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Gossman Forensics – Louise Denlinger, David Gossman

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Investigation of Fires and Explosions using the Scientific Method

The destructive forces of a fire and/or explosion usually present significant challenges when investigating an incident. Evidence can be hidden under charred debris and possibly trampled or submerged in water from firefighting activities. For these reasons and others, every incident scene is rendered unique and determining a specific cause and/or origin of a fire and explosion can be challenging. Using a systematic approach, uniform sets of protocols and methods to determine an incident cause and origin are not only accepted, but necessary to produce reliable opinions that can withstand scrutiny in litigation.

Fire and explosion professionals utilize the guidelines and standards of The National Fire Protection Association (NFPA) for their investigations. In particular, NFPA 921, Guide for Fire and Explosion Investigations, identifies scientific methods and procedures to use when working to identify and formulate an opinion regarding cause and origin in investigations. NFPA 921 considers the scientific method to be the principle of inquiry that forms the basis for legitimate scientific and engineering processes, including fire and explosion investigations. The Scientific Method (NFPA Chapter 4, Basic Methodology) plays a key role in any sound investigation and is the foundation for legally defensible cause and origin determinations.

How does the Scientific Method work?

The scientific method is used as the analytical process in all aspects of the investigation, including development of conclusions. NFPA 921 lists the steps of the scientific method as follows: recognize the need, define the problem, collect the data, analyze the data, develop a hypothesis, test the hypothesis, and select a final hypothesis.

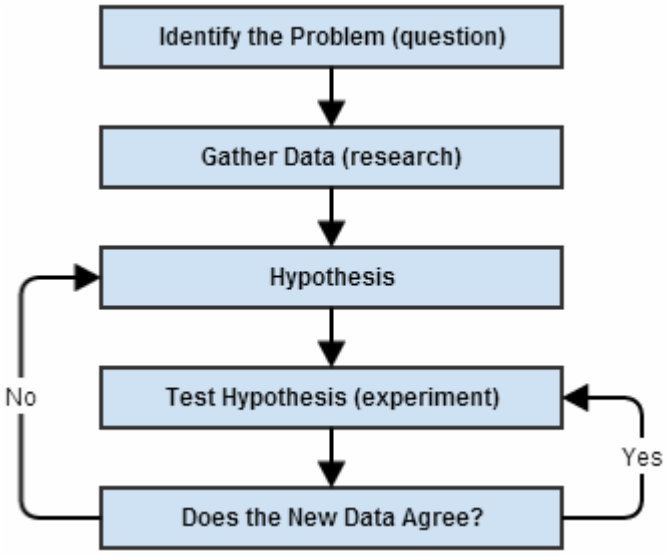

Figure 1. The steps of the Scientific Method (Wikimedia commons)

The basic methodology begins with recognizing the need and defining the problem. Once a fire and/or explosion occurs, the investigator must identify the scope of the assignment. For example, it may be to identify the cause and origin, and/or decide where the responsibility for the fire lies, if the fire was deliberate or accidental, caused by equipment malfunction/failure, or by actions/inactions of a specific party.

Data collection should bring forward the facts associated with the incident scene. This can include qualitative and quantitative information, physical evidence collection, research, witness interviews and statements, fire patterns, measurements, photographs and video, laboratory testing and experiments.

The scientific method requires that all data collected be analyzed. This is a crucial step that must take place before the formation of the final hypothesis. The data should undergo a careful and rigorous analysis using inductive reasoning, laboratory test results, and the investigators training, knowledge, experience and expertise. The mere processes of identification, gathering, and indexing data does not equate to data analysis. Speculations or subjective information must not be included in the analysis, only facts that can be proven clearly by observation or experiment. All investigations of fire and explosion incidents should be approached by the investigator without presumption as to origin, ignition sequence, cause, fire spread, or responsibility for the incident until the use of the scientific method has yielded testable hypotheses.

Based on thorough data analysis and inductive reasoning, the investigator should develop a hypothesis. The results of the data analysis will lead to the development of a hypothesis that can explain the defined problem: such as the development, cause and origin of the fire and/or explosion. The hypothesis should be based solely on the empirical data that the investigator has collected and developed into explanations of the event. The investigator does not have a valid hypothesis unless it can stand the test of careful and serious challenge. Testing the hypothesis is done using deductive reasoning. The investigator compares his/her hypothesis to all the known facts as well as the body of scientific knowledge associated with the incident. A hypothesis can be tested either physically by conducting experiments or analytically by applying scientific principles in "thought experiments." Testing of hypotheses routinely includes collecting new data and/or re-analyzing existing data until all feasible hypotheses have been tested and no discrepancies remain.

If the hypothesis cannot withstand an examination by deductive reasoning it should be discarded and a new hypothesis tested. Hypothesis testing is a repetitive process until all feasible hypotheses have been tested. Only hypotheses that cannot be eliminated should still be considered feasible and viable. In the instances when data or experimental results are logically inconsistent, then that hypothesis must be discarded. Any hypothesis that is incapable of being tested is an invalid hypothesis. A hypothesis developed based on the absence of data is an example of a hypothesis that is incapable of being tested. The inability to refute a hypothesis does not mean that the hypothesis is true.

When a hypothesis has been tested and found to be consistent with the research, collected evidence and data, it can be recognized as a final hypothesis. These are typically presented as an expert opinion of the investigator. If the level of certainty of an opinion is merely "suspected," the opinion does not qualify as an expert opinion. In the instances when a final hypothesis is deemed "possible" and cannot be supported with a degree of probability, the incident cause should be listed as "undetermined. A hypothesis at the "possible" level of certainty can be demonstrated to be feasible, but cannot be declared probable. An incident that is deemed "undetermined" can later be updated with a final hypothesis. In some instances, an "undetermined" cause is listed because the incident is still under investigation and in others a cause cannot withstand the hypothesis test, as required by the scientific method.

Conclusion

The quality and credibility of an investigation resides with the decisions made by the investigator and adherence to the scientific method as required in NFPA 921. Performing evidence and data collection with diligence is the foundation for a confident final opinion. A high degree of knowledge, training, experience and expertise is needed in a fire and explosion investigator to uncover facts, suggest laboratory analysis, analyze data and formulate a hypothesis that is unbiased and solid. The team at Gossman Forensics will provide the technical expertise and experience needed for a fire and explosion investigation that will follow the scientific method and withstand scrutiny in litigation.

Forensic Science Insights is a publication by Gossman Forensics, a division of ChemRight Laboratories, Inc. Please contact David Gossman, Chief Investigator, at 563-652-2822, by email at dgossman@gossmanforensics.com or visit us on the web at GossmanForensics.com.