullet Comparison:	B1-B12
Final Findings		Examiner:	Sheila Brown
Item:	B12		
Weight:	229.6 gr.	Diameter:	0.449"
# of lands/grooves:	6	Direction of Twist:	Right
Land Engraved Measurements (Inches) & Lines			
LEA 1:	0.0835"/ 23 lines	LEA 4:	0.0837"/ 12 lines
LEA 2:	0.0833"/ 0 lines	LEA 5:	0.0882"/ 4 lines
LEA 3:	0.0842"/ 2 lines	LEA 6:	0.0842"/ 9 lines
LEA AVG.	0.0845"		
Rifling type:	Conventional	Caliber:	45 cal.
Type:	FMJ	Damage:	N/A
Manufacturer:	Remington (UMC)		
Jacket finish:	Brass		
Remarks:	45 AUTO, 230 gr., FMJ, Shot from Ruger P90 Model 45 Auto Pistol		

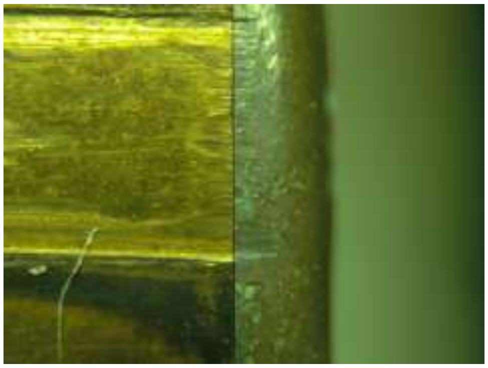
Figure 174: B1 (LEA 1) to B12 (LEA 1) 28X FINAL

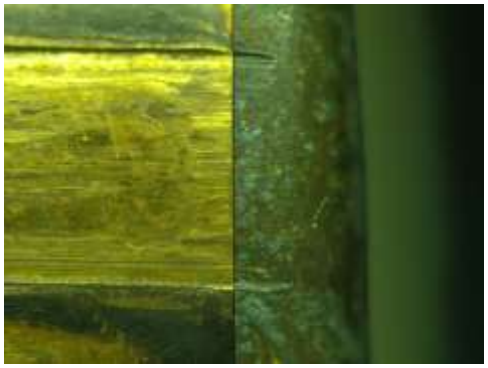
Figure 175: B1 (LEA 2) to B12 (LEA 2) 28X FINAL

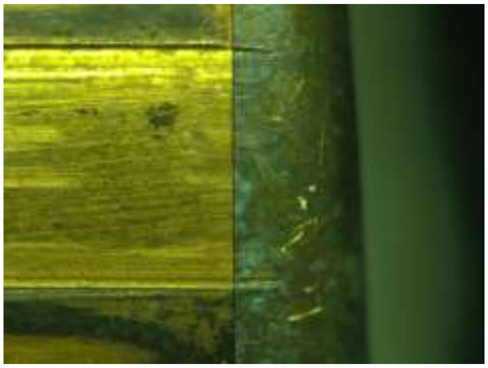
Figure 176: B1 (LEA 3) to B12 (LEA 3) 28X FINAL

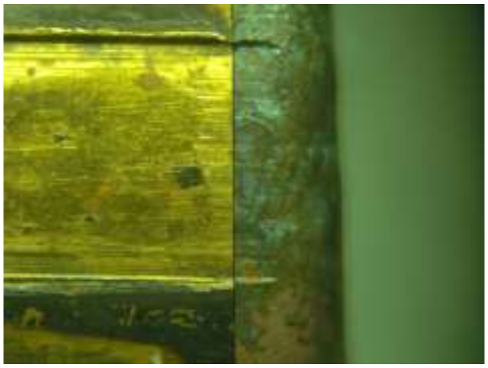
Figure 177: B1 (LEA 4) to B12 (LEA 4) 28X FINAL

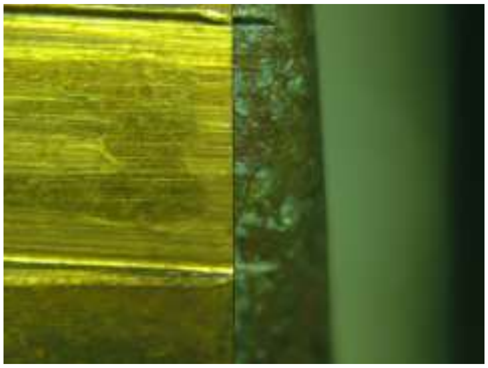
Figure 178: (LEA 5) to B12 (LEA 5) 28X FINAL

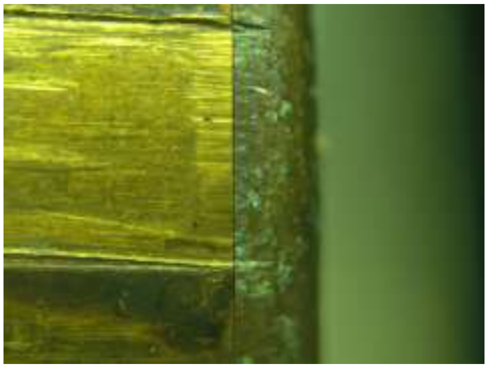
Figure 179: B1 (LEA 5) to B12 (LEA 5) 28X FINAL

Cartridge Case Work Sheet		Casing Comparison:	C1-C12
Final findings		Examiner:	Sheila Brown
Item:	C12		
Headstamp:	R-P 40 S & W	Manufacturer:	Remington (UMC)
Caliber:	40 cal.	Cannelure(s):	N/A
Primer finish:	Nickel	Case finish:	Brass
Extractor position:	3 o'clock ?	Ejector position:	N/A
Firing pin shape:	Circle	Breechface pattern:	Parallel
Misc. marks:	Chamber marks & magizine lip marks		
Damage:	N/A		
Comparisons:	L of FPI: 47 lines	R of FPI: 23 lines	
Conclusions:	Identification		
Remarks:	40 Semi-Auto, 180 gr., MC, Shot from Hi-Point JCP model		

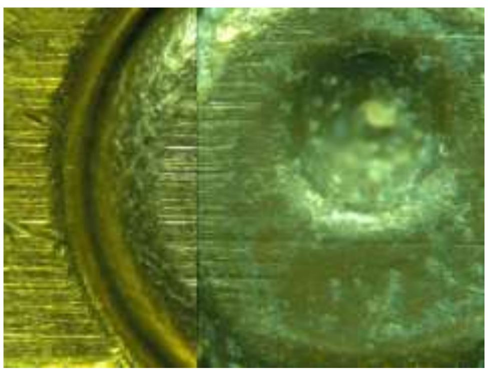

Figure 180: C1 (L OF FPI) to C12 (L OF FPI) 28X FINAL

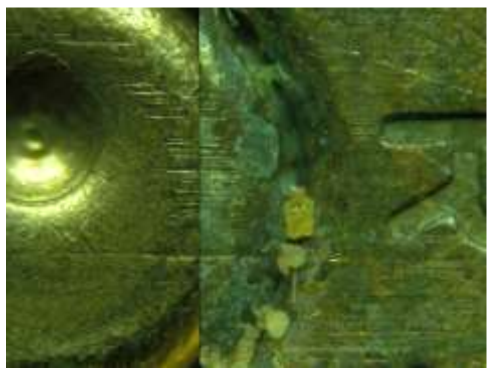

Figure 181: C1 (R OF FPI) to C12 (R OF FPI) 28X FINAL