NFPA 1033 List of 16 Part 3: Understanding Topics 9 to 12

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This submission of the FISC Bulletin Board will continue to address the topics listed in NFPA 1033, Section 1.3.7. The first two articles in this series were published in the January 2018 and April 2018 editions of the F&AI Journal. They are available to IAAI members on the IAAI website at this URL: https://www.firearson.com/Publications-Resources/Fire-Arson-Investigation-Journal/Default.aspx (sign in required).

The intent of the FISC Committee is to provide the reader with resources to gain the requisite knowledge, and the ability to better articulate that knowledge, of the topics listed in NFPA 1033 Section 1.3.7 "beyond the high school level." Any opinions expressed in this series are those of the FISC and do not necessarily reflect the opinions of the National Fire Protection Association, the NFPA Technical Committee on Fire Investigations, the NFPA Technical Committee on Fire Investigator Professional Qualifications or the International Association of Arson Investigators, Inc.

NFPA 1033, as a Standard, requires that "The fire investigator shall remain current in the topics listed in section 1.3.7 by attending formal education courses, workshops and seminars and/or through professional publication and journals". [i] A competent fire investigator must be able to properly apply their knowledge, explain how that knowledge was applied to a set of facts (or to hypothetical situations), and articulate their work in a litigation setting. With that in mind, let us continue with discussion on topics 9 through 12.

(9) Fire analysis

(10) Fire investigation methodology

(11) Fire investigation technology

(12) Hazardous materials

(13) Failure analysis and analytical tools

(14) Fire protection systems

(15) Evidence documentation, collection, and preservation

(16) Electricity and electrical systems

Fire Analysis

Traditionally, conducting a fire investigation has been synonymous with determining the origin and cause of the fire. However, there are many instances where the fire investigator will have to expand the scope of that investigation. This is known as *Fire Analysis.* NFPA 921 defines Fire Analysis as; "The process of determining the origin, cause development, responsibility and, when required, a failure analysis of a fire or explosion." [ii] NFPA 921 explores the subject of Fire Analysis in depth in chapters 21 and 22.

Fire investigators are often asked to broaden the scope of their investigation to include an accurate determination of the circumstances outside of the traditional origin and cause model. These factors may include;

1. The cause of the damage to property resulting from the fire
   - i. Building construction
   - ii. Fire protection features
   - iii. Factors contributing to flame and smoke damage
2. The cause of bodily injury or death
   - i. Fire protection systems
   - ii. Means of egress
   - iii. Life safety factors
   - iv. Products that may contribute to toxic atmosphere or fire spread
   - v. Fire fighter line-of-duty injuries or deaths
3. Human factors contributing to fault or responsibility
   - i. Intentional acts
   - ii. Unintentional acts
   - iii. Acts of omission
   - iv. Negligence or carelessness
   - v. Incompetence

In order to complete a thorough fire analysis, the fire investigator may be tasked with performing a failure analysis. Failure analysis is defined in NFPA 921 as "A logical, systematic examination of an item, component, assembly or structure and its place and function within a system, conducted in order to identify and analyze the probability, causes and consequences of potential and real failures."[iii] It is important to note that the use of Failure Analysis is consistent with the use of the Scientific Method and should be employed when a fire investigator is tasked with assessing responsibility or accountability for the event, or the sequence of events, that caused the fire or explosion, the spread of the fire, the resulting deaths or injuries and/or the property damage.

A complete discussion of Failure Analysis can be found in NFPA 921, 2017 edition, Chapter 22 and will be discussed in the next part of this series.

Ultimately, it is the role of the legal system to assign responsibility, the fire investigator may be asked to identify responsible parties to initiate the legal process. Responsibility for the factors surrounding the fire/explosion incident can only be accurately assessed after the completion of the Failure Analysis process. iv It is important to remember that a fire or explosion is often caused by a series of events, rather than a singular event. As such, multiple entities or persons may share in the causal responsibility, and may have varying degrees of responsibility.

Fire Investigation Methodology

Arguably, the most important aspect of conducting a proper fire investigation is the basic methodology outlined in great detail in NFPA 921. Failure to follow this basic methodology may result in the incomplete collection and interpretation of data, as well as a faulty, quite possibly, unsubstantiated origin and cause determination. NFPA 921, Chapter 4 is entirely devoted to step-by-step instruction on the basic methodology for conducting a fire investigation. That section states, in part; "The basic methodology of the fire investigation should rely on the use of a systematic approach and attention to all relevant details. The use of a systematic approach often will uncover new factual data for analysis, which may require previous conclusions to be reevaluated. With few exceptions, the proper methodology for a fire or explosion investigation is to first determine and establish the origin(s), then investigate the cause circumstances, conditions, or agencies that brought the ignition source, fuel and oxidizer together". [v]

One of the most misunderstood factors about this systematic approach is its relationship to science. This systematic approach is NOT "track the fire from the least amount to the greatest amount of damage". NFPA 921 is quite clear on this. Section 4.2 states; "The systematic approach recommended is based on the scientific method, which is used in the physical sciences." [vi] While the word "recommended" may seem out of place in this section, the investigator must view this section in context with the relevant section of NFPA 1033. Section 4.1.2 states clearly and succinctly: "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." [vii] There can be no doubt that a fire investigator is required to utilize the scientific method as the foundational methodology for every fire investigation.

The basic methodology of fire and explosion investigation, in the context of the scientific method is summarized as follows:

1. Recognize the Need

The investigator is notified that a fire or explosion incident has occurred and that the origin and cause of the fire must be determined.

2. Define the problem

The investigator receives the assignment and the proposed scope of the investigation. At this point, the pathway to solving the problem is addressed and specific investigative tasks are determined.

3. Collect the Data

The investigator conducts a complete and thorough examination of the fire scene, documents personal observations, documents the incident scene through photographs, sketches and notes, interviews witnesses, identifies pertinent evidence, submits samples for laboratory analysis and reviews resulting lab reports, reviews documentation of other investigators and searches for documents from any other relevant sources of information, identifying and memorializing all empirical data.

4. Analyze the Data

The investigator conducts an objective examination of all data, facts and evidence collected during the fire investigation. This analysis is conducted using the knowledge, education and expertise of the investigator. If data needs to be evaluated that lies outside the scope of the investigator's expertise, assistance from outside persons should be sought. The goal of this objective analysis is to understand the meaning of data, evidence and facts.

5. Develop hypotheses (Inductive reasoning)

The fire investigator uses the empirical data developed during the data analysis to form a working hypothesis or hypotheses to address the "Define the Problem" section. At this step, the working hypothesis is an "educated guess" that is a possible explanation for the event. Because of the complexity of a fire or explosion incident, there may be more than one hypothesis to fully address the problem.

6. Testing the hypotheses (Deductive reasoning)

At this stage of the investigative process, it is

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vitally important for the investigator to properly test the developed hypotheses. All hypotheses must undergo rigorous scrutiny. The investigator will compare each hypothesis to all known facts and the bodies of pertinent scientific knowledge that are relevant to the fire or explosion incident in question. The investigator must also understand that the proper way to use deductive reasoning is to attempt to DISPROVE the hypothesis, thereby preventing confirmation bias. This testing process will continue until all feasible hypotheses have been considered. If none of the proposed hypotheses can withstand rigorous challenge, the incident should be considered "undetermined".

a. The hypothesis must withstand rigorous scrutiny

b. Investigator compares the hypothesis to-

  i. All known facts

  ii. Body of pertinent scientific knowledge

  iii. Relevant to specific incident

c. Investigator must test to DISPROVE the hypothesis

  i. Prevent confirmation bias

  ii. Testing continues until all feasible hypotheses have been considered and one hypothesis is found to be uniquely consistent with the facts

  iii. If no hypothesis can withstand the above challenge, incident should be considered "undetermined"

7. Select final hypothesis

Once testing has been completed, there will likely be one hypotheses that is uniquely consistent with the empirical evidence and whose theories cannot be disproved. The entire testing process should be reviewed and evaluated to ensure that all alternate hypotheses have been considered and conclusively eliminated. At that point, the final explanation for the fire/explosion incident can be chosen.[viii]

It should be noted that there are at least three critical errors that could cause the investigator's opinion to be disregarded in a legal setting.

1. Failure to consider ALL empirical data developed
2. Failure to properly test ALL hypotheses
3. Failure to consider ALL alternative hypotheses as part of the selection of the final hypothesis[ix]

Finally, the investigator must remember that memorizing the basic methodology/scientific method will not be sufficient for the investigator's opinions to be accepted by a court. The investigator must document all areas of the investigation and demonstrate how he/she used the seven steps of the scientific method in reaching their final determination on the origin and cause of the fire/explosion incident.[x]

Fire Investigation Technology

Fire Investigation Technology is defined in NFPA 1033 as; "Applied technology subjects related to and used in fire investigation including, but not limited to, specialized knowledge and skills in documentation of the investigation, scene and evidence processing, and failure analysis and analytical tools." [xi] Arguably, no aspect of fire investigation has changed more than the technology that is available to make the investigative process more efficient and effective.

Computer technology lies at the heart of the dramatic rise in the quantity and quality of technological tools available to the fire investigator. In no area is the impact of technology on fire investigation more apparent than in scene documentation. Unmanned aerial vehicles (UAV), geospatial technology, digital photography and video equipment, measuring tools, computer-aided drafting (CAD) applications combine to make it possible for even a novice investigator to accurately pinpoint, process and analyze a fire scene to ensure that as much data as possible is pulled from the ashes.

The challenge to the modern fire investigator is to heed the advice given in NFPA 1033 to "…remain current… by attending formal education courses, workshops and seminars and/or through publications and journals." [xii] The IAAI has been at the forefront of the effort to bring the latest in technology to the field through articles and columns in the "Fire and Arson Investigator" and through the trade show at the International Training Conference. Training courses available at the state and local level will frequently analyze and discuss how technology can improve the quality of fire and explosion investigations. It is vitally important that all fire investigators aggressively research the latest available technology and decide how it can be used to their benefit.

Hazardous Materials

As noted in NFPA 921, a fire scene is an inherently dangerous workplace. Investigators may be exposed to falling objects, holes in floors, and sharp surfaces, or may sustain an injury as a result of fatigue or the structural instability of the fire building. Hazardous materials are of particular concern when processing a fire scene. These may include chemical, biological, radiological or inhalation hazards. It is incumbent upon the fire investigator to be aware of Hazardous Materials and take the necessary steps to protect themselves and their teams from the potential harmful effects.

Hazardous Materials are defined in NFPA 472, as "Matter (solid, liquid or gas) or energy that when released is capable of creating harm to people, the environment and property, including weapons of mass destruction (WMD) as defined in 18 US Code Section 2332, as well as any other criminal use of hazardous materials, such as illicit labs, environmental crimes or industrial sabotage".[xiii] The particular aspects of Hazardous Materials awareness are outlined in NFPA 921 Chapter 13, 2017 Edition.

Chemical and radiological hazards can be absorbed through the skin, eyes, and airway. Post fire suppression scene environments have been shown to contain trace amounts of multiple deadly compounds. Protection against such compounds begins with an awareness of their presence and the donning of proper personal protective equipment (PPE.)[xiv] While the investigator's agency or company may outline the PPE to be worn during fire scene investigation processes, the investigator should be aware of, and keep current on, state and federal safety laws as well as OSHA requirements.[xv]

Safety Data Sheets (SDS) and Placards, fire department and AHJ information and witness interviews can provide information on the hazards present at the site prior to the fire. The investigator should make efforts to understand the nature of the occupancies prior to entering the site.

Inhalation hazards constitute the most clear and present danger to fire investigators. Dust, toxic gases and vapors, asbestos and lead are just a few of the common items that may be encountered at fire scenes. Because each fire scene is different, the presence and/or concentrations of hazardous materials will vary at each fire site. As the scene is processed for origin and cause, the scene undergoes further rapid changes which can necessitate subsequent modifications or enhancements in PPE selections.[xvi] The level of respiratory protection that may be required is up to the investigator and is outlined in section 13.6.2.1 of NFPA 921, 2017 Edition. Ultimately, the investigator must never assume that a site is free of hazardous materials, or that the level of hazardous materials at a particular site is negligible.[xvii] Proper preparation, adherence to applicable laws and standards, and constant assessment of the fire scene are crucial to maintaining health and safety.

Conclusion

As this series progresses, it should be becoming more clear that mastery of the requisite knowledge outlined in NFPA 1033 is essential to demonstrating proficiency as a fire investigator and that it involves personal commitment and effort. In the next edition of the FISC Bulletin Board, we will explore the final four topics in the list; 13) Failure Analysis and analytical tools, 14) Fire protection systems, 15) Evidence Documentation and Collection and 16) Electricity and Electrical Systems.

Endnotes

i NFPA. 2014. NFPA 1033: Standard for Professional Qualifications for Fire Investigator. Section 1.3.8. Quincy, MA. National Fire Protection Association.

ii NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 3.3.67. Quincy, MA. National Fire Protection Association.

iii NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 3.3.63. Quincy, MA. National Fire Protection Association.

iv NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 21.5.4. Quincy, MA. National Fire Protection Association.

v NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 4.1. Quincy, MA. National Fire Protection Association.

vi NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 4.2. Quincy, MA. National Fire Protection Association.

vii NFPA. 2014. NFPA 1033: Standard for Professional Qualifications for Fire Investigator. Section 4.1.2. Quincy, MA. National Fire Protection Association.

viii International Association of Arson Investigators. Fire Investigator: Principles and Practice to NFPA 921 and 1033. p 17-20. 3rd edition. Sudbury, MA. Jones and Bartlett Publishing.

ix NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 4.3.7. Quincy, MA. National Fire Protection Association.

x NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 4.4.3.4. Quincy, MA. National Fire Protection Association.

xi NFPA. 2014. NFPA 1033: Standard for Professional Qualifications for Fire Investigator. Section 3.3.6. Quincy, MA. National Fire Protection Association.

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xiii NFPA. 2018. NFPA 472: Standard for Competencies of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents. Section 3.3.32. Quincy, MA. National Fire Protection Association.

xiv NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 13.6.1. Quincy, MA. National Fire Protection Association.

xv NFPA. 2016, NFPA 400: Hazardous Materials Code. Chapter 3. Quincy, MA. National Fire Protection Association.

xvi NFPA. 2017, NFPA 921: Guide for Fire and Explosion Investigations. Sec. 13.1.1. Quincy, MA. National Fire Protection Association.

xvii Donahue, Michael L. 2002. Safety and Health Guidelines for Fire and Explosion Investigators. Oklahoma City, OK. Fire Protection Publications, Oklahoma State University.