

# Fire Investigation: First Responders

FI: FR-Student Manual

*1st Edition, 6th Printing-March 2024*



**FEMA**

FEMA/USFA/NFA

FI: FR-SM

March 2024

1st Edition, 6th Printing

***Fire Investigation: First Responders***



**FEMA**

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Acronyms

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**ACKNOWLEDGMENTS**

The development of any National Fire Academy (NFA) course is a complex process aimed at providing students with the best possible learning opportunity we can deliver. There are many players in course development, each of whom plays an equally important part in its success. We want to extend our heartfelt thanks to everyone who participated in making this quality product.

Sincerely,

Kevin Oliver, IAAI-CFI  
Training Specialist  
U.S. Fire Administration, National Fire Academy  
Emmitsburg, Maryland

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**COURSE GOAL**

The goal of this course is to enable students to identify and define key concepts of fire investigation specifically as they relate to the scientific method, scene preservation and the role of the first responder.

**AUDIENCE, SCOPE AND COURSE PURPOSE**

The target audience for “Fire Investigation: First Responders” (FI: FR) is first responders and their advancement in the professional development of fire, rescue and emergency service personnel, as well as the mitigation of loss of life and property from fire and other hazards. An integral part of the program is training and professional development in fire and life safety education programs/courses.

The scope of this course is to provide first responders with the fundamental understanding of the principles, processes and procedures involved in fire scene examination.

The purpose of this course is to provide first responders with the tools to understand the key role they play in fire scene examination and in preserving and protecting important evidence for any subsequent investigation. The content of the course will provide a clear definition of the role of the first responder and identify the preservation and protection of evidence and proper reporting of information to appropriate officials. By strengthening the partnership between first responders and investigators, the chances for successfully solving arson-related crimes will increase.

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**SCHEDULE**

<b>TIME</b>	<b>DAY 1</b>	<b>DAY 2</b>
8:00 - 9:00	Introduction, Welcome and Administrative	Unit 3: The Fire Scene
9:00 - 9:10	<i>Break</i>	<i>Break</i>
9:10 - 10:20	Unit 1: Overview of Fire Investigation and National Fire Protection Association 921/1033	Unit 3: The Fire Scene (cont'd)
10:20 - 10:30	<i>Break</i>	<i>Break</i>
10:30 - 11:30	Unit 1: Overview of Fire Investigation and National Fire Protection Association 921/1033 (cont'd)	Unit 3: The Fire Scene (cont'd)
11:30 - 12:30	<i>Lunch</i>	<i>Lunch</i>
12:30 - 2:15	Unit 2: Fire Science	Unit 3: The Fire Scene (cont'd) Unit 4: Uncomfortable Fire Investigation Topics
2:15 - 2:30	<i>Break</i>	<i>Break</i>
2:30 - 5:00	Unit 2: Fire Science (cont'd) Activity 2.1: Candle Experiment	Unit 4: Uncomfortable Fire Investigation Topics (cont'd) Unit 5: Making the Call

Note: This schedule is subject to modification by the instructors and approved by the training specialist.

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# FIREFIGHTER CODE OF ETHICS

## Background

The Fire Service is a noble calling, one which is founded on mutual respect and trust between firefighters and the citizens they serve. To ensure the continuing integrity of the Fire Service, the highest standards of ethical conduct must be maintained at all times.

Developed in response to the publication of the Fire Service Reputation Management White Paper, the purpose of this National Firefighter Code of Ethics is to establish criteria that encourages fire service personnel to promote a culture of ethical integrity and high standards of professionalism in our field. The broad scope of this recommended Code of Ethics is intended to mitigate and negate situations that may result in embarrassment and waning of public support for what has historically been a highly respected profession.

Ethics comes from the Greek word ethos, meaning character. Character is not necessarily defined by how a person behaves when conditions are optimal and life is good. It is easy to take the high road when the path is paved and obstacles are few or non-existent. Character is also defined by decisions made under pressure, when no one is looking, when the road contains land mines, and the way is obscured. As members of the Fire Service, we share a responsibility to project an ethical character of professionalism, integrity, compassion, loyalty and honesty in all that we do, all of the time.

We need to accept this ethics challenge and be truly willing to maintain a culture that is consistent with the expectations outlined in this document. By doing so, we can create a legacy that validates and sustains the distinguished Fire Service institution, and at the same time ensure that we leave the Fire Service in better condition than when we arrived.



# FIREFIGHTER CODE OF ETHICS

**I understand that I have the responsibility to conduct myself in a manner that reflects proper ethical behavior and integrity. In so doing, I will help foster a continuing positive public perception of the fire service. Therefore, I pledge the following...**

- Always conduct myself, on and off duty, in a manner that reflects positively on myself, my department and the fire service in general.
- Accept responsibility for my actions and for the consequences of my actions.
- Support the concept of fairness and the value of diverse thoughts and opinions.
- Avoid situations that would adversely affect the credibility or public perception of the fire service profession.
- Be truthful and honest at all times and report instances of cheating or other dishonest acts that compromise the integrity of the fire service.
- Conduct my personal affairs in a manner that does not improperly influence the performance of my duties, or bring discredit to my organization.
- Be respectful and conscious of each member's safety and welfare.
- Recognize that I serve in a position of public trust that requires stewardship in the honest and efficient use of publicly owned resources, including uniforms, facilities, vehicles and equipment and that these are protected from misuse and theft.
- Exercise professionalism, competence, respect and loyalty in the performance of my duties and use information, confidential or otherwise, gained by virtue of my position, only to benefit those I am entrusted to serve.
- Avoid financial investments, outside employment, outside business interests or activities that conflict with or are enhanced by my official position or have the potential to create the perception of impropriety.
- Never propose or accept personal rewards, special privileges, benefits, advancement, honors or gifts that may create a conflict of interest, or the appearance thereof.
- Never engage in activities involving alcohol or other substance use or abuse that can impair my mental state or the performance of my duties and compromise safety.
- Never discriminate on the basis of race, religion, color, creed, age, marital status, national origin, ancestry, gender, sexual preference, medical condition or handicap.
- Never harass, intimidate or threaten fellow members of the service or the public and stop or report the actions of other firefighters who engage in such behaviors.
- Responsibly use social networking, electronic communications, or other media technology opportunities in a manner that does not discredit, dishonor or embarrass my organization, the fire service and the public. I also understand that failure to resolve or report inappropriate use of this media equates to condoning this behavior.

**Developed by the National Society of Executive Fire Officers**

## A Student Guide to End-of-course Evaluations

**Say What You Mean ...**

### Ten Things You Can Do to Improve the National Fire Academy

The National Fire Academy takes its course evaluations very seriously. Your comments and suggestions enable us to improve your learning experience.

Unfortunately, we often get end-of-course comments like these that are vague and, therefore, not actionable. We know you are trying to keep your answers short, but the more specific you can be, the better we can respond.



Actual quotes from student evaluations:	Examples of specific, actionable comments that would help us improve the course:
1 "Update the materials."	<ul style="list-style-type: none"> <li>The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices.</li> <li>The student manual references building codes that are 12 years old.</li> </ul>
2 "We want an advanced class in (fill in the blank)."	<ul style="list-style-type: none"> <li>We would like a class that enables us to calculate energy transfer rates resulting from exposure fires.</li> <li>We would like a class that provides one-on-one workplace harassment counseling practice exercises.</li> </ul>
3 "More activities."	<ul style="list-style-type: none"> <li>An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept.</li> <li>Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.</li> </ul>
4 "A longer course."	<ul style="list-style-type: none"> <li>The class should be increased by one hour per day to enable all students to participate in exercises.</li> <li>The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.</li> </ul>
5 "Readable plans."	<ul style="list-style-type: none"> <li>The plans should be enlarged to 11 by 17 and provided with an accurate scale.</li> <li>My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.</li> </ul>
6 "Better student guide organization," "manual did not coincide with slides."	<ul style="list-style-type: none"> <li>The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21.</li> <li>The instructor added slides in Unit 4 that were not in my student manual.</li> </ul>
7 "Dry in spots."	<ul style="list-style-type: none"> <li>The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy.</li> <li>Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.</li> </ul>
8 "More visual aids."	<ul style="list-style-type: none"> <li>The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern.</li> <li>There was a video clip on NBC News (date) that summarized the topic very well.</li> </ul>
9 "Re-evaluate pre-course assignments."	<ul style="list-style-type: none"> <li>The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them.</li> <li>The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.</li> </ul>
10 "A better understanding of NIMS."	<ul style="list-style-type: none"> <li>The instructor did not explain the connection between NIMS and ICS.</li> <li>The student manual needs an illustrated guide to NIMS.</li> </ul>

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# **UNIT 1: OVERVIEW OF FIRE INVESTIGATION AND NATIONAL FIRE PROTECTION ASSOCIATION 921/1033**

## **TERMINAL OBJECTIVE**

*The students will be able to:*

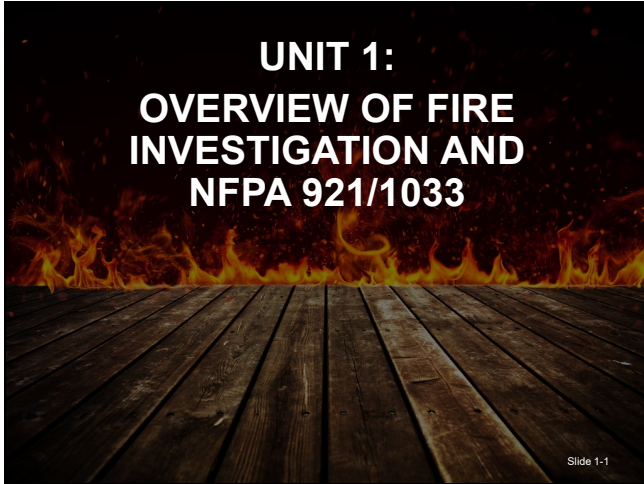
- 1.1 *Evaluate how the role of first responder relates to the fundamentals of fire investigation.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 1.1 *Establish the scope of roles and associated actions for fire investigation response.*
  - 1.2 *Use an understanding of the fire investigation profession to interpret the limitations on the first responder.*
  - 1.3 *Compare national guides and standards related to fire investigation.*
  - 1.4 *Summarize the responsibilities associated with fire investigation and testifying as a fact or expert witness.*
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### TERMINAL OBJECTIVE

Evaluate how the role of first responder relates to the fundamentals of fire investigation.



Slide 1-2

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### ENABLING OBJECTIVES

- 1.1 Establish the scope of roles and associated actions for fire investigation response.
- 1.2 Use an understanding of the fire investigation profession to interpret the limitations on the first responder.
- 1.3 Compare national guides and standards related to fire investigation.
- 1.4 Summarize the responsibilities associated with fire investigation and testifying as a fact or expert witness.

Slide 1-3

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I. WHAT IS FIRE INVESTIGATION?

**WHAT IS A FIRE INVESTIGATION?**

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An attempt to discover, through investigating the facts, the scene, and any evidence, what happened at a given location to result in a fire.

“The process of determining the origin, cause, and development of a fire or explosion.”

-NFPA 921, Section 3.3.79

Slide 1-4

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A. An attempt to discover — through investigating the facts, the scene and any evidence — what happened at a given location to result in a fire.

“The process of determining the origin, cause, and development of a fire or explosion” (National Fire Protection Association (NFPA) 921, 2024, Section 3.3.79).

**WHY INVESTIGATE?**

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- Save lives.
- Prevent future fires.
- Identify product failures.
- Prosecute crimes.
- Identify responsibility.
- Provide answers.
- Others?



Slide 1-5

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B. What is the purpose behind a fire investigation? Why even do them?

1. Save lives.
2. Prevent future fires.
3. Identify product failures.
4. Prosecute crimes.

5. Identify responsibility.
6. Provide answers.
7. Others?

**EXPECTATIONS**

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This is an overview course. It will not make you a fire investigator.



Slide 1-6

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C. This is an overview course. It will not make anyone a fire investigator.

**ROLES**

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- Why are you on the scene?
  - ✓ Investigate smoke.
  - ✓ Extinguishment.
  - ✓ Medical call.
- How were you dispatched?
- What did you do there?
- That is your initial role or responsibility.



Slide 1-7

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- D. Roles.
1. Why are we on the scene?
    - a. Investigate smoke.
    - b. Extinguishment.
    - c. Medical call.

2. How were we dispatched?
3. What did we do there?
4. That is our initial role or responsibility.

**WHEN DOES THE ROLE SHIFT?**

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After the event is stabilized or the fire is controlled.

Does your responsibility change as?

- ✓ Investigator.
- ✓ Overhaul.
- ✓ Witness.
- ✓ Interviewer.

Slide 1-8

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- E. When does the role shift?
1. After the event is stabilized or the fire is controlled.
  2. Does our responsibility change?
    - a. Investigator.
    - b. Overhaul.
    - c. Witness.
    - d. Interviewer.




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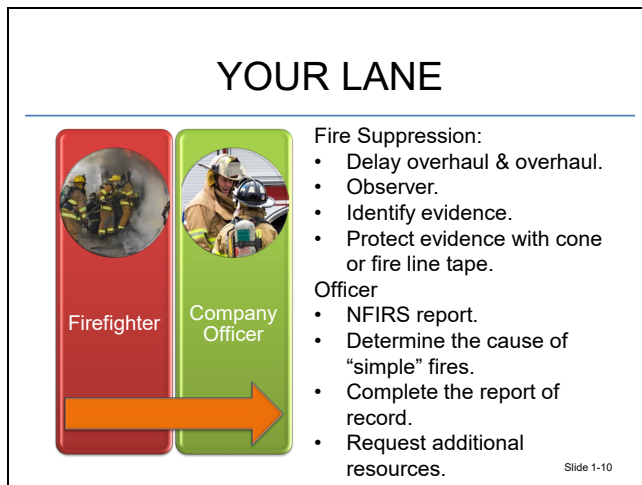
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- F. The fire investigation level of responsibility varies with the role and duties of each investigation. The responsibility of origin determination and case development increases with the title. Identify the role and let that role within each lane be a guide as the incident progresses.
- G. Be aware of the responsibility at the fire scene. Why are you there? Fire suppression, truck company operations, rescue?
1. Behavior related to one's duties at the scene will affect the future investigation. Remember what actions were taken. Pay attention to observations.




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2. Specific actions that may affect the investigation:
  - a. Delay overhaul and overhaul.
  - b. Observation.

- c. Evidence identification.
- d. Evidence protection, with cone or fire line tape.
- 3. If you are the officer, do you have the training, skills and ability to determine the origin and cause of the fire?
  - a. What stage was the fire extinguished?
  - b. Was this a witnessed fire?
  - c. Officer making the National Fire Incident Reporting System (NFIRS) report?
  - d. Are you determining the cause of “simple” fires?
  - e. Completing the report of record?
  - f. Requesting additional resources?
- 4. Or does your responsibility go further? Do you do all of the above, but continue on with the investigation?

**IS THIS YOUR LANE?**

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- Fire Marshal or Investigator?
- By title or by default?
- Complete fire scene inspection?
- Documents scene?
- Report writing?
- Expert witness testimony?
- Criminal investigation?
- Arrests?

The diagram consists of two vertical rectangular boxes. The left box is purple and labeled 'Fire Investigator' at the bottom. It contains a circular image of a fire scene with investigators. The right box is light blue and labeled 'Law Enforcement' at the bottom. It contains a circular image of police officers. A large orange arrow points from the bottom of the purple box to the bottom of the blue box. Below the boxes, the text 'Slide 1-11' is visible.

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- H. Would you:
- 1. Conduct a criminal investigation?
  - 2. Make arrests?
  - 3. Provide expert witness testimony?



## HISTORY OF PROFESSION

### 1600-1900s

Apprentice-like approach.

### 1960s

Recognition of legal impact, training to include science and testing.

### 1970s-80s

Loss of ventilation science AND transition of home furnishing materials (fuel) from natural to synthetic, result in a significant loss of the understanding, application, and testing in regard to the relationship between fuels, heat, and air.

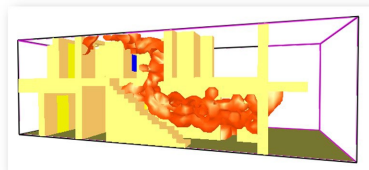
Slide 1-12

### I. History of the profession.

1. 1600s to 1900s: Apprentice-like approach.
2. 1960s: Recognition of legal impact; training to include science and testing.
3. 1970s to 1980s: The loss of ventilation science and the transition of home furnishing materials (fuel) from natural to synthetic result in a significant loss of the understanding, application and testing in regard to the relationship between fuels, heat and air.

## TODAY'S CULTURE

- Development and acceptance of standards and guidebooks.
- Technological advancements in fire testing.
- Advancement of fire engineering disciplines.
- Integration of science and the investigative approach.



Slide 1-13

### J. Today, a fire investigator will make use of multiple training, education and learning opportunities.

1. Development of standards and guidebooks.
2. Advancements in fire testing.

3. Advancement of fire engineering disciplines.
4. The merging of fire science and the investigative process.

**DO YOU WANT TO BE A  
FIRE INVESTIGATOR?**

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Provide expert testimony in a court of law  
**AND**  
potentially deprive someone of their life  
or liberty.

Slide 1-14

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K. Duties of the fire investigator include:

1. Provide expert testimony in a court of law and potentially deprive someone of their life or liberty.
2. Ensure that an innocent person is not wrongfully accused.
3. Ensure that bad science and faulty investigation do not happen.

## II. WHEN MISTAKES ARE MADE

**CONVICTION BASED ON  
FAULTY SCIENCE**

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This video introduces the story of Todd Willingham  
and illustrates the legal pitfalls and responsibility  
associated with bad science.  
<https://youtu.be/W5gTVdQ0rjE>

Slide 1-15

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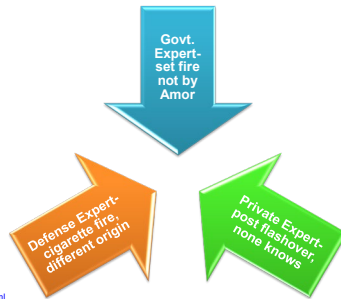
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## THE BATTLE OF THE EXPERTS

In 1995, William Amor, confessed to arson, after a 15 hour interrogation. He was tried and convicted in 1995, for arson murder.

In May 2017, Judge Liam Brennan, ruled it was scientifically impossible for the fire to have started in the way Amor described.

Retrieved from:  
<https://www.chicagotribune.com/suburbs/napeeville-sun/ct-napeeville-arson-defendant-puts-bond-0531-20170530-story.html>



Slide 1-16

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## FIRST RESPONDER ASSISTANCE

The fire investigation profession needs YOUR help to ensure an innocent person is not wrongfully accused!

YOU are critical to success.

Slide 1-17

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- A. The fire investigation profession needs your help to ensure that an innocent person is not wrongfully accused! You are critical to success.

## PREVENT MISTAKES

An understanding of the science and principles contained within texts, publications, journals, guides and standards empower first responders to avoid mistakes at the scene.



Slide 1-18

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- B. An understanding of the science and principles contained within texts, publications, journals, guides and standards empowers first responders to avoid mistakes at the scene.

III. SCIENTIFIC METHOD IDENTIFICATION AND APPLICATION

**SCIENTIFIC METHOD**

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“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 hypotheses; and, where possible, the selection of a final hypothesis.”

*-NFPA 921, Section 3.3.171*

Slide 1-19

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- A. The Scientific Method is: “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 hypotheses; and, where possible, the selection of a final hypothesis” (NFPA 921, 2024, Section 3.3.171).

**FIRE INVESTIGATION NEEDS THE SCIENTIFIC METHOD**

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Essential for all fire investigations:

- Universal recognition.
- Consistent with all sciences.
- Recognized in court via Daubert and Rule 702.
- Applies to both origin and cause.
- Applied by using a Systematic Approach.



First responders control an active investigation scene.

Slide 1-20

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- B. The Scientific Method is essential for all fire investigations.
  1. Universally recognized: no debate over its relevance or use.
  2. Used in all sciences.
  3. Recognized in court via Daubert and Rule 702.

## SYSTEMATIC APPROACH

Example:

- Exterior to interior process of examination.
- Consistent fire scene documentation.
- Decontaminating tools, equipment and footwear.
- Examining all potential ignition sources.
- Consider alternate theories.



Must understand where actions fit within the Scientific Method.

Slide 1-21

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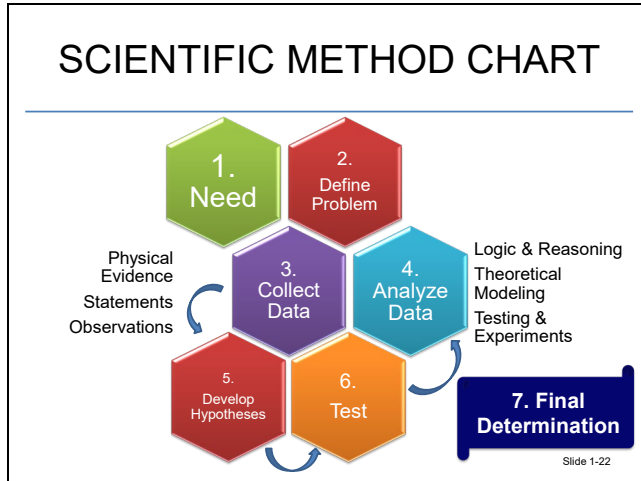
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C. How the Scientific Method works:

1. The Scientific Method applies to both the origin and cause, and the process does not stop at the scene.
2. The Scientific Method is applied to fire investigation by using a **systematic approach**.
3. Examples of using the Scientific Method in a systematic approach:
  - a. Exterior to interior process of examination.
  - b. Consistent fire scene documentation.
  - c. Decontaminating tools, equipment and footwear.
  - d. Examining all potential ignition sources.
  - e. Considering alternate theories.



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D. As applied to fire investigation:

1. Recognize the need.
  - a. There was a fire.
  - b. The investigator may respond to loss, protect the scene and assess resources in this step.
2. Define the problem.
  - a. Where did this fire start, and how?
  - b. An investigator may be asking themselves:
    - What caused the fire or explosion?
    - What investigation should be conducted?
    - Is there more than one issue to resolve?
3. Collect data.
  - a. This is any information related to the incident.
  - b. Data collection may occur during any stage of the investigation and is derived from:
    - Witness information.
    - Fire patterns.
    - Arc mapping.

- Fire dynamics.
  - K-9 teams.
  - Other sources.
4. Analyze the data.
- A detailed examination and evaluation of the data must occur before a hypothesis can be developed.
5. Develop hypotheses.
- a. A hypothesis is based on empirical data collected through observations which are developed into explanations for the event.
  - b. The theory of what happened.
6. Test the hypothesis.
- a. The purpose of hypothesis testing is to disprove a hypothesis.
  - b. Means of testing a hypothesis:
    - Cognition.
    - Thought experiments.
    - Physical testing.
    - Reference literature.
    - Fire models.
    - Appliance examinations.
  - c. Examples are:
    - **Cognition:** the mental action or process of acquiring knowledge and understanding through thought, experience and the senses.
    - **Thought experiments:** devices of the imagination used to investigate the nature of things.
    - **Physical test:** a qualitative or quantitative procedure that consists of determination of one or more characteristics of a given product, process or service according to a specified procedure.

- **Reference literature:** an authoritative and traditional reference source. Many scientific reference works serve as secondary sources.

7. Select final hypothesis.
  - a. Once all testing and evaluation are completed, the one remaining hypothesis that is most probable is selected and reported.
  - b. If there are two competing hypotheses, both of which cannot be disproven, the result is an undetermined classification.

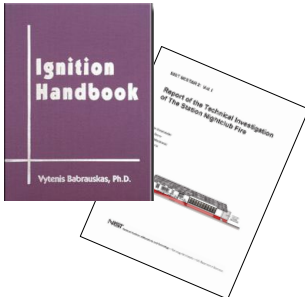
#### IV. TEXTS, GUIDES AND STANDARDS

**TEXTS**

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Texts such as:

- “Ignition Handbooks.”
- “Kirk’s Fire Investigation.”
- Government technical reports.



Slide 1-23

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- A. Texts such as the “Ignition Handbook,” “Kirk’s Fire Investigation” or government technical reports provide a solid foundation for research.

**GUIDES**

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A document, advisory or informative in nature, and contains only non-mandatory provisions.



Slide 1-24

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- B. Guide: a document that is advisory or informative in nature and contains only nonmandatory provisions.



## GUIDE EXAMPLE

*Guide for Fire and Explosion Investigation*, published by the National Fire Protection Association (NFPA).



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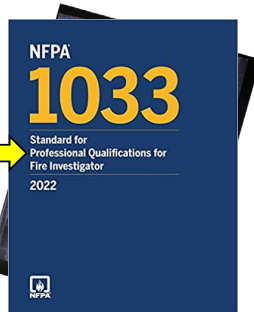
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- C. One example is NFPA 921, *Guide for Fire and Explosion Investigations*, published by the NFPA. Students will use this reference at length during this course and throughout their careers.

## STANDARDS

A document, containing mandatory provisions, using the word “shall” to indicate requirements. Generally suitable for mandatory reference by another code or for adoption into law.



Slide 1-26

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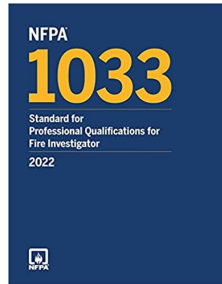
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- D. Standard: a document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Five-year revision cycle.

## STANDARDS EXAMPLE

The *Standard for Professional Qualifications for Fire Investigator*, published by the National Fire Protection Association (NFPA).



Slide 1-27

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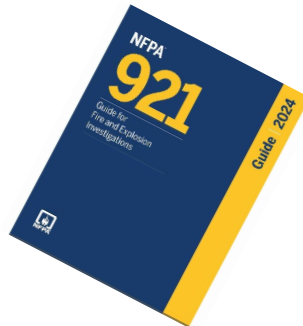
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E. Another example is NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, also published by the NFPA.

## POTENTIAL USES FOR NFPA 921

- Fire investigator conclusions.
- Attorneys support or contest opinions.
- Judges to qualify witnesses.
- Agencies for training and education programs.



Slide 1-28

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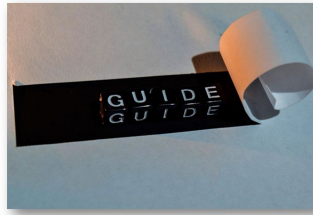
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F. Potential uses for NFPA 921.

1. Fire investigators to support their conclusions.
2. Attorneys to support or contest opinions.
3. Judges to qualify witnesses.
4. Agencies as the basis for training and education programs.

## USING NFPA 921

- The guidebook of the profession. Courts use to evaluate the quality of the investigation and/or investigator.
- Investigators may be asked to read from the text. Can you read the formulas?



Slide 1-29

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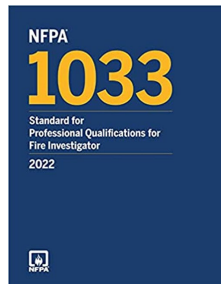
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G. NFPA 921 is the guidebook of the profession. Courts use it to evaluate the quality of the investigation and/or investigator. Investigators may be asked to read from the text.

## USING NFPA 1033

- Defines the minimum standards necessary to be a fire investigator.
- The educational knowledge base and Job Performance Resources (JPRs)



Slide 1-30

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H. NFPA 1033 defines the minimum standards necessary to be a fire investigator, such as the educational knowledge base and job performance resources (JPRs).

## NFPA 1033

Requires investigators to remain current in the subjects listed as "requisite knowledge" as they relate to fire investigations, which include the following:

1. Fire Science
  - a. Fire Chemistry
  - b. Thermodynamics
  - c. Fire Dynamics
  - d. Explosion Dynamics
2. Fire Investigation
  - a. Fire Analysis
  - b. Fire Investigation Methodology
  - c. Fire Investigation Technology
  - d. Evidence Documentation, Collection, and Preservation
  - e. Failure Analysis and Analytical Tools

-NFPA 1033, Section 4.1.7

Slide 1-31

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## NFPA 1033 (cont'd)

Requires investigators to remain current in the subjects listed as "requisite knowledge" as they relate to fire investigations, which include the following:

3. Fire Scene Safety
  - a. Hazard Recognition, Evaluation, and Basic Mitigation Procedures
  - b. Hazardous Materials
  - c. Safety Regulations
4. Building Systems
  - a. Types of Construction
  - b. Fire Protection Systems
  - c. Electricity and Electrical Systems
  - d. Fuel Gas Systems

-NFPA 1033, Section 4.1.7

Slide 1-32

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## V. RESPONSIBILITIES WITH TESTIMONY

### YOU CAN BE A FACT WITNESS

State what you:

- Saw.
- Smelled.
- Touched.
- Tasted.



**Fact Witness - No opinions.**

Slide 1-33

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- A. Most likely the first responder would be called to testify as a fact witness.

## A FIRE INVESTIGATOR CAN BE AN EXPERT WITNESS

A Judge will determine if an investigator qualifies as an expert witness by considering:

- Relevancy – impact of specialized testimony on a jury.
- Qualifications – CV, education and training.
- Methodology – science, repeatability, accepted.
- Will determine if the investigator meets the threshold to provide testimony.



Slide 1-34

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B. As a fire investigator and expert witness, the judge will decide if you are permitted to testify. They look to:

1. Relevancy: impact of specialized testimony on a jury.
2. Qualifications: curriculum vitae (CV), education and training.
3. Methodology: science, repeatability, accepted.
4. To determine if the investigator meets the threshold to provide testimony.

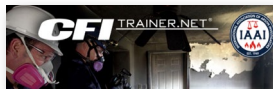
## CONSIDERING A CAREER?

• **Curriculum vitae (CV)** is an extensive resume style, listing of your experience, training, and education.

A CV includes items such as:

- Formal education, degrees, certifications.
- Seminars, training attended.
- Test and training burns.
- Publications.
- Presentations.
- (May include) case citation information on past testimony, e.g., docket number, dates.

• **CFI Trainer Courses**  
• New Fire Officer Cert.



Slide 1-35

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C. A CV is an extensive resume style, listing experience, training and education. It includes items such as:

1. Formal education, degrees and certifications.
2. Seminars and training attended.

3. Test and training burns.
4. Publications.
5. Presentations.
6. May include case citation information on past testimony, e.g., docket number, dates.

### CONSIDERATIONS GOING FORWARD

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- When investigating a fire, the goal is to arrive at **accurate determinations** of the origin, cause, facts surrounding the way the fire happened, and potential responsibility for the fire.
- An opinion, determination, investigation, and report **will be heavily scrutinized** many times, possibly over many years, after the incident.
- **Embrace the science**, it is the pillar on which this profession is based.
- **Document** as much as possible, notes, photos, sketches, reports, statements.
- Be as thorough as possible with that documentation, it will be **vital to you work** with fire in the future.

Slide 1-36

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- D. When investigating a fire, the goal is to arrive at accurate determinations of the origin, the causation, the facts surrounding the way the fire happened, and possibly if anyone or anything was directly responsible for the fire.
1. Your opinion, determination, investigation and report will be heavily scrutinized many times, possibly over many years, after the incident.
  2. Embrace the science. It is the pillar on which this profession is based.
  3. Document as much as possible — notes, photos, sketches, reports, statements. Be as thorough as possible with that documentation as it will be vital to your work with the fire in the future.

## VI. SUMMARY

## REFERENCES

- Icove, David and Haynes, Gerald (2018). *Kirk's Fire Investigation*. New York, NY: Pearson.
- Kennedy, P. M. (1989, November/December). The crisis in fire investigation education. *Fire Journal*, 83(6), 13-14.
- National Fire Protection Association. (2022). *Standard for professional qualifications for fire investigator*. (Standard no. 1033). Retrieved from <https://www.nfpa.org>
- National Fire Protection Association. (2024). *Guide for fire and explosion investigations*. (Standard no. 921). Retrieved from <https://www.nfpa.org>
- Ward, C. (2017, May 30). Man accused of Naperville murder leaves jail for first time since 1995. *Chicago Tribune*. Retrieved from <http://www.chicagotribune.com>

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# **UNIT 2: FIRE SCIENCE**

## **TERMINAL OBJECTIVE**

*The students will be able to:*

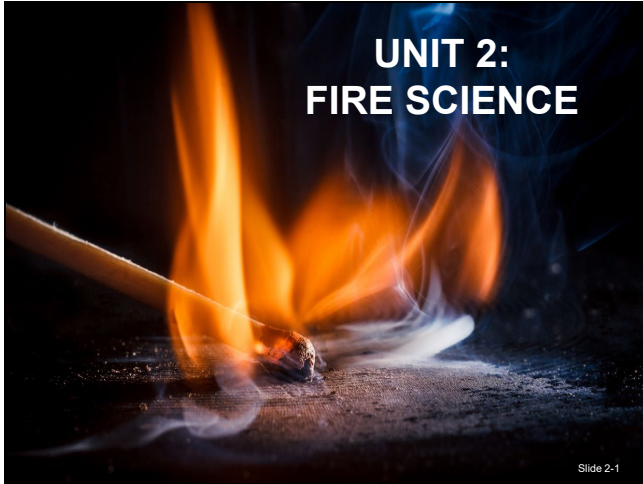
- 2.1 *Evaluate the impact of fire dynamics on the fire investigation.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 2.1 *Define fire.*
  - 2.2 *Correlate the components of the fire tetrahedron with fire development.*
  - 2.3 *Classify each phase of fire development related to the fuel and ventilation available.*
  - 2.4 *Explain the three methods of heat transfer.*
  - 2.5 *Summarize the relationship between fire dynamics, firefighter actions and the fire investigation.*
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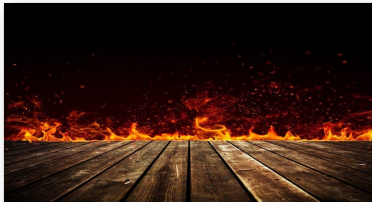
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## TERMINAL OBJECTIVE

Evaluate the impact of fire dynamics on the fire investigation.



Slide 2-2

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## ENABLING OBJECTIVES

- 2.1 Define fire.
- 2.2 Correlate the components of the fire tetrahedron with fire development.
- 2.3 Classify each phase of fire development related to the fuel and ventilation available.
- 2.4 Explain the three methods of heat transfer.
- 2.5 Summarize the relationship between fire dynamics, firefighter actions and the fire investigation.

Slide 2-3

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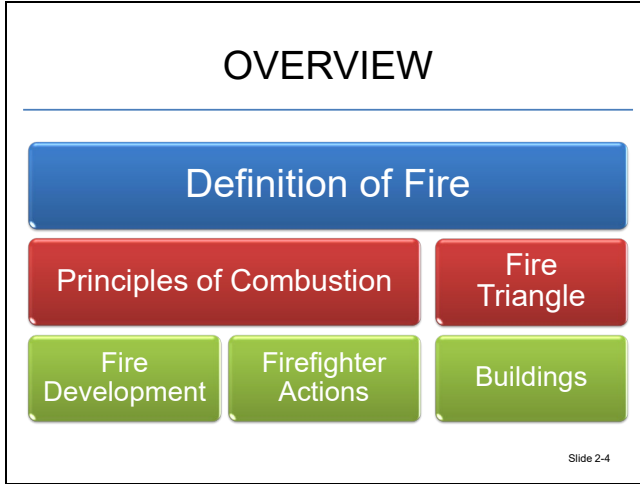
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**I. DEFINITION OF FIRE**

DEFINITION OF FIRE

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“Fire is a **rapid oxidation** process, which is an exothermic **chemical reaction**, resulting in the **evolution of light and heat** in varying intensities.”

— NFPA 921, Section 3.3.71  
Slide 2-5

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- A. Fire is “a rapid oxidation process, which is an exothermic chemical reaction, resulting in the evolution of light and heat in varying intensities” (National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, 2024, Section 3.3.71).

**WHAT IS FIRE?**

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<https://youtu.be/tMDKeBaLWDw>

Slide 2-6

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- B. Through the investigation of a fire, there is an attempt to discover, through investigating the facts, the scene and any evidence, what happened at a given location to result in a fire.

**FIRE**

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- **Behavior:** Fire behavior is a complex phenomenon that must be understood to formulate scientifically valid opinions and conclusions.
- **Investigation:** “The process of determining the origin, cause and development of a fire or explosion.”

— NFPA 921, Section 3.3.79

Slide 2-7

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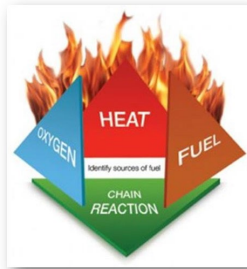
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- C. Fire behavior is a complex phenomenon that must be understood to formulate scientifically valid opinions and conclusions.
- D. Fire investigation is “the process of determining the origin, cause, and development of a fire or explosion” (NFPA 921, 2024, Section 3.3.79).

### FIRE TETRAHEDRON AND SUPPRESSION

- In addition to fuel, heat and oxygen, a chemical chain reaction is required to continue flaming combustion.
- If any one of the four elements is removed, the fire is extinguished.



Slide 2-8

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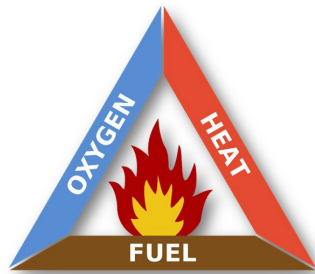
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- E. In addition to fuel, heat and oxygen, a chemical chain reaction is required to continue flaming combustion.
- F. If any one of the four elements is removed, the fire is extinguished.
1. Heat.
  2. Fuel (reducing agent).
  3. Uninhibited chemical chain reaction.
  4. Oxidizing agent.

### THE FIRE TRIANGLE AND INVESTIGATION



Slide 2-9

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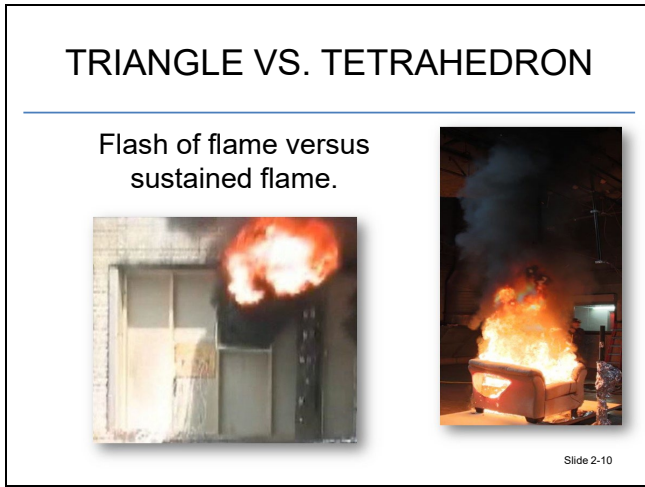
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- G. All three legs of the fire triangle must be present for a fire to exist.
1. Fuel in the form of a gas can change from a solid or liquid to a gas.
  2. Sufficient heat to vaporize the material and ignite the vapor.

- 3. Oxygen above the minimum levels needed to sustain combustion.

II. PRINCIPLES OF COMBUSTION

- A. When heat, fuel and oxygen mix in the correct quantities, a flame can exist. However, for the flame to continue, the chemical chain reaction must continue to support flaming combustion.



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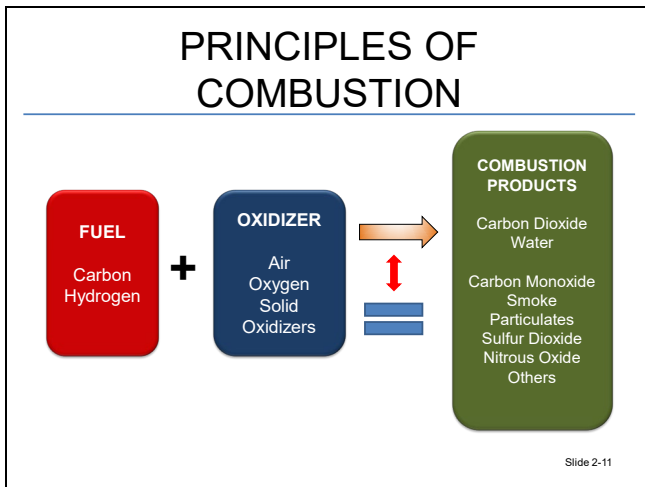
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- B. In the left photo on the slide, the flame is generated once the hot, fuel-rich gases (smoke) are mixed with enough air (oxygen) to enable autoignition and generate a flame. Once the fuel that ignited burns away, or the mixture of fuel and air becomes too rich or too lean to burn, the flaming combustion stops.
- C. In the right photo on the slide, the flame continues to heat solid fuels in the chair, causing them to change into a gaseous fuel, which supplies the flaming combustion process. The flames will be sustained until the fuel is consumed or until someone works to extinguish the fire.



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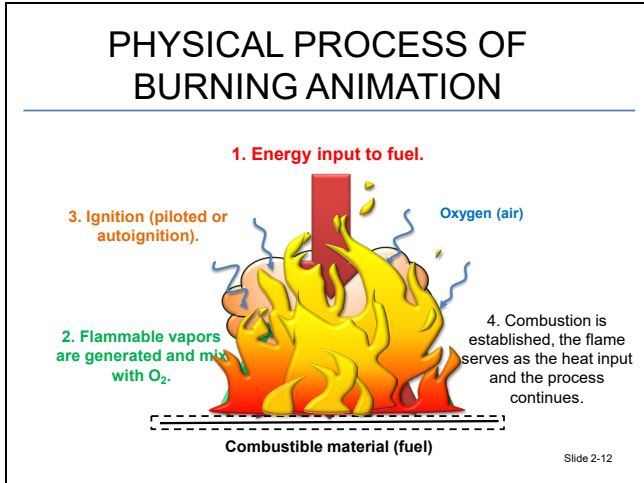
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D. General combustion reaction.



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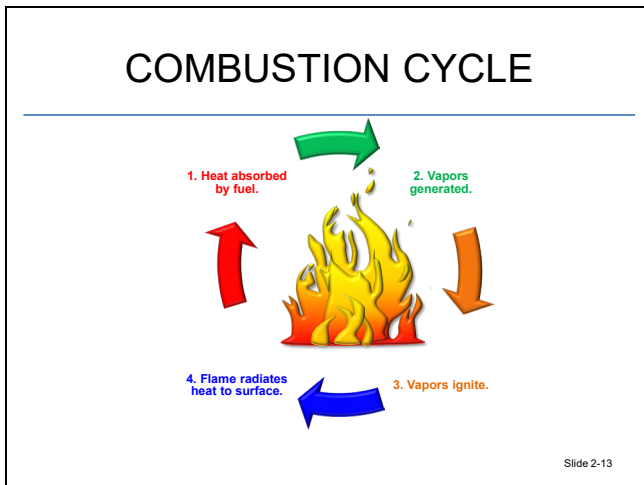
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E. Physical process of burning.

1. Heat input to fuel.
2. Vapors are released from a surface.
3. Ignition occurs.
4. The process repeats.



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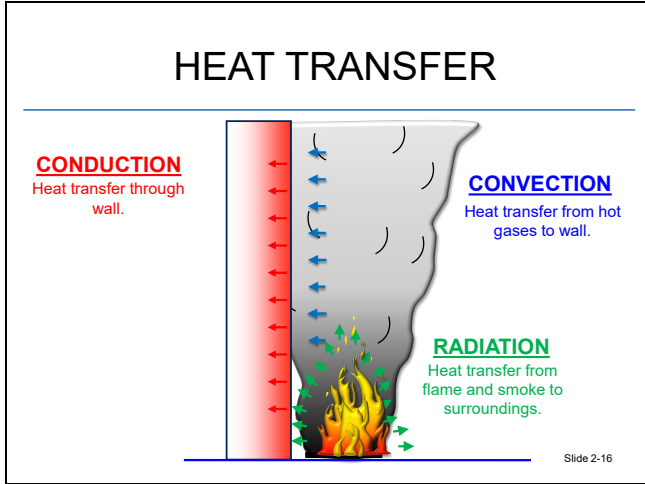
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F. Another way to look at the combustion cycle.







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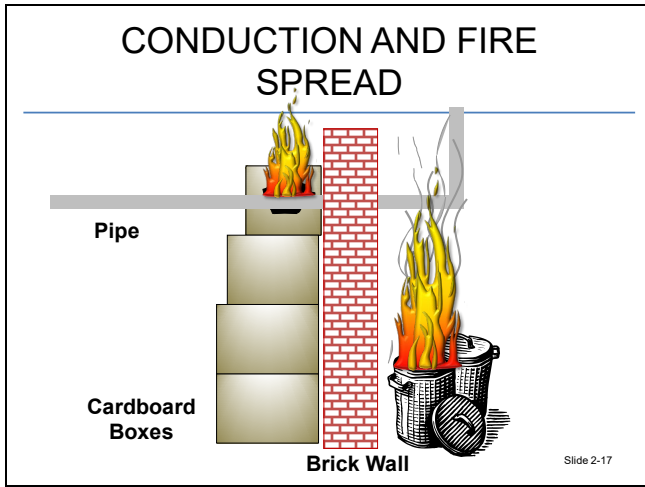
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- I. Heat transfer.
  - 1. Conduction: heat transfer through a solid.
  - 2. Convection: heat transfer within a medium such as a gas or liquid.
  - 3. Radiation: heat transfer through electromagnetic waves longer than visible light waves and shorter than radio waves.



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- J. The slide shows an example of how conduction might spread fire to another area on the other side of the wall.

## CONDUCTION VIDEO



Slide 2-18

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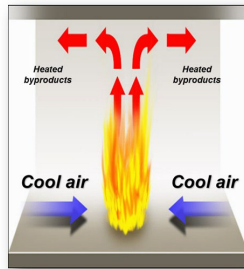
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## CONVECTION AND FIRE SPREAD

Early in a fire, convection:

- moves hot gases from the fire to the upper portion of the room.
- transports hot gases to other areas outside of the room of fire origin.
- provides convective cooling low in the room.



Slide 2-19

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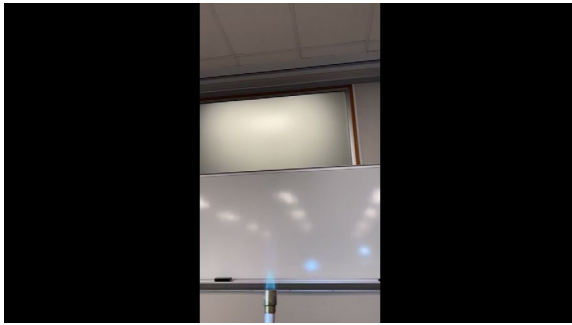
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- K. Early in a fire, convection is important because it moves hot gases from the fire to the upper portion of the room of fire origin.
1. Hot gases are moved to other areas outside of the room of fire origin.
  2. Convection provides convective cooling low in the room.
- L. The heat transfer rate at the ceiling will be higher than the heat transfer rate at the floor.

### CONVECTION VIDEO



Slide 2-20

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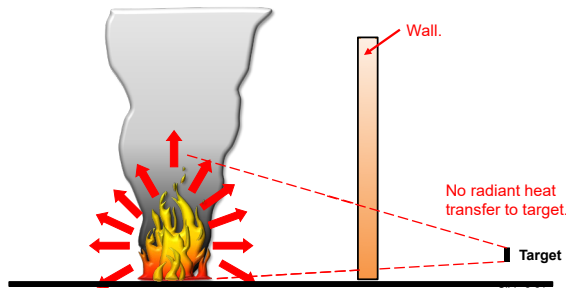
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### RADIATION AND LINE OF SIGHT

The target must be in view of the radiating object.



Slide 2-21

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M. The target must be in view of the radiating object.

### OTHER FACTORS THAT AFFECT RADIATION HEAT TRANSFER

- Distance between radiating object and target.
- Size of both the radiating object and target.
- Orientation of both the radiating object and target.



Target

Slide 2-22

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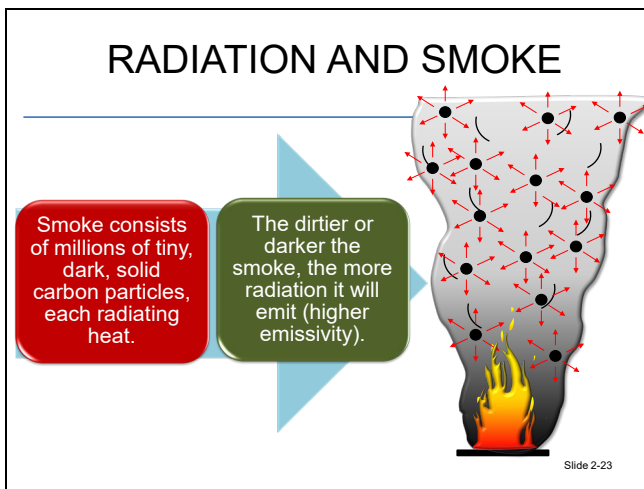
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N. Other factors that affect radiation heat transfer.

1. Distance between radiating object and target.
2. Size of both the radiating object and target.
3. Orientation of both the radiating object and target.
4. View factor = shape factor = configuration factor.
  - a. In general, the radiant heat flux will decrease as the distance between the radiating object and target increases.
  - b. Keep in mind that the target will begin to heat up and start to radiate (emit energy) as well.



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- O. Smoke consists of millions of tiny, dark, solid carbon particles, each radiating heat.
1. The dirtier or darker the smoke, the more radiation it will emit (higher emissivity).
  2. Keep in mind that if the soot-filled smoke is between a target and a flaming source, the soot will absorb and scatter radiation.






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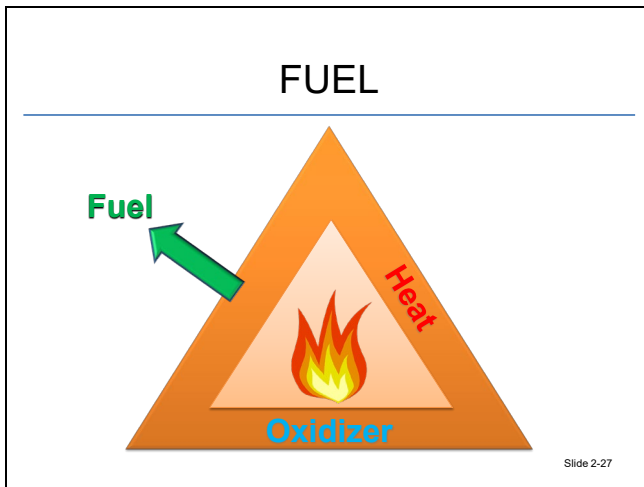
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Q. Underwriters Laboratories (UL) burned two sofas. One was more than 50 years old, and the other is available for sale today. The older sofa had cotton padding in the seat cushions, back cushions and arms. The new sofa had polyurethane foam-filled seat cushions and polyester batting-filled back cushions. The sofa made of synthetic materials reached a peak heat release rate (HRR) of approximately 4 megawatts (twice the amount of HRR that you need for flashover of a residential-scale room with an open door) in less than five minutes. The cotton sofa burned for almost an hour and had a peak HRR of 300 kilowatts.

III. FIRE TRIANGLE




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- A. Phase combustion.
1. Solids and liquids do not burn (and result in flaming combustion).
  2. Liquids evaporate into a vapor that burns when mixed with the proper amount of air.

3. Most solids chemically decompose due to heat (pyrolyze) into gases that burn when mixed with the proper amount of air.



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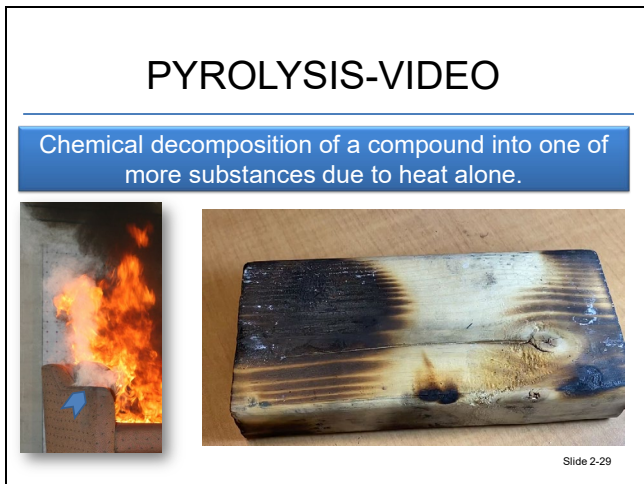
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- B. In the first video, the vapors from the candle can be ignited remotely from the source of the fuel (the wick).
- C. In the second video, a cold object (a spoon) is inserted into the flame. The result is that some of the carbon in the flame cools and condenses on the spoon. This demonstrates that soot is a component of the flame.



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- D. Pyrolysis.
1. Chemical decomposition of a compound into one or more substances by heat alone.
  2. Pyrolysis applies to the chemical decomposition of solids due to heat alone. In other words, a chemical change takes place as opposed to just a change of state.



## FORM OF FUEL

Fuels exist in different forms:

- Solids.
- Liquids.
- Gases.

The state (solid, liquid, gas) of a given material depends on temperature and pressure.

Slide 2-30

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- E. Fuel vapor generation.
1. Phase changes (reversible events).
    - a. Melting: No change in chemical structure; liquids change back to a solid when cooled (candle wax).
    - b. Evaporation: No change in chemical structure; gases change back to a liquid when cooled.
  2. Thermal decomposition (irreversible changes).
    - a. Changes to the chemical structure of the material due to the effects of heat (pyrolysis).
    - b. Sublimation: When heated, solid material changes directly into a vapor (naphthalene, methenamine).

## SOLID FUELS

Wood  
Plastics  
Cloth  
Synthetics  
Metals



Slide 2-31

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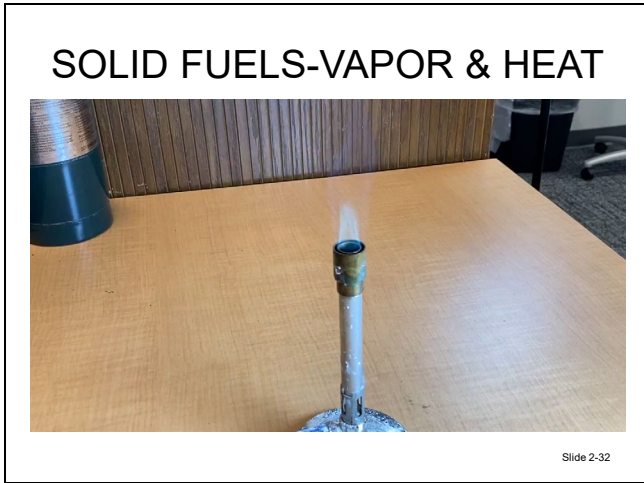
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- F. Most of the fuels contain carbon and hydrogen in some combination. From a fire suppression perspective, these are Class A fuels.



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## LIQUID FUELS



Slide 2-35

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G. All liquid fuels are some form of liquid hydrocarbon. From a fire suppression perspective, these are Class B fuels.

1. Gasoline.
2. Kerosene.
3. Diesel.
4. Cooking oil.
5. Solvents.
6. Thinners.

## LIQUID FUELS-VAPOR SLO



Slide 2-36

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## FLASH POINT

The lowest temperature of a liquid, as determined by specific laboratory tests, at which the liquid gives off vapors at a sufficient rate to support a momentary flame across its surface.

Examples:

- 45 °F (-43 °C) for gasoline.
- 126 °F (>52 °C) for diesel fuel.

— NFPA 921, Section 3.3.92

Slide 2-37

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H. Flash point is the lowest temperature of a liquid, as determined by specific laboratory tests, at which the liquid gives off vapors at a sufficient rate to support a momentary flame across its surface.

## GASEOUS FUELS

Propane  
Methane  
Carbon monoxide  
Hydrogen  
Acetylene

Vapors: produced by solid or liquid fuels.



Slide 2-38

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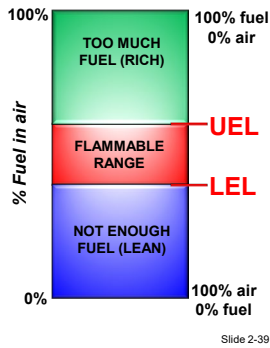
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I. Gaseous fuels.

1. Propane.
2. Methane.
3. Carbon monoxide.
4. Hydrogen.
5. Acetylene.
6. Vapors: produced by solid or liquid fuels.

## FLAMMABILITY RANGE

- Lower explosive limit (LEL). Lowest concentration of vapor in the air that will ignite.
- Upper explosive limit (UEL). Highest concentration of vapor in the air that will ignite.




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- J. Lower explosive limit (LEL): minimum concentration of fuel vapors in air that will burn.
- K. Upper explosive limit (UEL): maximum concentration of fuel vapors in air that will burn.
- L. Also referred to as the flammability limits (lower flammable limit (LFL) and upper flammable limit (UFL)).
- M. Gases require less than 1 millijoule of energy to ignite.  
A strong static shock is on the order of 1 joule or 1,000 millijoules.
- N. Ignition energy must be applied in a region of the vapors within the flammable range to start the reaction.

### FLAMMABILITY RANGE: MAGIC BOX-VAPOR IGNITION SET UP



Slide 2-40

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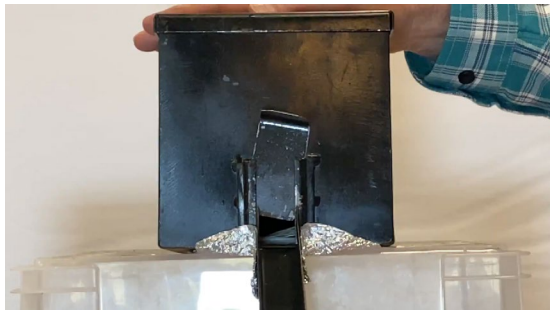
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FLAMMABILITY RANGE:  
MAGIC BOX-VAPOR IGNITION



Slide 2-41

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FLAMMABILITY RANGE:  
MAGIC BOX - REVEAL



Slide 2-42

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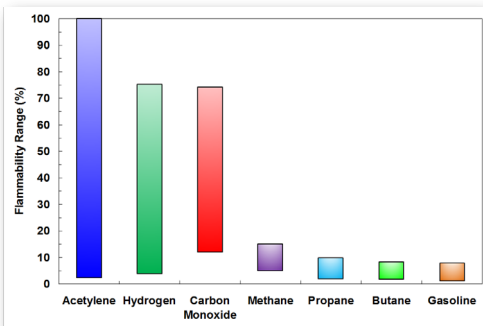
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RANGE OF FLAMMABILITY



Slide 2-43

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O. Examples of flammability ranges.

1. Acetylene UEL = 100%.

2. In those cases, the gas does not require oxygen to react, since the fuel molecule itself can explosively decompose.

NBC TODAY ROSSEN REPORTS

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Summary video of how fuels burn.

<http://www.today.com/home/newer-homes-furniture-burn-faster-giving-you-less-time-escape-t65826>

Slide 2-44

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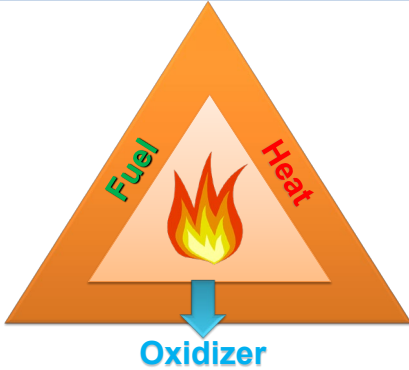
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OXIDIZER (AIR)

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Slide 2-45

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P. Air:

OXIDIZERS

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**Air:**

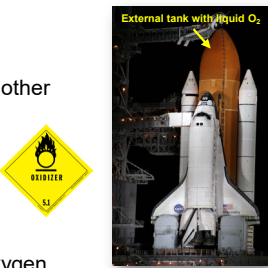
- 21 percent oxygen.
- 79 percent nitrogen and other constituents.

**Enriched oxygen:**

- Medical environments.
- Industrial/scientific.

**Solid oxidizers:**

- materials that contain oxygen.
- chemicals: nitrates, chlorates, sulfates, phosphates, etc.



Slide 2-46

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1. Twenty-one percent oxygen.
2. Seventy-nine percent nitrogen and other constituents.

Q. Enriched oxygen:

1. Medical environments.
2. Industrial/scientific.

R. Solid oxidizers:

1. Materials that contain oxygen.
2. Chemicals: nitrates, chlorates, sulfates, phosphates, etc.

### ENRICHED OXYGEN FIRE-VIDEO



Slide 2-47

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### VENTILATION-VIDEO



Slide 2-48

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## IF YOU WERE A DETECTIVE...

Working a fraud case what would you say?

Follow the \_\_\_\_\_.

Similarly,

A fire investigator should follow the \_\_\_\_\_.

Slide 2-49

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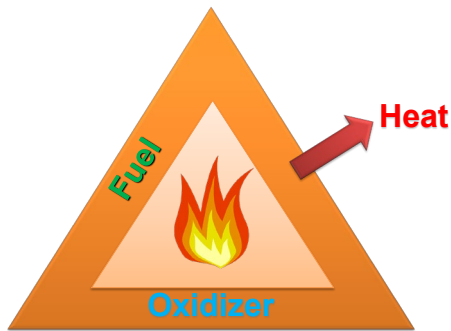
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## HEAT FOR IGNITION



Slide 2-50

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S. Heat for ignition.

## IGNITION

The process of initiating self-sustained combustion.

Ignition Temperature:

- Minimum temperature required to cause combustion.

Types of Ignition:

- Piloted ignition.
- Autoignition.



— NFPA 921, Section 3.3.120

Slide 2-51

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1. Ignition is “the process of initiating self-sustained combustion” (NFPA 921, 2024, Section 3.3.120).

- a. Ignition temperature: minimum temperature required to cause combustion.
- b. Types of ignition:
  - Piloted ignition: combustion by heat with the assistance of a spark or flame.
  - Autoignition: combustion by heat without the assistance of a spark or flame.

**COMPETENT IGNITION SOURCE**

A competent ignition source will have:

- enough energy.
- will be in contact with the fuel long enough to raise it to the fuel's ignition temperature.



— NFPA 921, Section 3.3.37  
Slide 2-52

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- 2. A competent ignition source will have sufficient energy and will be in contact with the fuel long enough to raise it to the fuel's ignition temperature.

During origin and cause, one must be able to articulate each of these points.

**EXAMPLE: A MATCH AS AN IGNITION SOURCE**

A single match can ignite a toothpick, but not a 2 x 4 piece of wood (or can it), even though:

- Both objects have the same material properties.
- The flame temperature is above the ignition temperature of the wood.

Remember: Only works if the flame is held in contact with the fuel long enough.

Slide 2-53

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- T. A single match can ignite a toothpick, but not a two-by-four piece of wood (or can it), even though:
1. Both objects have the same material properties.
  2. The flame temperature is above the ignition temperature of the wood.
  3. Remember: It only works if the flame is held in contact with the toothpick long enough.



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IV. FIRE DEVELOPMENT

**FIRE DEVELOPMENT**

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After ignition, what happens in the fire compartment?



Slide 2-56

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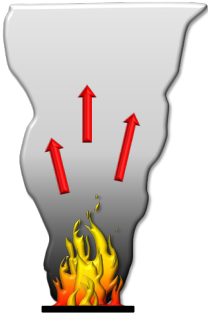
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Apply the basic principles of fire science to a fire in a compartment.

**BUOYANCY EFFECT**

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- Buoyancy causes the vertical motion of hot gases and combustion products.
  
- Buoyancy exists when two adjacent fluids (gas or liquid) exist at different densities.



Slide 2-57

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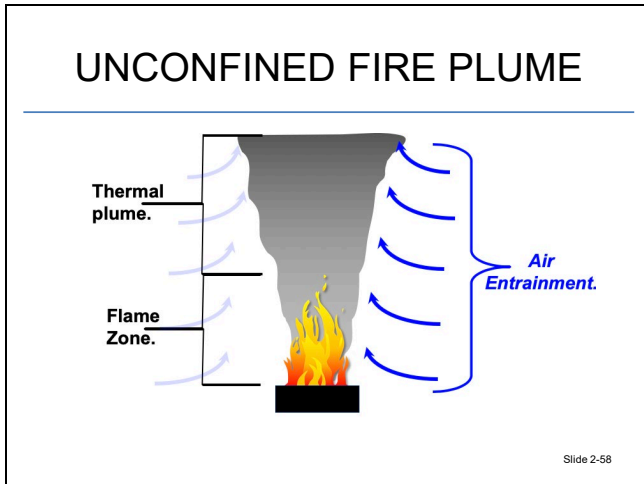
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- A. After ignition, fuel and air meet and combustion occurs. The hottest part of the plume is just above the flame. As the plume rises, air is entrained and cools the plume.
  
- B. Buoyancy causes the vertical motion of hot gases and combustion products.
  
- C. Buoyancy exists when two adjacent fluids (gas or liquid) exist at different densities.
  
- D. Combustion increases the temperature of the gases and causes them to rise (buoyancy — hot air is less dense than its surroundings, which causes it to rise).
  - 1. We call these rising hot gases and the flames above the surface of the fuel the fire plume.

2. As combustion gases rise, fresh, cool air moves in to take its place and its temperature is increased by combustion and the process continues.
3. This process of drawing in air is called “entrainment.”
4. No ceiling means that the plume disperses into the atmosphere (hot gases cool down quickly).
5. Ceilings trap hot fire gases (gases do not cool down as fast).



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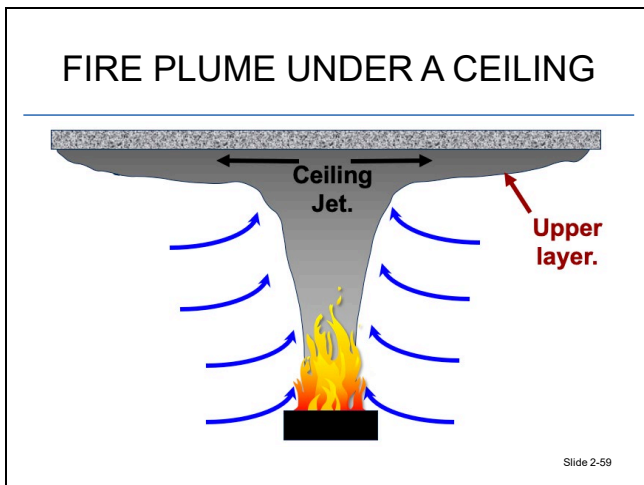
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- E. An unconfined plume gets wider due to entrainment. Eddies facilitate air entrainment. Entrainment occurs throughout the height of the plume, not just down at the base of the fire.
- F. Higher velocity gases result in a local decrease in pressure, resulting in air entrainment.



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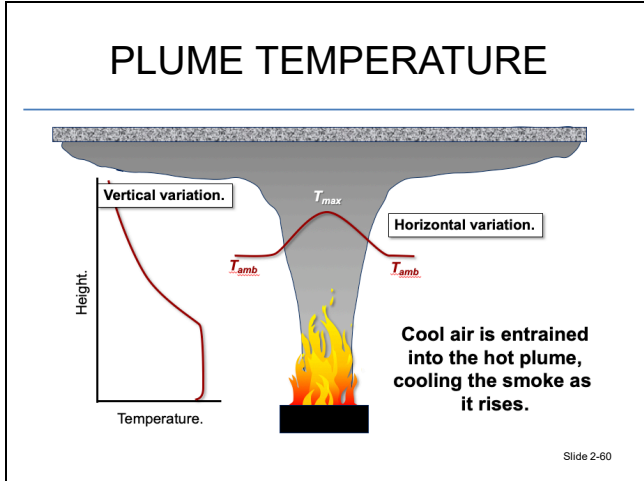
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- G. Note the symmetry: Plumes, and the jet created when the plume hits the ceiling, are symmetrical.




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- H. Cool air is entrained into the hot plume, cooling the smoke as it rises.
- I. Entrainment continues until the plume reaches ambient temperature.
- J. Gases in the plume are less dense than the surroundings.

**COMPARTMENT FIRES**

Fire growth in a compartment is a function of:

- Fuel properties (chemistry, thermal inertia (kpc), etc.).
- Fuel quantity.
- Ventilation (natural or mechanical).
- Compartment geometry - volume and ceiling height.
- Location of fire within compartment.
- Ambient conditions (wind, temperature and RH).
- Time.

The block includes four sequential photographs showing a fire starting in a compartment, growing, and eventually reaching the ceiling. Slide 2-61.

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- K. Fire growth in a compartment is a function of:
  1. Fuel properties (chemistry, thermal inertia (kpc), etc.).
  2. Fuel quantity.
  3. Ventilation (natural or mechanical).
  4. Compartment geometry: volume and ceiling height.
  5. Location of the fire within the compartment.

- 6. Ambient conditions (wind, temperature and relative humidity (RH)).
- 7. Time.
- L. Extra air does not react; it absorbs some of the heat produced by the combustion reaction, thereby lowering the flame temperature.

**FUEL LIMITED FIRES**

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- Also known as over-ventilated fires.
- More oxygen supplied to the fire than required to react with all the fuel.
- Fires start as fuel limited fires.

The diagram shows a seesaw with a triangular fulcrum in the center. The left side is higher and has the word 'FUEL' written above it in red. The right side is lower and has the word 'OXYGEN' written above it in blue.

Slide 2-62

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- M. Fuel-limited fires.
  - 1. Also known as over-ventilated fires.
  - 2. More oxygen is supplied to the fire than is required to react with all the fuel.
  - 3. In general, all fires start out as fuel-limited fires.

**VENTILATION LIMITED FIRES**

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- Also known as under-ventilated or fuel rich fires.
- Insufficient oxygen to react with all the fuel (more fuel than air), which results in the incomplete combustion of the fuel.
- Compartment fires can transition from fuel limited to ventilation limited and back again.

The diagram shows a seesaw with a triangular fulcrum in the center. The left side is lower and has the word 'FUEL' written above it in red. The right side is higher and has the word 'OXYGEN' written above it in blue.

Slide 2-63

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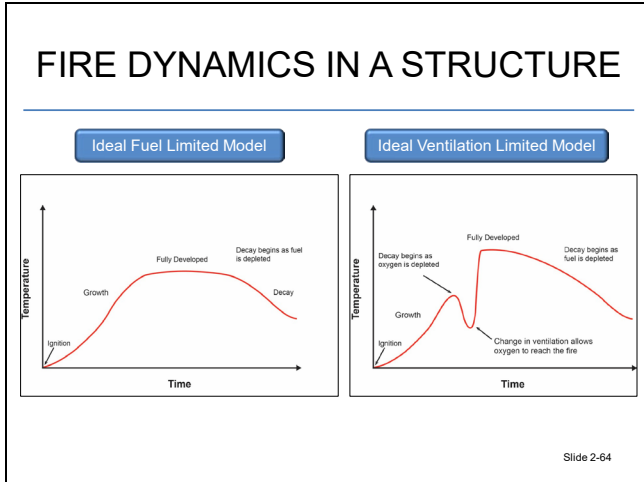
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- N. Ventilation-limited fires.
1. Also known as under-ventilated or fuel-rich fires.
  2. Insufficient oxygen to react with all of the fuel (more fuel than air), which results in the incomplete combustion of the fuel.
  3. Compartment fires can transition from fuel-limited to ventilation-limited and back again.




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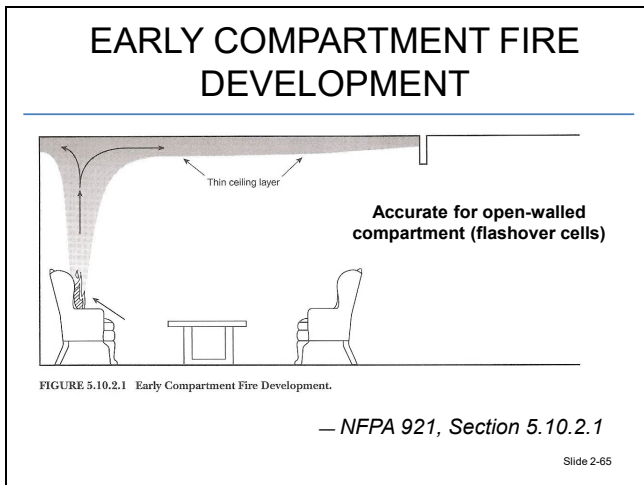
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- O. The slide shows idealized graphs of a fuel-limited and a ventilation-limited fire. Both curves start off as fuel controlled, then the impacts of compartment size, ventilation, fuel types, etc., generate a ventilation-limited fire condition.




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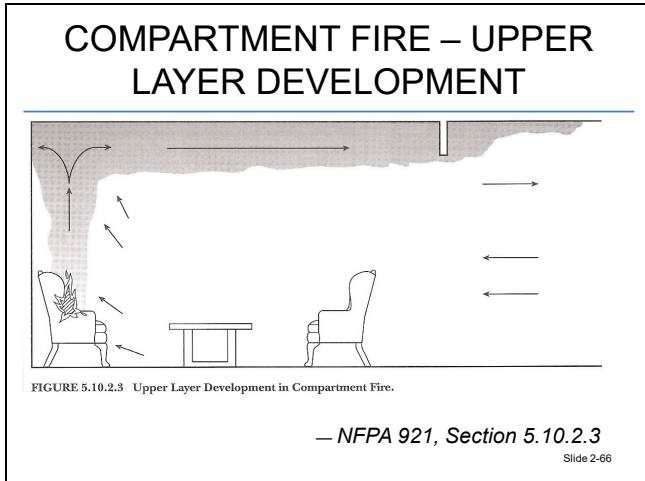
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- P. The series of room fire drawings on the following slides are representative of a flashover cell, i.e., a room with an open wall — not necessarily applicable for all compartment fires.





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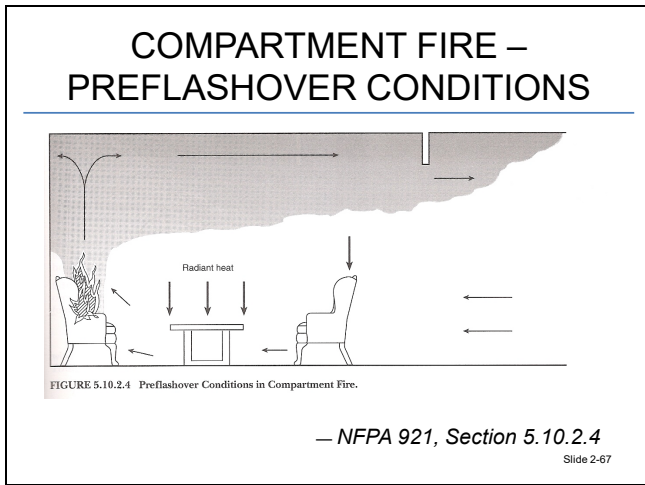
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- Q. Thermal damage is limited to the areas where the fire or hot gases are making contact.
- R. Thermal damage on the sides of furnishings close to the fire may be starting due to radiant heat transfer.



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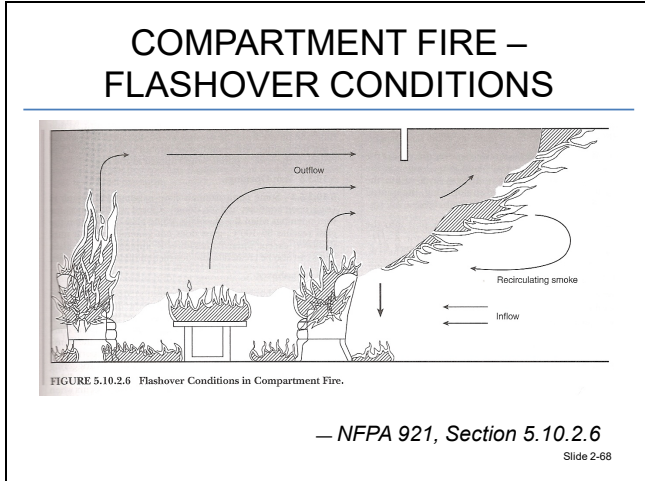
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- S. Radiant heat from the hot gas layer preheats all fuels within the line of sight of the layer.  

As the temperature of the hot gas layer increases, the radiant heat causes the horizontal surfaces to pyrolyze.
- T. Provided enough fuel, heat and makeup air, the fire will continue to grow in HRR and size.




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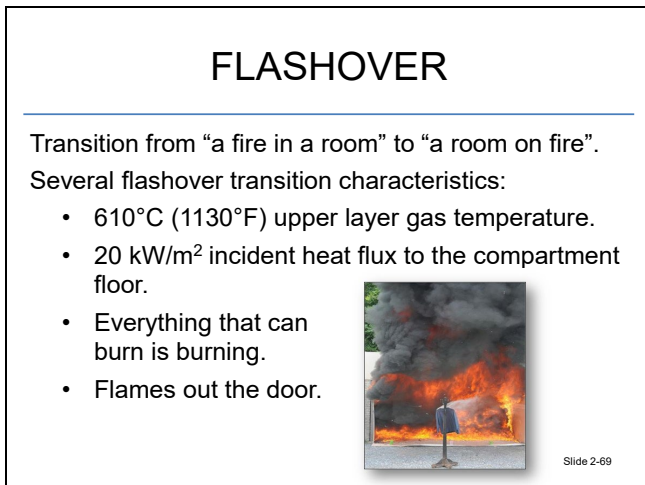
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- U. The hot gas layer ignites, and flames spread toward the room opening (low-pressure vent). As the HRR increases, everything in the room that can burn will burn if the oxygen can reach it.
  1. The amount of damage will be based on duration and available ventilation.
  2. Flaming combustion may cease in the areas of the room most remote from the air inflow due to a lack of oxygen.




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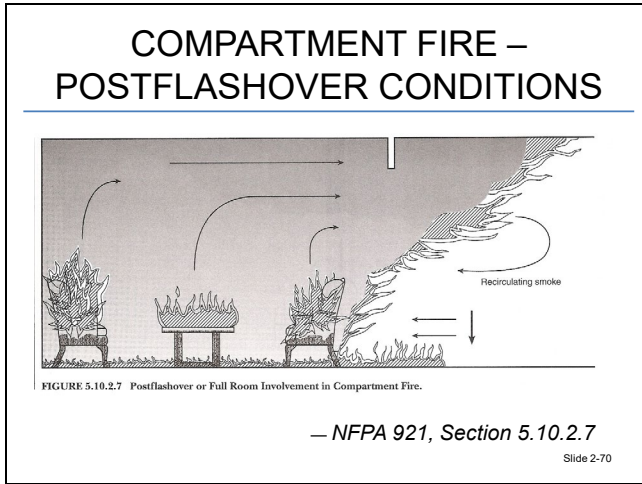
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- V. Flashover is the transition from “a fire in a room” to “a room on fire.”
- W. Several flashover transition characteristics:
  1. Six hundred and ten degrees Celsius (1130 F) upper layer gas temperature.
  2. Twenty kilowatts per square meter incident heat flux to the compartment floor.

- 3. “Everything that can burn is burning.”
- 4. “Flames out the door.”



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- X. This slide has to be examined carefully. Here is a case where it is likely that the area of origin would no longer be burning due to a lack of oxygen at that location in the room.



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## HEAT RELEASE RATE

- Heat Release Rate (HRR) is the amount of heat energy released by the fire per unit time.
- Fire power.
- The “size” of a fire is often specified by the heat release rate.
- ***HRR is single most important factor in characterizing fire behavior.***

Slide 2-72

- Y. HRR is the amount of heat energy released by the fire per unit time.
1. Often used to describe the “size” of a fire.
  2. Remember: It is the single most important factor in characterizing fire behavior.
- Z. HRR from an object is controlled by:
1. The chemical and physical properties of the fuel.
  2. Geometry of fuel and containment.
  3. Ventilation.
  4. Surrounding fuels.

## PEAK HEAT RELEASE RATES

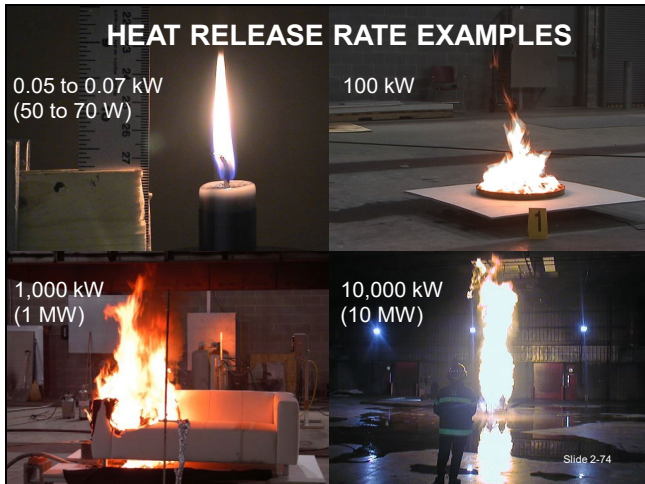
Peak Heat Release Rate	
Burning cigarette	5 W
Burning match	80 W
Small trash can fires	50 to 300 kW
Burning upholstered chair	80 kW to 2.5 MW
Burning upholstered sofa	3,000 kW or 3 MW
Burning Christmas tree	1.6 MW to 5.2 MW

kW = 1,000 watts      MW = 1 million watts

Slide 2-73

AA. Peak HRRs.

1. Cigarette: 5 W.
2. Match: 80 W.
3. Coffeemaker: 40 kW.
4. Small plastic trash can: 50 kW.
5. Trash bag fires: 50 kW to 300 kW.
6. Upholstered chair: 80 kW to 2.5 MW.
7. Upholstered sofa: 3 MW to 5 MW.
8. Dry holiday tree (6 to 8 feet): 1.6 MW to 5.2 MW.



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BB. HRR examples.

1. Candle: 5 kW.
2. Heptane pool (2-foot diameter). About a 2-foot tall flame, which is 100 times bigger than a single candle flame.
3. Upholstered couch: This fire is 10 times bigger than the heptane pool fire.
4. Heptane spray burner: 20 to 25-foot tall flame. This fire is 10 times bigger than the previous couch fire.

## FLASHOVER DEMO



Slide 2-75

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### V. KNOWLEDGE CHECK

#### KNOWLEDGE CHECK: SCIENCE TO THE STREET

- What are the specifications for structural firefighting PPE?
- At what level of Heat Flux does the weakest component fail? (not temperature)
- If flashover is  $20\text{kW/m}^2$ , what will turnout gear withstand? For how long?
- Technically, how does the turnout gear protect you?

Slide 2-76

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### VI. FIREFIGHTER ACTIONS



**RESEARCH FOUNDATION**  
RESEARCH FOR THE NFPA MISSION

Nothing a firefighter wears or uses is fireproof. The data and standard requirements indicate flame temperatures can exceed  $1,000^{\circ}\text{C}$  ( $1,832^{\circ}\text{F}$ ), yet most of the PPE or gear is tested to  $260^{\circ}\text{C}$  ( $500^{\circ}\text{F}$ ) for 5 minutes.

The peak heat flux exposures to firefighting coats and pants are  $84\text{ kW/m}^2$ . This is a significant exposure, but the data shows heat flux values exceeding the TPP test by a factor of **two** can occur on the fire ground (Madrzykowski, 2017,p.56)

-- Fire Fighter Equipment Operational Environment: Evaluation of Thermal Conditions, UL Firefighter Safety Research Institute

Slide 2-77

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- A. “Nothing a firefighter wears or uses is fire proof. The data and standard requirements indicate flame temperatures can exceed 1,000 °C (1,832 °F), yet most of the PPE or gear is tested to 260 °C (500 °F) for 5 minutes” (Madrzykowski, 2017, p. 56). This does not mean that the PPE will protect someone for five minutes at 260 C (500 F).
- B. “The peak heat flux test exposures to firefighting coats and pants are 84 kW/m<sup>2</sup>. This is a significant exposure, but the data shows heat flux values exceeding the thermal protective performance (TPP) test by a factor of two can occur on the fire ground” (Madrzykowski, 2017, p. 56, retrieved from <https://ulfirefightersafety.org/docs/RFEvaluationThermalCondition.pdf>).

### FIREFIGHTER ACTIONS

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Firefighter actions affect the fire dynamics, and as a result, the investigation of a fire scene.

- Actions of suppression.
- Observations.
- Forced entry.
- Flow path control.
- Delays in suppression.
- Rekindle.



Slide 2-78

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- C. First responders should evaluate actions in two dimensions: the first as related to fire suppression, and the second as related to the fire investigation.
- D. Any of these actions could impact the fire investigation:
  - 1. Actions of suppression.
  - 2. Observations.
  - 3. Forced entry.
  - 4. Flow path control.
  - 5. Delays in suppression.
  - 6. Rekindle.

## FIRST RESPONDER & INVESTIGATOR

- Building construction type.
- Occupancy classifications.
- Structural loads.
- Fire travel predictions.
- Fire protection systems.
- Ventilation and flow path.



Slide 2-79

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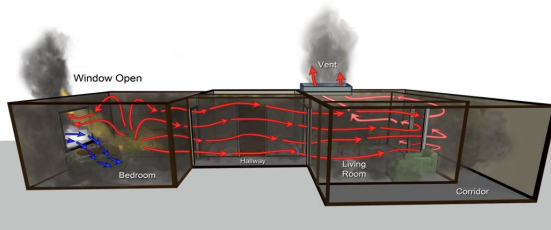
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E. While these items are considerations for fire suppression, they are also important to the fire investigation.

1. Building construction type.
2. Occupancy classifications.
3. Structural loads.
4. Fire travel predictions.
5. Fire protection systems.
6. Ventilation and flow path.

## FLOW PATH



The area(s) within a structure where heat, smoke and air flow from an area of higher pressure to areas of lower pressure.

Slide 2-80

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F. Flow path is the area(s) within a structure where heat, smoke and air flow from an area of higher pressure to areas of lower pressure. A flow path must have at least one intake vent and one exhaust vent.



### FLOW PATH VIDEO



Slide 2-81

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## VII. BUILDINGS

### BUILDING CONSIDERATIONS

- Type of building.
- Type of occupancy.
- Building construction.
- Building renovations.
- Building systems (HVAC, electric, gas).
- Large open spaces.
- Volume of air available for combustion.



Slide 2-82

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A. The first responder should also be aware of other issues affecting fire spread and development specifically related to the building.

1. Type of building.
2. Type of occupancy.
3. Building construction.
4. Building renovations.
5. Building systems (heating, ventilating, and air conditioning (HVAC), electric and gas).
6. Large open spaces.

7. Volume of air available for combustion.

**DIFFERENT CONFIGURATIONS**



Slide 2-83

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**DIFFERENT CONFIGURATIONS**



Slide 2-84

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**COMPARTMENTATION RESTRICTS FIRE MOVEMENT**

The use of fire-resistive barriers to confine heat and flames (walls, ceilings, floors).



Slide 2-85

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B. The use of fire-resistive barriers to confine heat and flames (walls, ceilings, floors).

## BUILDING CONSTRUCTION TYPES

- Building construction types and features will help to determine fire growth and spread.
- Development, spread, and control of a fire often depend upon the type of construction and the ability of structural elements to remain intact.

Slide 2-86

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- C. Understanding building construction types and features will help in determining fire growth and spread.
- D. Development, spread and control of a fire within a structure often depend on the type of construction and the ability of structural elements to remain intact.

## BALLOON FRAME CONSTRUCTION



Slide 2-87

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- E. Balloon frame construction.
  1. Usually built prior to 1940.
  2. Studs run from foundation wall to roofline.
  3. Floors are attached with a ribbon board.
  4. If the fire is in the attic of a balloon frame building, check the basement for fire origin. No fire blocking (“fire stops”).

## LIGHTWEIGHT CONSTRUCTION



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### F. Lightweight construction.

1. One of the most widely used types of building construction; however, it also poses the greatest collapse hazards.
2. Uses lightweight assemblies of small components.
3. Commonly found in new homes, apartments, commercial buildings and warehouses.

## ENGINEERED BEAMS

- High surface-to-mass ratio.
- Often unprotected by gypsum wallboard.
  - Early failure.
- Improper field cuts and penetrations.



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### G. Engineered beams: structural components composed of top and bottom flanges, which may be solid or laminated wood, united with a plywood or Oriented Strand Board (OSB) web of various depths.

1. Used extensively in residential construction.
2. Rising cost of lumber makes the wood I-beam affordable.
3. Ease of installation reduces labor cost.

- H. UL Firefighter Safety Research Institute (FSRI) tested four common types of floor assemblies: nominally dimensional lumber, wood I-joists, lightweight steel C-joists, and parallel cord trusses constructed with gusset plates.

### PRE-FIRE ASSEMBLIES



REF: UL FSRI Full-Scale Floor System Field and Laboratory Fire Experiments  
Kerber, Madrzykowski, Dalton, and Backstrom.

Slide 2-90

### POST FIRE ASSEMBLIES



REF: UL FSRI Full-Scale Floor System Field and Laboratory Fire Experiments  
Kerber, Madrzykowski, Dalton, and Backstrom.

Slide 2-91

### Collapse Times less than 5 minutes

Experiment Number	Floor Support	Ventilation Description	Time from Ignition to Collapse	ΔT Time to Collapse – Time to fire spread to floor assembly.
1	Dimensional Lumber (2 x12)	Max Vent	11:09	7:11
2	Dimensional Lumber (2 x12)	Sequenced Vent	12:45	10:45
3	Engineered Wood I-Joist (12 in.)	Max Vent	6:00	2:45
4	Engineered Wood I-Joist (12 in.)	No Vent	6:49	4:06
5	Engineered Wood I-Joist (12 in.)	No Vent/No boxes	8:27	4:42
6	Engineered Wood I-Joist (12 in.)	Max Vent/Furnace DHS load	6:49	2:29
7	Steel C-Joist (12 in.)	Max Vent	8:15 (6:11 exceeds ISO 834:1)	5:15
8	Steel C-Joist (12 in.)	Sequenced Vent	14:04* (10:08 exceeds ISO 834:1)	10:32
9	Parallel Chord MPCWT	No Vent	6:08	3:42
10	Parallel Chord MPCWT	Max Vent	3:28	1:50

REF: UL FSRI Full-Scale Floor System Field and Laboratory Fire Experiments  
Kerber, Madrzykowski, Dalton, and Backstrom.

Slide 2-92

## FIRE PROTECTION SYSTEM CONSIDERATIONS

- Actions of occupants.
- Fire alarm systems.
- Automatic suppression systems.
- Fire department interaction with automatic suppression systems.



Animation



Slide 2-93

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- I. Fire protection system considerations.
  1. Actions of occupants.
  2. Fire alarm systems.
  3. Automatic suppression systems.
  4. Fire department interaction with automatic suppression systems.

## ACTIVITY 2.1

### Candle Experiment

#### Purpose

Demonstrate the anatomy of a flame, review methods of heat transfer, reinforce chemistry of fire and combustion reaction zone, and show the differences between a diffusion and premixed flame.

#### Directions

1. Clear off your tables.
2. Place the candle securely inside the pie plate and light the candle.
3. Follow exercise directions from your instructor.

#### Exercises

1. Place hands in a cupped fashion around candle flame. What type of heat transfer is taking place into your hands?
2. Place hand over candle flame. What type of heat transfer is taking place into your hand?
3. Place paper clip into flame while holding one end. What type of heat transfer is occurring in the paper clip?
4. Place a spoon into the blue luminous zone just above the wick. Observe how this produces little soot.
5. Hold the spoon at the tip of the candle's flame. Observe how there are large amounts of soot and carbon deposits present.
6. Hold the spoon in a vertical position against the side of the candle flame, limiting the fresh air intake into the candle fire plume. Observe the shadow heat patterns left on the spoon. Note that little soot is present.
7. Hold the mesh screen above the tip of the candle flame, and slowly move it downward toward the base of the flame. While moving the mesh screen through the flame, observe the differences in the flame structure, especially toward the midsection of the candle. Note change in smoke production; why?

8. Use glass eye dropper to extract unburned paraffin vapors from the side of the candlewick. Vapors may be reinjected to the combustion zone and ignite and burn at the tip of the eye dropper.
9. Extinguish the candle. Ignite the white vapors trailing off the wick, causing the flame to jump back to the candlewick.





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## REFERENCES

Madrzykowski, D. (2017). *Fire fighter equipment operational environment: Evaluation of thermal conditions* (Report no. FPRF-2017-05). Retrieved from <https://ulfirefightersafety.org/docs/RFEvaluationThermalConiditoins.pdf>

National Fire Protection Association. (2024). *Guide for fire and explosion investigations*. (Standard no. 921). Retrieved from <https://www.nfpa.org>

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# **UNIT 3: THE FIRE SCENE**

## **TERMINAL OBJECTIVE**

*The students will be able to:*

- 3.1 *Consider the process of a fire scene investigation.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 3.1 *Assess the fire scene activities of the first responder in relation to the fire investigation.*
  - 3.2 *Summarize the process by which data is identified, documented and preserved during the process of a fire scene investigation.*
  - 3.3 *Explain the three types of information that can assist with determining the origin of a fire as outlined in National Fire Protection Association (NFPA) 921, Guide for Fire and Explosion Investigations.*
  - 3.4 *Evaluate potential factors impacting responsibility determinations.*
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## TERMINAL OBJECTIVE

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Consider the process of a fire scene investigation.

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## ENABLING OBJECTIVES

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- 3.1 Assess the fire scene activities of the first responder in relation to the fire investigation.
- 3.2 Summarize the process by which data is identified, documented and preserved during the process of a fire scene investigation.
- 3.3 Explain the three types of information that can assist with determining the origin of a fire as outlined in National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*.
- 3.4 Evaluate potential factors impacting responsibility determinations.

Slide 3-3

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I. FIRST RESPONDERS

**FIRST RESPONDERS**

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- First emergency services on the scene.
- First source of data for the investigator above the layman level.
- Make observations, protect evidence, and communicate information.



Slide 3-4

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A. First responders are the first emergency services on the scene and the first source of data for the investigator above the layman level. They will make observations, protect evidence and communicate information.

**FIRE SCENE ACTIVITIES AND THE FIRST RESPONDER**

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- Arrive.
- Observe.
- Involve fire/police departments.
- 360 Size-up.
- Note injuries/fatalities.



Slide 3-5

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B. What did the first responder do? What actions were taken?

1. First arriving.
2. Observations.
3. Involved fire/police departments.
4. Did anyone do a size-up 360?
5. Are there injuries/fatalities?




C. First arriving firefighters are a primary source of information for the investigator.

**FIRST RESPONDER  
ACTIONS**

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- Interviews or information provided.
- Flow path control.
- Rescues.
- Fire protection systems.
- Time to water.



Slide 3-6

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D. These are the types of information an investigator will be seeking:

1. Interviews or information provided.
2. Flow path control.
3. Rescues.
4. Fire protection systems.
5. Time to water.

**FIREFIGHTERS EXPECT  
QUESTIONS**

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- Identify apparatus on scene and locations.
- Offensive or defensive attack.
- Condition of utilities upon arrival.
- Condition of doors and windows.
- Bystander details.



Be as specific as possible in answering, use correct terms  
(Flashover vs. Roll over)

Slide 3-7

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E. Firefighters expect questions.


1. Identify apparatus on-scene and their locations.

2. Offensive or defensive attack.
  3. Condition of utilities upon arrival.
  4. Condition of doors and windows.
  5. Bystanders present.
- F. Be as specific as possible in answering; use correct terms (flashover versus rollover).

## FIREFIGHTERS

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- Identify first firefighters on scene.
- Personnel - who made entry and where.
- Description of fire conditions, location, and spread.
- Areas of access to the structure.



ENG 00-1    ENG 00-5    ENG 00-9  
TRUCK 00-1    CAR 00-08

Recount Actions during suppression. Snap a photo of RIT board.

Slide 3-8

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- G. Identify first firefighters on-scene.
1. Personnel who made entry and where.
  2. Description of fire conditions, location and spread.
  3. What areas of the structure were accessed?

## FIRE GROUND OBSERVATIONS

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- Fire or burglar alarms noises.
- Status of suppression systems.
- Sections of structure energized.



Discussion Question: What's a potential hazard illustrated above?

Slide 3-9

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H. Examples of observations made by the first responder.

1. Fire or burglar alarm noises.
2. Suppression systems operating.
3. Sections of structure energized.

**FIRE GROUND ACTIONS**

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- Effects of fire suppression on fire spread and pattern development.
- Mechanical ventilation of windows, doors, and roof.
- Delays.
- "Write-Off" areas.



Slide 3-10

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I. What effects did fire suppression have on fire spread and pattern development?

1. Mechanical ventilation of windows, doors and roof.
2. Delays.
3. Any "Write-Off" areas.

**FIRE GROUND OPERATIONS**

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- Gasoline powered tools.
- Heavy equipment used.
- Aqueous foams used.
- Evidence noted/preserved.



Slide 3-11

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J. Things happening during fire suppression that the investigator may need to be aware of:

1. Gasoline-powered tools.
2. Heavy equipment used.
3. Aqueous foams used.
4. Evidence noted/preserved.

**OVERHAUL**

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Overhaul Procedures.  
Post Fire Alterations.



Fire investigation happens **BETWEEN** Suppression and Overhaul.

Slide 3-12

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- K. Fire investigation occurs between suppression and overhaul.
1. Excessive overhaul will make the scene examination more difficult to conduct.
  2. Contents and structural members need to be reconstructed to accurately interpret fire patterns.

**SEE SOMETHING**

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Identify, preserve and document potential evidentiary items identified early in the investigation.



This is the type of evidence the firefighter will be the first to see- protect it!

Slide 3-13

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- L. Identify, preserve and document potential evidentiary items identified early in the investigation.

1. Evidence should be identified, preserved, documented and collected early when possible.
2. If the evidence is not preserved, it runs the risk of being moved, altered or destroyed.

**FIREFIGHTER-VIDEO**



Fire Fighter Helmet Camera

Slide 3-14

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**THERE IS AN INVESTIGATION**

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- If there is going to be an investigation, there are ground rules.
- The investigation must be systematic.
- It must adhere to the Scientific Method in spirit and in action.



Slide 3-15

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- M. If there is going to be an investigation, there are some ground rules.
1. The investigation must be systematic.
  2. It must adhere to the Scientific Method in spirit and in deed.

### SCIENTIFIC METHOD-REVIEW

“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 hypotheses; and, where possible the selection of a final hypothesis.”

-NFPA 921, Section 3.3.171

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N. Scientific Method review.

“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 hypotheses; and, where possible, the selection of a final hypothesis” (National Fire Protection Association (NFPA) 921, 2024, Section 3.3.171).

### SCIENTIFIC METHOD CHART



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O. Scientific Method chart.

1. Need.
2. Define problem.
3. Collect data.
4. Analyze data.
5. Develop hypotheses.

- 6. Test.
- 7. Final determination.

**THE SYSTEMATIC PROCEDURE: WHAT IS THAT?**

- The investigator will follow the same basic steps at any size fire.
- Each investigation should be conducted about the same way each time.
- Scene circumstances may cause the investigator to deviate from their systematic procedure.

Where to start?

Slide 3-18

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- P. The systematic approach.
  - 1. Deviations from the investigators' systematic approach should be documented in the report.
  - 2. Typically, investigators start the scene exam at the exterior and work to the interior.

**II. FACTOR ONE: BREAKING DOWN THE ORIGIN**

**BREAKING DOWN THE INVESTIGATION: ORIGIN**

- Establish the area where the fire started.
- An investigator should always be able to determine an origin, it may be a small area or an entire building.

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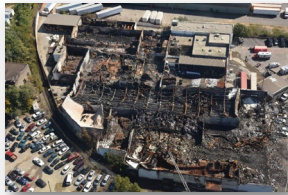
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- A. The origin investigation is to establish the area where the fire started. An investigator should always be able to determine an origin; it may be a small area or an entire building.

## SIZE DOESN'T MATTER



Small countertop fire



Large warehouse fire

There are no short cuts. A firefighter must ask similar questions, regardless of the size of the fire.

Slide 3-20

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- B. The size, type and complexity of a scene will change, but the methodology should remain the same. Developing the process and the method and practicing it on small fires reinforces the habit and methodology.

## ORIGIN DEFINITIONS

- **Area of Origin** – a structure, part of structure, or general geographic location within a fire scene, in which the “point of origin” is believed to be located.
- **Point of Origin**- the physical location within the area of origin where a heat source, a fuel, and an oxidizing agent first interact, resulting in a fire or explosion.



-NFPA 921, Sections 3.3.14 and 3.3.153

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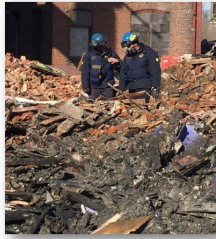
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- C. The origin investigation and determination are to establish the area where the fire started. The investigator should always be able to determine an origin; it may be a small area or an entire building.
1. Area of origin — “a structure, part of 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” (NFPA 921, 2024, Section 3.3.14).
  2. Point of origin — “the physical location within the area of origin where a heat source, a fuel, and an oxidizing agent first interact, resulting in a fire or explosion” (NFPA 921, 2024, Section 3.3.153).



## RECOMMENDED METHODOLOGY

- 1) Initial scene assessment.
- 2) Preliminary origin and fire spread hypothesis.
- 3) In-depth scene examination and reconstruction.
- 4) Development of final fire spread hypothesis.
- 5) Fire origin identification.



Firefighters typically participate in #s 1, 2, or 5.

-NFPA 921, Section 18.2.5

Slide 3-22

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### D. Recommended methodology.

1. Initial scene assessment.
2. Preliminary origin and fire spread hypothesis.
3. In-depth scene examination and reconstruction.
4. Development of final fire spread hypothesis.
5. Fire origin identification.

## SEQUENCE IN INVESTIGATIONS

- Non-linear.
- Record the scene, note taking, photography, evidence identification, witness interviews, cause investigation, failure analysis, and other data collection may be performed independently or simultaneously at various stages of the investigation.



Slide 3-23

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### E. Fire scene investigations are nonlinear.

Recording the scene, note taking, photography, evidence identification, witness interviews, cause investigation, failure analysis and other data collection may be performed independently or simultaneously at various stages of the investigation.

## THE INVESTIGATOR DOCUMENTS EVERYTHING

Completely document scene:

- Before starting, while working, when done.
- To include photos, drawings, notes, items collected, videos/photos discovered, anything related to the scene.
- Documentation clearly reflects a systematic approach.

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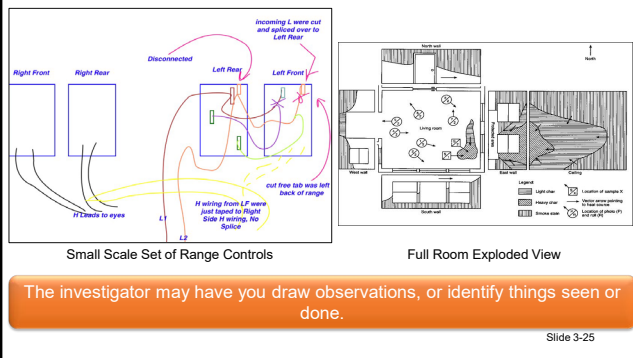
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### F. Investigator documentation.

1. While the investigator will be working more closely with documentation, this does not mean the first responder will not be involved. They should assist and document items as found, even prior to the arrival of the investigator.
  - a. Before the investigator starts, as they are working and when they are done, they must document the scene completely.
  - b. This includes photos, drawings, notes, items collected, videos/photos discovered, i.e., anything related to the scene.
  - c. Documentation should reflect a systematic approach.

## INVESTIGATORS USE DIAGRAMS



Slide 3-25

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### 2. Diagrams.

- a. Paper and pencil. No necessity for straight lines or mistake-free work.
- b. A legend and notes off to the side.
- c. Made after the preliminary scene examination has been conducted and before moving or removing any evidence.
- d. Objects are not drawn with infinite detail.
- e. Choose and use symbols when drawing sketches.
- f. When the investigator uses letters or numbers in the sketch or diagram, they may place them in a circular or rectangular box.
- g. Use common fire service or diagramming symbols for notations and show a legend.

**PHOTOGRAPHY**

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A methodical order is used to orient the viewer to include identifying markers when needed.



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- 3. Photography.
  - a. If the first responder is taking photos, use a systematic process. Take photos in order to orient the viewer to what is important.
  - b. Use a methodical order and orient the viewer.
  - c. Use identifying markers when needed.

## TYPES OF PHOTOS

- 360° camera to document the fire scene during various stages of processing.
- Several affordable models available from various manufacturers.
- Demonstrative evidence for courtroom.



Animation

Does the department provide a camera on the rig? Could use your cell phone? Should you use your cell phone?

Slide 3-27

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4. Types of photos.
  - a. Consider a 360-degree camera to document the fire scene during various stages of processing.
  - b. Several affordable models are available from various manufacturers.
  - c. Demonstrative evidence for the courtroom.

## USE OF AERIAL DEVICES

Aerial examination and documentation may help depict origin area and fire spread.



Slide 3-28

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5. Aerial examination and documentation may help depict origin area and fire spread.

## OTHER PHOTO SOURCES

The internet as a data source: Pre-fire photos, satellite photos, social media, maps, websites, realtor sites, weather, etc.



Business website photo

Post fire photo

Slide 3-29

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6. Consider the internet as a data source.
  - a. Pre-fire photos, mobile phone photos, satellite photos, social media, maps, websites and realtor sites are all examples.
  - b. Also, consider asking users of the building if they have any photos from parties, weddings, selfies, etc., inside the building of interest, as the backgrounds of those photos can be very helpful.
    - For example, parishioners at some church fires provided photos from weddings, funerals and baptisms, all of which provided background details useful during reconstruction of the fire scene.

## FIRST RESPONDER AND ORIGIN DETERMINATION

- Recall the importance of NFPA 921 and impact on the fire investigation.
- The first responder, deciding a fire origin, should be able to articulate consideration of the three factors.
- NFPA 921, says only ONE factor is needed to establish origin. Is that prudent?
- Non-linear

Slide 3-30

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- G. Origin determination.
  1. Recall the importance of NFPA 921 and its effect on the fire investigation.


- a. The first responder, when determining a fire origin, should be able to articulate consideration of the three factors.
- b. NFPA 921 says only one factor is needed to establish origin. Is that prudent?

### THE ORIGIN

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

- Witness Information and/or Electronic Data
- Fire Patterns
- Fire Dynamics

- NFPA 921, Section 18.1.2



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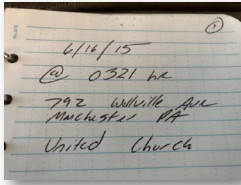
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- 2. “Determination of the origin of the fire involves the coordination of information derived from one or more of the following” (NFPA 921, 2024, Section 18.1.2):
  - a. Witness information and/or electronic data.
  - b. Fire patterns.
  - c. Fire dynamics.

### COLLECTING DATA (INFORMATION)

- Data collection and planning begins at the time the investigator is notified of an incident.
- Document via notes.
- Basic incident information include:
  - date, time, & location.
  - structure/occupancy type.
- Notes may be discoverable.



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- H. Collecting data (information).
  - 1. Data collection and planning for the investigator begins at the time the investigator is notified of an incident. For the first responder, that may begin at dispatch.
  - 2. Basic incident information includes:
    - a. Date, time and location.
    - b. Structure/occupancy type.
  - 3. Notes may be discoverable.

### FIRE SCENE SECURITY

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- Maintain the integrity of the scene.
- Treat the scene as a potential crime scene.
- Establish secure perimeter.
- Limit access to the scene.
- Escort witnesses into scene as needed.
- Authority to be on the scene.

First Responders may be critical for security throughout the incident.

Slide 3-33

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- 4. Fire scene security.
  - a. Maintain the integrity of the scene.
  - b. Treat the scene as a potential crime scene.
  - c. Establish a secure perimeter.
  - d. Limit access to the scene.
  - e. Escort witnesses into the scene as needed.
  - f. Arrange overnight security.
  - g. The first responder is lawfully under a slightly different capacity as the fire investigator. Lawful access to the scene may be different for each group; each person must know why they are there.

- h. Establish lawful entry to the scene for the investigator:
  - Exigent circumstances.
  - Consent.
  - Search warrant.
  - Administrative warrant.

**SAFETY: IN SUPPRESSION  
AND INVESTIGATION**

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Common Hazards:

- Investigating alone on scene.
- Investigator fatigue.
- Heavy equipment.
- Physical.
- Structural stability.
- Electrical.
- Mechanical.



Slide 3-34

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- I. Fire scene safety.
  - 1. Common hazards:
    - a. Investigating a scene alone.
    - b. Investigator fatigue.
    - c. Working around heavy equipment.
    - d. Physical hazards.
    - e. Structural stability hazards.
    - f. Electrical hazards.
    - g. Mechanical hazards.



## SAFETY: COLLAPSE

- Identify safety hazards during interior survey.
- Collapse potential.
- Floor integrity.
- Hazardous or explosive atmospheres.
- Condition of utilities.



Slide 3-35

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2. Identify safety hazards during the interior survey.
  - a. Collapse potential.
  - b. Floor integrity.
  - c. Hazardous or explosive atmospheres.
  - d. Condition of utilities.

## NON-APPARENT HAZARDS

Wear appropriate type and level of PPE:

- Chemical.
- Biological.
- Radiological.
- Explosive atmospheres.
- Low oxygen atmospheres.
- Drug labs.
- Energized.



Slide 3-36

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3. Wear appropriate type and level of personal protective equipment (PPE):
  - a. Chemical hazards.
  - b. Biological hazards.
  - c. Radiological hazards.

- d. Explosive atmospheres.
- e. Low oxygen atmospheres.
- f. Drug labs.

**FIRE SCENE SAFETY-VIDEO**



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**FIRE SCENE CONTAMINATION**

Cross-contamination:  
the unintentional contamination of scene or evidence during examination, collection, storage, or transport.



Clean tools:

- New gloves for every sample.
- Protect evidence containers.
- Decontamination line.



Avoid gasoline powered equipment.

Slide 3-38

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- J. Cross-contamination is the unintentional contamination of a scene or evidence during examination, collection, storage or transport.
  - 1. Clean tools.
  - 2. New gloves for every sample.
  - 3. Avoid gasoline-powered equipment.
  - 4. Decontamination line.

## OBTAINING INFORMATION: PEOPLE TALK

- People may talk to you as the first responder.
- Engage them, listen to them.
- Document information via notes, audio/video recordings, photographs and diagrams.
- Ongoing process that occurs prior to, during, and post fire scene examination.



Slide 3-39

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### K. Obtaining information.

1. Document information via notes, audio/video recordings, photographs and diagrams.
  - a. Ongoing process that occurs prior to, during and post-fire scene examination.
  - b. People may talk to first responders; engage them and listen to them.

## HELPFUL INFORMATION FROM A WITNESS

- Establish timeline, pre-fire, during, post-fire.
- Establish pre-fire activities.
- Note unusual smells, electrical issues.
- Note known potential ignition sources
  - Accidental
  - intentional
- Recent contract/DIY work.



Slide 3-40

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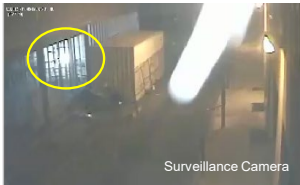
2. Helpful information from a witness.
  - a. Establish timeline: pre-, during, post-fire.
  - b. Establish pre-fire activities.
  - c. Unusual smells, electrical issues, etc.
  - d. Known potential ignition sources.

- Accidental.
  - Intentional.
- e. Recent contract/do-it-yourself (DIY) work.
3. Establishing a timeline of events is critical to the fire investigation. Witness data is typically considered soft-time data. The investigator should attempt to establish activities that were taking place prior to the fire incident. The data can be used to develop potential fire origin and cause hypotheses.

**HELPFUL INFORMATION:  
ELECTRONIC**

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- Witness photographs.
- Witness video.
- Surveillance systems.
- Drone footage.



Slide 3-41

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4. Helpful information: electronic.
- a. Witness photographs.
  - b. Witness video.
  - c. Surveillance systems.
  - d. Drone footage.

## FIRE EFFECT

- Fire effects are the observable or measurable changes in or on material as a result of a fire.
- Fire effects form fire patterns through heat, deposition and consumption.



-NFPA 921, Section 3.3.77

Slide 3-42

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### L. Fire effect and patterns.

1. Fire effects are “the observable or measurable changes in or on a material as a result of a fire” (NFPA 921, 2024, Section 3.3.77).
2. Fire effects form fire patterns through heat, deposition and consumption.

## FIRE PATTERNS

- Second Item Identified by NFPA 921 for use in determining origin.
- Fire Pattern Analysis is an integral function of origin determination and can be subjective.



Slide 3-43

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3. Fire pattern.
  - a. The second item identified by NFPA 921 for use in determining origin.
  - b. Fire pattern analysis is an integral function of origin determination and can be subjective.

## WHAT IS A FIRE PATTERN?



The visible or measurable physical changes, or identifiable shapes, formed by a fire effect or group of fire effects.

- NFPA 921, Section 3.3.81

Slide 3-44

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- c. Fire patterns are “the visible or measurable physical changes, or identifiable shapes, formed by a fire effect or group of fire effects” (NFPA 921, 2024, Section 3.3.81).
  - Keep in mind that fire effects and fire patterns must be considered within the context of the entire fire scene.

## SMOKE DEPOSITION

Smoke particulates collect on cooler surfaces walls, windows and content surfaces.



Slide 3-45

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- 4. Smoke deposition.
  - a. If a surface is cold relative to the smoke, components of the smoke will condense on the surface. This is like taking a cold drink outside on a hot and humid day. The water in the air will condense on the outside of the cold can or glass.
  - b. If the surface is a similar temperature to or hotter than the smoke, the smoke is not likely to attach to that surface. As smoke cools, soot may settle out on a horizontal surface due to gravity.

## CLEAN BURN

Burning of fuels such as paper, paint and soot from noncombustible surfaces can be indicative of high heat flux exposure.



Clean Burns alone do not indicate an area of origin.

Slide 3-46

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5. Clean burn.
  - a. Burning of fuels such as paper, paint and soot from noncombustible surfaces can be indicative of high heat flux exposure.
  - b. Clean burn is a visible fire effect, typically on noncombustible surfaces, where the surface covering has burned away and no soot was deposited.
  - c. A clean burn indicates that the area was exposed to a very high heat flux; **however, clean burns alone do not indicate an area of origin.**
  - d. Clean burn lines of demarcation can assist investigators in determining fire spread.

## LINE OF DEMARCATION

A line of demarcation representing the lower extent of the hot gas layer may form on vertical surfaces.



Slide 3-47

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6. Line of demarcation.

- a. A line of demarcation representing the lower extent of the hot gas layer may form on vertical surfaces.
- b. A line of demarcation is the boundary between a damaged or undamaged area, or between different levels of damage.
- c. If the lower part of the wall heats up sufficiently or if the lower edge of the hot gas layer cools, the soot deposition line on the wall may stop above the floor, even though the smoke may have been down to the floor.

**DEMARICATION EXAMPLE**

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Smoke and soot collect on cooler surfaces of buildings, or its contents, often on upper parts of walls in rooms adjacent to the fire.



Slide 3-48

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- d. Smoke and soot collect on cooler surfaces of buildings, or their contents, often on upper parts of walls in rooms adjacent to the fire.

**PLUME GENERATED PATTERNS**

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- V-pattern
- Inverted cone
- Hourglass U-shaped
- Pointer / Arrow
- Circular



One V Pattern does not a fire investigation, make.

Slide 3-49

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- e. Fire plumes create lines of demarcation which are identified by geometrical shapes.



- V-pattern, inverted cone, hourglass, U-shaped, pointer/arrow, circular patterns.

### VENTILATION AFFECTED FIRE PATTERNS

Location, shape and magnitude of patterns can be affected by vent openings.



Ventilation can create location of greatest damage. Location of greatest damage is NOT always the point of origin.

Slide 3-50

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7. Location, shape and magnitude of patterns can be affected by vent openings.

### VENTILATION FIRE PATTERNS



Ventilation can create location of greatest damage.

Slide 3-51

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8. Ventilation can create a location of greatest damage. The location of greatest damage is **not** always the point of origin.

## GENERATED BY HOT GAS LAYER

Lines of demarcation may define the hot gas layer.

Radiant heat flux from the hot gas layer may generate thermal damage to floor and content surface areas.



Slide 3-52

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9. Lines of demarcation may define the hot gas layer.
  - a. Radiant heat flux from the hot gas layer may generate thermal damage to the floor and content surface areas.
  - b. Location, shape and magnitude of patterns can be affected by vent openings.

## FIRE PATTERNS AND FULL ROOM INVOLVEMENT

- Room transitioned to flashover conditions.
- Severe fire damage throughout compartment.
- Burning of carpet, under furniture, and baseboards.



Slide 3-53

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10. Room transitioned to flashover conditions.
  - a. Severe fire damage throughout compartment.
  - b. Burning of carpet, under furniture, and baseboards.
  - c. Post flashover burn times must be considered when conducting fire pattern analysis.

- Lengthy post-flashover burn times may cover, obliterate or destroy fire patterns.
- The fire pattern analysis must consider the elements of the fire triangle before and after flashover.

**SUPPRESSION GENERATED PATTERNS**

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Hose stream generated patterns  
Ventilation generated patterns



Slide 3-54

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11. Fire ventilation efforts may move fire throughout the structure.
  - a. Pressure differences move fire through a building.
  - b. Fire suppression operations may alter or destroy fire patterns.

**EXTERIOR INSPECTION**

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Conduct an exterior scene survey prior to a detailed exterior scene examination and documentation:

- General fire damage assessment.
- Identify hazards present.
- Preserve potential evidence for subsequent collection.
- Develop investigative strategy.



**Is there possible evidence outside the fire line tape?**

Slide 3-55

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M. Exterior inspection.

The investigator will conduct an initial exterior scene survey.


1. This is similar to the size-up 360 conducted by the initial responders. It is to orient and familiarize the investigator with the location. This occurs prior to a detailed exterior scene examination and documentation, which will occur later in the process.
2. Things to look for include:
  - a. General fire damage assessment.
  - b. Identify hazards present.
  - c. Preserve potential evidence for subsequent collection.
  - d. Develop investigative strategy.
  - e. Other resources or equipment needed.

### THINGS ON THE EXTERIOR

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Examine security surrounding the fire scene:

- Physical security measures and condition.
- Scene access points.
- Barricaded areas.
- Damage pre-existing, from first responders, or others.



Slide 3-56

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3. Look outward: Examine areas surrounding the fire scene. Look for things like:
  - a. Perimeter physical security measures.
  - b. Scene access or egress points.
  - c. The condition of physical security measures.
  - d. Damage: Is it preexisting, or was it from first responders or others?

## EXPOSURES

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Exposure damage:

- Document exposure physical address.
- Proximity/Orientation to primary fire scene.
- Degrees of damage.



Was damaged observed? Do you know when it happened?

Slide 3-57

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4. The investigator will document any damage to exposure buildings, including the physical address and amount of damage. Was damage observed? Does the investigator know when it happened?

## INVESTIGATION 360°

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- Examine and document all sides of the structure.
- Analyze fire effects and patterns.
- Identify areas which warrant further examination.



Slide 3-58

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5. The investigator should conduct a detailed exterior scene examination, much like the size-up 360 conducted by the first arriving unit.

- a. This is an additional inspection after the previously discussed initial survey.
- b. This examination is more detailed, methodical and slower.
- c. The investigator would take notes, photographs and measurements and develop an initial sketch during this activity.

## WHAT IS OBVIOUS ABOUT THE BUILDING?

- Building construction type and materials.
- Occupancy type.
- Building construction has significant impact on fire growth and spread.
- Data critical for future investigation, testing, and fire modeling.



The firefighter may be a significant source of this information.

Slide 3-59

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6. Understand the importance of documenting building construction types. The investigator should also understand the effect of building construction on fire spread.

a. Information such as:

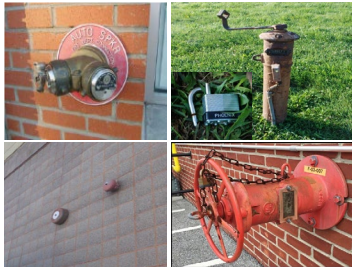
- Document building construction type and materials.
- Construction must be considered when analyzing fire dynamics.
- Construction and building data will be critical for future testing and fire modeling.

b. The firefighter may be a significant source of this information.

## FIRE PROTECTION SYSTEMS

First Responders are interacting with building fire protection systems from arrival. Alarm and suppression system:

- Components.
- Valve positions.
- Evidence of tampering
- Obstructions.



ken, when, and by whom to assist in timeline development.

Slide 3-60

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- 7. First responders are interacting with building fire protection systems from arrival. Note what actions were taken and when to assist in timeline development.

Investigators will inspect any fire alarm or suppression systems. Items to consider include:

- a. Fire alarm and suppression system components and condition.
- b. Valve positions (open/closed).
- c. Evidence of tampering, damage or sabotage.
- d. Obstructions placed in the system.
- e. Inspection history.

### EXTERIOR ACTIONS

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Electric Service:

- Underground service lateral.
- Overhead service drop.
- Condition of service.
- Utility on scene and actions.

Slide 3-61

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- 8. As first responders, investigation of electrical systems should be limited.
  - a. De-energize!
  - b. Identify transformer: pole mount/pad mount.
  - c. Identify utility company pole number/pad number.
  - d. Additional items to consider include:
    - Determine if the service arrives by an underground service lateral or overhead service drop.
    - What is the condition of the service raceway and weather head.


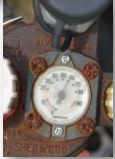

- Identify and examine the meter base and meter.
- Was the meter removed by the utility company?
- Smart meter data.
- Verify building earth-ground.
- Circuit transformer (CT) enclosures.
- Service disconnects.

### GAS UTILITIES

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Location and condition of LP gas tanks:

- Tank capacity and volumes.
- Valve control positions.
- Last filled.
- Appliances serviced, when.



The first responder should document any actions taken that affect the gas delivery system.

Slide 3-62

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9. The first responder should document any actions taken that affect the gas delivery system.

The investigator will examine the natural gas service, if the structure is so equipped:

- a. Liquefied natural gas (LNG) or gas service entrance location and condition.
- b. Connections.
- c. Condition of regulator.
- d. Make/model/serial number.
- e. Valve positions.
- f. Flow rate data may be needed.



## STANDING ON OTHER CLUES

Identify, preserve and collect trace evidence:

- Lighter, matches, devices.
- Ignitable liquids, containers.
- Clothing.
- Footprints, tire tracks.
- Documents.
- DNA/Blood, Fingerprints.
- Tool marks.



Slide 3-63

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10. First responders may encounter trace or other evidence. For example:
- a. Lighter, matches.
  - b. Devices.
  - c. Ignitable liquids.
  - d. Containers.
  - e. Clothing.
  - f. Footprints, tire tracks.
  - g. Documents.
  - h. DNA/blood.
  - i. Fingerprints.
  - j. Tool marks.

### FIRE SCENE INTERIOR

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In an initial survey the investigator will identify safety hazards and outline a preliminary hypothesis of fire origin and spread.



Preservation of the interior "as is" is the most beneficial action?

Slide 3-64

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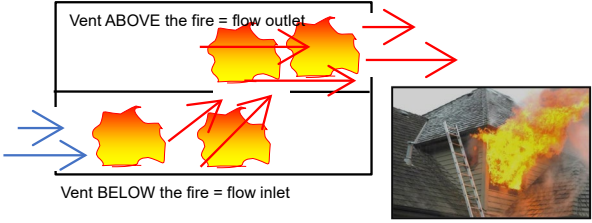
N. Fire scene interior.

1. The initial survey identifies safety hazards and areas that warrant comprehensive examination. A preliminary hypothesis of fire origin and spread may be developed during the survey.

### FIRE BEHAVIOR IN THE INITIAL SURVEY

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Apply fire dynamics concepts when analyzing fire movement patterns and developing fire origin hypothesis.



Slide 3-65

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2. Apply fire dynamics concepts when analyzing fire movement patterns and developing fire origin hypotheses.

### KNOWLEDGE CHECK INTERIOR



Slide 3-66

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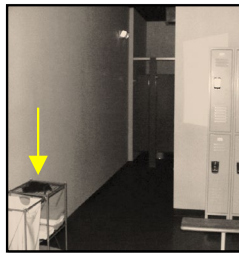
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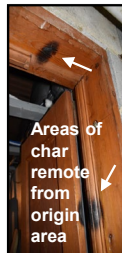
### POST SUPPRESSION OBSERVATIONS

Firefighters should:

- Examine and document all areas.
- Identify areas that for further examination.
- Avoid tunnel vision.
- Separate and distinct fires.



Burned towel missed during initial scene investigation.



Areas of char remote from origin area

Slide 3-67

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3. Once inside the structure, the first responder and investigator should attempt to examine all areas related to the fire:
  - a. Examine and document all rooms/areas.
  - b. Identify fire movement and intensity patterns.
  - c. Note degrees of damage.
  - d. Avoid tunnel vision.
  - e. Are there separate and distinct areas of fire origin?

### EXAMPLE OF FIRE DYNAMICS APPLIED TO INVESTIGATION



What fire spread hypothesis can be developed from this photo?  
Overhaul hazards?

Slide 3-68

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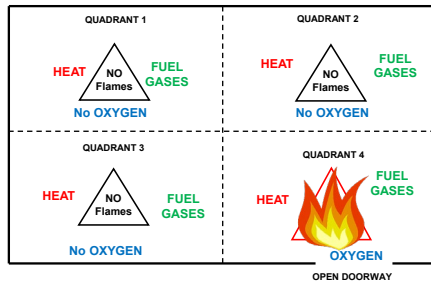
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4. Discuss the objectives of the initial scene survey. The investigator should evaluate building construction and its effect on fire dynamics. Are the fire effects and patterns consistent with fire dynamics theories?

### SCIENCE HOLDS: SUPPRESSION OR INVESTIGATION

Post-Flashover Compartment Fire Conditions



Slide 3-69

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5. Apply origin matrix and damage dynamics when conducting the fire scene investigation. Structural members and contents near ventilation points may have sustained greater degrees of damage depending on the fire's duration. Remember that the fire origin is not always the area of greatest damage.

## DAMAGE DYNAMICS

The investigator will compare damage on contents and structural surfaces and will compare similar items when possible.



Sofa, limited ventilation



Love seat right by ventilation point

Delay overhaul. If moved, would the results be the same?

Slide 3-70

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6. The investigator will evaluate and understand damage created by fire dynamics. Items considered include:
  - a. Compare damage on contents and structural surfaces.
  - b. Compare similar items when possible.
  - c. Is damage a result of ventilation, duration or fuel loads?

## EVALUATE AND DOCUMENT INTERIOR

Document interior construction, finish materials, and dimensions.



Slide 3-71

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7. Document interior construction and finish materials. How did they affect fire dynamics?

The investigator should consider:

- a. Flooring.
- b. Walls.
- c. Ceilings.


- d. Framing.
- e. Insulation type.

**OTHER INFORMATION**

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Video Surveillance Systems:

- Document camera location/perspective.
- Take steps to preserve and recover data.
- Where is the data stored?
- Are date and time stamps accurate?



Documentation of owner/occupant interviews conducted on-scene are critical to the investigator. Be sure to ask about systems or cameras.

Slide 3-72

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- 8. First responders should identify, preserve and document potential evidentiary items identified early in the investigation.
  - a. Investigators may take steps to identify the presence of video surveillance systems in the structure.
  - b. Sources of digital media (digital video recorder (DVR), cameras, hard drives, cloud-based servers) may need to be identified and be recovered immediately.
  - c. Preserve any hard drives, even if damaged.
  - d. Technical assistance may be needed to recover the data.

**FIRE PROTECTION SYSTEMS OPERATING ON ARRIVAL**

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Active Fire Protection Systems:

- Monitored vs Unmonitored.
- Sensor Types – Smoke detector/alarm, heat detector, gas detector, etc.
- Sensor Locations.
- Activation history.
- Inspection/Maintenance records.
- Stored data.



Slide 3-73

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9. First responders should notify the investigator of any fire protection system operating on arrival, and if they disabled any systems.
10. The investigator should evaluate any active fire protection or alarm systems. Items of interest may include:
  - a. Monitored versus unmonitored.
  - b. Sensor types: smoke detector/alarm, heat detector, gas detector.
  - c. Evidence of activation such as observation, witness statements, soot agglomeration.
  - d. Sensor locations.
  - e. Activation history.
  - f. Inspection/Maintenance records.
  - g. Where is the data stored?

**DATA SOURCES**

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- Consider the presence of all data sources.
- Appliances, smart plugs, routers, cameras, thermostats.
- Data can assist with timeline development and origin determination.



Slide 3-74

The image shows a hand holding a glowing blue sphere with various icons representing different IoT devices and services. The text 'Internet of Things' is written across the sphere, with the tagline 'Everything will be connected' below it.

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11. The investigator and first responder should consider the presence of data contained in smart appliances, plugs, thermostats, cameras, light fixtures, appliances and other automated home systems.
  - a. Data could be stored in a cloud, smartphone, routers, etc.
  - b. Data can be activation times, communication loss and other information.

- c. Items may contain multiple sensors and records logs valuable for investigations, such as temperatures, carbon dioxide levels, occupancy, microphones, power loss or other data.
- d. Cloud and apps.
  - Store conversations, commands, locations, other routers, extenders, switch, etc.


### BUILDING SYSTEMS: GAS

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Investigators will go in-depth with building systems.

Fuel Gas Systems:

- Make, model and fuel type.
- Valve positions.
- Thermostat settings.
- Proximity to combustibles.



Observations, valves open, valves closed, appliances operating, controls on?

Slide 3-75

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- 12. Other systems include the gas delivery system.
  - a. Document and examine the gas delivery system and associated appliances.
  - b. Document make, model and any other information.
  - c. Did the system contribute to the fire cause or add to the fuel load?
  - d. Additional information may be available on the delivery method, and any effect that the system had on the fire development or spread.
    - Delivery pipe construction:
      - Black iron.
      - Copper.
      - Corrugated Stainless Steel Tubing (CSST).
    - Flexible appliance connector (FAC).



### FIRST RESPONDER ACTIONS

Did FD alter control positions?



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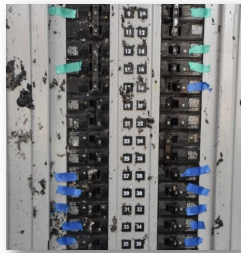
13. As the investigator progresses farther down the gas distribution system to reach the appliance, other items may need to be documented.

They would include:

- a. Valve positions.
- b. Control knobs.
- c. Proper appliance conversions (liquefied petroleum gas (LPG) versus LNG).
- d. Proximity to fuels.
- e. Timeline.

### BUILDING SYSTEMS: ELECTRICAL

- Identify Over Current Protection Device (OCPD).
- Means of documentation
- Position i.e. on, off, tripped.
- Witness info may be needed for position prior to fire.



Keep circuit breaker positions "as is"

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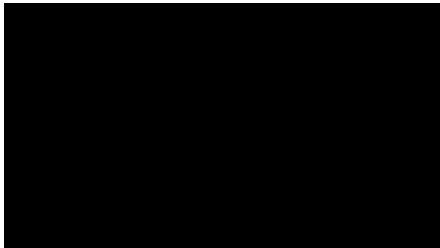
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14. While outside the scope of the first responder, during the inspection of the electrical system, certain items should be considered.

They may include:

- a. Identify Over Current Protection Device (OCPD), i.e., circuit breaker, type: standard, Arc Fault Circuit Interrupter (AFCI).
  - b. Ground Fault Circuit Interrupter (GFCI), Edison Fuses.
  - c. Document OCPD manufacturer.
  - d. Document OCPD position — on, off, tripped.
  - e. Witness information may be needed for OCPD position prior to the fire.
  - f. Document OCPD amp rating.
15. Electrical system analysis is beyond the scope of this course. However, arc fault circuit analysis is one of the four items identified in NFPA 921 as a factor to be used in the origin determination.

**DATA COLLECTION: ARC SURVEY VIDEO**



Slide 3-78

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**IDENTIFYING THE ORIGIN AREA: SUMMARY**

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- Everything learned to this point is combined to determine the origin.
- The fire origin should not be undetermined.
- The fire origin may be broad to encompass the entire structure.

Slide 3-79

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O. Determining the origin.

One of the primary focuses of the investigation is identifying the origin area. The fire origin should never be undetermined. The fire origin may be broad to encompass the entire structure.

**PROCESSING THE AREA OF ORIGIN**

- “The origin of a fire is one of the most important hypotheses that an investigator develops and tests during the investigation.”
- Excavation is conducted to reveal fire effects, fire patterns, ignition sources and locate evidence.



- NFPA 921, Section 18.1

Processing happens before overhaul.

Slide 3-80

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1. “The origin of a fire is one of the most important hypotheses that an investigator develops and tests during the investigation” (NFPA 921, 2024, Section 18.1).
2. Excavation is conducted to reveal fire effects, fire patterns, ignition sources and locate evidence.

**K-9'S AND THE FIRE SCENE**

Ignitable liquids detection canine (ILDC):

- Consider ILDC use prior to and during excavation.
- Safety concerns for canine and handler.
- Lab confirmation is required.



Accelerant, cadaver, and explosive K-9s have unique characteristics. Notify the investigator if the scene gets contaminated.

Slide 3-81

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3. If the investigator has access to an ignitable liquids detection canine (ILDC), they should consider the following:
  - a. Consider ILDC use prior to and during excavation.
  - b. Specific areas versus broad search.

- c. Safety concerns for canine and handler.
- d. Lab confirmation is required.

### HEAVY EQUIPMENT

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- Document scene prior to use.
- Avoid adding debris to scene.
- When possible collect fire debris samples prior to use.
- Justification.



Just because you can order an excavator from public works, does NOT mean you should. If possible, do not destroy the fire scene.

Slide 3-82

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- 4. Fire scene excavation.
  - a. Do not destroy the scene.
  - b. Document the scene prior to use.
  - c. Avoid adding debris to the scene, e.g., pushing walls into the scene.
  - d. When possible, collect fire debris samples prior to use.

### CLEARING THE ORIGIN AREA

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Overall Excavation:

- Excavate fire debris in layers.
- Document excavation process.
- Examine fire patterns and effects on contents and structural surfaces.
- Preserve fire debris for other interested parties.



Slide 3-83

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- 5. During fire scene excavation, remember to:
  - a. Excavate fire debris in layers.

- b. Document the excavation process, including during the process. Avoid having only two photos (one of the room filled with debris and the other a completely clean excavation). Take photos during the process.
- c. Examine fire patterns and effects on contents and structural surfaces.
- d. Preserve fire debris for other interested parties.

**SYSTEMATIC PROCESSING**

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Excavate the origin area to locate evidence, reveal fire patterns, and establish sequence of events.

→→

Pre-ExcavationWindow glass beneath debrisProtected carpet beneath window glass

Slide 3-84

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- 6. Excavation can reveal evidence and fire patterns and establish the sequence of events in this situation.

**LAYERING DEBRIS**

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- Layering of debris in stages.
- Document layering process.
- Consider washing floors to reveal patterns.



The best evidence is likely under the debris, under your boots.

Slide 3-85

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- 7. Simple fire scene excavation.
  - a. Layering of debris in stages.
  - b. Document layering process.

- c. Consider washing floors to reveal patterns.

**FRAGILE EVIDENCE**

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Investigation happens between suppression and overhaul.  
Look beneath furniture and other contents. Was furniture moved during suppression/overhaul?



Slide 3-86

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- 8. Sequence of a fire scene excavation. Other features and techniques of fire scene excavation:
  - a. Look beneath furniture and other contents.
  - b. Are fire effects/patterns consistent with the scene?
  - c. Potential ignition sources or other evidence may be located.
  - d. Was furniture moved during suppression/overhaul?

**COLLECTING EVIDENCE**

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Collecting Evidence:

- Document, preserve, and collect.
- Photograph.
- Avoid cross contamination.
- Use methods to protect the evidence till documented and collected by the investigator.



Slide 3-87

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- 9. First responders and investigators will discover evidence; they need to preserve and collect that evidence.


Some basic topics to consider include:

- a. Document, preserve and collect evidence when located.
- b. Photograph, measure, scale.
- c. Proper collection techniques and packaging.
- d. Avoid cross-contamination.
- e. Comparison samples.

**RECONSTRUCTION**

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Fire scene reconstruction is necessary to accurately interpret fire effects and patterns on contents and structural surfaces.



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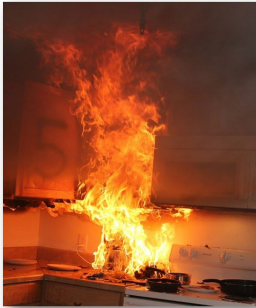
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- 10. Scene reconstruction is necessary to accurately interpret fire effects and patterns on contents and structural surfaces. Investigators should be familiar with the process of fire scene reconstruction.
- 11. Fire scene reconstruction will vary widely in complexity. It may include or occur both inside and outside the confines of the scene/origin area.

**BRING IT ALL TOGETHER**

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- Apply all the data collected to summarize the area of origin.
- Processing the fire origin area involves identification, documentation, and examination of all factors that would lead an investigator to where the fire started.



Slide 3-89

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- 12. Apply all data collected to reach a determination as to the area of origin. Processing the fire scene involves the identification, documentation and examination of the area where the fire started.

III. FACTOR TWO: CAUSATION

**FACTOR TWO: CAUSATION**

Causation will determine:

- The first fuel ignited.
- The competent Ignition source.
- The act or circumstances that brought them together.

Slide 3-90

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A. Causation: What happened?

**STAY IN YOUR LANE**

The determination of the fire cause requires the identification of those factors that were necessary for the fire to have occurred.

-NFPA 921, Section 19.1.1

Slide 3-91

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- B. “The determination of the fire cause requires the identification of those factors that were necessary for the fire to have occurred” (NFPA 921, 2024, Section 19.1.1).
  - 1. The first responder should not exceed their level of training, skills and abilities. This process of causation determination may be farther than they want to take the investigation.



## FIRE CAUSE

Those factors include the presence of a competent ignition source, the type and form of the first fuel ignited, and the circumstances, such as failures or human actions that allowed those factors to come together.

-NFPA 921, Section 19.1.1

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2. A causation determination requires the identification of:
  - a. Competent ignition source in the area of origin.
  - b. Most probable first fuel ignited.
  - c. Identification of the oxidant.
  - d. The circumstances that brought these together to initiate a fire (e.g., failures or human action).

## COMPETENT IGNITION

- Enough energy to ignite the first fuels.
- The capability to transfer the energy to the first fuel.
- A duration of time, sufficient to raise the fuel to its ignition temperature.



Slide 3-93

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- C. What is a competent ignition source? How important is the word “competent”? Investigators should understand the importance of heat flux (energy) and time as related to the ignition process.

## WHAT IS A FIRST FUEL IGNITED?

- First fuel ignited sustains combustion beyond the initial ignition source.
- First fuel may be part of, or in close proximity to, source of heat.



Example: The potential ignition source is the cigarette. What is the first fuel ignited?

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## THE OXIDIZER

- The ignition source may have enough energy to ignite the first fuel.
- Flaming fires require at least 14% to 16% oxygen.
- Smoldering combustion requires as little as 8% oxygen.



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D. Investigators should understand the importance of the fire triangle. The lack of oxygen (oxidizer) will prevent a combustion reaction.

## FIRE CAUSE

Circumstances, conditions, or agencies that bring the first fuel, ignition source, and oxidizer together.

**DO NOT CONFUSE FIRE CAUSE WITH FIRE (INCIDENT) CLASSIFICATION**



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E. Fire cause.


1. Circumstances, conditions or agencies that brought the first fuel, ignition source and oxidizer together causing the fire to occur.
2. **Do not confuse fire cause with fire (incident) classification.**

**KNOWLEDGE CHECK**

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Identify in this photo:

- a competent ignition source.
- first fuel ignited.
- the oxidant.
- the circumstances, conditions, or agencies that brought these together.



Slide 3-97

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**COMMON IGNITION SOURCES**

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Attempt to identify appliance and relevant information:

- Manufacture.
- Model.
- Serial number.
- Recalls.
- Exemplars.



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- F. When the investigator encounters an appliance, they should attempt to obtain as much identifying data as possible.
1. Items to look for include:
    - a. Manufacturer.
    - b. Model.
    - c. Serial number.
    - d. Wire gauge.


- e. Recalls.
  - f. Exemplars.
2. Every effort should be made to properly identify the appliance's manufacturer, model and serial number, without altering or causing physical damage to the product.

**POSSIBLE ELECTRICAL SOURCES**

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Artifact Identification:

- Be familiar with appliance components.
- Post fire appliance artifacts may be difficult to identify.
- Do not break it open.



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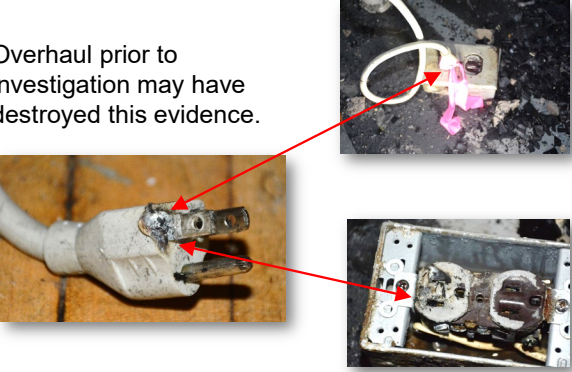
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3. Appliance identification: Items appear different after a fire, such as this relocatable power tap (RPT or power strip) pre-fire and post-fire.
- a. Be familiar with appliance components.
  - b. Post-fire appliance artifacts may be difficult.
  - c. Seek technical assistance when needed.

**EVIDENCE EASILY MISSED**

Overhaul prior to investigation may have destroyed this evidence.



Slide 3-100

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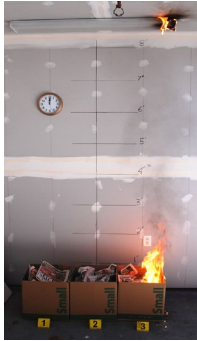

4. Another source of potential ignition is connections and components within receptacles:
  - a. Document locations.
  - b. Appliances/Cords connected.
  - c. Condition of connection points.
  - d. Enclosure type, e.g., plastic versus metal.
  - e. Wiring, gauge, type (e.g., series versus parallel).

### LIGHTING IGNITION SOURCES

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Lights:

- Bulb type.
- Condition of connection points.
- Enclosure type i.e. plastic vs metal.
- Diffusers present.
- In Contact (IC) vs Non-IC ratings.
- Electronic vs magnetic ballast.



Slide 3-101

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5. Lights and fixtures should be documented:
  - a. Locations.
  - b. Bulb type.
  - c. Condition of connection points.
  - d. Enclosure type, e.g., plastic versus metal.
  - e. Diffusers present.
  - f. In contact (IC) versus non-IC ratings.
  - g. Electronic versus magnetic ballast.

### IGNITION SOURCE: BATTERIES

- Associated appliances.
- Type i.e. lithium, NiCd, Lead acid, etc.
- Damage to cells.
- All cells accounted for?
- Charging state.
- Compatible transformer.



Slide 3-102

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6. Other potential ignition sources include batteries. The investigator should attempt to locate and examine associated appliances and batteries (lithium, nickel cadmium, lead acid). Identify damage to cells and check if all cells are accounted for. Battery explosions are energetic and can result in ignition of combustible materials located at distances away from the appliance. What was the condition of the batteries at the time of the fire? Were they charging? Was the correct transformer being used?

### THERMAL RUNAWAY LITHIUM –ION BATTERIES VIDEO



Slide 3-103

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## COOKING FIRES

Range:

- Type.
- Knob Position.
- Shaft Position.
- First fuels present.
- Witness information.
- Pungent smell.
- Timeline.



Ask occupant if they were cooking. Protect evidence, keep in the orientation and condition it was found.

Slide 3-104

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### G. Cooking fires.

1. When the investigator encounters fires involving electric ranges or stoves, they should document and protect the infinite control knobs, as well as the heating elements, pans and any wiring inside the range.
2. Indicators of a range heating element in operation.
  - a. Document locations.
  - b. Type.
  - c. Knob position.
  - d. Shaft position.
  - e. First fuel.
  - f. Witness information.
  - g. Pungent smell.
  - h. Timeline.

## SMALL APPLIANCES

Several Safety Features Built in evaluate:

- Tip over switches.
- Thermostats.
- TCO's.
- First fuels.
- Appliance housing.
- Timelines.

Beyond the scope of the first responder.  
Do not disassemble these items.



Slide 3-105

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### H. Appliances.

1. Small household appliances such as coffee pots, toasters, curling irons, hair dryers, popcorn makers, straight irons, etc., can be a source of ignition and are often implicated in a fire cause when they were not the cause.
  - a. Tip over switches.
  - b. Thermostats.
  - c. Thermal cutoff (TCO).
  - d. First fuels.
  - e. Appliance housing.
  - f. Timelines.

## SPACE HEATER FIRES

Electric Heaters:

- Radiant or convective.
- Heating element; ceramic, quartz, nichrome, other.
- Thermostat position.
- Tip over switches.
- Heat regulating TCO's.
- Distance from combustibles.
- Arc damage.



Slide 3-106

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2. The investigator should evaluate any observed electric heaters:
  - a. Radiant or convective.
  - b. Heating element, ceramic, quartz, nichrome, other.
  - c. Thermostat position.
  - d. Tip over switches.
  - e. Heat regulating TCOs.
  - f. Distance from combustibles.
  - g. Arc damage.

**MAJOR APPLIANCES**

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- Dryers:
- Type electric or gas.
- Gas conversion.
- Spontaneous combustion.
- Lint accumulation.
- Vents and associated ductwork.
- Witness statements.



Protect evidence, keep in the orientation and condition it was found.

Slide 3-107

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3. When evaluating or documenting clothes dryers, the investigator should attempt to determine the type of dryer (gas, electric) and attempt to identify or document the following:
  - a. Gas conversion.
  - b. Spontaneous combustion.
  - c. Lint accumulation.
  - d. Vents and associated ductwork.
  - e. Witness statements.

## OTHER IGNITION SOURCES

**Vent Fans:**

- Motor failure can result in ignition of combustible materials.
- Condition of vents and associated ductwork.
- Condition of windings.
- Arc damage.
- Witness statements.



Slide 3-108

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I. Other ignition sources.

1. When the fire involves a ceiling-mounted vent fan, such as is found in a bathroom, evaluate the following:
  - a. Motor failure can result in ignition of combustible materials.
  - b. Condition of vents and associated ductwork.
  - c. Condition of windings.
  - d. Arc damage.
  - e. Witness statements.

## DISCARDED SMOKING MATERIALS

**Smoking:**

- Presence and type of smoking material.
- Ashtrays, containers, etc.
- Witness statements.
- Smoking habits.
- Ambient conditions.



Slide 3-109

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2. When evaluating fire involving smoking materials:
  - a. Document the presence and type of smoking materials.

- b. Ashtrays, containers.
  - c. Witness statements.
  - d. Smoking habits.
  - e. Ambient conditions.
3. While a review of surface and autoignition temperature (AIT) may suggest that cigarettes are a competent ignition source for ignitable liquids and gases, in reality, cigarettes make poor ignition sources for most ignitable liquids and gases.




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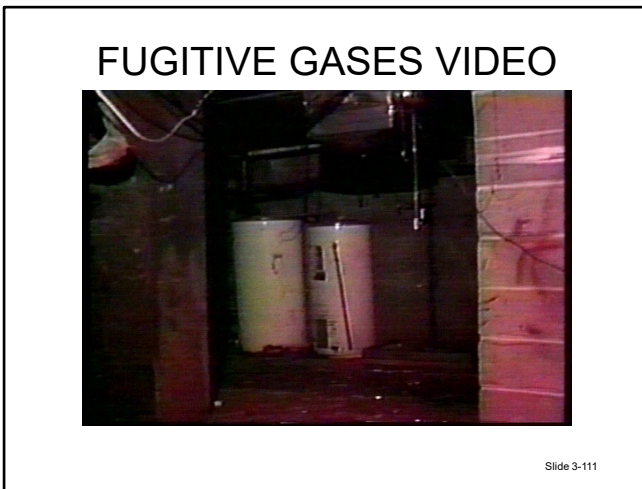
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## OPEN FLAME IGNITION

### Open Flame Sources:

- Lighters, matches, candles, oil lamps.
- Containers plastic, glass, wood.
- Proximity to other fuels.
- Witness statements.
- Timelines.



Slide 3-112

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4. When ignition is suspected by the use of an open flame source, the investigator should evaluate the following:
  - a. Lighters, matches, candles, oil lamps, etc.
  - b. Containers, e.g., plastic, glass, wood, etc.
  - c. Proximity to other fuels.
  - d. Witness statements.
  - e. Timelines.

## SPONTANEOUS COMBUSTION

- Types of organic materials.
- Storage/disposal conditions.
- Fuel configurations.
- Ambient conditions.
- Witness statements.
- Timeline.



Cleaning rags contaminated with cooking oils and grease stored in green milk crate.

Slide 3-113

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5. Spontaneous combustion fires would necessitate the investigator evaluating the following:
  - a. Types of organic materials.

- b. Storage/Disposal conditions.
- c. Fuel configurations.
- d. Ambient conditions.
- e. Witness statements.
- f. Timeline.

### SOLID FUEL BURNING APPLIANCES

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- Type of fuels i.e. wood, coal, pellets.
- Type of chimney, masonry or metal, double or triple walled.
- Chimney/Appliance clearances.
- Chimney/connector maintenance.
- Attic insulation shield.
- NFPA 211.



Slide 3-114

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6. During the evaluation of solid fuel-burning appliances, consider the following:
- a. Type of fuels, e.g., wood, coal, pellets, etc.
  - b. Type of chimney, e.g., masonry or metal.
  - c. Chimney/Appliance clearances.
  - d. Chimney/Connector maintenance, e.g., creosote.
  - e. Air-cooled chimney, e.g., double versus triple wall.
  - f. Attic insulation shielding.
  - g. NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.

## EXTERIOR IGNITION SOURCES

- Receptacles, service entrance.
- Lights, lighted signs.
- Grills and gas appliances.
- Cigarettes.
- Garbage bins, fire pits.



Slide 3-115

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7. Exterior ignition sources.
  - a. Receptacles and extension cords.
  - b. Service entrance.
  - c. Gas regulators and lines.
  - d. Lights, lighted signs.
  - e. Grills and gas appliances.
  - f. Cigarettes.
  - g. Garbage bins, fire pits.
  - h. Intentional.

## IGNITION SOURCES REMOVED

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

-NFA 921, Section 19.4.4.3



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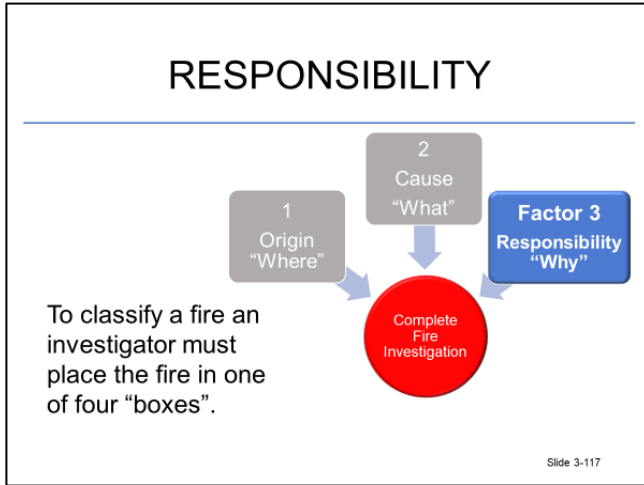
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8. “There are times when there is no physical evidence of the ignition source found at the origin, but where an ignition sequence can logically be inferred using other data” (NFPA 921, 2024, Section 19.4.4.3).

**IV. FACTOR THREE: RESPONSIBILITY**




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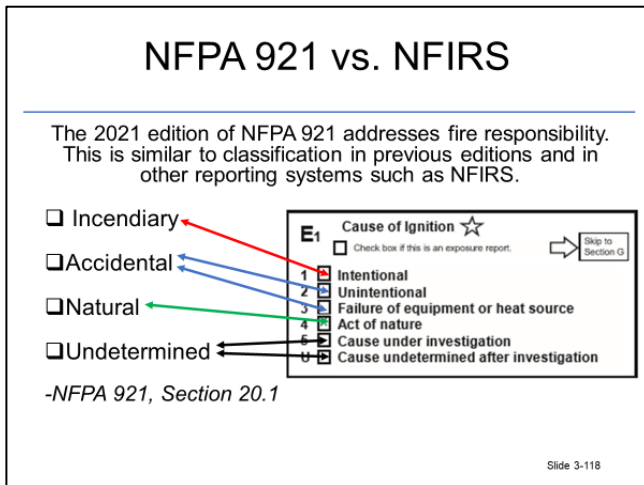
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- A. To classify a fire an investigator must place the fire in one of four NFPA 921-defined "boxes."
- B. Fire classifications and responsibility.




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NFPA 921 discusses the responsibility associated with the cause of fires. The National Fire Incident Reporting System (NFIRS) has the following cause classifications: intentional, unintentional, failure of equipment or heat source, act of nature, cause under investigation, cause undetermined after investigation.

## ARSON AND RESPONSIBILITY

Arson versus responsibility for intentionally setting a fire.  
Arson is a crime, not a definition of fire responsibility.  
There is a difference between an incendiary or intentional fire and arson.



Slide 3-119

1. Arson and responsibility (in NFPA 921) are **not** the same thing.
2. Arson versus responsibility for intentionally setting a fire. Arson is a crime, not a definition of fire responsibility. There is a difference between an incendiary or intentional fire and arson.

## WITNESS STATEMENTS VIDEO



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## INCENDIARY OR INTENTIONALLY SET FIRE INDICATORS

- The following slides represent possible indicators of an incendiary or intentional fire.
- These possible indicators may assist the investigator with assigning responsibility for the cause of the fire.
- **In and of themselves, they are not what makes a fire incendiary.**



Multiple Fire Origins or Drop Down?

- NFPA 921, Section 20.5.2


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C. Incendiary or intentionally set fire indicators.

**POTENTIAL EVIDENCE ITEMS**

- Multiple origins.
- Trailers.
- Pour patterns, ignitable liquids.
- Disabling fire protection systems.
- Tampering with utilities.



Slide 3-122

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1. Other potential evidence items.
  - a. Multiple origins.
  - b. Trailers.
  - c. Containers.
  - d. Pour patterns, ignitable liquids.
  - e. Disabling fire protection systems.
  - f. Tampering with utilities.

**DEVICES AND OTHER CRIMES**

- Unusual fuel loads or fuel configurations.
- Incendiary devices.
- Crime concealment.



Slide 3-123

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2. Devices and other crimes.

- a. Unusual fuel loads or fuel configurations.
- b. Incendiary devices.
- c. Crime concealment.



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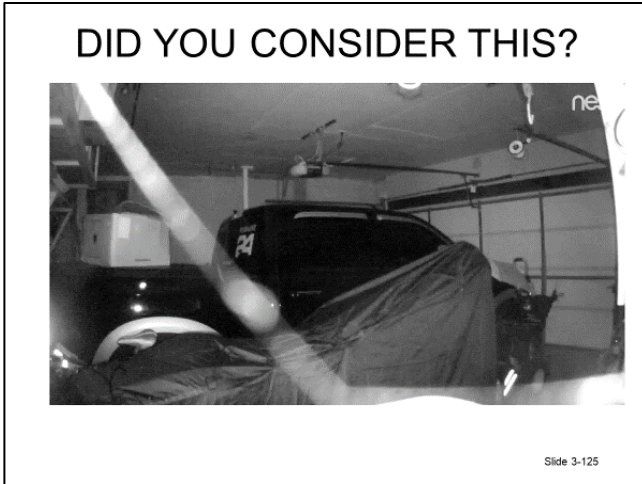
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- 3. Discoveries by first responders.
  - a. Contents.
  - b. Contents lacking.
  - c. Contents obviously replaced.
  - d. Contents placed suspiciously.
  - e. Overinflated claim of loss.
  - f. Condition of contents.
  
- 4. “The process of elimination is an integral part of the scientific method” (NFPA 921, 2024, Section 19.6.5). In this circumstance, the investigator opines all accidental sources were eliminated. Inference is made that an open flame source was used to ignite the fire and was either destroyed or left the scene with the actor. This opinion is based solely on the belief that all accidental ignition sources were eliminated.



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FIRE SCENE SPOILIATION

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The Investigator AND first responder should consider:

- The willful destruction of evidence, or the failure to preserve potential evidence for another's use in pending or future litigation.
- Loss, destruction, or material alteration of an object or document that is evidence or potential evidence in a legal proceeding by one who has the responsibility for its preservation.

-NFPA 921, Section 3.3.190

Remember the excavator?

Slide 3-126

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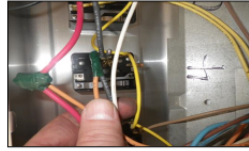
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D. Fire scene spoliation.

1. Before the first responder or investigator enters the structure and begins to move items in relation to an investigation, they should consider:
  - a. The willful destruction of evidence, or the failure to preserve potential evidence for another’s use in pending or future litigation.
  - b. “Loss, destruction, or material alteration of an object or document that is evidence or potential evidence in a legal proceeding by one who has the responsibility for its preservation” (NFPA 921, 2024, Section 3.3.190).

## MORE THAN ONE WAY

- Intentional or malicious destruction of evidence.
- If you feel that the fire cause was due to a certain piece of equipment, do not take the item apart.



Don't break stuff open to see if it was a fire cause.  
Truckies need not apply.

Slide 3-127

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2. Investigators need to be careful how they manipulate evidence or artifacts to avoid intentional or malicious destruction of evidence. If they feel that the fire cause was due to a certain piece of equipment, they **should not take apart the item**. Evaluate intrusive versus destructive. Regardless of their actions, they must document everything.

## V. SUMMARY

### Summary



Slide 3-128

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**REFERENCE**

National Fire Protection Association. (2024). *Guide for fire and explosion investigations*. (Standard no. 921). Retrieved from <https://www.nfpa.org>.

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# **UNIT 4: UNCOMFORTABLE FIRE INVESTIGATION TOPICS**

## **TERMINAL OBJECTIVE**

*The students will be able to:*

- 4.1 *Develop an understanding of potential issues and hazards affecting the first responder that relate to fatal fires, trauma, behavioral health, arson and social media.*

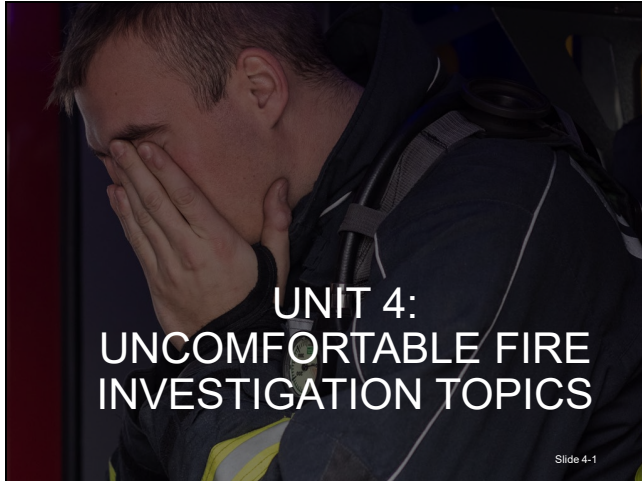
## **ENABLING OBJECTIVES**

*The students will be able to:*

- 4.1 *Recognize the importance of managing a fire scene that involves a fatal fire or line-of-duty death (LODD).*
  - 4.2 *Recognize the roles and responsibilities in managing a fatal fire scene and review the data regarding LODDs.*
  - 4.3 *Consider the repercussions of secondary trauma on first responders and the people around them.*
  - 4.4 *Recognize the issues and responsibilities associated with firefighter arson.*
  - 4.5 *Explain the potential perils associated with social media misuse.*
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## TERMINAL OBJECTIVE

Develop an understanding of potential issues and hazards affecting the first responder that relate to fatal fires, trauma, behavioral health, arson and social media.



Slide 4-2

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## ENABLING OBJECTIVES

- 4.1 Recognize the importance of managing a fire scene that involves a fatal fire or line-of-duty death (LODD).
- 4.2 Recognize the roles and responsibilities in managing a fatal fire scene and review the data regarding LODDs.
- 4.3 Consider the repercussions of secondary trauma on first responders and the people around them.
- 4.4 Recognize the issues and responsibilities associated with firefighter arson.
- 4.5 Explain the potential perils associated with social media misuse.

Slide 4-3

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**Advisory**

This presentation contains a graphic photo and frank discussions of firefighter injuries and death.

Students sensitive to traumatic event topics may step out of the room if necessary.

Slide 4-4

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**I. FATAL FIRES**

**FATAL FIRES**

- According to the USFA website, fire killed 3,700 and injured 16,600 people in 2019.
- Fire responses with significant personal injury or fatalities are more stressful and complex than those without.
- The initial actions of the first responders are likely more significant in a fatal fire.

Slide 4-5

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- A. Fires resulting in significant personal injury or fatalities have the same chemistry and fire dynamics, and the investigative process still follows the scientific method. However, the potential consequences may be more significant.
1. Fire responses with significant personal injury or fatalities are more stressful and complex.
  2. The initial actions of the first responders are likely more significant.

## FATAL FIRE COMPLEXITY

- Substantially more complex investigations.
- Require an understanding of the victim's actions.
- Require interaction with the medical community.
- Long term resolution – often years between death and subsequent litigation.
- Provide ONE chance at a scene examination.

Firefighters have the first chance to process the scene correctly.

Slide 4-6

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B. Fatal fires may:

1. Have a greater level of investigative complexity.
2. Require an understanding of the victim's actions (e.g., escaping, fighting the fire, etc.).
3. Require interaction with the medical community.
4. Have years between the death and the start of litigation.
5. Provide **one** chance at a scene examination.

## LIMITED ROLES

First responders role will be limited in the fatal fire investigation, post victim treatment or fire extinguishment.

The first responder plays a critical role in the early stages of the incident and investigation.



Slide 4-7

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C. First responders' roles will be limited in the fatal fire investigation, post victim treatment or fire extinguishment.

1. The first responder plays a critical role in the early stages of the incident and investigation.

## FATAL FIRE INVESTIGATION PARTICIPANTS

- Fire Fighters / EMS.
- Law Enforcement.
- Fire Investigator.
- Medical Examiner.
- Pathologist.
- State Agencies.
- Federal Agencies.
- Private Attorneys.
- Mental Health Professionals.



Slide 4-8

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2. The investigator should be familiar with the role and responsibility of each participant of a fatal fire investigation.

## FIRST RESPONDERS AT FATAL FIRES

- Best first chance at evidence.
- Protect and preserve evidence.
- Stay aware during patient care.
- Protect yourself.



Slide 4-9

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- D. First responders at fatal fires.
  1. Best first chance at evidence.
  2. Protect and preserve evidence.
  3. Stay aware during patient care.

**SAFETY FOR ALL  
ON-SCENE**

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Observe universal precautions to include:

- Disposable gloves.
- Eye and face protection.
- Fluids protection.
- Proper disposal of debris.
- Decontamination.



A square orange biohazard sign with a black border. At the top, the word "BIOHAZARD" is written in bold black letters on a white background. Below the text is a black biohazard symbol consisting of three curved shapes that meet at a central point.

Slide 4-10

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- E. On-scene safety.
1. Exposure to bloodborne pathogens from blood and other potentially infectious materials (OPIM) because employees are not using universal precautions.
    - a. Bloodborne pathogens are pathogenic microorganisms that are present in human blood and can cause disease in humans.
    - b. Some infections that can be transmitted through contact with blood and body fluids include:
      - HIV; Hepatitis A, B and C; staph and strep infections; gastroenteritis (e.g., salmonella and shigella); pneumonia; syphilis; tuberculosis; malaria; measles; chicken pox; herpes; urinary tract infections; and blood infections.
      - The greatest risks are from HIV and Hepatitis B and C.
  2. Use universal precautions. Universal precautions is an approach to infection control to treat all human blood and certain human body fluids as if they were known to be infectious for HIV, HBV and other bloodborne pathogens, (Bloodborne Pathogens Standard 29 CFR 1910.1030(b) definitions).
  3. Bloodborne Pathogen Standard 29 CFR 1910.1030(d)(1) requires:
    - a. Employees to observe Universal Precautions to prevent contact with blood or OPIM.

- b. Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials.
  - c. Treat all blood and other potentially infectious materials with appropriate precautions such as:
    - Use gloves, masks, and gowns if blood or OPIM exposure is anticipated.
    - Use engineering and work practice controls to limit exposure.
4. Standard precautions apply to blood; all body fluids, secretions and excretions, except sweat, regardless of whether they contain visible blood; non-intact skin; and mucous membranes. Standard precautions are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection in hospitals. Standard precautions include the use of hand washing and appropriate personal protective equipment (PPE) such as gloves, gowns and masks, whenever touching or exposure to patients' body fluids is anticipated (Occupational Safety and Health Administration OSHA, n.d.).

**CIVILIAN FATAL FIRE-  
CRIME SCENE**

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- Limit access to scene and victim.
- Identify and preserve evidence surrounding or on victim.
- Limit handling of clothing and other items.
- Preserve any electronic data sources on victim.



What are additional considerations with a victim not in a structure?

Slide 4-11

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- F. Civilian fatal fire crime scene.
- 1. Limit access to scene and victim.
  - 2. Identify and preserve evidence surrounding or on victim.
  - 3. Limit handling of clothing and other items.
  - 4. Preserve any electronic data sources on victim.

### FIRE FIGHTER LINE OF DUTY DEATHS (LODD)

- Firefighting claims about 100 lives annually in the United States.
- Approximately half are volunteer fire fighters.
- Over half are on-scene or on-duty.
- Over half are attributed to stress and/or overexertion.
- Heart attack has consistently been the leading cause of “on-duty” deaths accounting for about 45 percent of the mortality.
- The vast majority of the remaining deaths are traumatic with motor vehicle related deaths, smoke inhalation / burns, and falls / structure collapse being common causes.
- Approximately one third are not incident-related.

Slide 4-12

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G. Firefighter line-of-duty deaths (LODDs).

1. Firefighting claims about 100 lives annually in the United States.
  - a. Approximately half are volunteer firefighters.
  - b. Over half are on-scene or on-duty.
  - c. Over half are attributed to stress and/or overexertion.
2. Heart attack has consistently been the leading cause of on-duty deaths, accounting for about 45% of the mortality.
3. The vast majority of the remaining deaths are traumatic, with motor vehicle-related deaths, smoke inhalation/burns and falls/structure collapse being common causes.
4. Approximately one-third are not incident related.

### STEPS IN A LODD INVESTIGATION

1. Immediately secure the area.
2. Make notifications.
3. Identify potential witnesses.
4. Document the scene and capture physical evidence.
5. Conduct interviews.
6. Collect records, reports, and documentation.
7. Analyze the information and identify root causes.
8. Develop recommendations.
9. Prepare the report.



From IAFF Fire Fighter Line-of-Duty Death or Injury Investigation Manual

Slide 4-13

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5. Overview of investigative steps in an LODD investigation.
  - a. Immediately secure the area.
  - b. Make notifications.
  - c. Identify potential witnesses.
  - d. Document the scene and capture physical evidence.
  - e. Conduct interviews.
  - f. Collect records, reports, and documentation.
  - g. Analyze the information and identify root causes.
  - h. Develop recommendations.
  - i. Prepare the report (International Association of Fire Chiefs (IAFC), n.d.).

**FATAL FIRE EVIDENCE**

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Anything on the victim should be preserved or collected to include items removed at the scene during medical treatment.

- All clothing worn under turnouts.
- Apple™ or other smart watch.
- Cell phone.
- Helmet Camera or Body Camera.



Everything on the victim is evidence. Preserve it!

Slide 4-14

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H. Fatal fire evidence.

Anything on the victim should be preserved or collected to include items removed at the scene during medical treatment.

1. All clothing worn under turnouts.
2. Apple™ or other smart watch.
3. Cell phone.
4. Helmet camera or body camera.



## MAINTAIN CHAIN OF CUSTODY

- Appropriate storage conditions.
- Chain of custody.
- Limit handling of clothing and equipment.



Slide 4-15

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### I. Maintain chain of custody.

Typical evidence collection and storage protocol should be followed.

1. Appropriate storage conditions.
2. Chain of custody.
3. Limitation of handling if clothing and equipment are fragile.

## U.S. FIRE ADMINISTRATION AUTOPSY PROTOCOL



Autopsies are recommended for all firefighter fatalities. Even non-line-of-duty deaths so that potential links to exposure can be identified.

Available at: [firefighter\\_autopsy\\_protocol.pdf](#)

Slide 4-16

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### J. “Firefighter Autopsy Protocol.”

1. The “Firefighter Autopsy Protocol” has been extensively revised since its original 1994 edition. In this new protocol, a number of additional areas of information have been provided to take into account emerging issues and new technologies as applied to the conduct of autopsies.


2. As stated in the report, it is recommended that autopsies be performed for all firefighter fatalities where an LODD has occurred. It is further recommended that an autopsy be performed when a non-LODD may be linked to a line-of-duty exposure.
  
3. “The National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) conducts independent investigations of selected fire fighter line-of-duty deaths (LODD) and offers recommendations to prevent similar deaths. The purpose of the current study was to provide information on more recent FFFIPP recommendations and to determine if recommendations have changed over time” (Hard et al., 2019).

## AUTOPSY PROTOCOL

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The protocol is divided into the following sections:

- Preliminary.
- Initial examination.
- External examination.
- Internal examination.
- Toxicological examination.
- Microscopic examination.
- Summary of pathological findings.
- Conclusions.



The specific areas of procedures are described, but detailed step-by-step instructions are not provided as autopsy practice varies and changes with the specific circumstances of death.

Slide 4-17

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4. The protocol is divided into the following sections:
  - a. Preliminary.
  - b. Initial examination.
  - c. External examination.
  - d. Internal examination.
  - e. Toxicological examination.
  - f. Microscopic examination.
  - g. Summary of pathological findings.
  - h. Conclusions.

5. The specific areas of procedures are described, but detailed step-by-step instructions are not provided as autopsy practice varies and changes with the specific circumstances of death.
6. Securing the PPE is crucial since an examination to determine if it failed in some way needs to be performed by qualified personnel.
  - a. Entire turnout gear ensemble, protective hood.
  - b. Helmet, gloves, boots.
  - c. Self-contained breathing apparatus (SCBA) (Black Box).
  - d. Personal Alert Safety System (PASS).

**PUBLIC SAFETY OFFICER  
BENEFITS ACT**

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- Public Safety Officer Law (Public Law 94-430), became law on Sept. 29, 1976.
- The amount of the PSOB benefit is \$389,825.00 for eligible deaths and disabilities occurring on or after Oct. 1, 2021.



Slide 4-18

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- K. Public Safety Officer Benefits (PSOB) Act.
1. The PSOB Law 26, the PSOB Act (42 United States Supreme Court (USSC) 3796, Public Law 94-430), became law on Sept. 29, 1976.
  2. The amount of the PSOB benefit is \$389,825.00 for eligible deaths and disabilities occurring on or after Oct. 1, 2021
  3. As part of the PSOB, an autopsy is recommended on all LODDs, regardless of how they occurred.
  4. More information provided at <https://bja.ojp.gov/program/psob>.

**NATIONAL INSTITUTE FOR  
OCCUPATIONAL SAFETY AND HEALTH  
(NIOSH)**

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- Fire Fighter Fatality Investigation and Prevention Program (FFFIPP).
- Implemented by Congress in 1998 to address the problem of occupational firefighter fatalities.
- Team conducts investigations of all line-of-duty firefighter fatalities.
- Issues reports and recommendations to prevent future incidents. <http://www.cdc.gov/niosh/fire/>

Slide 4-19

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- L. NIOSH.
  - 1. Implemented by Congress in 1998 to address the problem of occupational firefighter fatalities.
  - 2. Team conducts investigations of all line-of-duty firefighter fatalities.
  - 3. Issues reports and recommendations to prevent future incidents.
  - 4. For information, visit <http://www.cdc.gov/niosh/fire/>.



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The NIOSH Fire Fighter Fatality Investigation and Prevention Program conducts independent investigations of selected fire fighter line-of-duty deaths (LODD) and offers recommendations to prevent similar deaths.

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- 5. The NIOSH FFFIPP conducts investigations of firefighter LODDs to formulate recommendations for preventing future deaths and injuries.
  - a. The FFFIPP is a public health practice investigation program.
  - b. NIOSH investigators are not conducting their investigation to enforce compliance with state or federal occupational safety and health standards and do not determine fault or place blame on fire departments or individual firefighters.

- c. The program’s goal is to learn from these tragic events and prevent future similar events through its recommendations.
- d. “Typically, the FFFIPP has investigated annually about one third to one half of fire fighter deaths since the program’s start in 1998. Completed or pending NIOSH investigations are identified on the map and the case listing views. For those deaths with a completed investigation, links are provided to the final NIOSH reports” (Centers for Disease Control and Prevention, 2020).



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Methods:

- Fatality investigations completed from 2006 to 2014 were selected for this study with recommendations being assigned into twelve major categories when possible.
- The most frequently occurring recommendations were then rank ordered overall and then by medical and traumatic fire fighter LODD.

Slide 4-21

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- e. “Fatality investigations completed from 2006 to 2014 were selected for this study with recommendations being assigned into twelve major categories when possible. The most frequently occurring recommendations were then rank ordered overall and then by medical and traumatic firefighter LODD” (Hard et al., 2019).

## NIOSH STUDY RESULTS

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Between 2006 and 2014, there were 1,067 total recommendations made in the published fire fighter investigative reports.

Of those, 784 (73%) could be placed within one of 12 recommendation categories, the top 10 were.



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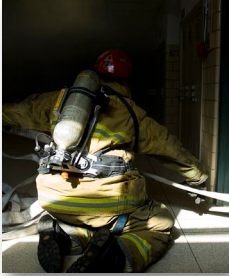
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- 6. NIOSH study results.
  - a. Between 2006 and 2014, “there were 1,067 total recommendations made in the published firefighter investigative reports.”
  - b. “Of these, 784 (73%) could be placed within one of the 12 recommendation categories” noted previously (Hard et al., 2019).

**THE TOP 10 CATEGORIES FOR PREVENTING DEATHS**

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- 1. Medical screening.
- 2. Fitness and wellness program.
- 3. Training.
- 4. Medical clearance.
- 5. Standard Operating Procedures/SOG.
- 6. Incident command.
- 7. Strategy and tactics.
- 8. Communications.
- 9. PPE.
- 10. Staffing.



Slide 4-23

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- M. Top 10 categories for preventing firefighter deaths.
  - 1. Medical screening.
  - 2. Fitness and wellness program.
  - 3. Training.
  - 4. Medical clearance.
  - 5. Standard operating procedures (SOPs)/standard operating guidelines (SOGs).
  - 6. Incident Command.
  - 7. Strategy and tactics.
  - 8. Communications.
  - 9. PPE.
  - 10. Staffing (Hard et al., 2019).


II. SECONDARY TRAUMA AND SELF-CARE

**FIREFIGHTING AND MENTAL HEALTH**

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Experiences of repeated exposure to trauma:

- Firefighters are responding to fewer fires, but are increasingly called upon to provide Emergency Medical Services (EMS), perform rescues, and are exposed to multiple tragic events.



*-Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Murphy, B. (2016)*

Slide 4-24

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A. Firefighting and mental health.

Firefighters are responding to fewer fires but are increasingly called upon to provide Emergency Medical Services (EMS), perform rescues and are exposed to multiple tragic events.

B. Traumatic stress reactions can be broken down into four categories:

1. Emotional — shock, anxiety, guilt, grief, severe panic, fear, irritability, shame.
2. Cognitive — self-blame, confusion, blaming others, nightmares, memory problems.
3. Behavioral — withdrawal, emotional outbursts, changes in normal activities, paranoia, sexual dysfunction.
4. Physical — tension, chest pains, difficulty breathing, constant fatigue, difficulty sleeping, edginess, elevated blood pressure.

## SECONDARY TRAUMA

- Firefighters can experience “secondary trauma” or “compassion fatigue” from exposure to the trauma of others.
- Secondary trauma can manifest in many forms such as:
  - Depression/Helplessness.
  - Sleep Disorders.
  - Avoidance Behaviors.
- Secondary trauma can be diagnosed as repeated exposure trauma (RET) or post-traumatic stress injury (PTSI).

Slide 4-25

### C. Secondary trauma.

1. Firefighters can experience “secondary trauma” or “compassion fatigue” from exposure to the trauma of others.
2. Secondary trauma can manifest in many forms, such as:
  - a. Depression/Helplessness.
  - b. Sleep disorders.
  - c. Avoidance behaviors.
3. Secondary trauma can be diagnosed as repeated exposure trauma (RET) or post-traumatic stress injury (PTSI).

## FIREFIGHTING AND EXPOSURE TO TRAUMA

Experiences of repeated exposure to trauma:

Firefighters are exposed to a wide variety of tragic situations that play out in or around their homes, along highways, and in every other conceivable part of their communities.



-Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Murphy, B. (2016)

Slide 4-26

### D. Firefighting and exposure to trauma.



1. The cumulative effect of regularly caring for the broken bodies and wounded minds of victims and their families.
2. Firefighters are exposed to a wide variety of tragic situations that play out in or around their homes, along highways, and in every other conceivable part of their communities.
3. These actions are thought to have a negative psychological impact on firefighters' own mental health.

### HISTORICAL STUDY DATA

- Evidence shows that rates of depression among fire and EMS personnel are higher than in the general population.
- Firefighters have higher rates of alcohol use and binge drinking compared to the general population. There is a possible connection between risky drinking behaviors and post-traumatic stress disorder (PTSD).
- Firefighters may not be diagnosed with PTSD, but clearly suffer from symptoms such as sleep disorders, avoidance behaviors, and feelings of helplessness that are associated with PTSD.

Slide 4-27


#### E. Historical study data.

1. “Evidence shows that rates of depression among fire and EMS personnel are higher than in the general population. Firefighters have higher rates of alcohol use and binge drinking compared to the general population. There is a possible connection between risky drinking behaviors and post-traumatic stress disorder (PTSD)” (USFA, 2018).
2. Firefighters may not be diagnosed with PTSD, but clearly suffer from symptoms such as sleep disorders, avoidance behaviors and feelings of helplessness that are associated with PTSD.
3. PTSD or disorder is an anxiety disorder that is twice as likely to occur in women than in men.
4. Those who are at risk are traditionally exposed to environments that are deemed to be traumatic and stressful (e.g., police, fire, EMS, hospital employees). They often develop skills and strategies to cope and do not often deal with the feelings and emotions that the situation evokes. The thing for investigators to understand is that stress compounds stress.

**FIRE FIGHTING AND MENTAL HEALTH STUDY**

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- It's more common for firefighters to experience a negative impact from a series of traumatic events rather than from one event.
- Symptoms of RET for most firefighters include desensitization, irritability, cynicism, and intrusive flashbacks.



• Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Murphy, B. (2016). *Firefighting and mental health: Experiences of repeated exposure to trauma*. Emmitsburg, MD: National Emergency Training Center.

Slide 4-28

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F. Firefighting and mental health study.


1. It is more common for firefighters to experience a negative impact from a series of traumatic events rather than from one event.
2. RET is different from previous studies that have investigated firefighter mental health challenges in the context of PTSI, which relies on assessment instruments attuned to one traumatic event.
3. Symptoms of RET for most firefighters include desensitization, irritability, cynicism and intrusive flashbacks.

**FIRE FIGHTING AND MENTAL HEALTH STUDY**

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Many firefighters effectively manage their emotional response to trauma. Future research should explore their protective coping methods.

Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Murphy, B. (2016). *Firefighting and mental health: Experiences of repeated exposure to trauma*. Emmitsburg, MD: National Emergency Training Center.



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4. Many firefighters effectively manage their emotional response to trauma. Future research should explore their protective coping methods (Jahnke et al., 2016).

## SELF AWARENESS

Sometimes, it's easier to recognize PTSD in others rather than ourselves. Warning signs for ourselves:

1. Intrusive memories or thoughts of a traumatic event.
2. Avoidance of thoughts, feelings or external reminders of the event.
3. Feelings of numbness.
4. Hypervigilance or exaggerated states of fear.
5. Persistent, negative beliefs about yourself and the world.



Ignoring or keeping quiet about these warning signs can be dangerous.

Slide 4-30

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### G. Self awareness.

1. Sometimes, it is easier to recognize PTSD in others rather than ourselves. Some warning signs include:
  - a. “Intrusive memories or thoughts of a traumatic event.
  - b. Avoidance of thoughts, feelings or external reminders of the event.
  - c. Feelings of numbness.
  - d. Hypervigilance or exaggerated states of fear.
  - e. Persistent, negative beliefs about yourself and the world.
2. Ignoring or keeping quiet about these warning signs can be dangerous” (IAFF, 2017).
3. For more information, visit <https://www.iaffrecoverycenter.com/blog/recognizing-ptsd-fire-fighters-5-warning-signs/>.

## SIGNS IN OTHERS



At the kitchen table or in the bunk room, lookout for these warning signs of PTSD:

1. Isolation from others.
2. Disturbed sleep.
3. Increased irritability.
4. Loss of interest in previously enjoyable activities.
5. Self-destructive or reckless behavior.

Slide 4-31

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H. Signs in others.

“At the kitchen table or in the bunk room, if you notice a change in an individual’s behavior or mood, be on the lookout for these five warning signs of PTSD:

1. Isolation from others.
2. Disturbed sleep.
3. Increased irritability.
4. Decreased interest in significant activities.
5. Self-destructive or reckless behavior” (IAFF, 2017).


**GLASS TEST**

Imagine stress as water and our ability to handle stress is an empty glass.

People without PTSD start each day with an empty glass, and as the day goes on, that glass slowly fills with stress.

Someone with PTSD starts out their day with their glass already three-quarters full.

*“Emotional survival for law enforcement: A guide for officers and their families” by Kevin M. Gilmartin, PhD*



Slide 4-32

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I. Glass test.

1. “Imagine stress as water and our ability to handle stress as an empty glass. Normal folks without PTSD start each day with an empty glass, and as the day goes on, that glass slowly fills. Someone with PTSD starts out their day with their glass already three-quarters full.
2. Watch your spouse on a normal off duty day with regular life stresses: How quickly does the glass overflow, and were those stresses ‘normal’? If they were, and the threshold of being overwhelmed was noticeably low (being overwhelmed will appear as tantrums, loss of temper, storming out, tears, etc.), bang the big red button on the dash” (Gillie, 2016).

**REMEMBER**

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- The most important rule of when seeking treatment for others? Include yourself.
- Don't underestimate the impact of trauma on you, your coworkers, and/or family.
- Don't overestimate the stigma of getting help. It is a treatable injury, not a life sentence.



Resource: "Emotional survival for law enforcement: A guide for officers and their families" by Kevin M. Gilmartin, PhD

Slide 4-33

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J. Things to remember.

1. The most important rule when seeking treatment for others is to include oneself.
2. Do not underestimate the impact of trauma on oneself, one's coworkers and/or family.
3. Do not overestimate the stigma of getting help. It is a treatable injury, not a life sentence.



**THE FIREFIGHTERS RESCUER**

STARBUCKS®  
**STORIES**  
& NEWS

<https://stories.starbucks.com/stories/2017/upstanders-the-firefighters-rescuer/>

Slide 4-34

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## 2019 FIRE SERVICE BEHAVIORAL HEALTH SYMPOSIUM

- <https://www.firstrespondercenter.org/fire-service-behavioral-health-symposium-day-1/>
- <https://www.firstrespondercenter.org/fire-service-behavioral-health-symposium-day-2/>

Slide 4-35

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## HEALTH AWARENESS

The National Volunteer Fire Council and The International Association of Fire Chiefs provide recommendations for first responders:

- Use full PPE.
- Have multiple hoods.
- Decontamination:
  - Gross PPE.
  - Face wipes.
  - Change clothes.
  - Shower within the hour.
  - Don't bring it home.
  - Contain PPE.
- Annual physical.
- No tobacco.
- Document your exposures.



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### K. Health awareness.

1. The National Volunteer Fire Council (NVFC) and the IAFC provide recommendations for first responders:
  - a. Use full PPE.
  - b. Have multiple hoods.
  - c. Decontamination.
    - Gross PPE.
    - Face wipes.
    - Change clothes.
    - Shower within the hour.

- Do not bring it home.
  - Contain PPE.
  - d. Annual physical.
  - e. No tobacco.
  - f. Document your exposures.
2. Additional information can be found at <https://www.nvfc.org/firefighters/resources/?category=resource-health>.

III. FIREFIGHTER ARSON

**FIREFIGHTER ARSON**

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**IS THIS REALLY A PROBLEM?**

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Two Indiana area volunteer firefighters charged in arson at Amish furniture store

Wednesday, September 25, 2019.

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## FF ARSON IS A PROBLEM

- Firefighter arson is not a new problem.
- Over 100 American firefighters are arrested for arson every year.
- When a firefighter is arrested anywhere it affects us all.
- There are things we can and must do.
- There are no excuses for setting fires.



Slide 4-39

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- A. Unfortunately, the issue of firefighter arson is not new, although it is impossible to definitively say if the problem is increasing or if more offenders are just being caught and prosecuted. At present, there is not an accurate estimate of the current number of firefighter arsonists because official data is not recorded. As a result, historical records, newspaper archives and other anecdotal accounts must be used to gain an understanding of the problem.
- B. The NVFC first explored the issue of firefighter arson in 1994. In 2010, the NVFC assembled a working group of national experts to commission a report on the firefighter arson problem. In gathering information for this report, it became apparent that the volume of cases has increased significantly since the early 1990s. This increase is likely due to the rise in instant communication thanks to the internet and social media. A collection of media reports from the year 2000 features over 900 firefighter arson cases.

## FIRE CHIEF RYAN SCHARBER

- In Babbitt, Minnesota, Ryan Scharber and his wife had recently had a second son. Needing a break from the crying infant. He decided to start lighting fires in vacant woodland areas.
- He was always one of the first responders who fought the fires and investigated the suspicious circumstances. Federal agents began to suspect that the arsonist was a firefighter. Investigators confronted Scharber.
- He confessed to setting nine fires. Scharber explained the fires were "an excuse to get out of his house for a few hours". After pleading guilty to arson, he was sentenced to five years in prison.



Photo credit: ABC News

Slide 4-40

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## FF ARSON EXAMPLES

- Blackhawk FD, Firefighter accused of 4 fires.
- Munhall firefighter convicted of 2 house fires.
- Wattsville Fire Department.
- Former Lawrence County Firefighter sentenced to 20 years.

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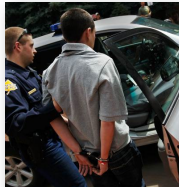
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## TYPICAL FF ARSONIST

- Average age is 24.  
(range from 14 to 65+)
- Predominately male.
- Over half involved multiple firefighters setting fires.
- Over 100 were ranking officers.
- Those arrested include volunteer, career, and wildland firefighters.
- Many were well-liked, decorated, and related to other members.  
(Based on research from 1,800+ cases)



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- C. Typical firefighter arsonist (based on research from more than 1,800 cases).
1. Average age is 24 (range from 14 to over 65).
  2. Predominately male.
  3. Over half involved multiple firefighters setting fires together.
  4. Over 100 of those arrested were ranking officers.
  5. Those arrested include volunteer, career and wildland firefighters.
  6. Many were well-liked, decorated and/or related to other members.

**MOTIVES**

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- There is no single reason why firefighters set fires.
- Some set fires before becoming firefighters.
- Some may have “a problem with fire”—but this is uncommon.
- Most never set fires before joining.
- Many had no desire to set fires before joining.



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D. Motives.


1. There is no single reason why firefighters set fires. Some set fires before becoming firefighters. Some may have “a problem with fire,” but this is uncommon.
2. Most never set fires before joining.
3. Many had no desire to set fires before joining. They got the idea in the fire service.
4. Many got the idea from friends in the fire department. We need to send a strong and unified message that this is not acceptable behavior.
5. Motives include:
  - a. Excitement: Competitiveness and boredom are unfortunately hallmarks of many fire departments across the nation. The silent fire alarm may discourage firefighters who have spent countless hours training to join the department and respond to fire incidents. They may be driven to create their own incidents to reduce boredom or to ensure that their skills remain current/fresh.
  - b. Hero complex: These are often referred to as “vanity firesetters.” In this case, firesetters set fires in order to warn others, potentially rescue trapped persons or even simply to demonstrate how alert and helpful they are.
  - c. Vandalism: The motive here is the destruction of property, usually similar targets. They may include sheds, port-a-potties, vacant buildings, or other readily available objects or structures.

- d. Revenge: This motive is sparked when the firefighter has an ax to grind and uses arson to right perceived wrongs. There have even been several cases of firefighters burning their own fire station out of anger over discipline or perceived mistreatment.
- e. Financial: Firefighters may be behind on their mortgage or vehicle loan payments and hope to get relief by burning their own property to collect insurance.
- f. Occupational overzealousness or training: Another common but often overlooked motive is the desire to provide the department with training opportunities. Recent research has highlighted a number of occurrences where firefighters took it upon themselves to rid the community of dilapidated buildings and flophouses. While they may think they are doing the fire department and the community a service, they are actually putting firefighters and the community at risk.

**WHEN A FIREFIGHTER IS ARRESTED FOR ARSON**

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- It ruins the reputation of the department in the community.
- It risks community support and donations that fund new equipment and buildings.
- It makes all firefighters look like potential criminals.
- It can cause respected members to quit out of shame.
- It can ruin the fire department.
- When a firefighter is arrested, we all lose!



Slide 4-44

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- E. Firefighter arrest.
  - 1. Firefighters enjoy widespread public support. However, when firefighters are arrested for setting fires, it directly threatens the reputation of the fire service, the department and the colleagues who are left behind to pick up the pieces.
  - 2. Firefighter arson incidents can significantly impact the community's perception of the fire department. The sense of betrayal is not limited to those community members who may have had property damaged or sustained injuries. The wider community is likely to have a strong reaction that may have both immediate and lasting effects.



3. Citizens have historically viewed firefighters as protectors — brave and selfless individuals who will sacrifice their own personal safety for others. When a local firefighter is exposed as an arsonist, that vision is likely to be compromised and that trust broken.
4. Perhaps even greater than the impact that firefighter arson has on the community is the impact it has on the department itself. Not only does firefighter arson put fellow firefighters and emergency responders in danger, it also creates an environment of distrust and suspicion within the ranks. The internal crisis that follows can be even more crippling than the external pressure being placed on the department.

**THE ARSONIST**

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If you set a fire, no matter how small, you ARE an arsonist:

- You will be kicked out of the department.
- Arsonists cannot remain a firefighter or join a new fire dept.
- You will have a felony record.
- Convicted felons cannot own a firearm or hunt.
- Convicted felons cannot vote or hold any elected office.
- You and your family will suffer social stigma.



Slide 4-45

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F. The arsonist.

1. If someone sets a fire, they are an arsonist, no questions. It does not matter if it was only a small fire, a vacant building or no one seemed to care. A fire is a fire, and someone who sets fire is an arsonist. Those who set fires **will** be kicked out of the fire department and will never be allowed to join ever again, no exceptions.
2. The firesetter will most likely be charged with a felony, the most serious type of crime. Being convicted of a felony will require prison time.
3. Firefighter arsonists are often sentenced for more than 10 years in prison because judges feel the crime is particularly heinous.
4. Convicted felons give up a number of rights. They cannot vote or hold any elected office. They cannot own, possess or use a firearm. Felons are also barred from many jobs, and employers may be unwilling to hire individuals with a criminal record.

## ACCOMPLICES

- Even those who did not strike a match can be arrested, charged, and convicted.
- If you know or suspect a fellow firefighter (or officer) is setting fires, you have a responsibility to do something.
- You have an ethical duty to stop this action.



Supporting Those Who Serve  
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### G. Accomplices.

1. Even those who did not strike a match can be arrested, charged and convicted.
2. If anyone knows or suspects a fellow firefighter (or officer) is setting fires, they have a duty to act.
3. Everyone has the ethical duty to do the right thing to stop this action.
4. Many people, including firefighters, are often unaware that laws can apply to any person who participated in a crime, even if they were not the main offender. In other words, if a firefighter knowingly drives another firefighter to set a fire, even if they stay in the car and do not actively participate, they can still be charged with arson and sent to prison. There is no such thing as a minor role in setting a fire.

## NATIONAL VOLUNTEER FIRE COUNCIL

Out in the Open Video

<https://www.youtube.com/watch?v=UxfsS7JAgdQ>



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IV. SOCIAL MEDIA



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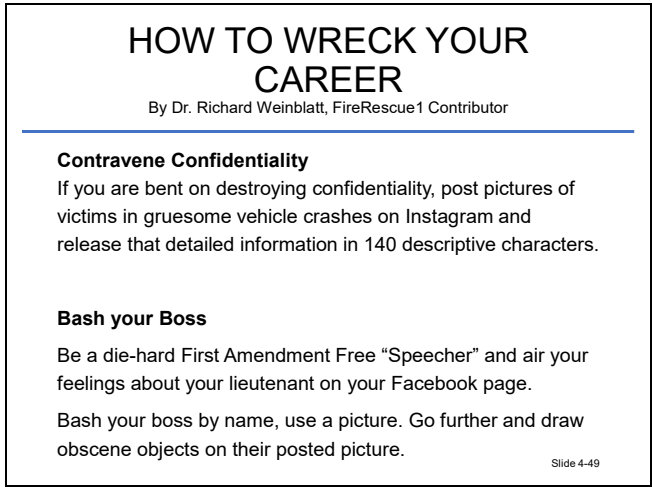
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- A. Contravene confidentiality.
  - 1. As a firefighting professional, you are trusted by your employer and have a duty to protect the confidentiality of information you obtain while serving your community.
  - 2. If you are bent on destroying that confidentiality, do post pictures of victims of gruesome vehicle crashes on Instagram and release that detailed information in 140 descriptive characters on Twitter.
  
- B. Bash your boss.
  - 1. Be a die-hard First Amendment Free Speaker and air your feelings about your lieutenant on your zero-privacy-settings Facebook page.

2. Bash your boss by name. Use a picture. That is sure to win them over. Go further and draw obscene objects on their posted picture.

**KEEP WRECKING YOUR CAREER**

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**Pornographic Pictures**  
Ride the wave of pornographic pictures that are all the rage on social platforms. Better yet, be sure to have your official uniform visible.

**Drugs and Alcohol**  
Open use of your favorite illicit drug in Facebook pictures. Be sure your face is visible as you use your method of ingesting that drug and go that extra mile of identifying yourself as a firefighter.  
If drugs aren't your thing, take heart as drinking behavior is always noticed by fire officials, so be outrageous in your actions. Heck, have some underage folks drinking with you in the picture for some real impact.

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C. Pornographic pictures.

Be sure to ride the wave of pornographic pictures that are all the rage on Instagram and Tumblr. Better yet, be sure to have parts of your official uniform visible with special attention to your department's insignia.

D. Drugs and alcohol.

1. Another variation would be the open use of your favorite illicit drug in Facebook pictures. Be sure your face is visible as you use your chosen method of ingesting that drug and go that extra mile of identifying yourself as a firefighter.
2. If drugs are not your thing, take heart, as drinking behavior is always noticed by fire officials, so be outrageous in your actions. Heck, have some underage folks drinking with you in the picture for some real impact.

**WRECK YOUR CAREER SOME MORE**

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**Racist Rants**  
Tired of being politically correct? Then go to the opposite end of the spectrum and put all sorts of racist, sexist, and homophobic rants on your Twitter. Defense attorneys particularly appreciate when they discover prejudicial or sexist attitudes that you display on social media and use them to impeach your credibility.

**Make It Count**  
Whatever method or methods above that you pursue in the destruction of your career, be sure to do it while on duty.  
Use the department's smartphone or computer and have all your social media privacy settings on open to the public.

By Dr. Richard Weinblatt, FireRescue1 Contributor. Retrieved from: <https://www.firerescue1.com/evergreen/articles/5-ways-to-destroy-your-firefighting-career-on-social-media-1Y08DF1phk0R3EJ/>

Slide 4-51

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E. Racist rants.

Tired of being politically correct? Then go to the opposite end of the spectrum and put all sorts of racist, sexist and homophobic rants on your Twitter. Defense attorneys particularly appreciate when they discover any prejudicial or sexist attitudes that you have on display on social media and use them in court to impeach your credibility.

F. Make it count.

1. Whatever method or methods above that you pursue in the destruction of your career, be sure to do it while on duty.
2. Use the department's smartphone or computer and have all your social media privacy settings on open to the public (Weinblatt, 2014).

**FIREFIGHTERS LOSE JOBS**

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<https://www.youtube.com/watch?v=OHehFQhQasI>

<https://www.youtube.com/watch?v=vinl16ukNuY>



Slide 4-52

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**SOCIALLY SUMMARIZING**

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- Your actions have consequences.
- You can say whatever you want, if you're prepared to make the sacrifice for those comments.
- You are always representing your department.



Slide 4-53

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G. On social media:

1. Your actions have consequences.



2. You can say whatever you want, if you are prepared to make the sacrifice for those comments.
3. Really, you are always representing your department.

**V. SUMMARY**

### SUMMARY

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Some topics are difficult to talk about, or require vigilance and added responsibilities from a first responder.

- Fatal fires require extra diligence on the part of both the investigator and the first responder to secure justice.
- Line of Duty Deaths are a traumatic experience for everyone.
- No one is immune from secondary trauma.
- Firefighter arson is a problem. Putting our collective heads in the sand is not an option.
- Don't be a jack ass on social media.

Slide 4-54

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# **UNIT 5: MAKING THE CALL**

## **TERMINAL OBJECTIVE**

*The students will be able to:*

- 5.1 *Evaluate a fire scene, and identify evidence applicable to determining the origin of the fire.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 5.1 *Compare fire patterns.*
  - 5.2 *Choose an area of origin based on the information provided.*
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## TERMINAL OBJECTIVE

Evaluate a fire scene, and identify evidence applicable to determining the origin of the fire.



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## ENABLING OBJECTIVES

- Compare fire patterns.
- Choose an area of origin based on the information provided.

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I. CASE 1

**CASE #1**

- Witness reported smoke coming from building.
- First arriving fire officer reported, heavy fire conditions coming from a window on the “A & D” sides.
- Fire units conducted suppression operations and requested an investigative team.



Slide 5-4

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- A. Witness reported smoke coming from building.
- B. First arriving fire department officer reported heavy fire and smoke conditions coming from a window on the “A” and “D” sides of the structure.
- C. Fire units conducted suppression operations and requested an investigative team.

**INITIAL WITNESS STATEMENT**

- Homeowner advised they are in the final stages of renovations.
- General contractor was hired to paint walls and strip/restore antique furniture.
- Homeowner advised all financial institutions are up to date and current.
- Day of the fire construction crew was in the building and completed work around sunset.
- Work consisted of stripping and staining antique furniture.
- Crew stated when they left, they turned off all lights and disconnected all portable work lamps.
- All doors and windows were secured.
- Fire department had to force entry to the building. Slide 5-5

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- D. Initial witness statement.
  - 1. The homeowner advised that they are in the final stages of renovations.
  - 2. A general contractor was hired to paint walls and strip/restore antique furniture.
  - 3. The homeowner advised that all financial institutions are up to date and current.



**MAKING THE CALL**

4. On the day of the fire, the construction crew was in the building and completed work around sunset.
5. Work consisted of stripping and staining antique furniture.
6. The crew stated that when they left, they turned off all lights and disconnected all portable work lamps.
7. All doors and windows were secured.
8. The fire department had to force entry to the building.

**SIDE A OF STRUCTURE**



Slide 5-6

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**SIDE C AND D OF STRUCTURE**



Slide 5-7

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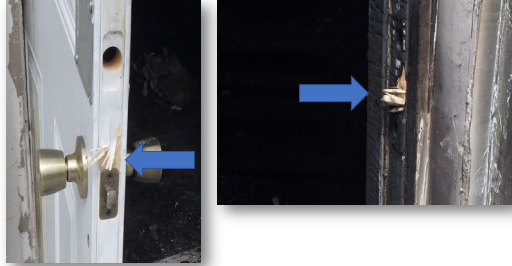
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## EXTERIOR EXAMINATION

Forced entry by fire department



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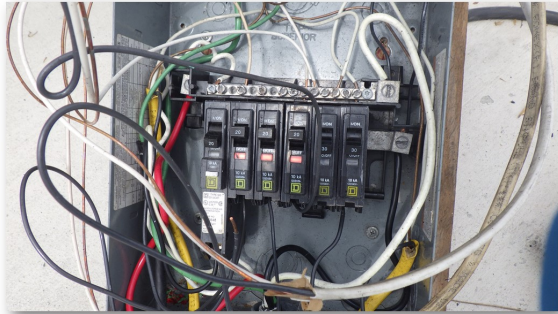
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## ELECTRICAL PANEL EXAMINATION



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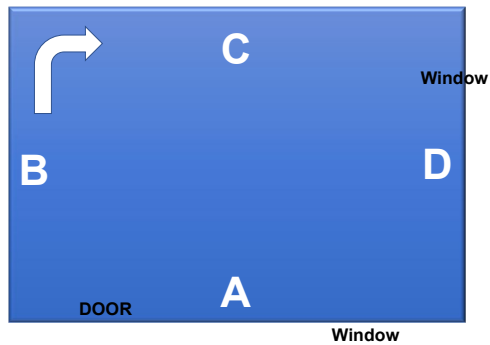
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## INTERIOR



Slide 5-10

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E. Understanding the A, B, C, D nomenclature.

INTERIOR



Slide 5-11

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Fire vent pattern.

Fire pattern behind area of origin B wall low.



Slide 5-12

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PATTERN ON B WALL TOP



Slide 5-13

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FIRE PATTERN C WALL



Slide 5-14

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SIDE D WITH WINDOW



Slide 5-15

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SIDE A WITH WINDOW AND DOOR



Slide 5-16

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F. View of sofa.



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G. Behind sofa on the floor.



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TOP VIEW OF SOFA



Slide 5-20

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H. Top view of sofa, looking down from back.

UNDER SOFA VIEW



Slide 5-21

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I. Under sofa view.

RAGS ON FLOOR BEHIND COUCH



Slide 5-22

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J. Rags on floor behind couch.

CLOSE UP OF RAGS



Slide 5-23

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K. Close-up of rags behind couch.

MARKING OF RAGS



Slide 5-24

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FLOOR AFTER CLEANING AND RECOVERING EVIDENCE



Slide 5-25

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L. Floor behind couch, after cleaning and recovering evidence.

### PORTABLE WORK LAMP #1



Slide 5-26

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M. Ignition sources eliminated. Portable work lamp 1.

### PORTABLE WORK LAMP #2



Slide 5-27

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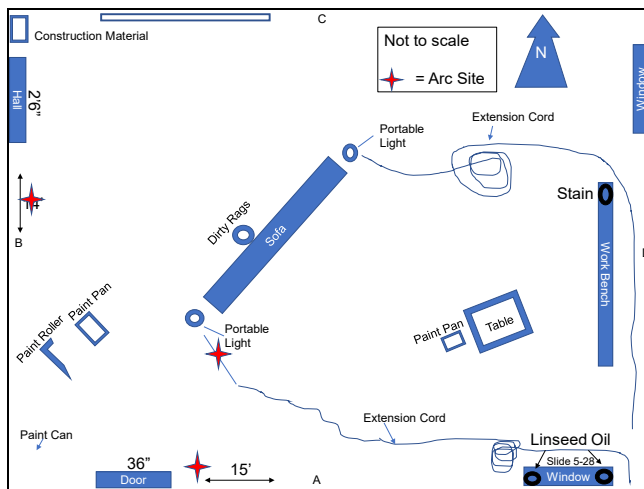
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N. Ignition sources eliminated. Portable work lamp 2.



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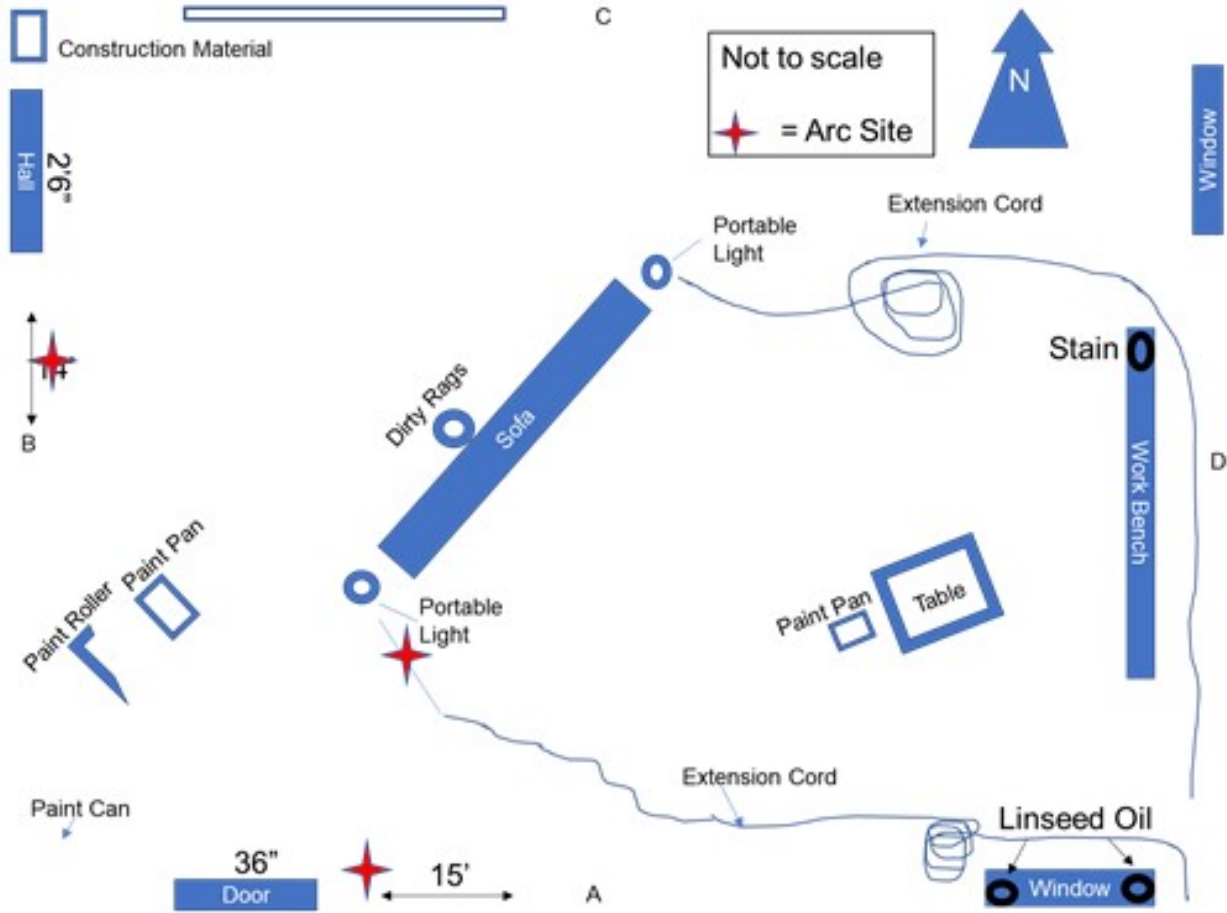
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### WHAT THE TEAM FOUND

Timeline:

- Approximately 1800-1900 hours construction crew leaves.
- 1939 hours sunset for April 7, 2019 (weather underground)
- 2134 hours 911 call for reported fire.
- 2138 hours homeowner advised by neighbor.
- 2155 hours homeowner arrived on scene.

Slide 5-29

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- O. What the team found.
1. Approximately 1800 to 1900 hours, construction crew leaves.
  2. 1939 hours: sunset for April 7, 2019 (Weather Underground).

3. 2134 hours: 911 call for reported fire.
4. 2138 hours: Homeowner advised by neighbor.
5. 2155 hours: Homeowner arrived on scene.

### EVIDENCE COLLECTED

- Item #1-Empty container of Newport cigarettes with five used cigarette filters.
- Item #2-One glass vial of unknown liquid that K-9 gave a positive alert to.
- Item #3-Halogen light, unknown brand.
- Item #4- Suspected oily rags from area of origin (submitted to lab).
- Item #4- Lab report produced a positive reading for fatty acids (linseed oil).
- Item #5- Suspected oily rags from the top of the sofa.

Slide 5-30

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P. Evidence collected.

1. Empty container of Newport cigarettes with five used cigarette filters.
2. One glass vial of unknown liquid that K-9 gave a positive alert to.
3. Halogen light, unknown brand.
4. Suspected oily rags from area of origin (submitted to lab).
5. Lab report produced a positive reading for fatty acids (linseed oil).
6. Suspected oily rags from the top of the sofa.

### CONCLUSION

Area of Origin: The rear/middle of the sofa, in a plastic garbage can filled with dirty rags (linseed oil).

Ignition Source: Chemical reaction with improperly discarded oily rags. This resulted in a exothermic reaction. Causing a fire in the plastic trash can attacking the rear of the sofa.

Responsibility: Accidental, contractor forgot to remove combustibles, from work area at the end of work day.

Slide 5-31

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Q. Conclusion.


1. Area of origin: the rear/middle of the sofa, in a plastic garbage can filled with dirty rags (linseed oil).
2. Ignition source: chemical reaction with improperly discarded oily rags. This resulted in an exothermic reaction, causing a fire in the plastic trash can and attacking the rear of the sofa.
3. Responsibility: Accidental; contractor forgot to remove combustibles from work area at the end of work day.

II. CASE 2

**CASE #2**

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- Address:  
265 North Street  
Emmitsburg, Maryland
- Date of Alarm / Time:  
May 6, 2019 @ 0330
- Weather Conditions:  
Temp - 59 F  
Winds – SE @ 8 MPH



Slide 5-32

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- A. Address: 265 North Street, Emmitsburg, Maryland.
- B. Date of alarm/time: May 6, 2019, at 0330 hours.
- C. Weather conditions:
1. Temperature: 59 F.
  2. Winds: southeast at 8 miles per hour (mph).

PHOTOGRAPHS EXTERIOR (DATA COLLECTION)

**A side (Front)**

Compromised front door outward. Fire department made entry through for fire suppression.



Exterior venting of windows and door way

Slide 5-33

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D. Exterior photographs.

1. Side A (front): Compromised front door outward. Fire department made entry through front door for fire suppression.
2. Exterior venting of windows and doorway.

PHOTOGRAPHS EXTERIOR (DATA COLLECTION)

#1 ON (closets) #2 Trip (ceiling light) #3 Trip (outlets) #4 ON (open - not wired)



Compromised window vented glass in side smooth edge fractures and warping, broken glass exterior and melted frames.



Slide 5-34

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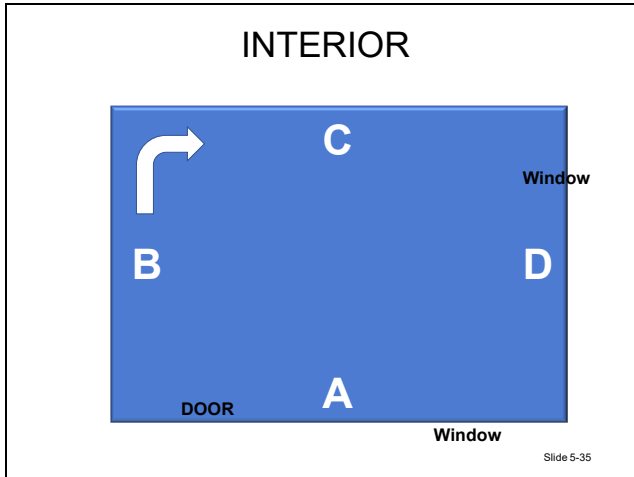
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3. Number 1 on (closets); number 2 tripped (ceiling light); number 3 tripped (outlets); and number 4 on (open, not wired).
4. Compromised window: vented glass inside, smooth edge fractures and warping, broken glass exterior, and melted frames.



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E. Understanding the A, B, C, D nomenclature.



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F. Interior, Side A.



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G. Interior, Side B.

DESK



Slide 5-38

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H. Desk.

1. Heavy char and deformation of shelf and veneer peeling behind pot on shelf (left to right).
2. Lava lamp, beer bottle with crazing toward door, tiki torch stand (bamboo/rattan), paper material (possible books) on table (left to right).
3. Multioutlet with four plugs, toaster in “off” position, toaster oven in “off” position with unburned wrapper inside.
4. Hot plate with pot containing carbon fries and oil/water, beer bottle, tiki torch cartridge (no indication of being lit — clean wick, no fuel remaining), nine volt battery.

SIDE C INTERIOR



Slide 5-39

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I. Side C interior.

1. Side B/C corner showed clean burn on lower walls and charred remains of a laundry hamper type structure of metal hoop, cloth material and clothing type material remains.
2. C wall had a couch with mass loss on the left side toward side B/C corner, with clean burn area above couch.
3. Next to couch toward the D wall, a standing lamp had fallen toward the couch.
4. A mass of melted plastic with some small springs was located in front of the couch.



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J. Side D interior.

1. D wall window heavily heated with warped glass on inside window sill demonstrating another vent path.
2. Mass of melted plastics over beer bottles was located below the window.



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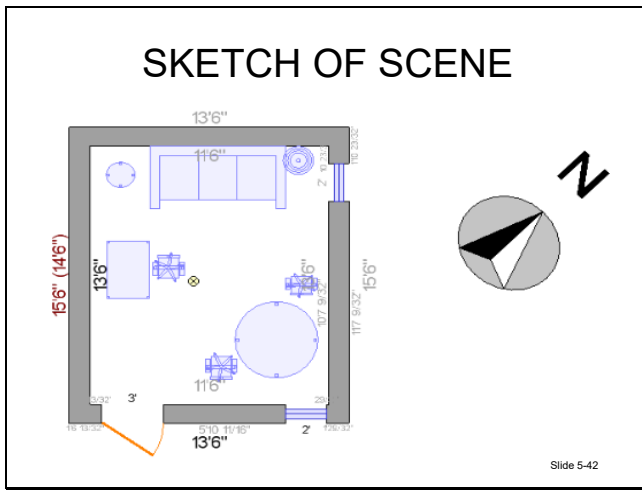
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K. Card table and two chairs.

1. Chair appeared to be in fallen position prior to fires indicated by burning of the bottom area and feet, congruent with the statements regarding a scuffle.
2. Table top had a collection of playing cards, ash trays, cigarettes and beer bottles.




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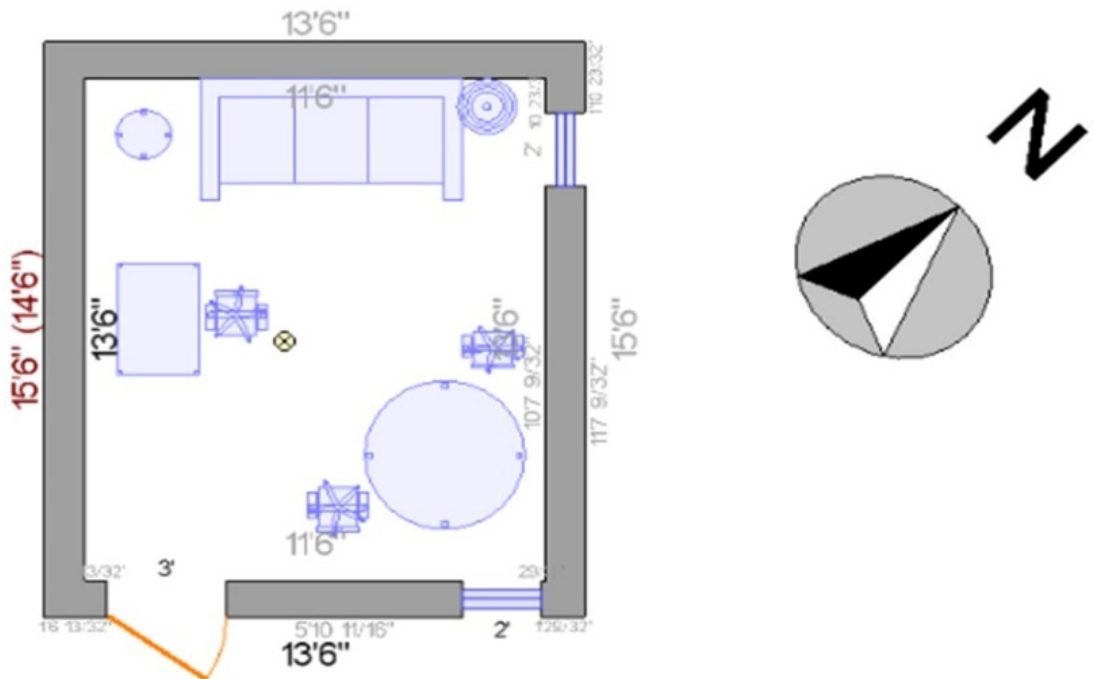
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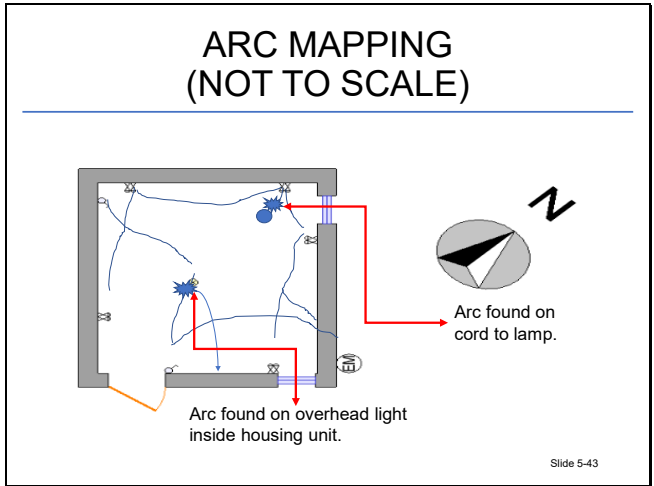
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L. Sketch/drawing of scene.







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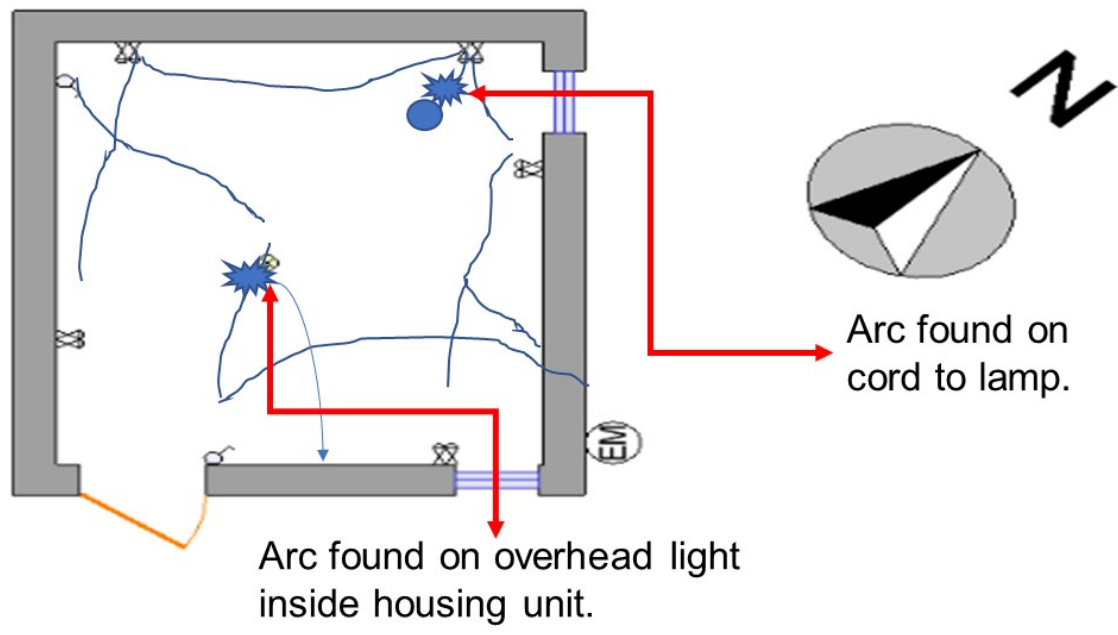
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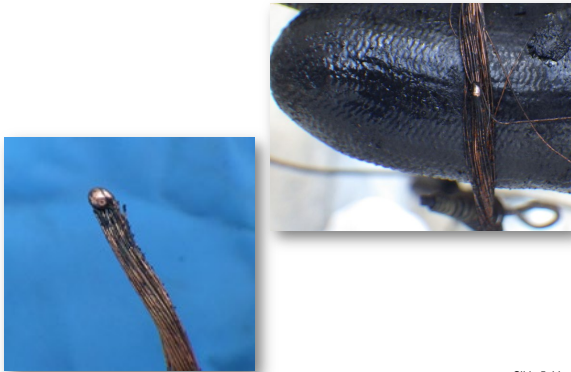
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M. Arc mapping (not to scale).



ARC EVIDENCE (ANALYZE DATA)



Slide 5-44

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1. All fixtures, extension and appliance cords were examined for arc damage.
  - a. Two arcs were identified.
  - b. Multioutlet analyzed, but nothing found.
  - c. Arc noted to the ceiling light which indicated that the light was in the "on" position at the time of the arc.
  - d. In conflict with witness statement of light being off.
2. Arc noted to the floor light which indicated that there was power to the lamp up to the switch, but undetermined if the lamp was on or off at the time of the fire.



Slide 5-45

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N. Burner with pot.

### HYPOTHESIS 1 (DEVELOP HYPOTHESES)

- Lamp on right of couch (not probable).
- Considered, but determined not to be a competent ignition.



Slide 5-46

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O. Hypothesis 1.

1. Lamp on right of couch (not probable).
2. Considered, but determined not to be a competent ignition.

### HYPOTHESIS 2

- Desk area multiple appliances plugged into removal power tap (RPT) (power strip).
- Overload unlikely because only one appliance was found in “on” position.



Slide 5-47

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P. Hypothesis 2.

1. Desk area — multiple appliances plugged into relocatable power tap (RPT) (power strip) (not probable).
2. Overload unlikely because only one appliance was found in “on” position.

### HYPOTHESIS 3

- Cooking pot with French fries overheated the oil and started the desk on fire (probable).
- Burner was found to be left in the high on position and some remaining oil water mix was still in the pot.



Slide 5-48

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Q. Hypothesis 3.

1. Cooking pot with french fries overheated the oil and started the desk on fire (probable).
2. Burner was found to be left in the high “on” position, and some remaining oil/ water mix was still in the pot.
  - a. Type of oil in pot, vapor point, autoignition point.
  - b. Hot plate and switch condition.
3. Hot plate was found to have a fused thermostat switch allowing for thermal runaway thereby exceeding design temperatures once in the “on” position.
4. Debris from side B/C corner suspected to be laundry hamper, and possible fuel connection to couch area was found to have no accelerant traces.
5. Cooking pot liquid sample was determined to contain medium distillate oil.

### ORIGIN AND CAUSE (FINAL HYPOTHESIS)

**ORIGIN**

- Based upon the examination of the fire scene to include: fire patterns, fire dynamics, electrical arc survey, and witness statements.
- The probable cause is this fire originated in the area of the desk on the B side wall.

**CAUSE**

- It is our opinion the cause to be an unattended faulty appliance left on.
- The ignition source brought the cooking oil to its’ auto ignition temperature as first fuel, and continuing on to surrounding combustible fuel loads, to fully develop the fire growth.

Slide 5-49

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R. Origin and cause (final hypothesis).

1. Origin: Based upon the examination of the fire scene to include fire patterns, fire dynamics, electrical arc survey, witness statements and in alignment with the probable cause, it is our opinion that this fire originated in the area of the desk on the B side wall.
2. Cause: By using the scientific method to analyze our hypothesis, it is our opinion that the cause was an unattended faulty appliance that was left on.

This ignition source brought the cooking oil to its autoignition temperature as first fuel, and it continued on to surrounding combustible fuel loads to fully develop the fire growth.

**III. SUMMARY**

**COURSE SUMMARY**

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How will the information presented  
in this course change your  
response behavior?

Slide 5-50

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# ACRONYMS

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**ACRONYMS**

<b>AFCI</b>	Arc Fault Circuit Interrupter
<b>AIT</b>	autoignition temperature
<b>CFI</b>	certified fire investigator
<b>CPSC</b>	Consumer Product Safety Commission
<b>CSST</b>	Corrugated Stainless Steel Tubing
<b>CT</b>	circuit transformer
<b>CV</b>	curriculum vitae
<b>DIY</b>	do-it-yourself
<b>DVR</b>	digital video recorder
<b>EMS</b>	Emergency Medical Services
<b>FAC</b>	flexible appliance connector
<b>FDC</b>	fire department connection
<b>FEMA</b>	Federal Emergency Management Agency
<b>FFFIPP</b>	Fire Fighter Fatality Investigation and Prevention Program
<b>FI: E</b>	“Fire Investigation: Essentials”
<b>FI: FR</b>	“Fire Investigation: First Reponders”
<b>FSRI</b>	Firefighter Safety Research Institute
<b>GFCI</b>	Ground Fault Circuit Interrupter
<b>HRR</b>	heat release rate
<b>HVAC</b>	heating, ventilating, and air conditioning
<b>IAAI</b>	International Association of Arson Investigators
<b>IAFC</b>	Intranational Association of Fire Chiefs

<b>IAFF</b>	International Association of Fire Fighters
<b>IC</b>	in contact
<b>ILDC</b>	ignitable liquids detection canine
<b>JPR</b>	job performance resource
<b>LEL</b>	lower explosive limit
<b>LFL</b>	lower flammable limit
<b>LNG</b>	liquified natural gas
<b>LODD</b>	line-of-duty death
<b>LPG</b>	liquefied petroleum gas
<b>mph</b>	miles per hour
<b>MSDS</b>	Material Safety Data Sheets
<b>NFA</b>	National Fire Academy
<b>NFIRS</b>	National Fire Incident Reporting System
<b>NFPA</b>	National Fire Protection Association
<b>NIOSH</b>	National Institute for Occupational Safety and Health
<b>NVFC</b>	National Volunteer Fire Council
<b>OCPD</b>	Over Current Protection Device
<b>OIC</b>	Officer in Charge
<b>OPIM</b>	other potentially infectious materials
<b>OSB</b>	Oriented Strand Board
<b>OSHA</b>	Occupational Safety and Health Administration
<b>PASS</b>	Personal Alert Safety System
<b>PIV</b>	post indicator valve

<b>PPE</b>	personal protective equipment
<b>Psi</b>	pounds per square inch
<b>PSOB</b>	Public Safety Officer Benefits
<b>PTSD</b>	post-traumatic stress disorder
<b>PTSI</b>	post-traumatic stress injury
<b>RET</b>	repeated exposure trauma
<b>RH</b>	relative humidity
<b>RIT</b>	Rapid Intervention Team
<b>RPT</b>	relocatable power tap
<b>SCBA</b>	self-contained breathing apparatus
<b>SDS</b>	Safety Data Sheet
<b>SOG</b>	standard operating guideline
<b>SOP</b>	standard operating procedure
<b>TCO</b>	thermal cutoff
<b>TPP</b>	thermal protective performance
<b>UEL</b>	upper explosive limit
<b>UFL</b>	upper flammable limit
<b>UL</b>	Underwriters Laboratories
<b>USAR</b>	Urban Search and Rescue
<b>USFA</b>	U.S. Fire Administration
<b>USSC</b>	United States Supreme Court

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