INTERNATIONAL ASSOCIATION of ARSON INVESTIGATORS INC.

IAAI

DISCLAIMER

DISCLAIMER

THE VIEWS EXPRESSED DURING THIS PRESENTATION ARE SOLELY THOSE OF THE PRESENTER AND DO NOT REPRESENT THE VIEWS OF NFPA OR THE 921 AND 1033 COMMITTEES

If it ain't
BROKE
don't fix it!

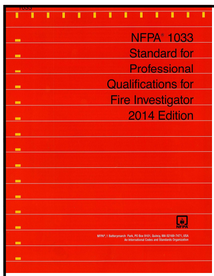
The theme for this presentation is presented by that great philosopher

Mr. ED

You can lead a human to knowledge, but you can't make him think!

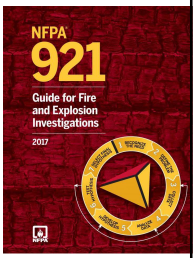
Thinking Is That Bridge Between

Knowledge and Application

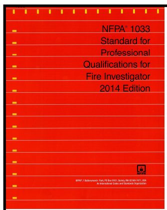


QUALIFICATIONS

VS

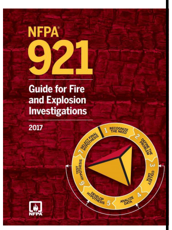


METHODOLOGY



REQUIREMENTS TO BE!
WHAT ACTIVITY TO DO!

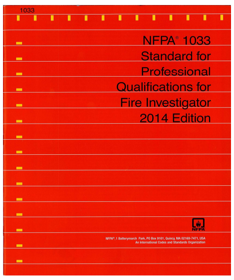
VS



HOW!
(APPLICATION)

NFPA 1033

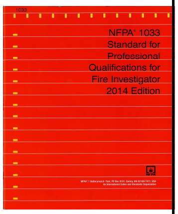
1987
1993
1998
2003
2009
2014

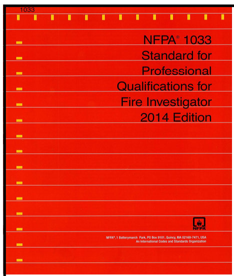


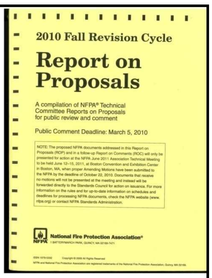
General Outline of 1033

4 Chapters

- **1 - Administration**
- **2 - Reference Publications**
- **3 – Definitions (4 New)**
- **4 - Fire Investigator**
- **Annex A, B, and C**
- **16 Pages**







NFPA 1033 had 56 Public Inputs

- ***Most involved two areas***
  - ***1.3.8 – The 16 subject knowledge topics***
  - ***Levels of Fire Investigator***

SCOPE OF 1033

1.1 – This standard identifies the *minimum* professional level of job performance requirements for Fire Investigators

PURPOSE OF 1033

1.2 – The purpose of this standard *shall* be to specify the minimum job performance requirements for *serving* as a fire investigator in both the *private and public sectors*.

CHAPTER 1

In addition to scope and purpose, 1.3 lays out the general requirements to be a fire investigator.

1.3 GENERAL

LISTS 8 REQUIREMENTS

1. **Shall be at least 18 years old**
2. **Shall have a high school diploma**

1.3.3 GENERAL

LISTS 8 REQUIREMENTS

3. Shall conduct a thorough background and character investigation prior to accepting an individual as a candidate for certification as a fire investigator

Certifications Depend on 921 and 1033!

1.3.4 GENERAL

LISTS 8 REQUIREMENTS

4. JPR’s shall be completed in accordance with established practices and procedures or as they are defined by law or the AHJ.

JOB PERFORMANCE REQUIREMENTS
(JPR'S)

DEFINED:

– ***"A STATEMENT THAT DESCRIBES A SPECIFIC JOB TASK, LISTS THE ITEMS NECESSARY TO COMPLETE THE TASK, AND DEFINES MEASURABLE OR OBSERVABLE OUTCOMES AND EVALUATION AREAS FOR THE SPECIFIC TASK."***

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JOB PERFORMANCE REQUIREMENTS
(JPR'S)

DEFINED:

– ***"A STATEMENT THAT DESCRIBES A SPECIFIC JOB TASK, LISTS THE ITEMS NECESSARY TO COMPLETE THE TASK, AND DEFINES MEASURABLE OR OBSERVABLE OUTCOMES AND EVALUATION AREAS FOR THE SPECIFIC TASK."***

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REQUISITE KNOWLEDGE

Fundamental knowledge one must have in order to perform a specific task.

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REQUISITE SKILLS

The essential skills one must have in order to perform a specific task.

1.3.5 GENERAL

LISTS 8 REQUIREMENTS

5. The JPR's listed are not required to be mastered in the order they appear.

1.3.6 GENERAL

LISTS 8 REQUIREMENTS

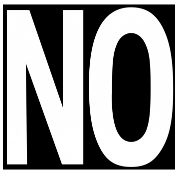
6. Evaluation of JPR's <u>shall</u> be by individuals who are qualified and approved by the AHJ.

1.3.7 GENERAL

LISTS 8 REQUIREMENTS

7. **The investigator shall have and maintain, at a minimum, an up-to-date basic knowledge of the following topics beyond a high school level:**

Is a college degree required?



1.3.7 GENERAL

LISTS 8 REQUIREMENTS

1. **Fire Science**
2. **Fire Chemistry**
3. **Thermodynamics**
4. **Thermometry**
5. **Fire Dynamics**
6. **Explosion Dynamics**
7. **Computer Fire Modeling**

1.3.7 GENERAL

LISTS 8 REQUIREMENTS

8. **Fire Investigation**
9. **Fire Analysis**
10. **Fire Investigation Methodology**
11. **Fire Investigation Technology**
12. **Hazardous Materials**
13. **Failure analysis and analytical tools**

1.3.7 GENERAL

LISTS 8 REQUIREMENTS

14. **Fire Protection Systems**
15. **Evidence Documentation, Collection, and Preservation**
16. **Electricity and Electrical Systems**

1.3.7 GENERAL

New Annex material added

A1.3.7

A discussion of how basic up-to-date information on these topics can be found in the current edition of NFPA 921.

THE APPLICATION OF NFPA 921:

1.3.5 This document is not intended as a comprehensive scientific or engineering text. Although many scientific and engineering concepts are presented within the text, the user is cautioned that these concepts are presented at an elementary level and additional technical resources, training, and education may often need to be utilized in an investigation.

1.3.8 GENERAL

LISTS 8 REQUIREMENTS

8. **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 publications and journals.**

1. FIRE SCIENCE

- **NFPA 921 3.3.67 Definition: 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.**
- **NFPA 921 Chapter 5 Basic Fire Science: Whole chapter addresses this issue.**
- **Section 5.1.1: "The fire investigator should have a basic 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."**

Chapter 5 Basic Fire Science

5.1.1 Fire and Energy. Fire is a rapid oxidation process, which is an exothermic chemical reaction, resulting in the release of heat and light energy in varying intensities. It is therefore important that the fire investigator understands the basic concepts of energy, power, and radiant heat flux, and how the units of measurement of these properties are used to describe the behavior of fire.

Chapter 5 Basic Fire Science

5.1.2 Energy. Energy is a property of matter that is manifest as an ability to perform work, either by moving over a distance or by transferring heat. Energy can be changed in form (e.g., from chemical to mechanical energy), or transferred to other matter, but it can neither be created nor destroyed. Energy is measured in joules (J) or calories (cal) or British Thermal Units (Btu). A joule is the heat produced when one ampere is passed through a resistance of one ohm for one second, or it is the work required to move over a distance of one meter against a force of one newton. A calorie is the amount of energy required to raise the temperature of 1 g of water by 1 °C (from 14 to 15 °C); a calorie is equal to 4.184 J. A Btu is the quantity of heat required to raise the temperature of one pound of water 1 °F at the pressure of 1 atmosphere and temperature of 60 °F; a British thermal unit is equal to 1055 joules, and 252.15 calories

Chapter 5 Basic Fire Science

5.1.3 Power. Power is a property that describes energy released *per unit time*. The same amount of energy is required to carry a load up a flight of stairs whether the person carrying it walks or runs, but more power is needed for running because the work is done in a shorter amount of time. Raising the temperature of a volume of water requires the same amount of energy whether the temperature increase takes place in 10 seconds or in 10 minutes. Raising the temperature more quickly requires that the energy be transferred more quickly. Power is measured in joules per second (J/s) or watts (W).

Chapter 5 Basic Fire Science

5.1.4 Heat flux. Heat flux is a property that describes the amount of power *per unit area*. A kilowatt spread over one square meter is approximately equal to the radiant heat flux outdoors on a sunny day. If that same kilowatt is concentrated using a magnifying glass and only spread over .05 m^2 (500 cm^2), there may be sufficient energy transferred to that area to cause ignition of combustibles. Heat flux is measured in kW/m^2 or W/cm^2.

Chapter 5 Basic Fire Science

5.2.3.4* Diffusion flames can only occur for certain concentrations of the mixture components. The lowest oxygen concentration in nitrogen is termed the limiting oxygen index (LOI). For most fuel vapors, the LOI is in the range of 10 percent to 14 percent by volume at ordinary temperatures (Beyler 2002). Similarly, the fuel gas stream can be diluted with nitrogen or other inert gas to the extent where burning is no longer possible. For example, methane diluted with nitrogen to below 14 percent methane will not burn with air at normal temperatures. An under-ventilated compartment fire may behave like a large diffusion flame. In a ventilation-controlled compartment fire, oxygen concentrations can drop to near zero at locations away from sources of ventilation. This will limit flaming combustion within the compartment.

Chapter 5 Basic Fire Science

5.3.9 Smoke production rates are generally less in the early phase of a fire but increase greatly shortly before and with the onset of flashover, if flashover occurs. At the beginning of a fire, there is an abundance of oxygen, but after flashover, the fire usually becomes significantly under-ventilated. This can be demonstrated by putting a glass over a candle and observing increased smoke production due to reducing oxygen in the volume surrounding the flame.

Chapter 5 Basic Fire Science

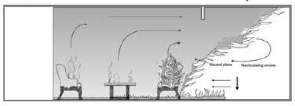
5.5.5.3.4* Most fire science calculations involving temperature require that specific units of temperature be used (typically Kelvins or degrees Celsius). It is important to understand the particular equation and know what units are required to ensure accurate results.

Chapter 5 Basic Fire Science

5.10.2.7*

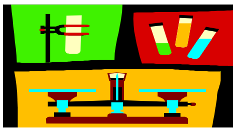
If the air flow into the compartment is not sufficient to burn all of the combustibles being pyrolyzed by the fire, the fire will shift from fuel controlled (i.e., where the heat release rate of the fire depends on the amount of fuel involved) to ventilation controlled (i.e., where ~~all~~ the ~~fuel is on fire, and the~~ heat release rate is controlled by the amount of oxygen available). In a ventilation-controlled fire, the hot gas layer will contain reduced oxygen levels. Fires that reach full room involvement can produce high levels of unburned pyrolysis products and carbon monoxide, and ~~very~~ low levels of oxygen (e.g., 0–5 percent). *(See Figure 5.10.2.7 for an example of a ventilation-controlled fire.)*

Figure 5.10.2.7 Postflashover or Full Room Involvement in a Typical Compartment Fire. Although pyrolysis can continue throughout the compartment, flaming combustion will only occur where there is sufficient oxygen present. Depending on the momentum of the entraining air, flaming combustion may occur within the ventilation stream at various depths into the compartment.



2. FIRE CHEMISTRY

- **5.2.1 Defines Fire Chemistry: "The study of chemical processes that occur in fire, including changes of state, decomposition, and combustion."**
- **The remaining subsections discuss these various components.**



3. THERMODYNAMICS

The branch of physics that deals with the relationship between heat and other forms of energy.
(New definition in the 2017 edition of NFPA 921)

- **The following sections discuss this topic:**
  - **5.5 Heat Transfer**
  - **5.6.3 Heat Release Rate**
  - **5.6.4.5 Flame Height**

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4. THERMOMETRY

5.5.5* Thermometry.
Thermometry is the study of the science, methodology, and practice of temperature measurement. Though thermometry is seldom, if ever, needed at the fire scene, it is frequently used during postscene analysis, or in cases of fire safety or code compliance, in which the various physics or thermodynamic formulae present themselves.
Four main temperature scales: Fahrenheit, Celsius, Rankin and Kelvin

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5.5.5* Thermometry

Celsius – H2O Freezes @ 0C

Rankin – H2O Freezes @ 491.67R

Kelvin – H2O Freezes @ 273.15K

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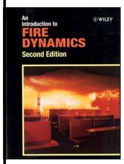
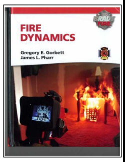
5.5.5* Thermometry

F to C - C=5/9(F-32)
C to F - F=(9/5C)+32
F to R - R=F+460
R to F - F=R-460
F to K - K=5/9(F-32)-273
K to F - F=9/5(K-32)+273



5. FIRE DYNAMICS



- **3.3.61 Defines Fire Dynamics: "The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior."**
- **Chapter 5 Basic Fire Science discusses principles related to fire dynamics.**
- **Chapter 6 Fire Patterns discusses principles related to fire pattern development which is a component of fire dynamics.**
- **18.2.1.2: "Fire spread scenarios within a compartment or building should be analyzed using principles of fire dynamics presented in Chapter 5 (Basic Fire Science) and fire pattern development in Chapter 6 (Fire Patterns)."**

Chapter 6 Fire Patterns

6.2.11 Clean Burn. A clean burn is a distinct and visible fire effect generally apparent on non-combustible surfaces after combustible layer(s) (such as soot, paint, and paper) have been burned away. ~~A~~ The effect may also appear where soot has failed to deposit because of high surface temperatures. A fire exposure to the surface can produce a clean area adjacent to areas darkened by products of combustion, as shown in Figure 6.2.11(a) and Figure 6.2.11(b) . Clean burn patterns produced by burning away of soot can be produced by direct flame contact or intense radiated heat. Smoke deposits on surfaces are subject to oxidation. The dark char of the paper surface of gypsum wallboard, soot deposits, and paint can be oxidized by continued flame exposure. The carbon will be oxidized to gases and disappear from the surface. *[See Figure 6.2.11(c) .]*

Chapter 6 Fire Patterns

Chapter 6 Fire Patterns

6.2 Fire Effects

6.2.11.1 Although they can be indicative of intense heating in an area, clean burn areas by themselves do not necessarily indicate areas of origin, though such patterns should be carefully examined. Clean burning that results from ventilation will usually occur after the fire has become ventilation-controlled. Such late-developing patterns may be misleading in origin determination, see Figure 6.2.11.1(A) and (B). The lines of demarcation between the clean burned and darkened areas may be used by the investigator to determine direction of fire spread or differences in intensity or time of burning. Determinations as to the direction of fire spread based on such patterns should be accompanied by a determination as to the likely mode of the pattern generation.

Chapter 6 Fire Patterns

6.3.3.2.5
Holes in floors may be caused by glowing combustion, radiation, ignitible liquid, or effects of ventilation. The surface below a liquid remains cool (or at least below the boiling point of the liquid) until the liquid is consumed. Holes in the floor from burning ignitible liquids may result when the ignitible liquid has soaked into the floor or accumulated below the floor level. Evidence other than the hole or its shape is necessary to confirm the cause of a given pattern.

Chapter 6 Fire Patterns

IGNITABLE LIQUIDS

6.3.5.2* Research has shown that the burning of ignitible liquids is rarely the sole cause of floor penetrations.

A.6.3.5.2 For more information see Mealy, Benfer and Gottuk, *Fire Dynamics and Forensic Analysis of Liquid Fuel Fires* , NCJ 238704, 2011, available at NCJRS.gov

Chapter 6 Fire Patterns

6.4.1.2.1

Every fire pattern in a fully involved compartment should be analyzed to determine whether it could have resulted from ventilation. Patterns that can be accounted for in terms of ventilation may provide little insight into the behavior of the fire in its early stages.

6. EXPLOSION DYNAMICS

Chapter 23 Explosions discusses all aspects of explosion dynamics with explanations of types of explosions, various categories of damage and various effects.

7. COMPUTER FIRE MODELING

Section 22.4 discusses "Mathematical Modeling". This has various forms and addresses many aspects, such as: heat transfer analysis, flammable gas concentrations, hydraulic analysis, thermodynamic chemical equilibrium analysis, structural analysis, egress analysis, fire dynamics analysis, specialized fire dynamics routines, zone models and field, and computational fluid dynamic models.

8. FIRE INVESTIGATION

- **Section 3.3.59 Definition: "The process of determining the origin, cause and development of a fire or explosion."**
- **All of NFPA 921 is dedicated to this topic.**

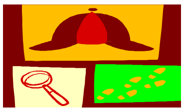
9. FIRE ANALYSIS

Section 3.3.59 Definition: "The process of determining the origin, cause, development, responsibility, and when required, a failure analysis of the fire or explosion."

Like number eight, most of NFPA 921 is dedicated to this topic.

10. FIRE INVESTIGATION METHODOLOGY

Chapter 4 Basic Methodology discusses the Scientific Method and Systematic Approach. The Scientific Method is the methodology that courts around the country are referencing as they evaluate expert testimony in Daubert and similar motions to exclude or limit.



4.1 GENERAL

- **4.1.1 THE INVESTIGATOR SHALL MEET THE JPR'S AS DEFINED IN 4.2 THROUGH 4.7.**
- **4.1.2 SHALL EMPLOY ALL ELEMENTS OF THE SCIENTIFIC METHOD AS THE OPERATING ANALYTICAL PROCESS THROUGH-OUT THE INVESTIGATION AND FOR THE DRAWING OF CONCLUSIONS.**

THE APPLICATION OF NFPA 921:

1.3.2 -" ...this document is not designed to encompass all the necessary components of a complete investigation or analysis of any one case. The scientific method, however, should be applied in every instance."

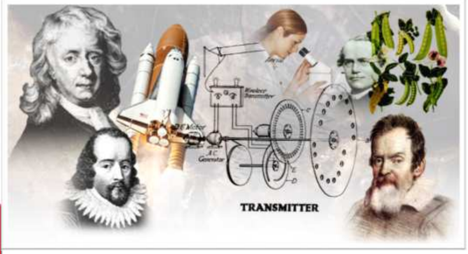
2017 EDITION

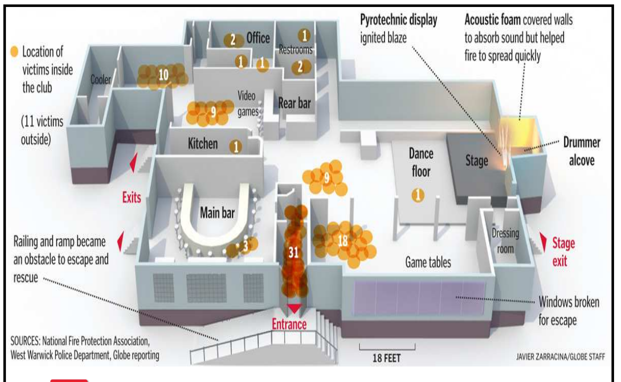
Definitions: Revised

Scientific Method: ***The systematic pursuit of knowledge involving the recognition and definition of a problem; the collection of data through observation and experimentation; analysis of the data; the formulation, evaluation and testing of ~~a hypothesis~~ hypotheses; and when possible, the selection of a final hypothesis.***

THE FUNDAMENTAL PREMISE OF Fire Investigation:

" THE SCIENTIFIC METHOD"





SCIENTIFIC METHOD

RECOGNIZE THE NEED

DEFINE THE PROBLEM

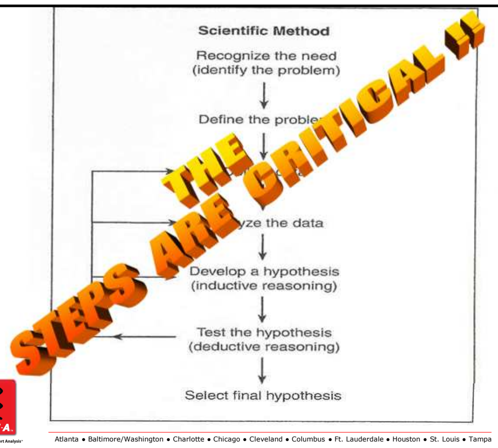
COLLECT DATA

ANALYZE THE DATA

DEVELOP A HYPOTHESIS

TEST THE HYPOTHESIS

SELECT FINAL HYPOTHESIS



OVERALL METHODOLOGY

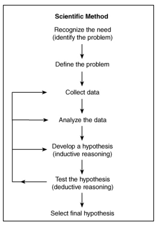


Figure 4.3

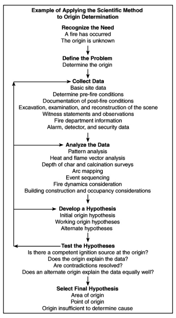


Figure 18.2

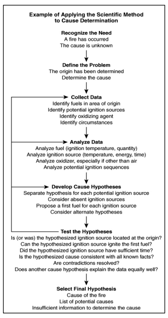


Figure 19.2

S·E·A Scientific Expert Analysis

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COLLECT DATA

S·E·A Scientific Expert Analysis

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"I have no data yet. It is a capital mistake to theorizes before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Sherlock Holmes "A Scandal in Bohemia"

S·E·A Scientific Expert Analysis

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COLLECT DATA

Interviews

Fire Patterns **Arc Mapping**

Fire Dynamics **Background**

Photographs **Lab Results**

Drawings

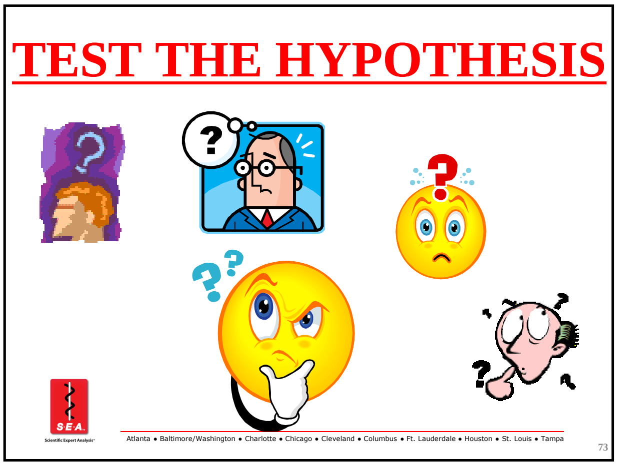
EVERYTHING

ANALYZE THIS

DEVELOP HYPOTHESIS

WORKING HYPOTHESIS

INITIAL HYPOTHESIS


TEST THE HYPOTHESIS
S-E-A
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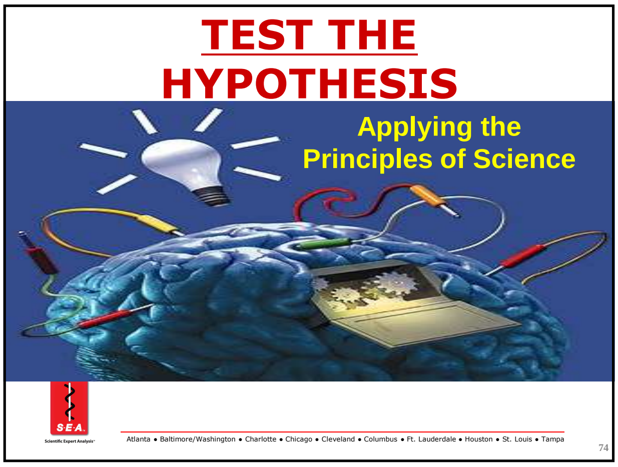
TEST THE
HYPOTHESIS
Applying the
Principles of Science
S-E-A
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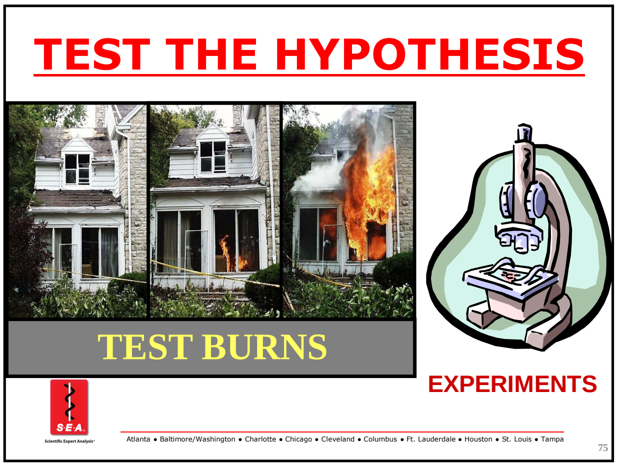
TEST THE HYPOTHESIS
TEST BURNS
EXPERIMENTS
S-E-A
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TEST THE HYPOTHESIS

BENCH TESTS

PHYSICAL EXAMINATION AND ANALYSIS

19.6.4 MEANS OF HYPOTHESES TESTING

- ***Scientific literature***
- ***Fundamental principles of science***
- ***Physical experiments or testing***
- ***Cognitive experiments***
- ***Time lines***
- ***Fault trees***
- ***Failure Analysis & Analytical Tools***

4.3.6 TESTING THE HYPOTHESIS
(DEDUCTIVE REASONING)

The investigator does not have a valid or reliable conclusion unless the hypothesis can stand the test of careful and serious challenge. Testing of the hypothesis is done by the principle of deductive reasoning, in which the investigator compares the hypothesis to all known facts as well as the body of scientific knowledge associated with the phenomena relevant to the specific incident. Testing of hypothesis should be designed to disprove, or refute, the hypothesis. This may also be referred to as falsification of the hypothesis. Working to disprove a hypothesis occurs when an attempt is made to find all the data, or reasons, why the hypothesis is not supported, or not true, rather than simply finding and relying on data that support the hypothesis , or why the hypothesis is true. This method of testing the hypothesis can prevent "confirmation bias," which can occur when the hypothesis or conclusion relies only on supporting data (see Section on Confirmation Bias). .....

4.3.6.1

Any hypothesis that is incapable of being tested either physically or analytically, 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.

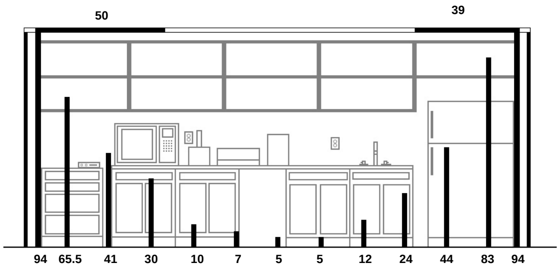
4.3.9* CONFIRMATION BIAS

Different hypotheses may be compatible with the same data. When using the scientific method, testing of hypotheses should be designed to disprove the hypothesis (falsification of the hypothesis), rather than relying only on confirming data that support the hypotheses.. Confirmation bias occurs when the investigator relies exclusively on data that supports the hypothesis and fails to look for, ignores, or dismisses contradictory, or non-supporting data. The same data may support alternate or even opposing hypotheses. The failure to consider alternate or opposing hypotheses, or prematurely discounting seemingly contradictory data without analysis and testing can result in incorrect conclusions. A hypothesis can be said to be valid only when rigorous testing has failed to disprove the hypothesis. Disproving the hypothesis is a process in which all the evidence is compared against the proffered hypothesis in an effort to find why the hypothesis is not true.

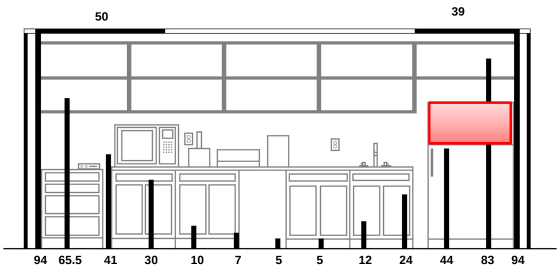
4.3.7 Select Final Hypothesis

The final step in applying the Scientific Method is to Select the final hypothesis. Once the hypothesis has been tested, the investigator should review the entire process, to ensure that all credible data are accounted for and all feasible alternate hypotheses have been considered and eliminated. When using the Scientific Method, the failure to consider alternate hypotheses is a serious error. A critical question to be answered is, “Are there any other hypotheses that are consistent with the data?” The investigator should document the facts that support the final hypotheses to the exclusion of all other reasonable hypotheses.

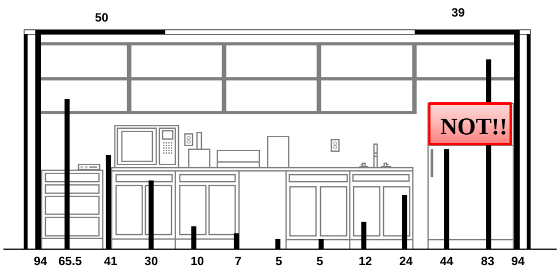
Animal Hospital Fire



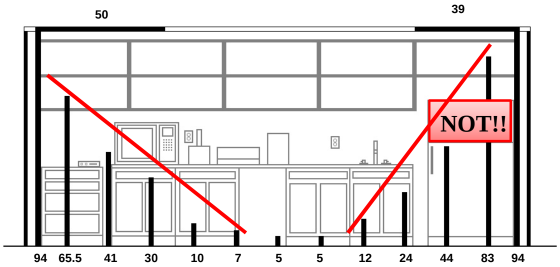
Plaintiff Theory



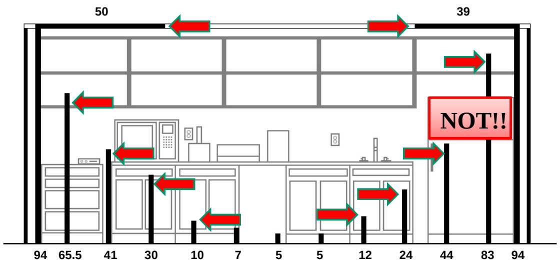
Plaintiff Theory



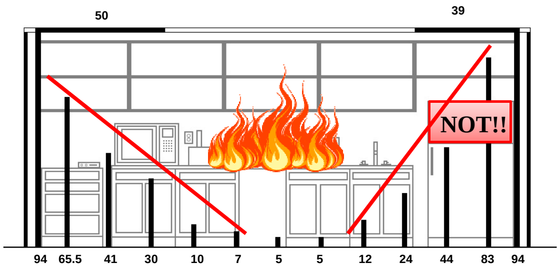
Origin Analysis



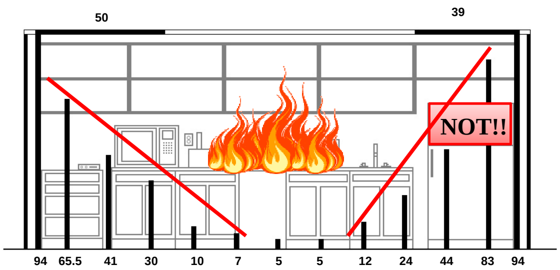
Heat and Flame Vector Analysis



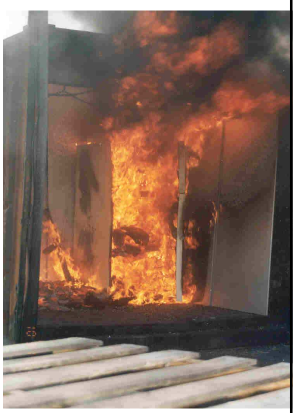
Origin Analysis



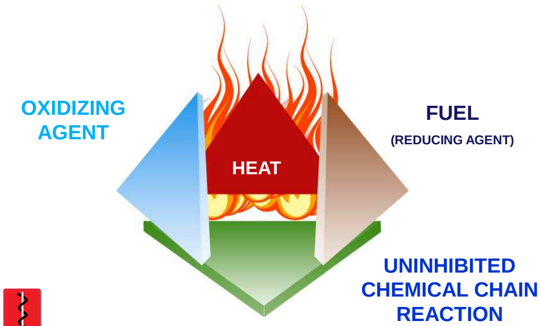
Origin Analysis



Testing The Hypothesis



FIRE TETRAHEDRON TEST



SELECT FINAL HYPOTHESIS

ONLY

PASSED CAREFUL AND SERIOUS CHALLENGE

AFTER

11. FIRE INVESTIGATION TECHNOLOGY

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.

Added to the definitions of 1033

11. FIRE INVESTIGATION TECHNOLOGY

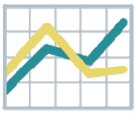
- All of NFPA 921 discusses the technology of fire investigation.
- Sections such as 18.4.3.2 (Measuring Depth of Char) and 22.4 (Computer Modeling) are just examples of specific technology discussed.

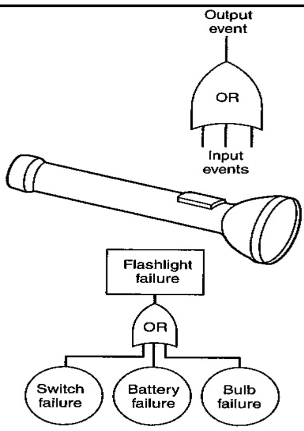
12. HAZARDOUS MATERIAL

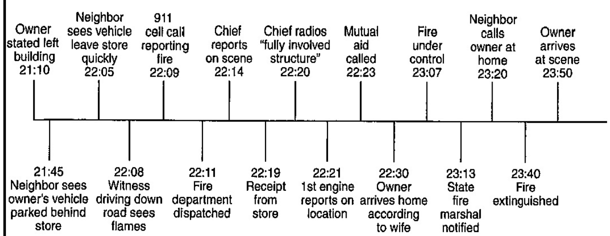
- Chapter 13 Safety discusses various aspects of Hazardous Material.
- NFPA 471 and 472 are specific documents that also address this topic.

13. Failure Analysis and Analytical Tools

Chapter 22 is dedicated to this specific topic. This chapter addresses such topics as timelines, system analysis, mathematical modeling and fire tests.

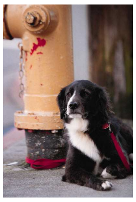






14. Fire Protection Systems

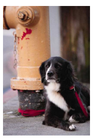
A new chapter (8) is being added to NFPA 921 on Fire Protection Systems for the 2014 Edition



Chapter 8 Fire Protection Systems

This chapter provides a basic understanding of active fire protection systems, which includes general information, key components, operational and installation parameters, data gathering, and analysis. Passive fire protection systems are addressed in chapter 7. It is important to have a basic knowledge of fire protection systems and their performance during an incident, in order to understand the role of the system and potential impact on the fire.

Chapter 8 Fire Protection Systems



8.1 - Introduction
8.2 - Documentation of Fire Protection Systems
8.3 - Fire Alarm Systems
8.4 - Water-Based Fire Suppressions Systems
8.5 - Non-Water-Based Fire Suppressions Systems
8.6 - Spoliation Issues

- ***This chapter was completely reorganized with a significant number of color images added.***

Chapter 8 Fire Protection Systems

8.2 - Fire Alarm Systems
- ***8.2.1 - General Information***
- ***8.2.2 - Key Components of Systems***
- ***8.2.3 - Operations and Installation Parameters of the System***
- ***8.2.4 - Analysis***

8.3 - Water-Based Fire Suppression Systems
- ***8.3.1 - General Information***
- ***8.3.2 - Key Components of Water-Based Systems***
- ***8.3.3 - Operations and Installation Parameters of the System***
- ***8.3.4 - Analysis***

Chapter 8 Fire Protection Systems

8.4 - Non-Water-Based Systems
- ***8.4.1 - General Information***
- ***8.4.2 - Key Components of Systems***
- ***8.4.3 - Operations and Installation Parameters of the System***
- ***8.4.4 - Analysis***

8.5 - Documentation of Fire Protection Systems
- ***8.5.1 - Design Documentation***
- ***8.5.2 - Permit History***
- ***8.5.3 - Invoices and Contracts***
- ***8.5.4 - Installation Documentation***
- ***8.5.5 - Inspection and Maintenance Records***
- ***8.5.6 - Product Literature***
- ***8.5.7 - Alarm / Activation History***

8.6 - Spoliation Issues

Chapter 8 Fire Protection Systems

8.1.4

The documentation and analysis of active fire protection systems often needs the technical assistance of engineers or technical specialists. The movement, manipulation, energizing, and de-energizing of system components may result in the destruction of critical data. The loss of this data may hinder the analysis and formulation of origin and cause hypotheses and might be considered spoliation of evidence. Even if the scope of an investigator's assignment does not include the analysis of the fire protection systems, the documentation and analysis of those systems may be important to other interested parties, so the preservation of those systems is critical.

15. Evidence Documentation, Collection, and Preservation

Chapter 12 Legal Considerations

Chapter 16 Documentation of the investigation

Chapter 17 Physical Evidence

Many other chapters discuss documentation of various evidence related issues.

15. Evidence Documentation, Collection, and Preservation

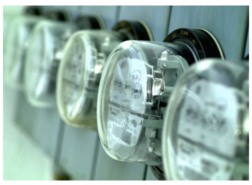
Issues such as:

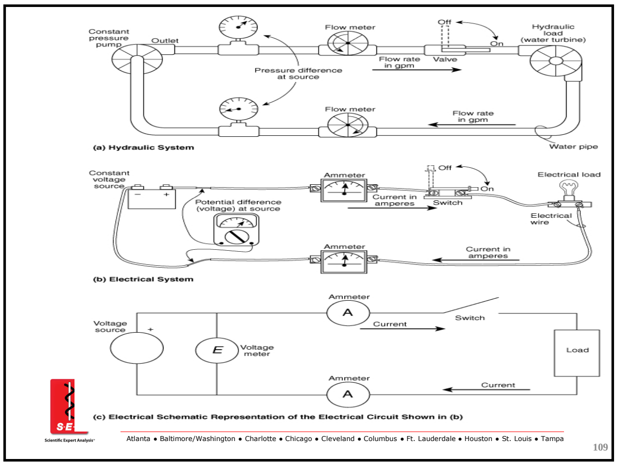
Photographs
Diagrams
Measurements
Labeling
Packaging
Chain of Custody
Spoliation

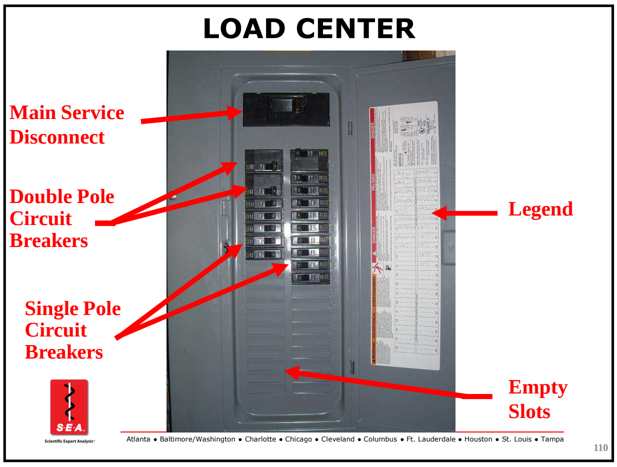
16. Electricity and Electrical Systems

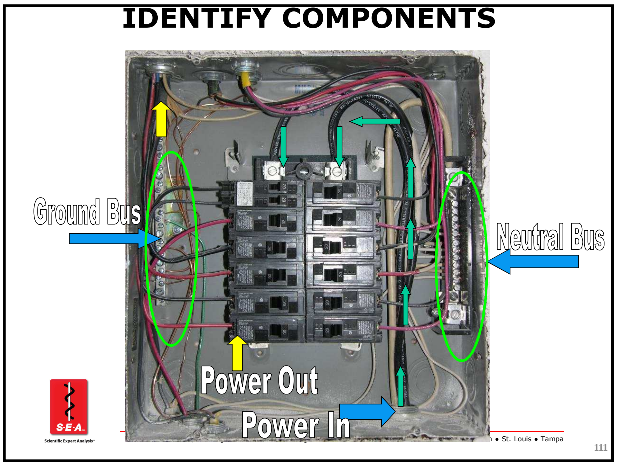
Chapter 9 Electricity and Fire

Chapter 26 Appliances




Constant pressure pump
Outlet
Flow meter
Off
On
Hydraulic load (water turbine)
Flow rate in gpm
Valve
Pressure difference at source
Flow meter
Flow rate in gpm
(a) Hydraulic System
Water pipe
Constant voltage source
Ammeter
Off
On
Electrical load
Potential difference (voltage) at source
Current in amperes
Switch
Electrical wire
Ammeter
Current in amperes
(b) Electrical System
Ammeter
A
Current
Switch
Voltage source
E
Voltage meter
Load
Ammeter
A
Current
(c) Electrical Schematic Representation of the Electrical Circuit Shown in (b)
Atlanta • Baltimore/Washington • Charlotte • Chicago • Cleveland • Columbus • Ft. Lauderdale • Houston • St. Louis • Tampa
109


LOAD CENTER
Main Service Disconnect
Double Pole Circuit Breakers
Single Pole Circuit Breakers
Legend
Empty Slots
Atlanta • Baltimore/Washington • Charlotte • Chicago • Cleveland • Columbus • Ft. Lauderdale • Houston • St. Louis • Tampa
110


IDENTIFY COMPONENTS
Ground Bus
Neutral Bus
Power Out
Power In
• St. Louis • Tampa
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Chapter 9 Electricity

9.6.3.4 Ground Fault Circuit Interrupter (GFCI).
In newer installations, a GFCI is required for specific circuits, such as those serving bathrooms, kitchens, and outside receptacles. All GFCIs are required to have a built-in test function for periodic testing. GFCIs are required to trip when an imbalance of 4–6 ma is detected. This level of current is deemed appropriate to avoid the inability to "let-go" of a live circuit. The GFCI is intended for bathrooms, patios, kitchens, or other locations where a person might be electrically grounded while near or using electrical appliances.

9.6.3.4.1 Ground Fault Circuit Interrupter (GFCI). GFCIs can be found in the following configurations:

(1) ***Portable GFCI.*** GFCI not connected to the buildings electrical distribution panel and intended to provide GFCI protection — ground fault only, not overcurrent — for those instances where a GFCI is required but not provided within a building.
(2) ***Receptacle type.*** Electrical current is supplied by an electrical distribution panel to the GFCI. The GFCI provides ground fault protection – not overcurrent protection — at that location and all duplex outlets located downstream of the GFCI receptacle.
(3) ***Circuit breaker–type GFCIs*** *located within the distribution panel.* This type of GFCI provides ground fault and overcurrent protection to devices downstream from the panel.

Chapter 9 Electricity

9.6.3.5 Arc Fault Circuit Interrupter (AFCI).

AFCIs are designed to ~~protect against~~ mitigate fires caused by arcing faults in home electrical wiring. The AFCI circuitry continuously monitors current flow. AFCIs use special circuitry to discriminate between normal and unwanted arcing conditions. Once an unwanted arcing condition is detected, the control circuitry in the AFCI opens the internal contacts, thus de-energizing the circuit and reducing the potential for a fire to occur. An AFCI should not trip during normal arcing conditions, which can occur when a switch is opened or a plug is pulled from a receptacle. Depending upon when the device was installed, *NFPA 70*, ~~*National Electrical Code*, requires that bedroom circuits be protected by AFCI circuit breakers~~ may have required that a branch circuit supplying outlets or devices in kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas be protected by an AFCI.

9.10.3.1 ARCING THROUGH CHAR

9.10.3.1 Studies of the arcing through char process in energized (AC), unloaded PVC, non-metallic sheathed cable (NM cable) exposed to a radiant heat source yielded the following conclusions:

(1) The general, physical appearance of arc beads was consistent over a wide range of heat fluxes. [See Figure 9.10.3.1(a) and Figure 9.10.3.1(b).] All arc beads resulting from this mass transfer were visually identified as arc melting based on the characteristics listed in 9.11.1.

(2) The lack of oxygen present in flashover conditions will neither prevent arc beads from forming nor impact the time required to create the arc bead. The physical appearances of the arc beads formed in normal and depleted oxygen environments were all similar and visually identified as arc melting based on the characteristics listed in 9.11.1. [See Figure 9.10.3.1(a), Figure 9.10.3.1(b), and Figure 9.10.3.1(c).]

9.10.3.1 ARCING THROUGH CHAR

9.10.3.1 Studies of the arcing through char process in energized (AC), unloaded PVC, non-metallic sheathed cable (NM cable) exposed to a radiant heat source yielded the following conclusions:

(3) Tests on cloth sheathed NM cable, which does not utilize PVC insulation, produced arc beads similar in appearance to the PVC NM cable tests; however, in some tests a visible arc bead was not observed despite tripping overcurrent protection.

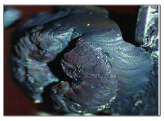
(4) Arcing through char can occur at voltages as low as 30 volts (RMS). The time to form the conductive path, create the arc bead, and trip the overcurrent protection within a timeframe of investigative interest (i.e., minutes vs. hours) generally occurred with voltages in excess of 60 volts (RMS).

(There is an * associated to 9.10.3 to see research)

Chapter 9 Electricity

9.10.4.1: Overheating in Duplex Receptacles

Overheating of poor electrical connections in duplex receptacles can lead to glowing connections [see Figure 9.10.4(d)]. Persistence of glowing connections can produce distinct evidence including melted copper conductors around steel screw terminals [see Figure 9.10.4.1(a)], severed copper conductors at or near the screw head [see Figure 9.10.4.1(b)], and enlarged screw heads due to severe corrosion [see Figure 9.10.4.1(c)] . These types of evidence are unique in appearance compared to melting and arcing events from external fire exposure. Poor connections may also exist at the point where the male plug blade contacts the internal receiver, or bus, of the duplex receptacle. The investigator should also find evidence of a loose or poor electrical connection.



Chapter 9 Electricity

9.10.7 * Insulation Damage.

Electrical insulation is rated to withstand a certain maximum operating voltage. If this voltage is exceeded, the insulation may break down (i.e., an electric discharge could pass through the solid material, permanently damaging it and causing a temporary fault path during the event). Insulation materials are normally specified to resist voltages above the intended operating voltage, including a safety margin. However, mechanical damage to the insulation is likely to reduce the dielectric breakdown strength. If the reduction is so large that the breakdown strength falls below the operating voltage, then a dielectric breakdown can be expected. Damaged insulation may have a breakdown strength above the normal operating voltage, yet below the voltage of some surges that might occur. In such cases, breakdown will occur only when a surge of sufficient magnitude is experienced.

9.10.7.1 * Hammer Mis-Hits.

If a hammer is used to install electric cables, a mis-hit may occur whereby the installer strikes the cable instead of the staple with the hammer. This can result in difficult-to-see damage to the wire insulation. For some mis-hits, the dielectric strength of the damaged cable can become lower than expected surge voltages. This can create arcs and a potential fire when a high-voltage surge occurs, which could happen long after the original installation.

Chapter 9 Electricity

9.11 Identification of Arc Melting of Electrical Conductors. Melted electrical conductors can be examined to determine if the damage is evidence of electrical arcing, melting by fire, or eutectic melting. Visual examination can provide reliable identification of damage from electrical arcing and melting by fire for most conductors. However, more advanced examination techniques including SEM/EDS examinations, X-ray, CT scanning (i.e., X-ray computed tomography), cross-sectioning and polishing, or other metallurgical methods could assist in discerning between damage by electrical arcing and melting by fire. Paragraph 9.11.1.1 and 9.11.2 identify characteristic traits commonly exhibited in arc-damaged conductors and fire-melted conductors, respectively. Using multiple characteristic traits and contextual information (e.g., damage to other components) when identifying damaged conductors provides greater confidence in the evaluation of that damage .

Chapter 9 Electricity

9.12.8.2 Lightning ~~Bolt~~ Characteristics.
Typical lightning channels have a core of energy plasma 12.7 mm to 19 mm (½ in. to ¾ in.) in diameter, surrounded by a 102 mm (4 in.) thick channel of superheated ionized air. Lightning return stroke currents average between 30,000 A and 45,000 A depending upon location, but can exceed 200,000 A. Potentials can range up to 15,000,000 V.

9.12.8.3.1
Lightning tends to strike the tallest object on the ground in the path of its discharge. Lightning enters structures in four ways may strike any object that generates a successful upward-going streamer connecting with the dart leader generated from the cloud. This may be the tallest object but could also be the perimeter of a roof that is not the tallest item on the structure. Lightning threats to a structure consist of the following :

(1) By striking a metallic object like a TV antenna, a cupola, or an air-conditioning unit extending up and out from the building roof A direct strike to the structure or an item attached to the structure, such as a TV antenna, air-conditioning unit, and so forth, extending up and out from the building roof)
(2) By directly striking the structure A strike near a structure that couples energy onto internal conductors
(3) By hitting a nearby tree or other tall structure and moving horizontally to the building A direct strike to incoming conductors connected to the structure
(4) By striking nearby overhead conductors and by being conducted into buildings along the normal power lines A strike near overhead conductors that can couple lightning currents onto conductors connected to the structure

Chapter 9 Electricity

9.12.8.4 Lightning Damage.
Damage by lightning is caused by two characteristic properties: first, the extremely high currents and energy in a lightning strike; and second, the extremely high heat energy and temperatures generated in the channel by the electrical discharge. (A) through (D) are examples of these effects.

(A) Occasionally a tree may be shattered by the explosive action of the lightning stroke striking the tree and the heat immediately lightning current being conducted deeper into the tree's heartwood with the heat vaporizing the moisture in the tree into steam, causing explosive effects.

(B) Copper conductors not designed to carry the thousands of amperes of a lightning strike may be melted, severed, or completely vaporized by the overcurrent effect of a lightning discharge. Lightning currents may also generate overvoltages that trigger power system overcurrents sufficient to sever conductors in one or numerous locations. Properly sized and routed copper and aluminum conductors (in accordance with NFPA 780) will not be damaged by up to a 200,000 A lightning impulse current.

(C) When lightning strikes a steel-reinforced concrete building, the current may follow the steel reinforcing rods as the least resistive path . The high energy may destroy the surrounding concrete with explosive forces to get to the reinforcing steel.

(D) Lightning can also cause fires by damaging fuel gas systems. Fuel gas appliance connectors have been known to have their flared ends damaged by electrical currents induced by lightning and other forms of electrical discharge. When gas lines are damaged, fuel gas can leak, and the same arcing that caused the gas line to fail may also cause ignition of the fuel gas.

FIGURE 9.10.4(b) Overheated Connections on Two-Pole Circuit Breakers.

FIGURE 9.10.4(c) Overheated Connection on 240 V Dryer Outlet.

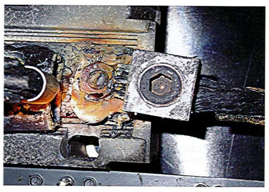


FIGURE 9.10.4(a) Overheated Connection on 208 V 3-Phase Fuse Terminal.

CHAPTER 4 FIRE INVESTIGATOR

- DIVIDED INTO 7 MAJOR SECTIONS
- SECTION 1 IS GENERAL
- SECTIONS 2 THROUGH 7 HAVE *THREE* BASIC PARTS:

  1. THE ACTIVITY
  2. REQUISITE KNOWLEDGE
  3. REQUISITE SKILL

7 SECTIONS OF CHAPTER 4

1. GENERAL
2. SCENE EXAMINATION
3. DOCUMENTING THE SCENE
4. EVIDENCE COLLECTION / PRESERVATION
5. INTERVIEW
6. POST-INCIDENT INVESTIGATION
7. PRESENTATIONS

*4.2 SCENE EXAMINATION

Duties shall include inspecting and evaluating the fire scene, and /or *conducting a comprehensive review of documentation generated during the original examination of the scene* if the scene is no longer available, so as to determine the area or point of origin, source of ignition, material ignited and act or activities that brought the ignition source and materials together and to assess the subsequent progression, extinguishment , and containment of the fire.

A.4.2 (NEW ANNEX ITEM)

Documents reviewed when the scene is not otherwise available may include but not limited to incident reports, notes, photographs, diagrams and sketches, evidence, witness statements, test results, laboratory reports and other information that would assist in the determination of the origin and cause.

4.2 SCENE EXAMINATION

- **4.2.1 Secure the fire ground**
- **4.2.2 Conduct exterior survey**
- **4.2.3 Conduct interior survey**
- **4.2.4 Interpret fire patterns**
- **4.2.5 Interpret and analyze fire patterns**
- **4.2.6 Examine and remove fire debris**
- **4.2.7 Reconstruct the area of origin**
- **4.2.8 Inspect the performance of building systems**
- **4.2.9 Discriminate the effects of explosions from other types of damage**

4.2 SCENE EXAMINATION

4.2.2 Conduct exterior survey

Conduct an exterior survey, given standard equipment and tools, so that evidence is *identified and* preserved, fire damage is interpreted, hazards are identified to avoid injuries, accessibility to the property is determined, and all potential means of ingress and egress are discovered.

4.2 SCENE EXAMINATION

4.2.4 Interpret fire patterns

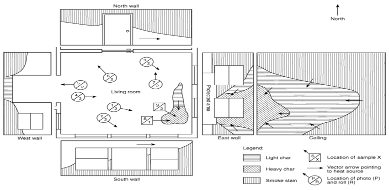
Interpret fire patterns, given standard equipment and tools and some structural or content remains, so that each individual pattern is evaluated with respect to the burning characteristic of the material involved; *and each pattern evaluated in context and relationship with all patterns observed and the mechanisms of heat transfer that lead to the formation of the pattern*.

4.3 DOCUMENTING THE SCENE

Duties shall include *diagramming the scene, photographing, and taking field* notes to be used to compile a final report.

4.3 DOCUMENTING THE SCENE

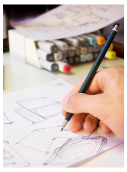
4.3.1 Diagram the scene
4.3.2 Photographically document the scene
4.3.3 Constructive investigative notes



4.3 DOCUMENTING THE SCENE

4.3.1 Diagram the scene

Diagram the scene, given standard tools and equipment, so that the scene is accurately represented and evidence, pertinent contents, significant patterns, and area(s) or point(s) of origin are identified.



DRAWINGS & DIAGRAMS
(NFPA 921 Section 16.4)

- Clear and concise
- Assist the investigator
- Provide support and detail
- Assist with interviews

Should be prepared in all cases that are expected to be involved in litigation!

4.3 DOCUMENTING THE SCENE

4.3.2 Photographically document the scene

Photographically document the scene, given standard tools and equipment, so that the scene is accurately depicted and the photographs support scene findings.

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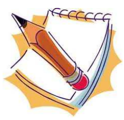
4.3 DOCUMENTING THE SCENE

4.3.3 Construct investigative notes

Construct investigative notes, given a fire scene, available documents (e.g., prefire plans and inspection reports), and interview information, so that the notes are accurate, provide further documentation of the scene, and represent complete documentation of the scene finding.



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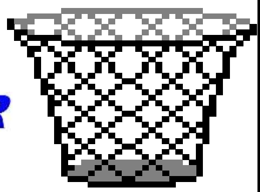
WHAT DO I DO WITH MY NOTES?

OR



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NFPA 921 16.3.4

The retention of original notes, diagrams, photographs and measurements........*Is the best practice*.

Unless otherwise required by a written policy or regulation, such data *should be retained*.

4.4 EVIDENCE COLLECTION/ PRESERVATION

5 SECTIONS DEALING WITH EVIDENCE COLLECTION / PRESERVATION:

4.4.1 UTILIZING PROPER PROCEDURES
4.4.2 LOCATE, COLLECT AND PACKAGE
4.4.3 SELECT EVIDENCE FOR ANALYSIS
4.4.4 MAINTAIN CHAIN OF CUSTODY
4.4.5 DISPOSAL OF EVIDENCE

4.4 EVIDENCE COLLECTION/ PRESERVATION

<u>DUTIES SHALL INCLUDE</u>:

Using proper physical and legal procedures to *~~retain~~ identify, document, collect and preserve* evidence required with the investigation

4.4.1 EVIDENCE COLLECTION/ PRESERVATION

<u>Utilize proper procedures</u> **for managing victims and fatalities, given a protocol and appropriate personnel, *<u>so that all</u>* evidence is discovered and preserved and the protocol procedures are followed.**

4.4.1 EVIDENCE COLLECTION/ PRESERVATION

4.4.1 (A) REQUISITE KNOWLEDGE

Types of evidence associated with fire victims and fatalities and evidence preservation methods

4.4.1 EVIDENCE COLLECTION/ PRESERVATION

4.4.1 (B) REQUISITE SKILLS

Observation skills and ability to apply protocols to given situations.

4.4.2* EVIDENCE COLLECTION/ PRESERVATION

Locate, *document,* collect*,* *label* & package *and store* evidence, given standard or special tools & equipment & evidence collection materials, so that evidence is identified, preserved, collected, & packaged *and stored for use in testing, legal or other proceedings and examinations, ensuring cross contamination* and investigator-inflicted damage *to evidentiary items is avoided* and the chain of custody is established.

4.4.2 EVIDENCE COLLECTION / PRESERVATION

4.4.2 (A) REQUISITE KNOWLEDGE

TYPES OF EVIDENCE , AUTHORITY REQUIREMENTS, IMPACT OF REMOVING EVIDENTIARY ITEMS ON CIVIL OR CRIMINAL PROCEEDINGS (EXCLUSIONARY OR FIRE-CAUSE SUPPORTIVE EVIDENCE), TYPES, CAPABILITIES, AND LIMITATIONS OF STANDARD & SPECIAL TOOLS USED TO LOCATE EVIDENCE, TYPES OF LABORATORY TESTS AVAILABLE, PACKAGING TECHNIQUES & MATERIALS, AND IMPACT OF EVIDENCE COLLECTION ON THE INVESTIGATION.

4.4.2 EVIDENCE COLLECTION / PRESERVATION

4.4.2 (B) REQUISITE SKILLS

ABILITY TO RECOGNIZE DIFFERENT TYPES OF EVIDENCE AND DETERMINE WHETHER EVIDENCE IS CRITICAL TO THE INVESTIGATION.

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4.4.2 EVIDENCE COLLECTION / PRESERVATION

4.4.2 (ANNEX A)*

FIRE INVESTIGATORS SHOULD DETERMINE AND IDENTIFY IN ADVANCE WHAT AUTHORITY AND SPECIFIC NEED EACH MAY HAVE TO SEIZE AND HOLD ITEM (S) CONSIDERED TO BE EVIDENCE, WHERE SUCH AUTHORITY OR NEED IS LACKING, THE ITEMS SHOULD NOT BE SEIZED.

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4.4.3 EVIDENCE COLLECTION/ PRESERVATION

Select evidence for analysis given all information from the investigation, so that items for analysis support specific investigation needs

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4.4.3 EVIDENCE COLLECTION/ PRESERVATION

4.4.3 (A) REQUISITE KNOWLEDGE

Purposes for submitting items for analysis, types of analytical services available, and capabilities and limitations of the services performing the analysis

4.4.3 EVIDENCE COLLECTION/ PRESERVATION

4.4.3 (B) REQUISITE SKILLS

Evaluate the fire incident to determine forensic, engineering, or laboratory needs.

4.4.4 EVIDENCE COLLECTION/ PRESERVATION

Maintain a chain of custody, given standard investigative tools, marking tools, and evidence tags or logs, so that written documentation exists for each piece of evidence and evidence is secured.

4.4.4 EVIDENCE COLLECTION/ PRESERVATION

4.4.4 (A) REQUISITE KNOWLEDGE

Rules of custody and transfer procedures, types of evidence (e.g., physical evidence obtained at the scene, photos, and documents), and methods of recording the chain of custody.

4.4.4 EVIDENCE COLLECTION/ PRESERVATION

4.4.4 (B) REQUISITE SKILLS

Ability to execute the chain of custody procedures and accurately complete necessary documents.

4.4.5 EVIDENCE COLLECTION/ PRESERVATION

Disposal of evidence, given jurisdictional or agency regulations and file information, so that the disposal is timely, safely conducted, and in compliance with jurisdictional or agency requirements.

4.4.5 EVIDENCE COLLECTION/ PRESERVATION

4.4.5 (A) REQUISITE KNOWLEDGE

Disposal services available and common disposal procedures and problems.

4.4.5 EVIDENCE COLLECTION/ PRESERVATION

4.4.5 (B) REQUISITE SKILLS

Documentation skills

4.5 INTERVIEWS

Duties shall include obtaining information regarding the overall fire investigation from others through verbal communication.

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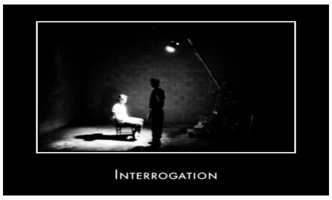
4.5 INTERVIEWS

4.5.1 Develop an interview plan
4.5.2 Conduct interviews
4.5.3 Evaluate interview



4.6 POST-INCIDENT INVESTIGATION

Duties shall include the investigation of all factors beyond the fire scene at the time of the origin and cause determination.

4.6 POST-INCIDENT INVESTIGATION

4.6.1 Gather reports and records
4.6.2 Evaluate the investigative file
4.6.3 Coordinate expert resources
4.6.4 Establish evidence as to motive and/or opportunity, given an incendiary fire
4.6.5 Formulate an opinion concerning origin, cause, or responsibility for the fire

4.7 PRESENTATIONS

Duties shall include the presentation of findings to those individuals not involved in the actual investigations.

4.7 PRESENTATIONS

4.7.1 Prepare a written report
4.7.2 Express investigative findings
4.7.3 Testify during legal proceeding
~~**4.7.4 Conduct public informational presentations**~~

4.7 PRESENTATIONS

4.7.1 Prepare a written report

Prepare a written report, given investigative findings, documentation, and a specific audience, so that the report accurately reflects the investigative findings, in concise, expresses the investigator's opinion, contains facts and data that the investigator relies on in rendering an opinion, contains the reasoning of the investigator by which each opinion was reached and meets the needs or requirements of the intended audience(s).

4.7 PRESENTATIONS

4.7.2 Express investigative findings.

Express investigative findings verbally, given investigative findings, notes a time allotment, and a specific audience, so that the information is accurate, the presentation is completed within the allotted time, and the presentation includes only need-to-know information for the intended audience.

4.7 PRESENTATIONS

4.7.3 Testify during legal proceeding.

Testify during legal proceedings, given investigative findings, contents of reports, and consultation with legal counsel so that all pertinent investigative information and evidence are presented clearly and accurately and the investigators demeanor and attire are appropriate to the proceedings.

REPORTS AND TESTIMONY

The Single biggest problem with reports and testimony……

It is not enough to just do a good investigation!

You MUST be able to ARTICULATE that good investigation!

YOU BEING EXCLUDED!

Some days all you can do is smile and wait for some kind soul to come pull your ass out of the bind you've gotten yourself into.

Adverse Lawyer's Goal

- ***Ultimate Goal is Exclusion of Expert***
  - ***Win case on Summary Judgment***
- ***Secondary Goal***
  - ***Build list of "negatives"***
  - ***Build video clips to discredit expert in opening statement***
    - ***Create unfavorable "first impression" with the jury***

Increase in *Daubert* Challenges

Between 2010 and 2012 = 2,000+ cases where expert opinions were challenged under Daubert

Between 2012 and 2014 = 6,000+ cases

Daubert challenges are standard practice

Increase in *Daubert* Challenges

Heightened emphasis on and need for expert testimony in fire litigation

Courts take a closer look at the expert's methodologies

NFPA 921 and the scientific method are taking center stage in their analysis

How Lawyers Build the Case for Your Exclusion

- ***Expert not qualified to give the specific opinions to which the investigator intends to testify***
- ***The opinions are not the product of a reliable methodology***

Your report may have to stand on it's own!

State of GA v. Gibson

The foundation for evidence based on a scientific principle or technique requires two findings regarding the evidence's reliability: such evidence is admissible upon a showing by the party offering the evidence that (1) the general scientific principles and techniques involved ... are valid and capable of producing reliable results[,]" and (2) the person performing the test "substantially performed the scientific procedures in an acceptable manner.

Your report may have to stand on it's own!

State of GA v. Gibson

The closest thing in the report to discussing the use of NFPA 921 is the following statement: "In accordance with the guidance set forth in NFPA 921, the Guide for Fire and Explosion Investigation, 2014 Edition, this fire can be classified as intentionally set." However, this does not show that Mr. applied the methodology reliably. "The mere assertion that [an expert] applied ... NFPA 921 is insufficient to establish that [his opinion] is based on the methods and procedures of science rather than on subjective belief or unsupported speculation." *United States v. Zhou*, WL 4067103, at *6 (D.N.J. Aug. 25, 2008). Although, Mr. testified about his methods in greater detail in the hearing, that is not enough for this Court to find that he met the second portion of the test to be qualified as an expert witness.

Your report may have to stand on it's own!

State of GA v. Gibson

The facts of this case can be likened to a grade school math problem: in order to receive credit the student must not only get the right answer, but must also show their work as to how they achieved that answer. Mr. achieved an answer in this case, but failed to show how he used NFPA 921 to get to that answer. Therefore, this Court cannot find that Mr. substantially performed the scientific procedures in an acceptable manner. As such, the State's proposed expert opinion evidence must be excluded.

Your report may have to stand on it's own!

State of FL v. Laurel

This Court determines that the State's witness lacks the requisite scientific knowledge to offer a reliable or relevant opinion as to materials combustion analysis. testimony is not supported by sufficient facts or data, or the product of reliable principles or methodology. The Court further determines that the witness does not possess any technical or specialized knowledge to permit any non-scientific expert opinion about any materials combustion or what should have been found in the debris if a particular item was consumed in the fire. Finally, this Court does not find that possesses the requisite training or qualifications to render any such opinion. As the State's expert appears to be offering a "pure opinion" which is explicitly no longer a valid opinion under F.S. 90.702 or the applicable Daubert/Kimbro standards, this Court determines that his opinion lacks probative value as it would tend to mislead, prejudice or confuse the jury.

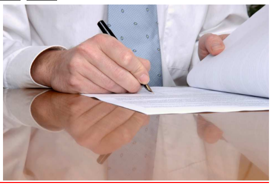
Reports

Neither NFPA 1033 nor 921 prescribes a specific report format. However, it does provide you some information about what a report should contain.

Chapter 16 Documentation

16.5 Reports

The final step in the documentation of the investigation may be the preparation and submittal of a report. The format and content of the report will depend on the needs of the organization or client on whose behalf the investigation was performed. Therefore, no report format is prescribed here. However, for guidance on court-mandated reports, see Chapter 12.



Chapter 16 Documentation

16.5.1 Purpose

The purpose of a written report is to document an accurate and concise reflection of the investigator's findings. The report should contain facts and data that the investigator can rely on to render any opinions and should contain the investigator's reasoning of how each opinion was reached. The report should meet the needs or requirements of the intended audience(s). Reports may be used for: improvement of public safety, prevention of similar future incidents, the basis for criminal or civil litigation, the basis for insurance claims, or simply documentation of the facts for the record. (See A.4.3.6 of NFPA 1033 .)

16.5.2 Report Organization
16.5.3 Descriptive Information
16.5.4 Opinions and Conclusions
16.5.5 Pertinent Facts
16.5.6 Reference to Methodology

When the investigator states that the scientific method was used (see Section 4.3) to determine origin and cause, the report should give sufficient detail to show that the methodology was indeed used and not just cited.

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16.5.3 OPINIONS AND CONCLUSIONS

- **The report should contain the opinions and conclusions rendered by the investigator.**
- **The report should also contain the foundation (s) on which the opinion and conclusions are based.**
- **The name, address and affiliation of each person who has rendered an opinion contained in the report should be provided.**

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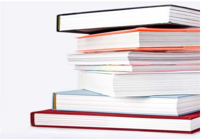
12.4.2.4 Reports

The Federal Rules of Civil Procedures and some state courts may require an expert to prepare a report prior to deposition or trial. This is commonly referred to as a Rule 26 Report.



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12.4.2.4 REPORTS

1. List of material reviewed and investigative activities conducted.
2. List of opinions.
3. Bases for those opinions.
4. List of your publications, last 10 years.
5. List of testimony, last 4 years.
6. Compensation.

18.6.1.3 Means of Hypothesis Testing (Origin Chapter)

Ultimately, the investigator should be able to ***explain*** how the growth and development of a fire, starting at the hypothesized origin, is consistent with the data.

Explain in a report!

19.7.1 Establishing the fire cause (Cause chapter)

In establishing a fire cause, the investigator should ***describe it*** in terms of competent ignition source providing enough heat to ignite the first fuel, and the circumstances of how they came together.

Describe in a report!

3 Annex's

A. Explanatory Material.

Not part of the requirements.
For information purposes only.

B. Explanation of the Standard and Concepts of JPRS

Not part of the requirements.

C. Informational References

What about my CV?

A CV is NOT a resume
A CV is a fairly detailed overview of your life's accomplishments
A "living document" that is updated frequently
A CV includes

- *Name and business contact information*
- *Education*
  - *a list of your degrees earned or in progress, institutions, and years of graduation. You may also include the titles of your dissertation or thesis here.*
- *Grants, Honors and Awards*
- *Publications and Presentations:*
- *Employment and Experience:*
- *Scholarly or Professional Memberships:*
- *List of depositions and expert testimony*

Your CV and the "16 points"

You will likely be asked about the "16 points" in a deposition

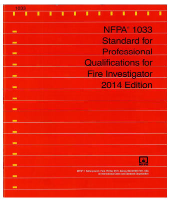
- *Will likely be an effort to discredit you*

Be prepared

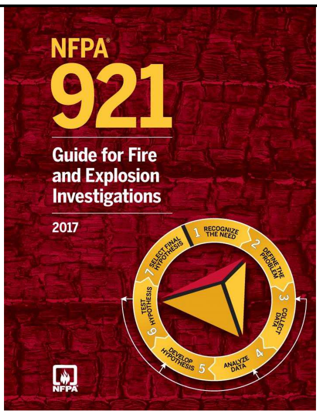
Use your CV to document where you had education or training in each of the 16 areas.

The more prepared you are, the less time you are likely to spend on these areas

NFPA 1033 ACTION PLAN

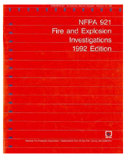


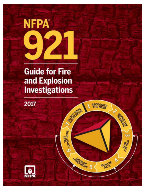
- ***Know what you know***
- ***Know what you don't know***
- ***Develop a plan to fill in the gaps***



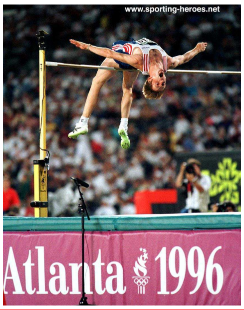
THE HISTORY OF 921

- 1992 Edition
- 1995 Edition
- 1998 Edition
- 2001 Edition
- 2004 Edition
- 2008 Edition
- 2011 Edition
- 2014 Edition
- 2017 Edition





Raising the Bar

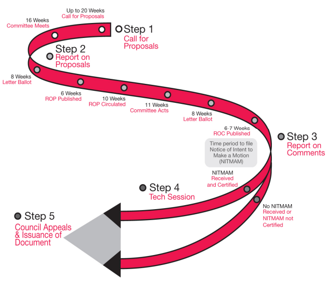


921 REVISION CYCLE

Public Input
- •Closed January, 2015
- •Posted September,2015

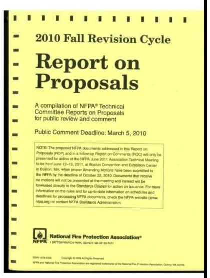
Comments
- •Closed November, 2015
- •Posted June, 2016

Document Issued
- •November, 2016
- •Available March, 2017



921 Public Input
(First Draft)

- *Public notice issued with closing date.*
- *Anyone can submit a proposal (except staff).*
- *Proposals can request any change.*
- *Reasons for change must be provided.*
- *Forms are on the website*
- *All proposals must be acted on.*



2010 Fall Revision Cycle

Report on Proposals

A compilation of NFPA® Technical Committee Reports on Proposals for public review and comment

Public Comment Deadline: March 5, 2010

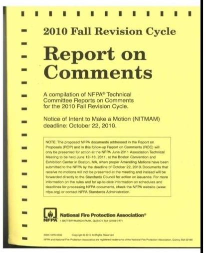
NOTE: The proposed NFPA documents addressed in this Report on Proposals (ROP) and in a follow-up Report on Comments (ROC) will only be presented for action at the NFPA June 2011 Association Technical Meeting to be held June 12–15, 2011, at Boston Convention and Exhibition Center in Boston, MA, when proper Amending Motions have been submitted to the NFPA by the deadline of October 22, 2010. Documents that receive no motions will not be presented at the meeting and instead will be forwarded directly to the Standards Council for action on issuance. For more information on the rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org) or contact NFPA Standards Administration.

National Fire Protection Association®

283 PI's

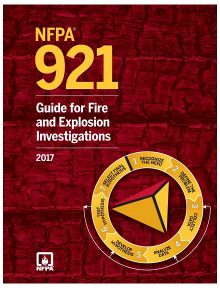
921 Comments
(Second Draft)

- ***Anyone can make a comment on a proposal.***
- ***The comment must be on a proposal.***
- ***Reason for comment must be provided.***
- ***Forms are on the website.***
- ***There is a deadline for submission.***
- ***Every comment must be acted on by the committee.***



53 Comments

2017 EDITION



More Color Images throughout
Chapter 1 - NFIRS
Definitions: 12 new and 5 revised
Chapter 5 Fire Science
Chapter 8 Fire Protection Systems
Chapter 9 Electrical
Chapter 16 Documentation
Chapter 18 Origin
Chapter 19 Cause
Chapter 20 Explosions (Dust)
Chapter 27 Vehicles
426 Pages – 30 Chapters
204 Definitions

FIGURE 6.2.6.1 Heat-Induced Color Change to Stucco.

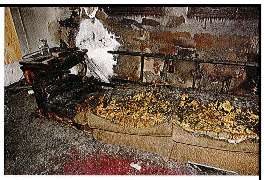


FIGURE 6.2.11(b) Clean Burn Pattern on Wallboard Behind Sofa.

FIGURE 6.3.7.8.3(a) Irregular Burn Patterns on a Floor of a Room Burned in a Test Fire in Which No Ignitible Liquids Were Used.

FIGURE 6.3.7.8.3(c) "Pool-Shaped" Burn Pattern Produced by a Cardboard Box Burning on an Oak Parquet Floor.

FIGURE 6.3.7.8.3(d) Irregular Pattern on Carpet.

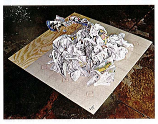


FIGURE 6.3.7.8.3(e) Test Burn on Vinyl Tiles.

FIGURE 6.3.7.8.3(f) Irregular Pattern Created from Test Burn of Newspapers on Vinyl Tiles.

FIGURE 6.3.7.8.4(a) Comparison of Fire Patterns Resulting From 0.5L Spills of Three Different Fuel Types on Three Different Substrates. Fuels Include Denatured Alcohol (left), Gasoline (center), and Kerosene (right). Substrates Include Oriented Strand Board (top), Plywood (center), and Vinyl, (bottom).

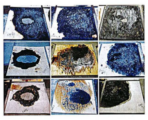


FIGURE 6.3.7.8.4(b) Comparison of Fire Patterns Resulting From Three Different Class A Fuels on Three Different Substrates. Class A Materials Include Wood Crib (left), Polyurethane Foam (center), and Thermoplastic (right). Substrates Include Carpet (top), Plywood (center), and Vinyl (bottom).

1.1 Scope

1.1.1 The completion of a United States National Fire Incident Reporting System (NFIRS) are outside the scope of this guide.

1.1.2 This guide considers NFIRS reports as incident reports and not as investigation reports. The information contained in NFIRS report should generally be considered as the preliminary report of the fire department concerning any fire or explosion incident. An NFIRS report should not be used as a fire investigation report.

1.1 Scope

Committee Statement:

A NFIRS report is not a comprehensive fire investigation report, is generally not completed by a trained fire investigator and does not meet the documentation requirements of NFPA 921. The National Association of State Fire Marshals has reported that many fire service personnel have significant concerns in completing NFIRS reports due to their perception that they will be held to the NFPA 921 guidelines. Therefore, some of the fire service personnel are reporting fires and explosions as unknown even when there is clear indicators and information available to establish the causal factors of an incident.

2017 EDITION

Definitions: New

Fire Area:* *The boundary of fire effects within a scene in which the area of origin will be located. The fire area is characterized by identifying the border between damaged and undamaged areas characterized by fire effects and patterns created by flame, heat and smoke.

Thermodynamics:* *The branch of physics that deals with the relationship between heat and other forms of energy.

Heat Transfer:* *The exchange of thermal energy between material through conduction, convection and /or radiation.

2017 EDITION

Definitions: New

Active Fire Protection System:* *A system that uses moving mechanical or electrical parts to achieve a fire protection goal.

Energy:* *Energy is a property of matter that is manifest as an ability to perform work, either by moving an object against force or by transferring heat.

2017 EDITION

Definitions: New

Explosible: ***A material with a pressure ratio (maximum pressure/pressure at ignition, in absolute units) equal to or greater than 2.0 in any test when tested using the explosibility or go/no-go screening test described in Section 13 of ASTM E1226, Standard Test Method for Explosibility of dust Clouds.***

Explosion Dynamics: ***The detailed study of how chemistry, physics, fire science, the engineering disciplines of fluid and solid mechanics, and heat transfer interact to influence explosion behavior.***

2017 EDITION

Definitions: New

Fire Effects: ***The observable or measurable changes in or on a material as a result of a fire.***

****Hybrid Mixture:*** ***An explosible heterogeneous mixture, comprising gas with suspended solid or liquid particulates, in which the total flammable gas concentration is ≥ 10 percent of the lower flammable limit (LFL) and the total suspended particulate concentration is ≥ 10 percent of the minimum explosible concentration MEC).***

2017 EDITION

Definitions: New

Minimum Explosible Concentration (MEC): ***The minimum concentration of a combustible dust cloud that is capable of propagating a deflagration through a uniform mixture of the dust and air under the specific conditions of test.***

Passive Fire Protection System: ***Any portion of a building or structure that provides protection from fire or smoke without any type of system activation or movement***

Power: ***Power is a property of a process such as fire that describes the amount of energy that is emitted, transferred, or received per unit time. Power is measured in joules per second (J/s) or watts (W)***

2017 EDITION

Definitions: Revised

***Heat Flux:** The measure of the rate of heat transfer to a surface or an area, typically expressed in kW/m², W/cm²*

***Incendiary Fire:** A fire that is intentionally ignited in an area or under circumstances where and when there should not be a fire.*

2017 EDITION

Definitions: Revised

***Overload:** Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.*

2017 EDITION

Definitions: Revised

***Point of Origin:** The exact physical location within the area of origin where a heat source and a fuel first interact, resulting in a fire or explosion.*

***Radiant Heat:** Heat energy carried by electromagnetic waves that are longer than visible light wave and shorter than radio waves; radiant heat (electromagnetic radiation) increases the sensible temperature of any substance capable of absorbing the radiation, especially solid and opaque objects.*

Chapter 11 Human Behavior

11.3.1.2 Cognitive Comprehension Limitations.

Cognitive comprehension limitations, which may affect an individual's ability to recognize and react ~~appropriately~~ to the hazards presented by a fire or an explosion incident, include age ~~(as it relates to~~ and mental comprehension~~)~~ level , level of rest, alcohol use, ~~drug use~~ (legal or illegal) drug use , developmental disabilities, mental illness, and inhalation of smoke and toxic gases. These cognitive limitations are more likely to affect an individual's ability to ~~accurately~~ assess the hazards presented by a fire or explosion. Often, such limitations account for delayed or inappropriate responses to such hazards. Children may fail to recognize the a hazard and choose an inappropriate response, such as hiding or seeking a parent. Many times a victim may be affected by multiple agents (e.g., alcohol ingested in a pre-ignition period and carbon monoxide in a post-ignition period). Investigators should carefully assess all possibilities before making assumptions. Behavior that is often determined to be inappropriate may be due to confusion caused by toxic gases.

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12.3.5.1 RESPONSIBILITY
(UNDER THE SPOLIATION SECTION)

It is the responsibility of the investigator (or anyone who handles or examines evidence) to avoid spoliation of evidence, and the scope of that responsibility varies according to such factors as the investigator's jurisdiction, whether he or she is a public official or private sector investigator, whether criminal conduct is indicated, and applicable laws and regulations. However, regardless of the scope and responsibility of the investigation, care should be taken to avoid destruction or material destruction of evidence that later may be considered spoliation. If artifacts will be altered, the investigator should use the techniques contained in this guide to preserve the evidentiary value of those items for others who may later examine the artifacts.

S·E·A
Scientific Expert Analysis™

12.3.5.6 ALTERATION AND MOVEMENT OF EVIDENCE
(UNDER THE SPOLIATION SECTION)

Fire investigation usually requires the movement of evidence or alteration of the scene. In and of itself, such movement of evidence or alteration of the scene should not be considered spoliation of evidence. Physical evidence may need to be moved prior to the discovery of the cause of the fire. Additionally, it is recognized that it is sometimes necessary to remove the potential causative agent from the scene and even to carry out some disassembly in order to determine whether the object did, in fact, cause the fire, and which parties may have contributed to that cause. For example, the manufacturer of an appliance may not be known until after the unit has been examined for identification. Such activities should not be considered spoliation. Because all interested parties may not be identifiable prior to the alteration or movement of evidence, the investigator should use the techniques contained in this guide to preserve the evidentiary value of those items by documenting the fire scene and the artifacts prior to alteration or movement to preserve the evidentiary value of those items for others who may later become involved in the investigation.

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Chapter 13 Safety

Change:

From

MSDS (Material Safety Data Sheets)

to

SDS (Safety Data sheets)

Chapter 15 Planning

15.2.8.2

The investigator, the private-sector investigator in particular, should recommend to the client that they need to notify all identifiable interested parties who may have a legal interest in the investigation of the inspection and give them the opportunity to participate or witness and record such activities. (See Section 12.3 and ASTM E-860, Standard Practice for Examining and Preparing Items that Are or May Become Involved in Criminal or Civil Litigation.)

Chapter 16 Documentation

16.1 Introduction

16.1.1: The goal in documenting any fire or explosion investigation is to make an accurate recording of the investigation using media that will allow investigators to recall and communicate their observations at a later date. Common methods of accomplishing this goal include the use of photographs, video, diagrams, maps, overlays, audio recordings, laser surveys, digital and handwritten, notes, sketches, and reports.

16.1.2: Thorough and accurate documentation of the investigation is critical, because compilation of factual data is necessary to support and verify investigative opinions and conclusions. There are a number of resources to assist the investigator in documenting the investigation.

16.2 Photography

16.2.1 General
16.2.2 Timing
16.2.3 Basics
16.2.4 Understanding the Parts of a Camera
16.2.5 Lighting
16.2.6 Special Types of Photography
16.2.7 Video
16.2.8 Suggested Activities to Be Documented
16.2.9 Photograph Tips
16.2.10 Presentation of Photograph

Chapter 16 Documentation

16.3 Note Taking

Note taking is a method of documentation in addition to drawings and photographs.

- 16.3.1 Forms of Incident Field Notes
- 16.3.2 Forms for Collecting Data
- 16.3.3 Dictation of Field Notes

16.4 Diagrams and Drawings

- 16.4.1 Types of Drawings
- 16.4.2 Selection of Drawings
- 16.4.3 Drawing Tools and Equipment
- 16.4.4 Diagram Elements
- 16.4.5 Drawings
- 16.4.6 Prepared Design and Construction Drawings

Chapter 16 Documentation

16.3.2 Forms for Collecting Data

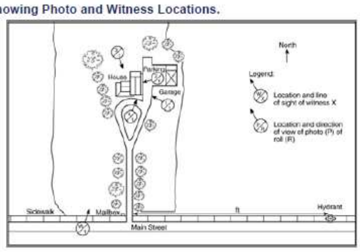
Table 16.3.2 Field Notes and Forms

Form	Purpose
Fire incident field notes	Any fire investigation to collect general incident data
Casualty field notes	Collection of general data on any victim killed or injured
Wildfire field notes	Data collection specifically for wildfire
Evidence form	Documentation of evidence collection and chain of custody
Vehicle inspection form	Data collection of incidents specifically involving motor vehicles
Photograph log	Documentation of photographs taken during the investigation
Electrical panel documentation	Collection of data specifically relating to electrical panels
Structure fire notes	Collection of data concerning structure fires
Insurance information	Documentation of insurance coverage for fire loss
Records/documents	Documentary records considered in the investigation
Compartment fire modeling	Collection of data necessary for compartment fire modeling

Chapter 16 Documentation

16.4 Diagrams and Drawings

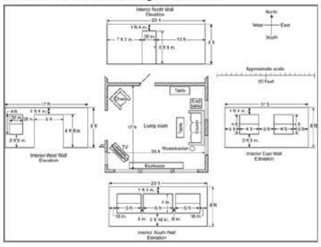
Figure 16.4.2(a) Site Plan Showing Photo and Witness Locations.



Chapter 16 Documentation

16.4 Diagrams and Drawings

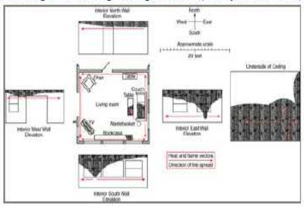
Figure 16.4.2(c) Diagram of Room and Contents Showing Dimensions.



Chapter 16 Documentation

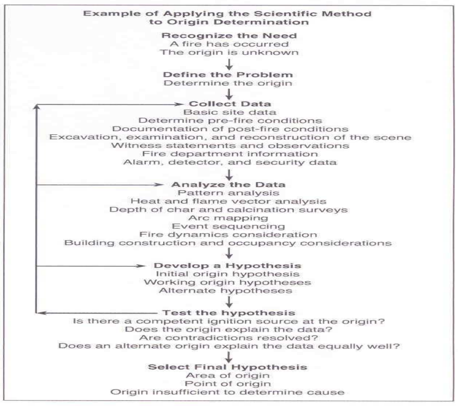
16.4 Diagrams and Drawings

Figure 16.4.2(d) Exploded Room Diagram Showing Damage Patterns, Sample Locations, and Photo Locations.



Chapter 18 Origin Determination

This chapter <u>recommends a methodology to follow</u> in determining the origin of a fire. The area of origin is defined as a structure, part of a structure, or general geographic location within a fire scene, in which the "point of origin" of a fire or explosion is reasonably believed to be located. The point of origin is defined as the <u>exact physical location</u> within the area of origin where a heat source and the fuel interact, resulting in a fire or explosion. <u>The origin of a fire is one of the most important hypotheses that an investigator develops and tests during the investigation</u>. Generally, <u>if the origin 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</u>. The purpose of determining the origin of the fire is to identify in three dimensions the locations at which the fire began.



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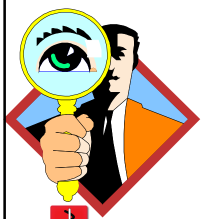
Information Sources for Origin Determination

Witness Information



Fire Patterns

Arc Mapping

Fire Dynamics

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Information Sources for Origin Determination

18.1.2 Determination of the origin of the fire involves the coordination of information derived from one or more of the following:

(1) **Witness Information.** **and/or Electronic Data.** The analysis of observations reported by persons who witnessed the fire or were aware of conditions present at the time of the fire as well as the analysis of electronic data such as security camera footage, alarm system activation, or other such data recorded in and around the time of the fire event

(2) **Fire Patterns.** The analysis of effects and patterns left by the fire (~~See~~ see Chapter 6 .)

(3) Arc Mapping. The analysis of the locations where electrical arcing has caused damage and the documentation of the involved electrical circuits (~~See~~ see Section 9.10 .)

(4) **Fire Dynamics.** The analysis of the fire dynamics~~, that is~~ [i.e. , the physics and chemistry of fire initiation and growth (see Chapter 5), and the interaction between the fire and the building's systems (~~See~~ see Chapter 7 .)]

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Chapter 18 Origin Determination

18.2.3 Sequential Pattern Analysis. The area of origin may be determined by examining the fire effects and fire patterns. The surfaces of the fire scene record all of the fire patterns generated during the lifetime of the event, from ignition through suppression, although these patterns may be altered, overwritten, or obliterated after they are produced. The key to determining the origin of a fire is to determine the sequence in which these patterns were produced. Investigators should strive to identify and collect sequential data and, once collected, organize the information into a sequential format. Sequential data not only indicate what happened, but the order in which it happened. One of the most important factors in determining the sequence of pattern production is considering whether the pattern can be accounted for in terms of ventilation. A large area of clean burning located next to, or directly across the room from an opening probably was created after full room involvement was achieved. As such, this pattern will offer little insight into the area of origin.

Chapter 18 Origin Determination

18.3.1.6 Structure Interior. On the initial assessment, investigators should examine all rooms and other areas that may be relevant to the investigation, including those areas that are fire damaged or adjacent to the fire and smoke damaged areas. The primary purpose of this assessment is to identify the areas that need more detailed examination. The investigator should be observant of conditions of occupancy, including methods of storage, nature of contents, housekeeping, and maintenance. The type of construction, interior finish(es), and furnishings should be noted. Areas of damage, and extent of damage in each area (severe, minor, or none) should be noted. At this point, the investigator should attempt to identify which compartments became fully involved (ventilation-controlled), and which did not. This damage should be compared with the damage seen on the exterior. During this examination, the investigator should reassess the soundness of the structure.

Chapter 18 Origin Determination

18.4 Analyze The Data

18.4.1.6* Every pattern should be evaluated to determine whether it can be accounted for in terms of ventilation. Ventilation-generated patterns may not be produced early in the fire. Patterns that cannot be accounted for in terms of ventilation are the patterns that require careful examination.

A.18.4.1.6 For further information, see Cox, A., Origin Matrix Analysis: A Systematic Methodology for the Assessment and Interpretation of Compartment Fire Damage. Fire and Arson Investigator, July 2013.

Chapter 18 Origin Determination

18.4.4.2 * Measuring Depth of Calcination.

The technique for measuring and analyzing depth of calcination should be performed using a probe survey. The-probe method requires that a survey of the depth of calcination be undertaken by inserting a probe device, such as illustrated in Figure 18.4.4.2(a) and Figure 18.4.4.2(b) , into the gypsum wallboard within the room of interest. Based on experimental data, it is recommended that the probe have a blunt tip with no tapering shoulders. The cross-sectional surface area of the probe used should be relatively small. Cross-sectional areas used in experimental work have ranged in size from 1.9 to 3.1 mm 2 (0.003 to 0.005 in.2). The probe can be ~~2~~ attached to a force gauge to ensure uniform pressure is applied at the probe tip during each measurement. The pressure required to reach the line of demarcation where calcined and virgin gypsum meet has been studied and values are generally consistent ranging from 800 to 900 g/m 2 (1120 to 1270 psi). Care should be taken to use approximately the same insertion pressure for each measurement. Currently available data suggests that probe pressures in this range are appropriate for both regular 12.7 mm (0.5 in.) and fire-rated 15.875 mm (0.625 in.) gypsum wallboardFor lightweight gypsum wallboard, which is becoming increasingly prevalent, less pressure should be used. When using this method the investigator should conduct the survey at regular lateral and vertical grid intervals along the surface of the involved wallboard, usually in increments of 0.3 m (1 ft) or less. Such surveys can be made on either wall or ceiling installations of wallboard. Some limited correlations between depth of calcination and total heat exposure have been developed that can be used to enhance the information obtained from a calcination depth survey.

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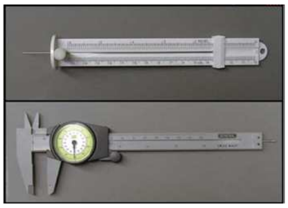
Chapter 18 Origin Determination



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Chapter 18 Origin Determination

18.4.7 Fire Dynamics

18.4.7.1* One of the most important fire dynamics considerations is the availability of oxygen. If the area of origin becomes oxygen deprived as a result of full room involvement, there may actually be less damage around the origin than elsewhere. The most severely damaged areas may have been damaged solely as a result of increased ventilation that occurred late in the fire. Basing an origin determination solely on the degree of damage has led to erroneous origin determinations in test fires.

A.18.4.7.1 For additional information see Carman, S.W., "Improving the Understanding of Post-flashover Fire Behavior."

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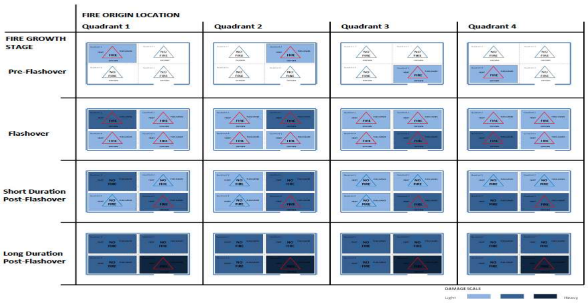
Chapter 18 Origin Determination

18.4.7.2* One tool a fire investigator may consider to account for the history of the various fire patterns observed is to divide each compartment into volumes, and then consider the extent of the damage expected before and at flashover, a short time after flashover, and a long time after flashover, given an origin in each of the volumes. This analysis has been called Origin Matrix Analysis.

A.18.4.7.2 For further information, see Cox, A., Origin Matrix Analysis: A Systematic Methodology for the Assessment and Interpretation of Compartment Fire Damage. Fire and Arson Investigator, July 2013.

Chapter 18 Origin Determination

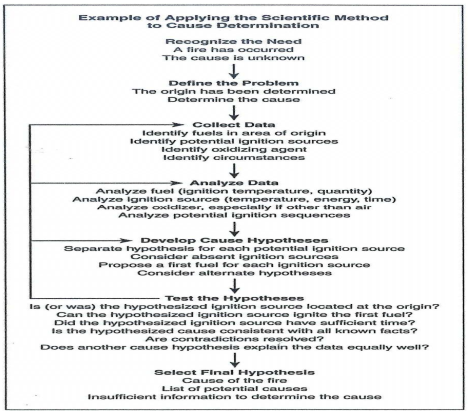


18.6.1.3 Means of Hypothesis Testing

Ultimately, the investigator should be able to *explain* how the growth and development of a fire, starting at the hypothesized origin, is consistent with the data.

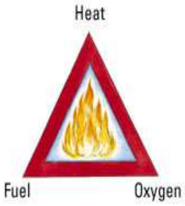
CHAPTER 19: CAUSE

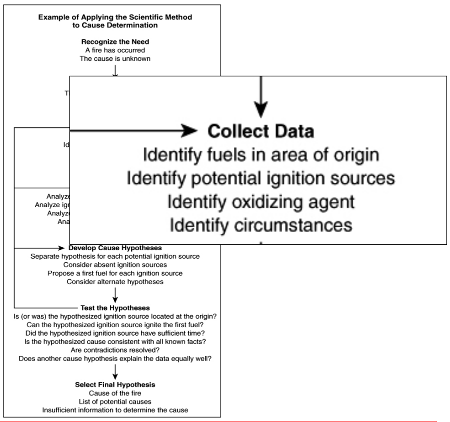
19.1 Introduction. This chapter recommends a <u>methodology to follow in determining the cause of a fire</u>. Fire cause determination is the process of identifying the first fuel ignited, the ignition source, the oxidizing agent, and the circumstances that resulted in the fire. Fire cause determination generally follows origin determination (see Origin Determination Chapter). <u>Generally a fire cause determination can be considered reliable only if the origin has been correctly determined.</u>



19.1.1 FIRE CAUSE FACTORS

- ***First fuel ignited***
- ***Ignition source***
- ***Oxidant***
- ***Ignition sequence***





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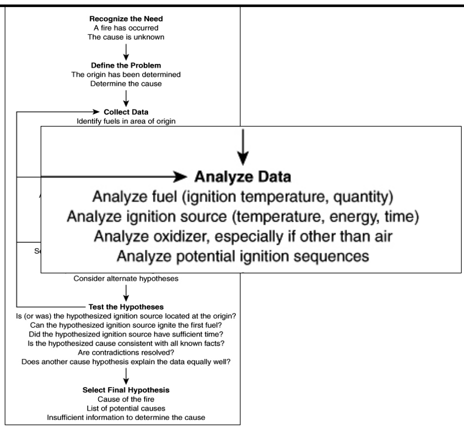

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19.4 Analyze Data

19.4.4.2.1 (Ignition Sequence)

In each fire investigation, the various contributing factors to ignition should be investigated and included in the ultimate explanation of the ignition sequence. These factors should include the following :

(1) How and sequentially when the first fuel ignited came to be present in the appropriate shape, phase, configuration, and condition to be capable of being ignited ~~(a competent fuel);~~

(2) How and sequentially when the oxidant came to be present in the right form and quantity to interact with the first fuel ignited and ignition source and allow the combustion reaction;

(3) How and sequentially when the competent ignition source came to be present and interact with the fuel; (4) How and sequentially when the competent ignition source transferred its heat energy to the fuel, causing ignition;

(5) How safety devices and features designed to prevent fire from occurring operated or failed to operate. (see Chapter 26)

(6) How and sequentially when any acts, omissions, outside agencies, or conditions brought the fuel, oxidant, and competent ignition source together at the time and place for ignition to occur;

(7) How the first fuel subsequently ignited any secondary, tertiary, and successive fuels that resulted in any fire spread. If the hypothesized ignition location is not within the main area of fire destruction, then, for the hypothesis to be valid, the investigator should be able to demonstrate that there was a viable fire spread mechanism that facilitated a path of fire propagation along which fire would have been able to propagate.

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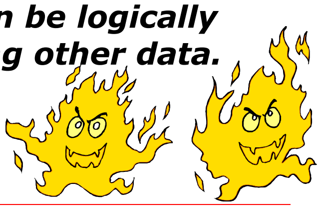
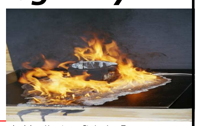
19.4.4.3

There are times when no physical evidence of the ignition source is found at the origin, but the ignition sequence can be logically inferred using other data.



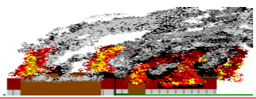
19.4.4.3

Any determination of fire cause should be based on evidence rather than on the absence of evidence; however, there are limited circumstances when the ignition source cannot be identified, but the ignition sequence can be logically inferred.



19.4.4.3

This inference may be arrived at through the testing of alternate hypotheses involving potential ignition sequences, <u>provided that the conclusion regarding the remaining ignition sequence is consistent with all known facts.</u>



19.4.4.3 EXAMPLES

- *Diffuse fuel explosions and flash fires.*
- *When ignitable liquid residue is found with no innocent explanation.*
- *Multiple fires (origins)*
- *Trailers*

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19.6 TESTING THE CAUSE HYPOTHESIS

Each of the alternate hypotheses that were developed must be tested using the scientific method.

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19.6 TESTING THE CAUSE HYPOTHESIS

If one remaining hypothesis is tested using the "scientific method" and is determined to be probable, then the cause of the fire is identified.

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19.6.1 Scientific Method

Use of the Scientific Method dictates that <u>any hypothesis formed from analysis of the data collected in an investigation must stand the test of careful and serious challenge</u>, by the investigator testing the hypothesis or by examination by others.

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Hypothesis Testing

Do you believe evidence is Important?

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19.6.5 Appropriate Use of the Process of Elimination:

The process of elimination is an integral part of the scientific method. <u>All potential ignition sources present, or believed to be present in the area of origin should be identified and alternative</u> hypotheses should be considered and challenged against the facts. Elimination of a testable hypothesis by disproving the hypothesis with reliable evidence is a fundamental part of the scientific method. However, the process of elimination can be used inappropriately. <u>Identifying the ignition source by believing to have eliminated all ignition sources found, known, or suspected</u> to have been present in the area of origin, and for which no supporting evidence <u>exists</u> , is referred to by some investigators as negative corpus. <u>Determination of the ignition source must be based on data or logical inferences drawn from that data.</u> Negative corpus has typically been used in classifying fires as incendiary, although the process has also been used to characterize fires classified as accidental. <u>The negative corpus</u> process is not consistent with the scientific method, is inappropriate, and should not be used because it generates untestable hypotheses, and may result in incorrect determinations of the ignition source and first fuel ignited. Any hypotheses formulated for the causal factors (e.g., first fuel, ignition source, and ignition sequence), must be based on the analysis of facts <u>and logical inferences that flow from those facts</u> . Those facts <u>and logical inferences</u> are derived from evidence, observations, calculations, experiments, and the laws of science. Speculative information cannot be included in the analysis.

(The committee has taken the input from 3 submitters and has developed wording to further clarify the text.)

Scientific Expert Analysis

WHAT DOES THIS PARAGRAPH REALLY SAY?

WHAT DOES THIS PARAGRAPH REALLY SAY?

WHERE'S THE PROOF?

Somnis v. Country Mutual Ins. Co., *840 F.Supp. 2d 1166 (D.Minn. 2012)*

A July 2, 2009 fire occurred in the basement of a Minnesota home significantly damaged the basement and, to a lesser extent, the upper floors. The homeowner filed a claim with his insurer to recover over $200,000 in losses. The insurer retained a certified fire investigator to investigate the fire. The investigation of possible ignition sources, including several space heaters in the basement, determined that none of these items were the cause. The investigator offered the following opinion: "After systematically examining the fire scene, no accidental fire cause has been found that explains the cause of this fire. In my opinion, this fire is an incendiary fire started by some person on the couch in the basement family room of the house."

Somnis v. Country Mutual Ins. Co., *840 F.Supp. 2d 1166 (D.Minn. 2012)*

The claim was denied on the basis of:
(1) The policy's "intentional loss" exclusion.
(2) The policy's "concealment or fraud" exclusion.

The insured sued for breach of contract and sought to recover policy proceeds. The insured moved, based on Federal Rule of Evidence 702 and Daubert v. Merrell Dow Pharmaceuticals, Inc to exclude the investigator's testimony from trial.

Somnis v. Country Mutual Ins. Co., *840 F.Supp. 2d 1166 (D.Minn. 2012)*

The Court found no principled basis to exclude the investigator's testimony on the elimination of accidental causes for the fire. However, the Court did find that the investigator's opinion that the fire was therefore incendiary should be excluded because an expert who simply "draws inferences or reaches conclusions within the jury's competence" and does not provide "helpful" testimony under Rule 702. Rather, the Court found that it is the jury's place to make an inference that an incendiary fire may have occurred given all facts of the case, including expert testimony that all reasonable accidental causes had been examined and excluded.

St. of Wisconsin v. Joseph Awe
Circuit Court, Marquette County

In 2007, the defendant was convicted of arson with intent to defraud in a September 2006 fire that destroyed a Wisconsin bar he owned. The defendant had served nearly all of his sentence before his conviction was vacated and a new trial granted in 2013.

A county circuit judge granted the new trial because the public investigator in the case had used "negative corpus" to conclude that the fire must have been incendiary because he could find no accidental cause.

In the interim between the defendant's conviction and his successful appeal, NFPA 921 was revised to say that negative corpus should never be used to reach a conclusion.

St. of Wisconsin v. Joseph Awe
Circuit Court, Marquette County

The defendant's motion for a new trial included the grounds that there was "newly discovered evidence which to a reasonable probability would have caused a jury to have a reasonable doubt as to his guilt." The judge's order specifically cited "a maturing development in the arson field [that] would bury the 'negative corpus' approach" from NFPA 921 (2011 Edition) section 18.6.5 as the new evidence upon which the new trial was ordered. Prior to 2011, the scientific objections to the use of negative corpus were not as strongly stated. The 2011 Edition of 921 changed that, and thus this new standard, if it had existed at the time of the original trial, would have been used to impeach the State's expert witness who used a now unapproved method to reach his conclusion of incendiary fire.

St. of Wisconsin v. Joseph Awe
Circuit Court, Marquette County

Because the case was "utterly dependent" on the expert's opinion that it was a "set fire" due to the absence of physical evidence of incendiary fire, circumstantial evidence of motive, and arguable "removal of keepsakes (just as likely consumed by the fire)", this new evidence of unapproved method created a reasonable probability that the jury would have had reasonable doubt as to the defendant's guilt if that evidence had been available at the original trial. Therefore, the defendant was released and a new trial ordered.

Awe (continued)

"the maturing field of fire investigation"

19.6.5.1 CAUSE UNDETERMINED

In the circumstance where all hypothesized fire causes have been eliminated and the investigator is left with no hypothesis that is evidenced by the facts of the investigation, the only choice for the investigator is to <u>conclude</u> that the fire cause, or specific causal factors, remains undetermined.

That is, it is improper to opine a specific ignition source that has <u>no evidence to support</u> it even though all other hypothesized sources were eliminated.

19.7.1 ESTABLISHING THE CAUSE

In establishing a fire cause, the investigator should <u>describe it</u> in terms of competent ignition source providing enough heat to ignite the first fuel, and the circumstances together.

<u>Chapter 23 Explosions</u>

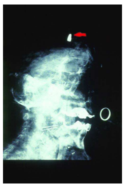
23.9 Dust Explosions

Chapter 24 Incendiary

24.3.2 Forced Entry.
Evidence of forced entry may be discovered by the investigator. Broken door locks, windows, and other points of entry should be documented and examined for potential physical evidence. The investigator is cautioned that first responders and suppression personnel may force entry as part of their response to the fire. Forced entry may be evidence of burglary. It may also be staged by the owner or occupant in an attempt to mislead investigators.

Chapter 25 Deaths and Injuries

25.10.3 Pre-Fire Victim Impairment.
Alcohol and(prescription and illegal) drugs can lead to impairment of a victim. The impairment can decrease the response to fire indicators such as smoke, noise, flames, or alarm activation resulting in delayed or no notification of the adverse conditions. Refer to the toxicology report for pertinent information regarding alcohol and drugs. The toxicological report may report the blood alcohol content (BAC) in % ethanol or g/dL ethanol. As a reference point, 0.08 g/dL is considered by some states to indicate that a driver is impaired, although studies have reported impairment to alcohol at even lower blood concentrations. The investigator should keep in mind that the effect of alcohol and drugs is additive with carbon monoxide (CO), hydrogen cyanide (HCN), and other fire gases so the total level of impairment may be due to a combination of pre-ignition and post-ignition effects.



Chapter 26 Appliances

26.5.2.3 Batteries.
Batteries are used for a wide variety of applications, including stationary and portable appliances. There are two types of batteries — primary and secondary. Primary batteries are discharged once and reach end of life, whereas secondary batteries can be discharged and recharged repeatedly. Batteries are produced in a variety of chemistries, each with their advantages and disadvantages. Some battery chemistries are better suited for certain applications than others. Batteries are produced in a wide variety of designs and form factors, for example, battery cells can be interconnected in series or parallel combinations to create a battery pack, which is housed in an enclosure that acts as a single unit. Depending on the chemistry and the materials used in the battery, remains of batteries that were present in an appliance may be found after a fire. They may be too damaged to indicate whether they provided power for ignition. However, what they were connected to could be important. A battery can provide enough power to ignite some materials under certain conditions. However, in most battery-powered devices circuitry and/or safety mechanisms should prevent the energy of the battery from being concentrated enough at one spot at one time to achieve ignition.

Chapter 27 Vehicles

27.3.1.1 * Hot Surface Ignition.

Some hot surfaces in motor vehicles may be of sufficient temperature to ignite ignitible liquids commonly found in these vehicles. This temperature is known as hot surface ignition temperature, a form of autoignition temperature. Autoignition temperatures are determined by ASTM E659, *Standard Test Method for Autoignition Temperature of Liquid Chemicals* , which is a laboratory test procedure and utilizes a closed test environment . There is a difference between autoignition temperature, which is a property of a liquid temperatures determined through standard test methods, and hot surface ignition temperatures that are dependent on a number of underhood conditions including, but not limited to, the temperature, which is not a property of the hot surface; the residence time of the ignitible liquid on the hot surface; the temperature of the ignitible liquid; the physical state of the ignitible liquid; the surface characteristics of the hot surface; the geometry, size, and mass of the hot surface; and the airflow in the surrounding area where the ignitible liquid contacts the hot surface . Experimental testing has shown that hot surface ignition temperatures for common automotive liquids may be substantially higher than reported autoignition temperatures. The study compared the autoignition temperatures, as derived from ASTM E659, and hot surface ignition temperatures, under test conditions using commercially available unleaded regular (CA ULR) gasoline.

Chapter 27 Vehicles

27.4.1 Open Flames.

A source of open flames in vehicles is an intake system backfire out of the carburetor. Propagation is rare if the air cleaner is properly in place. Another source of open flames is an after-fire from the exhaust system. Modern vehicles use computer- regulated fuel injection systems that reduce such conditions . Lit matches and other smoking materials may ignite combustible materials , resulting in a fire. In recreational vehicles, appliance pilots or operating burners of ranges, ovens, water heaters furnaces, and so forth are open-flame ignition sources.

Chapter 27 Vehicles

27.4.2.6 * Lamp Bulbs and Filaments.

Bulb surfaces can produce sufficient heat to ignite some combustible materials that may be in contact with them. Lamp filaments of broken bulbs can also be a source of ignition for some vapors, especially gasoline. Normally operating headlamp filaments have temperatures of approximately 1400° C (2550° F). However, most filaments operate in a vacuum or inert atmosphere. When the filament is exposed to ambient air, it will typically operate for only a few seconds, then burn open. Once the filament opens, the source of ignition is gone. When examining vehicle headlamps, the bulbs currently installed in the headlamp assembly should be inspected to determine if they are the correct size, type, and wattage that was recommended by the original equipment manufacturer (OEM). If an incorrect bulb type was installed, resistive heating at the connection point of the bulb and wiring could occur and cause a failure resulting in a fire. Also, if a bulb was installed that was of a higher wattage than the OEM bulb, the heating created by the bulb may be greater than the lamp assembly was rated to sustain. The heating caused by the greater wattage of the bulb could cause the lamp assembly to ignite.

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27.4.2.6.1

Vehicles may be equipped by the OEM with high-intensity discharge (HID) headlamps. The xenon bulbs used in HID lighting systems produce three times the light output of standard halogen headlamps with less operating energy. HID headlamps require a high-voltage ignition source to start, up to 25,000 volts, but, depending on the system, only 40–90 volts to operate once the initial arc has formed. The normal 12 volts dc from the vehicle's electrical system is stepped up and controlled by an igniter module and inverter (ballast), which also converts the voltage to the necessary ac to operate the HID headlamps. The ballast then adjusts the voltage and current frequency to operating requirements. Aftermarket HID conversion kits are commonly available and, if installed, could overload the OEM wiring or cause other installation issues that could result in a fire within the headlight assembly.

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27.5.3.3.4 *   Arc Mapping

Arc mapping has been researched and documented typically in post-flashover structural fires with properly fused, alternating current (ac) electrical circuits. Arc mapping may not be an effective technique for determining the origin of a fire in automobiles, trucks, buses, construction, agricultural, or other equipment that use direct current (dc) electrical circuits with a common ground circuit when analyzing secondary electrical circuits. Many of the electrical circuits in these products are routed together and often packaged in harnesses containing many different circuits and wires of many different gauges protected at different points by different levels of fuses, circuit breakers, fuse links, or are sometimes without over-current protection. When a fire destroys the insulating materials of powered circuits and components, all conductive materials of the vehicle or equipment are potentially available as alternate, inadvertent current paths, (including circuits routed adjacent to the powered circuits). Powered circuits can potentially energize alternative electrical paths and inadvertent current paths can be created, causing arcs and shorts, remote from, and unassociated with, the area of fire origin. Primary circuits with limited or no over-current protection in single conductor applications, may reveal evidence of electrical activity.

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27.5.3.6 Engine Control Modules (ECMs).

Electronic ECMs, which are generally found on fleet trucks and buses, may record and store data regarding recent operation of the engine and vehicle. Many truck and bus fleets are connected through electronic communication systems to companies that maintain records regarding the truck's operation and deficiencies in the truck’s systems. Monitoring agencies may be able to provide stored information that is unavailable from other sources after a fire.

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27.5.4.4 Electric Motors.

Vehicles such as pure electrics and hybrids (i.e., combination of internal combustion and electric) have one or more high-power electric motors to provide or augment the torque to drive the vehicle. These motors are connected to power electronics, which in turn are powered by a battery or ultra-capacitors . The power supply providing energy to the motor(s) may range up to 600 volts. Electric motors may also be used in vehicles to provide steering assistance instead of hydraulic power steering systems. Conventional electric motors have been designed for dc, but some manufacturers are trending toward variable frequency ac motors; however , small electric vehicles, such as golf carts, still operate on dc.

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Chapter 27 Vehicles

27.8.1 General.

The examination of a motor vehicle after it has burned is a complex and varied task. As with structure fires, the first step is to determine an area of origin. Motor vehicles can have five major areas : the exterior engine compartment, passenger compartment or interior, cargo compartment, and the underbody or underchassis . The size, construction, and fuel load of these compartments can vary considerably. The use of vehicle inspection field notes [see Figure A.16.3.2(h)] may assist the investigator in recording information.

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Chapter 27 Vehicles (27.8.1.1)

~~Examination~~ Where there are remaining surface coatings, combustible materials (e.g., plastic trim and rubber), and glass, an examination of the exterior may reveal significant fire patterns, which can aid in determination of the compartment of fire origin . The location of the fire and the way that the windshield reacts to it~~,~~ may allow a determination of the compartment of ~~the~~ origin. Diagrams illustrating potential fire pattern development as a function of compartment of origin are shown in Figure 27.8.1.1(a) and Figure 27.8.1.1(b). A passenger compartment fire will frequently cause failure at the top of the windshield and will leave radial fire patterns (fire patterns that appear to radiate from an area) on the hood. These patterns are created as the fire progresses and consumes the surface coatings , as shown in Figure 27.8.1.1(c) and Figure 27.8.1.1(d). Interior fire test and resulting damage and patterns are depicted in Figure 27.8.1.1(e) through Figure 27.8.1.1(g). Radial patterns from a passenger compartment fire are depicted in Figure 27.8.1.1(h) and Figure 27.8.1.1(i). Variations in the colors and patterns on bare metal surfaces are common in vehicle fires where most, if not all, surface coatings and combustible materials (e.g., plastic trim and rubber) have been consumed. However, caution should be exercised in relying solely on colors and patterns on bare metal surfaces without substantiating evidence. The various colors present can be due to different types of iron oxides formed both during and after a fire. Even a single oxide can have a range of colors depending on its crystal structure. Oxide color variations can also be due to variations in the type and concentration of contaminants on the surface, alloying elements, and the thickness of the oxide. Variations in oxide colors and patterns on bare metal surfaces from a vehicle fire are depicted in Figure 27.8.1.1(j) .

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Chapter 27 Vehicles (27.8.1.1)

Figure 27.8.1.1(a) Fire Pattern Development from an Interior Origin.

Figure 27.8.1.1(b) Fire Pattern Development from an Engine Compartment Origin.

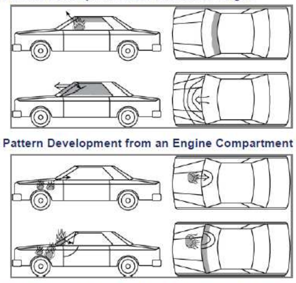

Figure 27.8.1.1(c) Radial Fire Pattern Produced by a Passenger Compartment Fire.

Chapter 27 Vehicles (27.8.1.1)

Figure 27.8.1.1(d) Another Radial Fire Pattern Produced by a Passenger Compartment Fire.

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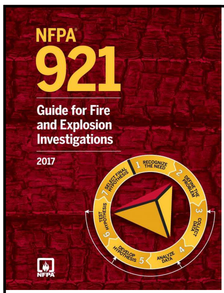

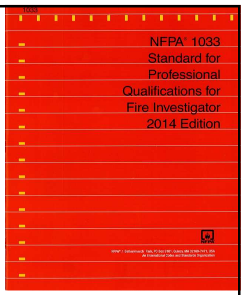

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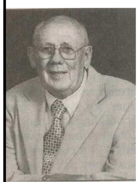

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"The hell with them good ole days! I'll take these good ole days right now!"

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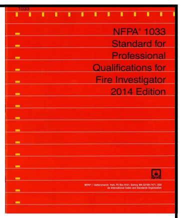

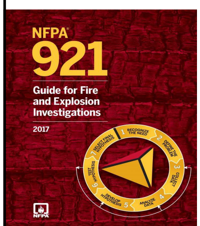

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