

# Chapter Thirteen – Methodology of Investigation

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*Author examining a large utility fan after a fire*

# Methodology of Investigation

## Purpose of Fire Investigations

The fundamental Origin and Fire Cause Objectives of a fire investigation are to:

- Determine the origin of the fire, the location where the ignition source and the fuel came together to start a fire
- Determine the fire cause, the circumstances or conditions that brought the ignition source, fuel, and oxygen together resulting in the fire
- Assess the development and spread of the fire
- In some cases, determine the responsibility for the fire, e.g., did it involve the negligence of some party or a product defect

An example of the purpose of an investigation applied to a commercial cooking equipment-related fire investigation would be as follows:

- The Origin of the Fire (location) was in the area of a deep fat fryer
- The Fire Cause was a failure of the fryer's high limit switch that resulted in the ignition of the cooking oil in the fryer. The circumstances that brought the fuel and ignition source together so that there could be a fire was the failure of the high limit.
- A fire resulted. It spread into the hood and duct system, where the accumulation of grease residues was a factor in the spread of the fire into the rest of the building

In many cases, the purpose of the investigation may go beyond determining fire origin and cause, and include the examination of circumstances that led to property damage, bodily injury or loss of life – the cause of the loss. Further, the investigative assignment may require that the investigator determine, through analysis of the facts, the responsibility of a party or parties regarding those circumstances or conditions that brought about the cause of the loss.

In the above fryer fire example, the investigator may conclude that, in addition to some malfunction of the deep fryer, an operational failure of the fire-extinguishing system caused the fire to spread beyond the hood and duct system and involve the building structure.

The scope of a specific fire investigation will depend on the role of the investigator. Typically, a fire department investigator or fire marshal will be concerned with the four fundamental Origin and Fire Cause objectives listed above in addition to the determination of whether the Cause was accidental or intentional. The findings may lead to improved fire prevention. A fire investigator retained by an insurance company may have a broader responsibility beyond Fire Origin and Cause to also make a determination regarding those factors contributing to the Cause of the Loss. Further, with the assistance of engineers or equipment experts, an examination and analysis may include the determination of specific equipment failures and parties responsible for those failures.

## Scientific Method of Investigation

In a large majority of commercial kitchen fires, the origin is quite obvious. The fire patterns left by the discoloration of the metal of the hood or filters identifies the cooking appliance on which the fire originated.

Common questions that need to be answered:

- What were the circumstances that allowed the fire to start in the first place?
- Why, given the fire-extinguishing equipment and fire preventative maintenance efforts, did the fire cause so much damage?
- Which piece or pieces of the fire prevention chain failed, and why?

In a smaller number of cases, there may be little indication of how or where the fire started. This can be a challenge because signs of cooking fires are almost always present on appliances.

In either case, the fire investigator or analyst must utilize a systematic, reliable methodology in the investigation and analysis. Failure (fire) is often due to more than one factor. Depending on the investigative assignment, it may be essential to analyze and determine the contributing cause components (causes for the loss) and the responsibilities of the parties involved.

**The Scientific Method.** In *NFPA 921 Chapter 4, Basic Methodology*, the NFPA 921 Committee has affirmed that the scientific method is applicable to the field of fire investigation as a systematic approach in developing and testing origin and fire cause hypotheses. NFPA 921 considers the scientific method to be a principle of inquiry that forms a basis for legitimate scientific and engineering processes, including fire incident investigation.

NFPA 1033 Standard for Professional Qualifications for Fire Investigator, Chapter 4 Section 4.1.2 states, “The fire investigator shall employ all elements of the scientific method as the operating analytical process throughout the investigation and for the drawing of conclusions.”

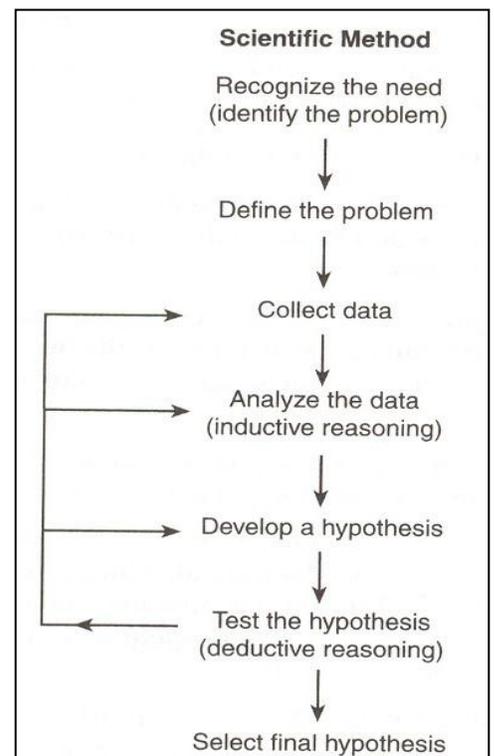
An investigator does not need to be a fire scientist. NFPA 921 does provide a systematic method for selecting, testing and accepting or discarding possible fire cause hypotheses. Further, when testing a hypothesis, an investigator does not necessarily need to utilize scientific tests or experiments in order to arrive at a conclusion. A hypothesis may be supported by cognitive testing, or a “thought experiment.”

Specifically, NFPA 921, Section 4.3.6 and Annex which state that in the testing of a hypothesis by deductive reasoning, “The testing of the hypothesis may be either cognitive or experimental.”

An example of cognitive testing (thought experiment) could be determining whether a door was open or closed, at the time of the fire, by examining the hinges. If the door was closed, then there should be mirror image patterns on the hinges. One is not required to run a fire experiment to prove this, but one must be able to set up a deductive test using the proposition. If A is true, then B should be observed.

### Basic Scientific Methodology

- **Define the Problem.** A fire has occurred. The fire investigator called to the scene needs to determine the scope of his assignment. It may be simply to determine if a fire was incendiary or accidental. It may be to determine which party or piece of equipment bears ultimate responsibility for the fire.
- **Collect Data.** Examine the scene. Combine this with other data collection methods, such as a review of possible previously conducted investigations of the incident, the interviewing of witnesses or other knowledgeable persons, and the results of scientific testing and research. Collect facts about the fire incident. This is done by observation, experiment or other direct data-gathering means. This is called empirical data because it is based on observation or experience and is capable of being verified.
- **Analyze the Data.** Analyze all collected and observed information by Inductive Reasoning. Inductive reasoning is defined as the process by which a person starts from a particular experience and proceeds to generalizations. It is the method in which the total body of empirical data collected is carefully examined in the light of the investigator’s knowledge, training, experience, and expertise. Subjective or speculative information cannot be included in the analysis, only facts that can be proven clearly by observation or experiment.



*NFPA 921, 2011 Edition, Figure 4.3  
Use of the Scientific Method*

# A Guide for Commercial Kitchen Fires

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- **Develop a Hypothesis.** Based on the data analysis, develop a hypothesis to explain the origin and cause of the fire. This hypothesis should be based solely on the empirical data that the investigator has collected.
- **Test the Hypothesis (Deductive Reasoning).** A truly provable hypothesis must stand the test of careful and serious challenge. Testing of the hypothesis is done by the principle of Deductive Reasoning, which is defined as the process by which conclusions are drawn by logical inference from given premises. Compare the hypothesis to all known facts. Testing of the hypothesis may be either cognitive or experimental. If the hypothesis cannot withstand an examination by deductive reasoning it should be discarded and a new hypothesis tested. This test may include the collection of new data or the reanalysis of existing data. Continue this process until all feasible hypotheses have been tested. Otherwise, the fire cause should be listed as “undetermined”.

In fire investigation and analysis this step in the process can include the comparison of the hypothesis to other known facts such as:

- Fire experience data
- Available fire test data
- Authoritative texts
- Experiments and published/peer reviewed books and articles

As noted in the Scientific Method flow chart previously, hypothesis testing is a repetitive process until a final hypothesis is selected.



- **Select the Final Hypothesis.** When the hypothesis has been tested and found consistent with the collected incident data and known research data, it is a final hypothesis, which can be presented as the expert conclusion or opinion.<sup>1</sup>

## Fire Origin Determination

In fire investigation work as in real estate, the three most important things are: location, location, and location i.e., fire origin, fire origin, and fire origin. The determination of the fire origin, through a systematic process, is the beginning point for an investigator’s findings and opinions. For the results to be objective and reliable, the origin must be determined first, then the fire cause.

NFPA 921, Section 17.1 states in part:

*Generally, if the origin of a fire cannot be determined, the cause cannot be determined, and generally, if the correct origin is not identified, the subsequent cause determination will also be incorrect. The purpose of determining the origin of the fire is to identify in three dimensions, the location where the fire began.*

Determination of the origin of the fire in the exhaust system involves the collection, analysis, and coordination of information derived from a range of activities and sources.

NFPA 921, Section 17.1.2 includes the following:

- (1) *Witness information. The analysis of observations reported by persons who witnesses the fire or were aware of conditions present at the time of the fire*
- (2) *Fire Patterns. The analysis of effects and patterns left by the fire*
- (3) *Arc Mapping. The analysis of the locations where electrical arcing has caused damage and the documentation of the involved electrical circuits.*
- (4) *Fire Dynamics. The analysis of the fire dynamics, that is, the physics and chemistry of the fire initiation and growth, and the interaction between the fire and the building’s systems.*

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<sup>1</sup> For further discussion of the scientific method applied to fire investigations see NFPA 921, Chapter 4. For more information about the testing of a working hypothesis see, Icove, David J., DeHaan, John D., *Forensic Fire Scene Reconstruction*, Chapter 1 Principles of Reconstruction, pages 2 to 9.