NFPA 1033 REQUIREMENTS
FOR FIRE INVESTIGATORS
A Basic Guide

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Most, if not all, of the readers of this magazine are considered expert witnesses, whether it is as a fire investigator, fire protection engineer, electrical engineer, etc. We are all aware of NFPA 921 and its influence on our fire investigations, reports, depositions and courtroom presentations. Of equal importance, but probably discussed much less, is NFPA 1033, Standard for Professional Qualifications for Fire Investigator (2009 Edition). The purpose of this article is to provide a very brief overview of NFPA 1033, an explanation as to why it is so relevant, and a suggested guide to meeting some of the knowledge requirements/standards of the document. This article is not an all-encompassing guide or list of suggested resources, but rather a starting point where investigators can become more familiar with NFPA 1033.

What is NFPA 1033?

The purpose of NFPA 1033 is to, "specify the minimum job performance requirements for service as a fire investigator in both the private and public sectors." The goal of the document was to ensure that on a national basis, all fire investigators meet a minimum standard of knowledge and skills concerning fire investigation. NFPA 1033 is a **standard**, -as Webster's states, a basis for comparison; a reference point against which other things can be evaluated; "they set the measure for all subsequent work". The standard was approved by the **American National Standards Institute** (ANSI), "an organization that is a source for timely, relevant, actionable information on national, regional, international standards and conformity assessment issues." In 1972, the Joint Council of National Fire Service Organizations created the (NPQB) National Professional Qualifications Board to address applicable performance standards of the following career areas: fire fighter, fire officer, fire service instructor, and fire inspector and investigator. NFPA 1033 is a document adopted by the NFPA as a National Fire Code.

NFPA 1033 is developed through the NFPA standards development process. The standard is revised every five years. This revision cycle is guided by a Technical Committee (comprised of volunteer experts of various backgrounds) and uses the consensus process set forth by NFPA. The process is open to everyone in the public, utilizing the outlined methodology of participation set forth by NFPA.

The document basically sets forth the minimum Job Performance Requirements (JPR's) – in other words tasks or duties - for service as a fire investigator, including things such as inspecting and evaluating fire scenes or evidence from such scenes, document the scene, collect evidence, etc. Each JPR lists the requisite knowledge and skills needed to successfully perform as a fire investigator. In Section 4.1, NFPA 1033 mandates, among other things, that the fire investigator shall:

1. Meet JPR's listed in the section.
2. Use the scientific method.
3. Conduct a safety assessment at fire scene investigation sites.
4. Maintain liaison with other interested professionals and entities.
5. Adhere to all legal and regulatory requirements.

Previous editions of NFPA 1033 were less complex documents and only required basic fire investigation knowledge. However, with the advent of the 2009 addition, 13 additional specific knowledge requirements were set forth in section 1.3.8. This change is of great importance to both private and public sector investigators alike, as it requires them to be able to articulate their post-high school knowledge of thirteen topics related to fire investigation. The focus of this article is largely on these 13 topics as opposed to an explanation of the JPR's.

Why is NFPA 1033 Important?

Quite simply, since NFPA 1033 is a standard, fire investigators must adhere to it. Unlike NFPA 921 where it can be argued that it is just a "guide" and where fire investigators can justify deviations from the recommended procedures, there is no such room for maneuver in regards to NFPA 1033. Fire investigators should expect to be scrutinized under NFPA 1033 before they offer expert testimony. And fire investigators therefore must ensure that they meet the minimum qualifications set forth in the document. The ramifications of not doing so are obvious.

First, your testimony may never even be admitted at trial unless you successfully cross the "1033 threshold". A well-versed fire science attorney will likely attack your expert witness qualifications long before he or she will attack your expert opinions. It may be easier for the attorney to attack your level of knowledge than the various aspects of your fire investigation. The danger is that your failure to qualify as an expert witness (fire investigator) can jeopardize the entire case! The Daubert Challenge (also known as FRE 702, a hearing conducted before the judge where the validity and admissibility of expert testimony can be challenged by opposing counsel) may not even be an issue if you cannot first qualify as an expert witness!

Federal Rule 702 requires that if scientific, technical, or other specialized knowledge will assist the trier of fact (the Judge) to understand the evidence, a witness qualified as an expert may testify in the form of an opinion. First, the testimony is based on sufficient facts or data. Second, the testimony is the product of reliable principles and methods. Third, the witness has applied the principles and methods reliably to the facts of the case. The Judge, who acts as gate keeper, uses two tests to admit the testimony: 1) the testimony must be based on sufficient facts or data, and be a product of reliable principles and methods; and 2) The expert has applied the principles and methods reliably to the facts of the case. As an example, 702 and the Scientific Method would be applied to the fire origin hypothesis as follows:

1. Have you gathered sufficient facts or data to determine the origin of the fire?
2. Is your hypothesis based on the application of reliable principles and methodology?
3. Are the principles and/or methodology you applied relevant to the facts on the subject case?

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Second, your failure to qualify in one hearing may have serious consequences for the rest of your career. In future court proceedings, in all likelihood you will be questioned under oath whether you have ever previously failed to qualify in court as an expert witness in fire investigation.

Third, and not the least important, the qualifications set forth by NFPA 1033 are entirely appropriate. As you will see below, the 13 topics from NFPA 1033 described below cover a broad spectrum of technical aspects of fire investigation. We all have the responsibility to obtain and maintain this basic level of understanding. Our fire investigations would be incomplete without this background. And incomplete investigations are a field day for opposing attorneys or parties.

The 13 Topics of NFPA 1033 and Suggested Resources

Within its first chapter, NFPA 1033 mandates that, "The fire investigator shall remain current with investigation methodology, fire protection technology, and code requirements by attending workshops and seminars and/or through professional publications and journals." Most of us attend at least one training event per year and almost all of us read professional journals and publications to keep updated. The real challenge in NFPA 1033 lies in Section 1.3.8, which mandates that:

The investigator shall have and maintain at a minimum an up-to-date basic knowledge of the following topics beyond the high school level at a post-secondary education level:

(1) Fire Science
(2) Fire Chemistry
(3) Thermodynamics
(4) Thermometry
(5) Fire Dynamics
(6) Explosion Dynamics
(7) Computer Fire Modeling
(8) Fire Investigation
(9) Fire Analysis
(10) Fire Investigation Methodology
(11) Fire Investigation Technology
(12) Hazardous Materials
(13) Failure Analysis and Analytical Tools

Many of these topics cover broad areas and are interrelated. And some of the topics, at first glance, seem to involve very technical and specific subjects. "Thermometry", for example, is a word that arguably is not thrown around the fire scene much (the authors reviewed the several significant publications on fire investigation, including NFPA 921, and did not find this particular term). However, its inclusion into NFPA 1033, a standard, means that investigators cannot claim ignorance. Nor can they get away with articulating why they don't need to know it. Investigators should, at the very least, be able to define the above terms, and have a basic understanding of how to apply those definitions. Investigators should further be able to articulate how they were trained in these areas, and be able to generally cite references such as textbooks to back up their claims of technical knowledge. Most of the required knowledge on these topics can be found within NFPA 921 and other relevant texts expound on this information.

The authors believe that a well-prepared and updated Curriculum Vitae (CV) is the first step in meeting the NFPA 1033 challenge. The CV should reflect all of your fire investigation training, especially that relevant to NFPA 1033. The CV should list your relevant course titles, location, dates, and number of hours. A long list of relevant training may act as a warning to the opposing side that you have been properly trained, at a post-secondary education level, on these topics. But you cannot allow your CV to be your shield, your only choice is to be truly knowledgeable about NFPA 1033 and the topics it requires up-to-date basic knowledge on. A sample CV has been attached to the end of this article for fire investigators to use as a starting point.

Following are some basic definitions related to the 13 topics, and lists of resources to find additional information on them:

1. Fire Science

Clearly this is a broad topic and is covered by a wealth of books and other publications. According to NFPA 921, Fire Science can be defined as the body of knowledge concerning the study of fire and related subjects (such as combustion, flame, products of combustion, heat release, heat transfer, fire and explosion chemistry, fire and explosion dynamics, thermodynamics, kinetics, fluid mechanics, fire safety) and their interaction with people, structures, and the environment. Since fire is essentially a chemical reaction, it is reasonable that fire investigators have an understanding of basic chemical and physical properties involved.

NFPA 921 recommends that the fire investigator should also have a basic understanding of ignition and combustion principles and should be able to use them to help interpret evidence at the fire scene and in developing conclusions about the origin and cause of a fire.

Where to Find Additional Information:

NFPA 921: Chapter 3, section 3.3.63, Chapter 5, section 5.1.1

CFITRainer.net Modules: Understanding Fire Through the Candle Experiments; Fire Dynamics Calculations; Introduction to Fire Dynamics and Modeling; Post Flashover Fires; A Ventilation-focused approach to the Impact of Building Structures and Systems on Fire Development

Books: An Introduction to Fire Dynamics (Drysdale); Kirk's Fire Investigation 6th Edition (DeHaan), pp. 11-21; Ignition Handbook (Barbrauskas); Principles of Fire Behavior (Quintere); Scientific Protocols for Fire Investigation (Lentini), pp. 15-91; Forensic Fire Scene Reconstruction (Icove); Users Manual for NFPA 921 (2005), pp. 21-32; Principles of Fire Protection Chemistry and Physics (Friedman)

2. Fire Chemistry

According to NFPA 921, fire chemistry can be defined as the study of chemical processes that occur in fires, including changes of state, decomposition, and combustion. In a basic sense, fire is a chemical reaction (rapid oxidation process), one in which energy is released in the form of light and heat. In An Introduction to Fire Dynamics, Drysdale points out that though fire is a manifestation of a chemical reaction (reference the fire tetrahedron and the "uninhibited chain reaction"), burning is largely dependent on the type of fuel, its state and surface to mass ratio, and its surrounding environment. DeHaan adds that although fire is a complex matter, there are only a few basic chemical reactions that form its foundation. Overall it is a series of oxidative reactions.

It is recommended that fire investigators be able to articulate the basics of a simple oxidation reaction. For example, when Hydrogen is oxidized (common in fires), two molecules of hydrogen combine with one molecule of oxygen to form two molecules of water. Beyond this, it is important that fire investigators be able to describe fires and fire progression in terms of Heat Release Rates (HRR); Heat Flux; Thermal Inertia; Convection/ Conduction/Radiation, etc.

Where to Find Additional Information:

NFPA 921: Chapter 5, section 5.2

CFITrainer.net Modules: Understanding Fire Through the Candle Experiments; Fire Dynamics Calculations; Introduction to Fire Dynamics and Modeling

Books: An Introduction to Fire Dynamics (Drysdale); Principles of Fire Protection Chemistry and Physics (Friedman); SFPE Handbook of Fire Protection Engineering; Ignition Handbook (Babrauskas), pp. 24-41; Scientific Protocols for Fire Investigations (Lentini), pp.15-51; Kirk's Fire Investigation 6th Edition (DeHaan), pp. 11-21; Principles of Fire Behavior (Quintere) pp. 149-167

3. Thermodynamics

Thermodynamics is the science of energy conversion involving heat. The first law of thermodynamics states that energy may change in form but is not created or destroyed. Fire involves the process of energy conversion. According to NFPA 921, heat transfer is defined as the transport of heat energy from one point to another caused by a temperature difference between those points (transport of energy from a high-to low-temperature object). The transfer of heat has a major effect on ignition,

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growth, spread, decay, and extinction of a fire. Heat transfer is measured in terms of energy flow per unit of time (kilowatts) and is accomplished by three mechanisms: conduction, convection, and radiation. The heat transfer rate per unit area (also known as heat flux) is normally expressed in kW/m2. These concepts should be very familiar to all fire investigators.

The HRR describes how the available energy is released. This quantity characterizes the power or energy release rate [watts (Joules/sec) or kilowatts] of a fire and is a quantitative measure of the size of the fire.

Where to Find Additional Information:

NFPA 921: Chapter 5, sections 5.5 and 5.6.3 and 5.6.4.5

CFITRainer.net Modules: Introduction to Fire Dynamics and Modeling; Post Flashover Fires; A Ventilation-focused approach to the Impact of Building Structures and Systems on Fire Development

Books: An Introduction to Fire Dynamics (Drysdale); Kirk's Fire Investigation 6th Edition (DeHaan), pp. 35-43; Ignition Handbook (Barbrauskas); Principles of Fire Behavior (Quintere), pp.47-63; Scientific Protocols for Fire Investigation (Lentini), pp. 18-23; Forensic Fire Scene Reconstruction (Icove); Users Manual for NFPA 921 (2005), pp. 22-26; Principles of Fire Protection Chemistry and Physics (Friedman)

4. Thermometry

Thermometry is the science and practice of temperature measurement. In a practical sense, fire investigators should understand the basic relationship of temperature and materials and how fire scene artifacts and patterns may have been shaped by the interaction of the two. It is important to distinguish between heat and temperature. Temperature is a measure that expresses the degree of molecular activity of a material compared to a reference point, such as the freezing point of water. Heat is the energy that is needed to change the temperature of an object. When heat energy is transferred to an object, the temperature increases. When heat is transferred away from an object, the temperature decreases. Thermal capacity of a material is basically an expression of how much heat or energy must be added to increase its temperature.

Where to Find Additional Information:

NFPA 921: Chapter 3

Books: Scientific Protocols for Fire Investigations (Lentini), p.30; User's Manual for 921 (2005), pp. 44-45; Kirk's (6th Edition), p. 34; Forensic Fire Scene Reconstruction (Icove), pp. 53-58

5. Fire Dynamics

This is obviously another very broad topic. According to NFPA 921, fire dynamics is the detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior. NFPA 921 also states in Section 17.1.2 that the determination of the origin of the fire involves the coordination of information derived from one or more of the following: *(1) Witness Information; (2) Fire Patterns; (3) Arc Mapping; and (4) Fire Dynamics [emphasis added]*. In addition, Lentini describes Fire Dynamics as concepts involving ignition, flames, flame spread, heat transfer and the interaction of a fire with its surroundings.

Fire investigators should be able to discuss fire dynamics issues such as heat transfer mechanisms, flashover, the effects of ventilation, fuel geometry, fire pattern analysis, ignition source evaluation, basic calculations such as flame heights and energy required for flashover, etc.

Where to Find Additional Information:

NFPA 921: Chapter 3, section 3.3.58, Chapter 17, section 17.2.1.2

CFITrainer.net Modules: A Ventilation-focused approach to the Impact of Building Structures and Systems on Fire Development; Post Flashover Fires; Arc Mapping Basics; Understanding Fire Through the Candle Experiments; Fire Dynamics Calculations; Introduction to Fire Dynamics and Modeling; Explosion Dynamics

Books: An Introduction to Fire Dynamics (Drysdale); Kirk's Fire Investigation (DeHaan); Ignition Handbook (Barbrauskas); Principles of Fire Behavior (Quintere); Scientific Protocols for Fire Investigations (Lentini), pp. 53-98; Forensic Fire Scene Reconstruction (Icove), pp. 36-68; Users Manual for NFPA 921 (2005), pp. 21-32

6. Explosion Dynamics

According to NFPA 921, explosions are defined as the sudden conversion of potential energy (chemical or mechanical) into kinetic physical energy with the production and release of gases under pressure, or the release of gas under pressure. Bear in mind it is an oxidation reaction, or a reaction in which there is a loss of electrons from one reactant to another. These high-pressure gases then do mechanical work such as moving, changing, or shattering nearby materials.

As described in Kirks, explosions commonly encountered by fire investigators are in two categories – chemical and mechanical. Mechanical explosions involve explosions of high pressure gas which, in turn, produces a physical reaction (such as a BLEVE) whereas chemical explosions involve a chemical reaction as the source of the high pressure gas (such as fuel air mixtures). The chemical nature of the fuel is changed in this type of reaction.

Where to Find Additional Information:

NFPA 921: Chapter 3, section 3.3.46, Chapter 21

CFITRainer.net Modules: Explosion Dynamics

Books: Kirk's 6th Edition, pp. 447-494; Ignition Handbook, pp. 451-470; User's Manual for NFPA 921 (2005), pp. 239-261

7. Computer Fire Modeling

According to NFPA 921, mathematical modeling techniques provide the investigator with tools for testing hypotheses regarding the origin and cause of the fire/explosion. Lentini further describes computer modeling as, "…an attempt to use quantitative information to mathematically describe how some or all of these processes will change over time under specific conditions." Fire modeling, in essence, helps us understand the complexities of fire and allows us to better appreciate the factors which influence the growth and spread of fire.

Simple models include hand calculation for flame height and heat transfer, whereas field models utilize Computational Fluid Dynamics to more complexly model the fire. These models solve multiple equations related to the fire. NIST's FDS (Fire Dynamics Simulator) is a field model which is free to the public and serves to calculate fire growth based on the quantification of fuel packages in a given compartment. NIST also developed SMOKEVIEW, a program that transforms the FDS model into a 3D view of the fire in progress. This allows investigators and researchers to be able to examine smoke, particles, and various temperatures.

Where to Find Additional Information:

NFPA 921: Chapter 20, Section 20.4

CFITrainer.net Modules: Fire Dynamics Calculations; Introduction to Fire Dynamics and Modeling

Books: Scientific Protocols for Fire Investigation, pp. 90-98; Kirk's 6th Edition (pp. 641-648); Forensic Fire Scene Reconstruction (Icove), pp. 202-223

8. Fire Investigation

Again, this is a very broad topic that encompasses every aspect of the profession. According to NFPA 921, Fire Investigation is defined as the process of determining the origin, cause, and development of a fire or explosion. In NFPA 921, this is distinguished from Fire Analysis which encompasses fire investigation but also seeks to assign responsibility and/or failure analysis (see below).

Where to Find Additional Information:

NFPA 921: Entire Document, specifically Chapter 3, section 3.3.59

Books: Kirk's (6th Edition), pp. 197-306; Ignition Handbook (Barbrauskas); Scientific Protocols for Fire Investigation (Lentini), pp. 101-104; Forensic Fire Scene Reconstruction (Icove); Investigation of Motor Vehicle Fires (Cole); Users Manual for NFPA 921

CFITrainer.net Modules: All 30+ modules have relevance to this topic

9. Fire Analysis

According to NFPA 921, Fire Analysis is the process of determining the origin, cause, development, responsibility, and a failure analysis of a fire or explosion.

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Where to Find Additional Information:

NFPA 921: Entire Book, Chapter 3, section 3.3.56

Books: Kirk's (6th Edition), pp. 197-306; Ignition Handbook (Barbrauskas); Scientific Protocols for Fire Investigation (Lentini), pp. 101-104; Forensic Fire Scene Reconstruction (Icove); Investigation of Motor Vehicle Fires (Cole); Users Manual for NFPA 921

CFITrainer.net Modules: All 30+ modules have relevance to this topic

10. Fire Investigation Methodology

According to NFPA 921, the recommended approach to fire investigation is that of the scientific method. This method provides for the organizational and analytical process necessary in a successful fire investigation. It encompasses a six step process including: 1) Recognize the Need; 2) Define the Problem; 3) Collect Data; 4) Analyze Data; 5) Develop Hypothesis; and 6) Test Hypothesis. A fire investigator does not have a provable hypothesis unless it can stand the test of serious challenge. Testing of the hypothesis is done by deductive reasoning - the investigator compares his hypothesis to all the known facts and the scientific data associated with the incident. A hypothesis can be tested either physically by conducting experiments or analytically by cognitive analysis. If the hypothesis cannot be supported, it is discarded and alternate hypotheses are developed and tested. The testing process continues until all have been tested and one is determined to be consistent with the facts and the principles of science.

The fire investigator should be well aware of this process and should have it memorized. The investigators' actions at the fire scene should always be couched in terms of the scientific method and should be easily explained in court.

Where to Find Additional Information:

NFPA 921: Chapter 4

CFITrainer.net Modules: Critical Thinking Solves Cases; The Scientific Method for Fire and Explosion Investigation

Books: User's Manual for NFPA 921 (2005), pp. 13-20; Scientific Protocols for Fire Investigations (Lentini), pp. 101-122; Forensic Fire Scene Reconstruction (Icove), pp. 2-10

11. Fire Investigation Technology

Fire investigators should be familiar with technology commonly associated with their investigations. Fire investigators should be able to basically describe what equipment is used to process the scene and to analyze evidence taken from the same scene. For example, investigators should be able to speak to the camera or video equipment they used to memorialize the scene, the circuit tracing equipment they used during arc mapping, the thermocouples they used during their live burn to test their hypothesis, etc.

Furthermore, investigators should be able to speak about how and why they package evidence and/or samples, and a brief overview of what equipment is used to analyze their samples. The laboratory expert will be expected to speak to most of this, but that does not mean the fire investigator can get away with pleading ignorance about the basic laboratory process.

Where to Find Additional Information:

NFPA 921: Chapter 17, section 17.4.3.2, Chapter 20, section 20.4

CFITrainer.net Modules: Evidence Examination: What Happens at the Lab?

Books: Kirk's (6th Edition), pp. 293-299, 516-542; Scientific Protocols for Fire Investigations (Lentini), pp. 139-181; Forensic Fire Scene Reconstruction (Icove), pp.331-338

12. Hazardous Materials

According to NFPA 921, fire scenes, by their nature, are dangerous places and fire investigators have a duty to themselves and to others who may be endangered at fire scenes to exercise due caution during their the investigations. Chapter 12 provides basic recommendations concerning a variety of safety issues, including however personal protective equipment (PPE). It should be noted, however, that the investigator should be aware of and follow the requirements of safety-related laws (OSHA, federal, or state) or those policies established by their organization.

Where to Find Additional Information:

NFPA 921: Chapter 12

CFITrainer.net Modules: The HAZWOPER Standard; Fire Investigator Scene Safety

Books: User's Manual for NFPA 921 (2005), pp. 157-8; Kirk's (6th Edition) pp. 512-514

13. Failure Analysis and Analytical Tools

NFPA 921 identifies methods available to assist the investigator in the analysis of a fire/explosion incident. These methods can be used to analyze fires of any size and are used to organize information collected during the investigation. The methods can also identify aspects of the investigation needing additional information and where future efforts should be directed. These methods include Timelines, Systems Analysis, Fault Trees, Failure Mode and Effects Analysis, etc.

Where to Find Additional Information:

NFPA 921: Chapter 20

CFITrainer.net: Scientific Method for Fire and Explosion Investigation

Books: User's Manual for NFPA 921, p. 219; Kirk's (6th Edition), p. 521

Conclusion

It is imperative that fire investigators understand the requirements NFPA 1033. As a **standard**, there is no room not to follow NFPA 1033 or to attempt to articulate why you were justified in not following it (the old cliché "it's a guide" doesn't work here). The 13 specific topics covered by NFPA 1033 are the basis that fire investigators use every day to make origin and cause determinations and to articulate their conclusions. In this respect, NFPA 1033 mandates nothing new. The best preparation for facing a challenge to your qualifications vis-a-vis NFPA 1033 is to do the following:

1. Purchase and thoroughly read a copy of NFPA 1033 – then re-read it!
2. Commit to fire investigation training annually and consistently.
3. Purchase or borrow publications to keep abreast of current topics in the field.
4. Maintain and update your CV. Create a binder with each of your certificates attached to each syllabus or course schedule. Maintain a separate section for articles and resources (such as this) about testifying and qualifying in court.
5. Know where to find information to assist you in preparing for a challenge to your qualifications, and be prepared to cite where you found this information.
6. Prepare your prosecutor or attorneys to face the challenge with you.
7. Develop a library of resources by periodically purchasing relevant books in the field of fire investigation and related topics. Many books have been listed in this article, these will only serve to make you a better investigator in the future.

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