The Invisible but Deadly Reliability Challenge for Fire Investigators: *How NFPA 1033 is Weeding Out Unqualified Investigators and Ruining Subrogation Cases in the Process*

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Imagine that you have a clear-cut case of responsibility of a product or a third-party service provider causing a fire at your insured's residence. You turn the case over to subrogation counsel, and the case is litigated for six months or a year until it comes time for the expert depositions. Shortly after your expert is deposed, you learn from counsel that it will be necessary to settle the case for a fraction of your dollar loss. This happens more often than many people know, especially in subrogation cases. When an insurance carrier gets into a dispute with their insured, they definitely have the upper hand in terms of resources. It is likely that most insureds are unable to recruit the expert talent that an insurance company can. Your expert may go unchallenged, but only in a first-party case. For those cases, the insurer might find it temporarily satisfying to use an expert who works for less, but if you're hoping to recover your loss through subrogation against a manufacturer, or a service provider who himself has insurance, you may find yourself wishing you had hired someone else.

Until 2009, challenges to experts were based almost entirely on methodology, and prior to 2000, it could be argued that although there was a standard for fire investigation in existence, it was not generally recognized, and it was "only a guide." Something important happened in 2009 that the changed the complexion of the expert witness business in fire investigation. 2009 was the year that the National Fire Protection Association (NFPA) Technical Committee on Fire Investigator Professional Qualifications raised the bar in its *Standard for Professional Qualifications for Fire Investigator*, NFPA 1033. The revised standard listed 13 areas in which fire investigators were required to have knowledge of certain subjects beyond the high school level. This change went unnoticed until recently, when some attorneys decided to change the way that they challenge experts. An expert can be challenged on methodology for sure, and it is almost unthinkable that a certified fire investigator with 30 years experience would not be qualified by the court to testify, but it has happened and **it will happen more frequently**. This is a result of the changes in NFPA 1033.

NFPA 1033 is not a "guide" like NFPA 921. It is a standard. It applies to everyone who investigates fires, whether they work in the public or private sector, whether

they are certified or not, and it even applies to professional engineers, if those engineers investigate fires.

So how is it that these people are being shown not to have the qualifications necessary to testify? It's simple. Fire is an exothermic chemical reaction involving the release of heat energy and light energy in various quantities. One would think, therefore, that a professional who holds himself out as an expert in the investigation of fires would have some notion of the basic concepts of energy. Too many fire investigators, however, cannot answer the question, "What are the basic units of energy?"

When counsel asks that question, it is not because he wants to know; it is because he wants to know if the expert knows. Too many experts answer the question with "I can look that up for you." When the questions progress to even more complicated areas of fire investigation such as, "What is the definition of radiant heat flux, and what is what units are used to measure radiant heat flux?" depositions can turn ugly for the proponent of the expert.

If the fire investigator cannot answer these questions **off the top of his head**, it can be argued that he does not meet the minimum qualifications set forth in NFPA 1033.

NFPA 1033 also requires that the fire investigator have a basic up-to-date knowledge of *fire chemistry* beyond the high school level. The simplest of all combustion reactions is the combustion of hydrogen in the presence of air to form water.

$$2H_2 + O_2 \rightarrow 2H_2O$$

The author once witnessed a federal judge disqualify a fire marshal when the witness was unable to describe the combustion of hydrogen. The judge said, "I'm sorry, if you don't know H_2O, you will not be rendering opinion testimony in my courtroom."

The simplest combustion reaction *for a hydrocarbon* is that of methane, CH_4, the main component of natural gas. The combustion reaction is written as follows:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

One cubic foot of methane combines with 2 cubic feet of oxygen—10 cubic feet of air—to yield a cubic foot of carbon dioxide and 2 cubic feet of water vapor, plus 1,000 Btus of heat energy. This is high school chemistry. Yet many fire investigators do not have a mastery of it.

You can rest assured that when the well-financed the defendant hires counsel to ask your expert these questions, he or she is prepared to file a *Daubert* challenge or a reliability challenge based on rule 702. Rule 702 does not answer the question "who is qualified," but that question can be answered by a judge who is familiar with NFPA 1033. Chances are, even the most unqualified fire investigator will have claimed to meet the requirements of 1033 when asked in his deposition. If it can be shown that the claim is not true, the expert is toast.

Three additional subjects were added to the knowledge list in 1033 in 2014, so now there are 16. There is some redundancy in the list (who could argue that "fire chemistry" and "thermodynamics" are not subsets of "fire science?"). The relevant **minimum requirements** of 1033 are printed below.

> **1.3.7*** The investigator shall have and maintain at a minimum an up-to-date basic knowledge of the following topics beyond the high school 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
> (14) Fire protection systems
> (15) Evidence documentation, collection, and preservation
> (16) Electricity and electrical systems
>
> **1.3.8*** The fire investigator shall remain current in the topics listed in 1.3.7 by attending formal education courses, workshops,

and seminars and/or through professional publications and journals.

With respect to electricity and electrical systems, why would you hire a fire investigator who is not familiar with the means of wiring a house? The investigator who says, "I'm not an electrical engineer," when asked about the malfunction of a simple 110-volt appliance that burned down your insured's house is not going to carry the day against the appliance manufacturer. The investigator who "eliminated" the gas water heater as the fire cause will not have much credibility if he doesn't know the chemical formula for methane or propane.

You will not find many reported cases on the subject of unqualified experts. Trial court judges have nearly unlimited power over who gets to testify, and appeals courts will overturn admissions or exclusions only if *abuse of discretion* can be demonstrated. This is a very tough standard. The fact is, in most cases where the expert tanks in deposition, the result is a small settlement. It is usually not even necessary for the reliability challenge to be filed.

The environment has changed. If you want to be successful in recovering your losses through subrogation, what is necessary is to contact counsel as soon you become aware of the loss. Don't hire the guy that you hire for simple arson defenses. Make sure that counsel has a list of experts who are knowledgeable, and who can answer (at least) the simple questions. The sidebar contains a quiz that would be useful in screening out unqualified investigators from your list of contractors.

SIDEBAR

Can Your Fire Expert Pass This Simple Quiz?

This is the short version. The following questions will let you know right away if the fire expert meets the requirements of NFPA 1033 (answers are in blue)

Q: Would you agree that fire involves the release of energy?

Q: What are the basic units of energy? (Joules, J, or calories, or Btus)

Q: What is the difference between energy and power?

Power describes the **rate** of energy release. A glass of ice water will gradually increase in temperature if left at room temperature. It may rise from 32 degrees F to 72 degrees F over a period of hours. It is also possible to raise the temperature of an equal amount of ice water by the same 40 degrees F in a much shorter time by heating it on a stove. The **energy** required to raise the temperature of the water by 40 degrees is the same in both cases. Adding more **power** to the situation allows it to happen at a faster rate.

Q: What are the basic units of power?
(Watts or kilowatts, W or kW)

Q: What is the definition of heat release rate?

NFPA 921 at 3.3.90* Heat Release Rate (HRR). The rate at which heat energy is generated by burning.

Q: What is the definition of energy release rate?

(Same as heat release rate.)

Q: How is heat release rate measured?

(In watts or kilowatts or megawatts)

Q: What is a watt?

(1 Joule per second)

Q: How is the size of a fire measured? (The size of a fire is the same as its heat release rate)

(In watts or kilowatts or megawatts)

Q: What is radiant heat flux?

(The amount of energy that strikes a particular surface area.)

Q: What units are used to describe radiant heat flux?

(The amount of energy that strikes a particular surface area is measured in **watts per square centimeter** or **kilowatts per square meter**)

Q: What is the generally accepted value of radiant heat flux on the floor at the beginning of flashover?

(20 kW per square meter or 2 W per square centimeter.)
Source NFPA 921-14 at **5.10.4.1**

Q: If you are outside on a cloudless day at noon, what is the radiant heat flux that a square meter of the Earth's surface is receiving from the sun?

(Approximately 1 kW. Put another way, the average radiant heat flux from the sun is 1 kW per square meter.)

Q: What is your definition of fire science?

The concept of fire science is defined in NFPA 921, Chapter 3, section **3.3.63** 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."

It is discussed further in Chapter 5, entitled "Basic Fire Science." Section 5.1.1 states, "**the fire investigator should have an understanding of ignition and combustion principles** and should be able to use them to help in interpretation of evidence at the fire scene and in the development of conclusions regarding the origin and causes of the fire."

Q: What is your definition of fire chemistry?

NFPA 921 in chapter 5, section 5.2.1 defines fire chemistry. "The study of chemical processes that occur in fires, including **changes of state, decomposition, and combustion**."

Q: What is your understanding of the phrase "changes of state?"

"Changes of state" refers to changes in the state of matter, as in melting, a change of state from solid to liquid, or vaporization, a change of state from liquid to gas. Changes of state **do not** involve changes in chemical composition.

Q: Is it your understanding that changes of state involve changes in chemical composition?

They do not.

Q: What is the definition of combustion?

Combustion is the same as fire. **From NFPA 921, 3.3.55** Fire. A rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.

Q: Do you agree that the combustion of hydrogen in the presence of air to form water is the **simplest of all chemical combustion reactions**? *(If he doesn't agree, ask him if he can think of a simpler combustion reaction)*

Q: What is the chemical symbol for hydrogen? (H)

Q: What is the chemical formula for hydrogen gas? (H_2)

Q: What is the chemical symbol for oxygen? (O)

Q: What is the chemical formula for oxygen gas? (O_2)

Q: What is the chemical reaction for the combustion of hydrogen?

$2H_2 + O_2 \longrightarrow 2H_2O$

Q: What is the chemical formula for methane? (CH_4)

Q: What is the chemical reaction for the combustion of methane?

$CH_4 + 2O_2 \longrightarrow 2H_2O + CO_2$

Q: What is the concentration of oxygen in air? (~20%)

Q: How many **volumes of oxygen** does it take to react with one volume of methane?

(2, as indicated by the 2 in front of the O_2)

Q: How many **volumes of air** does it take to react with one volume of methane?

(10, because air is only 20% oxygen)

Q: What is your definition of thermodynamics?

In science, thermodynamics is the study of energy conversion between heat and mechanical work, and subsequently the macroscopic variables such as temperature, volume and pressure.

Q: Do you know what the propellant is in most aerosol cans?

It is propane gas.

Q: Can you explain the difference between heat and temperature?

Heat is a form of energy. When matter absorbs energy, its temperature increases. The molecules that make up a substance are constantly in motion. Increased temperature is manifested by an increase in molecular motion or molecular vibration. *Temperature is the measurable effect of the absorption of energy (or heat) by matter.*

Q: What is the definition of flashover?

NFPA 921 at 3.3.74 Flashover. A transition phase in the development of a compartment fire in which surfaces exposed to thermal radiation reach ignition temperature more or less simultaneously and fire spreads rapidly throughout the space, resulting in full room involvement or total involvement of the compartment or enclosed space.

Q: What is the definition of a ventilation-controlled fire?

NFPA 921 at 3.3.176 Ventilation-Controlled Fire. A fire in which the heat release rate or growth is controlled by the amount of air available to the fire.

Q: What is the definition of a fuel-controlled fire?

NFPA 921 at 3.3.79 Fuel-Controlled Fire. A fire in which the heat release rate and growth rate are controlled by the characteristics of the fuel, such as quantity and geometry, and in which adequate air for combustion is available.

If your fire expert does not know the answers to these questions off the top of his head, it's time to find a new expert.

About the author

John Lentini has had a forty-year career in fire investigation, and has participated in most of the changes that have occurred over that time. He serves on the National Fire Protection Association Technical Committees on Fire Investigation and Fire Investigator Professional Qualifications. He is a past chair of ASTM Committee E30 on Forensic Sciences and a past chair of the American Academy of Forensic Sciences Criminalistics Section. He was named as Society of Fire Protection Engineers' "Person of the Year" in 2015.

Mr. Lentini's book, *Scientific Protocols for Fire Investigation* is in its second edition (CRC Press, 2103). He operates Scientific Fire Analysis, LLC of Islamorada, FL. His website is www.firescientist.com