A23 Methodology Used to Estimate the Measurement of Uncertainty: Accuracy, Reliability, and Validity Obtained for a Firearms Section Bullet Classification Procedure

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After attending this presentation, attendees will have an understanding of a measurement of uncertainty and how to perform a measurement of uncertainty on firearms measurement procedures. This presentation will impact the forensic science community by discussing how research defining error rates for the discipline of firearm and tool mark identification is needed to associate error with methods, assure reliability of methods, provide statistical proof to ensure "soundness" of methodologies to deter attacks by the defense (*Daubert*), and promote further understanding for uncertainty of measurement required for ISO 17025 accreditation. Uncertainty of measurement is crucial for forensic evidence analysis, which will be used by the justice system to make decisions where someone's life or freedom may be at stake.

This project addresses several aspects of accuracy, reliability, and measurement validity for the method utilized at the North Louisiana Criminalistics Laboratory to measure physical characteristics of bullets. The National Academy of Sciences Report (2009) spoke to the Firearm and Toolmark Identification discipline as lacking established statistical error rates for methodologies commonly used to measure physical aspects of weapons. Therefore, with no known error rates, the reliability of these methods is undocumented. In order to obtain a measurement of uncertainty for physical characteristics of bullets, a digital micrometer measuring instrument was utilized to determine the diameter and width of land and groove impressions. Guidelines published by ASCLD/LAB *International,* "Estimating Uncertainty of Measurement Policy" followed. Recommendations from NIST 6919, NIST 6969, and Guide to the Expression of Uncertainty in Measurement (GUM) per ACLASS for uncertainty of measurement were also considered.

Test samples (fired bullets) were obtained by firing several firearms of differing calibers with differing types of ammunition. Participants measured the diameter and width of land and groove impressions of each test sample. Descriptive statistics were calculated to propagate the overall error for the entire sample population. A propagation equation can be described as a compilation of errors via vector addition to incorporate many small errors into one all-encompassing error range, and was used to calculate the overall representative error for the methodology. A ninety five percent confidence interval was calculated around the population mean and the resultant value was compared to the theoretical value. The theoretical values were obtained from the GRC File published by the FBI. Statistical significance of the measured result was determined by assessing whether the calculated confidence range encompassed the theoretical value. If the theoretical value was found to not encompass the calculated range then the error was classified as systematic and was accounted for with a method adjustment.

A bottom-up approach for a measurement of uncertainty was utilized for this research. The method for measuring bullet characteristics was mapped out onto flow diagrams and sources of potential error were established. Cause and effect diagrams were developed to determine the significance of each contributor to the overall measurement of uncertainty for the method. Contributors encompassed within the error budget consist of errors that are both measureable and immeasurable; therefore, an assessment of the errors was performed to determine what errors could be accounted for statistically.

Thus far, measurement trials have been performed which display variance within the results. A window of uncertainty has been established for the method, and various aspects within the measurement method were shown to contribute a significant amount of error. Currently, measurement factors such as instrumentation, methodology, and analyst contributions are being reviewed to improve the reliability of measurements. Trials are still underway to collect additional data for statistical propagation. Solid conclusions will be made when a sufficient amount of data is collected to perform the statistical calculations.

ASCLD/LAB- International, Measurement of Uncertainty, Propagation of Error

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