B178 A Foundational Study of Fire Debris Interpretation Using Quantitative Measures of Chromatographic Features

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Learning Overview: The goal of this presentation is to introduce a validated method that quantifies the data supportive of a gasoline identification using a sufficiency chart and to introduce documentation software that allows for a more transparent inferential process and is capable of verification.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing a quantitative sufficiency chart and a computerized pattern-comparison documentation program that also facilitates verification that will make the fire debris experts' inferential process standardized, objective, and visible.

This presentation will discuss an interpretation method for fire debris Gas Chromatography/Mass Spectrometry (GC/MS) data using quantitative measures based on key chromatographic features, which were used to establish the sufficiency of the data for a conclusion. The analysis of the key chromatographic features is highlighted, as well as the process by which a graphical display of the sufficiency of the data was created. This novel approach to data interpretation is the first step toward a validated analysis method for ignitable liquids, starting with gasoline, in the presence of complex matrices. Ultimately, this research aims to make the fire debris analysis process more standard, objective, and transparent by establishing a validated method with quantitative measures that includes the implementation of intuitive documentation software and verification, all of which is based on robust data evaluation.

Ignitable liquid identification is based on pattern recognition techniques using chromatographic data. While the analytical processes associated with the analysis of fire debris for the presence of ignitable liquids are based on fundamental chemical properties, the interpretation process is entirely subjective. The degree of subjectivity is directly related to the abundance and type of interferences from volatile compounds produced by the matrix (including inherent, pyrolysis, and combustion products), as well as the concentration of any ignitable liquid residues present in the sample. Currently, there are no published, validated methods for the interpretation of these complex samples, which can, and does, lead to a lack of consistency in interpretation and reporting within the field. Therefore, this study was designed to establish a novel quantitative measure of assessing the chromatographic features of gasoline generated during analysis by applying statistical measures to create sufficiency parameters for use in interpreting data and rendering conclusions.

A methodology for establishing and measuring variables associated with quantity, quality, and confidence is being optimized and applied to neat gasoline samples, gasoline samples evaporated at 25%, 50%, 75%, and 90% levels, negative matrix samples, and real-world samples composed of mixtures of matrix and gasoline. Key chromatographic features in 150 gasoline samples were evaluated and 64 chromatographic peak height ratios determined for comparison. Statistical analysis was conducted to determine the variation observed for each of these ratios in the known gasoline samples and to determine the presence of these key chromatographic features in the negative matrix samples. This information was evaluated to determine the relative scores for each of these features. The scores were used to create a sufficiency chart, which is a graphical display detailing the totality of data supporting a potential gasoline identification. The sufficiency chart will also identify the "gray area" where analysts are more likely to form differing opinions. A discussion of this "gray area," its implications, and the proposed solutions under development will be presented.

The final results of this study will be a foundational validation with essential quality assurance measures for the purpose of identifying gasoline in fire debris samples. The investigators plan to use methodologies similar to Analysis/Comparison/Evaluation/Verification (ACE-V) for documenting the examination process, thereby ensuring greater transparency in fire debris examination and comparisons. However, this documentation process that will be introduced is currently under development. The end-goal of the proposed project is to generate a quantitative sufficiency chart for reliable data interpretation with the adaptation and utilization of a computerized pattern-comparison documentation program that also facilitates verification.

Fire Debris Analysis, Gasoline, Interpretation Method

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