Fire/Arson Origin-and-Cause Investigations

FAOCI-Student Manual

5th Edition, 1st Printing-October 2015

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 acknowledge their participation and contribution to this effort and extend our heartfelt thanks for making this quality product.

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COURSE GOAL

The goal of this course is to empower students with the knowledge to identify and define key concepts of fire dynamics and fire modeling and develop the ability to apply the available tools to fire investigation and prevention in order to support conclusions using scientific principles.

AUDIENCE, SCOPE AND COURSE PURPOSE

The target audiences for the "Fire/Arson Origin-and-Cause Investigations" (FAOCI) course (R0206) are investigators and code enforcement personnel. Priority will be reserved for full-time personnel with fire/arson investigation responsibility and/or full-time code enforcement responsibility. These personnel include fire/arson investigators, law enforcement personnel, and fire prevention staff/code enforcement officials.

The scope of this course encompasses five topics in fire dynamics and modeling. Included among these are identifying and defining the key concepts, locating and selecting appropriate data sources, identifying and using basic mathematical models, describing and analyzing the behavior of fire in compartment conditions, and critically evaluating the uses and limitations of computer modeling in fire prevention and investigation.

The purpose of this course is to provide students with the ability to identify and define key concepts of fire dynamics and fire modeling and develop the ability to apply the available tools to fire investigation and prevention in order to support conclusions using scientific principles.

GRADING METHODOLOGY

Final Course Grade

The student's final grade for the FAOCI course will be computed as follows:

Point Distribution:

- Attendance = 10 percent.
- Classroom participation/discussion = 10 percent.
- Learning activities = 30 percent.
- Final examination = 50 percent.

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SCHEDULE

TIME	DAY 1	TIME	DAY 2
8:00 - 9:30	Introduction, Welcome and Administrative	8:00 - 9:00	Unit 2: Fire Dynamics
9:30 - 9:40	*Break*	9:00 - 9:10	*Break*
9:40 - 10:40	Unit 1: National Fire Protection Association and the Scientific Method	9:10 - 10:00	Unit 2: Fire Dynamics (cont'd)
10:40 -10:50	*Break*	10:00 - 10:10	*Break*
10:50 - 12:00	Unit 1: National Fire Protection Association and the Scientific Method (cont'd)	10:10 - 12:00	Unit 2: Fire Dynamics (cont'd) Activity 2.1: Candle Experiment (Burn Range)
12:00 - 1:00	*Lunch*	12:00 - 1:00	*Lunch*
1:00 - 2:50	Unit 1: National Fire Protection Association and the Scientific Method (cont'd)	1:00 - 1:50	Unit 2: Fire Dynamics (cont'd)
2:50 - 3:00	*Break*	1:50 - 2:00	*Break*
3:00 - 4:00	Unit 1: National Fire Protection Association and the Scientific Method (cont'd)	2:00 - 2:50	Unit 2: Fire Dynamics (cont'd)
4:00 - 4:15	*Break*	2:50 - 3:00	*Break*
4:15 - 5:00	Unit 1: National Fire Protection Association and the Scientific Method (cont'd)	3:15 - 4:00	Activity 2.2: Flashover Demonstration Instructor-Led Burn Activity

TIME	DAY 3	TIME	DAY 4
8:00 - 8:50	Unit 3: Origin and Cause	8:00 - 8:50	Unit 4: Myths and Legends
8:50 - 9:00	*Break*	8:50 - 9:00	*Break*
9:00 - 9:50	Unit 3: Origin and Cause (cont'd)	9:00 - 9:50	Unit 4: Myths and Legends (cont'd)
9:50 - 10:00	*Break*	9:50 - 10:00	*Break*
10:00 - 12:00	Unit 3: Origin and Cause (cont'd)	10:00 - 12:00	Unit 5: Complex Fire Scene Activity 5.1: Complex Scenario Exercise
12:00 - 1:00	*Lunch*	12:00 - 1:00	*Lunch*
1:00 - 2:30	Unit 3: Origin and Cause (cont'd)	1:00 - 1:50	Unit 6: Evidence Collection and Preservation
2:30 - 3:20	Unit 3: Origin and Cause (cont'd)	1:50 - 2:00	*Break*
3:20 - 3:30	*Break*	2:00 - 3:00	Unit 6: Evidence Collection and Preservation (cont'd)
3:30 - 5:00	Unit 3: Origin and Cause (cont'd)	3:00 - 5:00	Unit 7: Documenting the Investigation

TIME	DAY 5	TIME	DAY 6
8:00 - 8:50	Midterm Exam	8:00 - 8:50	Unit 9: Health and Safety
8:50 - 9:00	*Break*	8:50 - 9:00	*Break*
9:00 - 9:50	Unit 8: Electrical Fire Investigation	9:00 - 9:50	Unit 9: Health and Safety (cont'd)
9:50 -10:00	*Break*	9:50 - 10:00	*Break*
10:00 - 12:00	Unit 8: Electrical Fire Investigation (cont'd)	10:00 - 12:00	Unit 10: Building Construction and Fire Protection Systems
12:00 - 1:00	*Lunch*	12:00 - 1:00	*Lunch*
1:00 - 1:50	Unit 8: Electrical Fire Investigation (cont'd)	1:00 - 1:50	Unit 11: Motives, Interviewing and Interrogation
1:50 - 2:00	*Break*	1:50 - 2:00	*Break*
2:00 - 2:50	Unit 8: Electrical Fire Investigation (cont'd)	2:00 - 2:50	Unit 11: Motives, Interviewing and Interrogation (cont'd)
2:50 - 3:00	*Break*	2:50 - 3:00	*Break*
3:00 - 5:00	Unit: 8 Electrical Fire Investigation (cont'd) Activity 8.1: Instructor-Led Practical Demonstration	3:00 - 5:00	Unit 12: Injury and Fatal Fire Investigation

TIME	DAY 7	TIME	DAY 8
8:00 - 9:00	Unit 13: Fire Scene Examination Activity 13.1: Fire Scene Examination Practical Exercise	8:00 - 9:00	Unit 15: Legal Considerations
9:00 - 9:10	*Break*	9:00 - 9:10	*Break*
9:10 - 10:20	Unit 13: Fire Scene Examination (cont'd) Activity 13.1: Fire Scene Examination Practical Exercise (cont'd)	9:10 - 10:20	Unit 15: Legal Considerations (cont'd)
10:20 - 10:30	*Break*	10:20 - 10:30	*Break*
10:30 - 11:30	Unit 13: Fire Scene Examination (cont'd) Activity 13.1: Fire Scene Examination Practical Exercise (cont'd)	10:30 - 12:00	Unit 15: Legal Considerations (cont'd)
11:30 - 1:00	*Lunch*	12:00 - 1:00	*Lunch*
1:00 - 2:15	Unit 14: Vehicle Fire Investigation	1:00 - 2:15	Unit 15: Legal Considerations (cont'd)
2:15 - 2:30	*Break*	2:15 - 2:30	*Break*
2:30 - 4:00	Unit 14: Vehicle Fire Investigation (cont'd) Activity 14.1: Instructor-Led Practical Demonstration	2:30 - 5:00	Unit 15: Legal Considerations (cont'd)

TIME	DAY 9
8:00 - 8:50	Final Exam
8:50 - 9:00	*Break*
9:00 - 10:30	Unit 16: Bomb Arson Tracking System Training
10:30 - 10:40	*Break*
10:40 - 12:00	Unit 17: Investigative Resources
12:00 - 1:00	*Lunch*
1:00 - 3:00	Student Presentations
3:00 - 3:30	*Break*
3:30 - 4:00	Evaluation

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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.

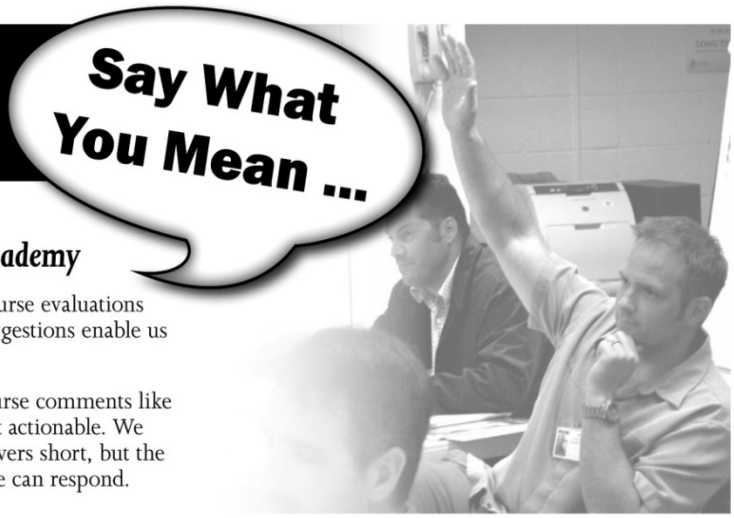
FIREFIGHTER CODE OF ETHICS

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



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."	• The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices. • The student manual references building codes that are 12 years old.
2 "We want an advanced class in (fill in the blank)."	• We would like a class that enables us to calculate energy transfer rates resulting from exposure fires. • We would like a class that provides one-on-one workplace harassment counseling practice exercises.
3 "More activities."	• An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept. • Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.
4 "A longer course."	• The class should be increased by one hour per day to enable all students to participate in exercises. • The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.
5 "Readable plans."	• The plans should be enlarged to 11 by 17 and provided with an accurate scale. • My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.
6 "Better student guide organization," "manual did not coincide with slides."	• The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21. • The instructor added slides in Unit 4 that were not in my student manual.
7 "Dry in spots."	• The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy. • Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.
8 "More visual aids."	• The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern. • There was a video clip on NBC News (date) that summarized the topic very well.
9 "Re-evaluate pre-course assignments."	• The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them. • The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.
10 "A better understanding of NIMS."	• The instructor did not explain the connection between NIMS and ICS. • The student manual needs an illustrated guide to NIMS.

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UNIT 1: NATIONAL FIRE PROTECTION ASSOCIATION AND THE SCIENTIFIC METHOD

TERMINAL OBJECTIVE

The students will be able to:

1.1 Define and apply the scientific method in a fire investigation.

ENABLING OBJECTIVES

The students will be able to:

1.1 Define the terms "guide" and "standard."

1.2 Explain the term "standard of care" as it relates to fire investigation.

1.3 List the 16 topics outlined in National Fire Protection Association (NFPA) 1033, Standard for Professional Qualifications for Fire Investigator *that investigators must be knowledgeable about.*

1.4 Discuss the purpose and uses of NFPA 921, Guide for Fire and Explosion Investigations.

1.5 List the key chapters of NFPA 921 that investigators must be familiar with.

1.6 Describe the appropriate use of the process of elimination.

1.7 Define the scientific method.

1.8 Name the seven steps in the scientific method.

1.9 Apply the scientific method to a fire investigation.

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UNIT 1: NATIONAL FIRE PROTECTION ASSOCIATION AND THE SCIENTIFIC METHOD

Slide 1-1

ENABLING OBJECTIVES

- Define the terms “guide” and “standard.”
- Explain the term “standard of care” as it relates to fire investigation.
- List the 16 topics outlined in National Fire Protection Association (NFPA) 1033, *Standard for Professional Qualifications for Fire Investigator* that investigators must be knowledgeable about.

Slide 1-2

ENABLING OBJECTIVES (cont’d)

- Discuss the purpose and uses of NFPA 921, *Guide for Fire and Explosion Investigations*.
- List the key chapters of NFPA 921 that investigators must be familiar with.
- Describe the appropriate use of the process of elimination.

Slide 1-3

ENABLING OBJECTIVES (cont'd)

- Define the scientific method.
- Name the seven steps in the scientific method.
- Apply the scientific method to a fire investigation.

Slide 1-4

I. NATIONAL FIRE PROTECTION ASSOCIATION GUIDES AND STANDARDS

NATIONAL FIRE PROTECTION ASSOCIATION GUIDES AND STANDARDS

- Guide — a document that is advisory or informative in nature and that contains only nonmandatory provisions.
- Standard — a document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements, that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law.

Slide 1-5

A. Guide — a document that is advisory or informative in nature and that contains only nonmandatory provisions.

B. Standard — a document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements, that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law.

1. Both documents are developed through a voluntary, consensus standards-making process based on the work of technical committees.

2. Committee members are appointed by the National Fire Protection Association (NFPA) Standards Council, and typically committees consist of no more than 30 voting members representing a balance of interests.

NATIONAL FIRE PROTECTION ASSOCIATION DOCUMENTS

- "Interested parties."
  - Public sector.
  - Private sector.
  - Manufacturers.
  - Attorneys.
- They review and consider proposals, deciding to adopt or reject.

Slide 1-6

3. NFPA membership is not required in order to participate on an NFPA technical committee, and appointment is based on such factors as technical expertise, professional standing, commitment to public safety, and the ability to bring to the table the point of view of a category of interested people or groups.

NATIONAL FIRE PROTECTION ASSOCIATION DOCUMENTS (cont'd)

- Public input is encouraged and accepted during revision cycles.
- Proposals are reviewed, considered, adopted or rejected by the appropriate technical committees.
- Final change via a proposal with two-thirds vote of the technical committee members.

Slide 1-7

4. Each technical committee is constituted so as to contain a balance of affected interests, with no more than one-third of the committee from the same interest category.

NATIONAL FIRE PROTECTION ASSOCIATION GUIDES AND STANDARDS (cont'd)

- Standards are revised every five years.
  - Revision guided by technical committee using NFPA consensus process.
  - Process is open to the public.
  - Use of **"shall."**

Slide 1-8

5. NFPA standards such as NFPA 1033, *Standard for Professional Qualifications for Fire Investigator* are revised every five years.

NATIONAL FIRE PROTECTION ASSOCIATION GUIDES AND STANDARDS (cont'd)

- Guides are revised every three years.
  - Revision guided by technical committee using NFPA consensus process.
  - Process is open to the public.
  - Use of **"should."**

Slide 1-9

6. Guides such as NFPA 921, *Guide for Fire and Explosion Investigations* are revised every three years.

7. These revision cycles typically last two years.

II. NATIONAL FIRE PROTECTION ASSOCIATION 1033

NATIONAL FIRE PROTECTION ASSOCIATION 1033

- 1987 Edition (inception).
- 2014 Edition (current).
- Revised every five years.

Slide 1-10

NATIONAL FIRE PROTECTION ASSOCIATION 1033 (cont'd)

- A thin document that carries a lot of weight.
- Contains **mandatory** provisions using the word **"shall."**
- 4.1.2 — The fire investigator **shall** employ all elements of the scientific method. …

Slide 1-11

NATIONAL FIRE PROTECTION ASSOCIATION 1033 (cont'd)

- Identifies minimum job performance requirements (JPRs) for both public and private sector investigators.
- Failure to meet these minimum JPRs or comply with this document can preclude you from testifying.

Slide 1-12

NATIONAL FIRE PROTECTION ASSOCIATION 1033 (cont'd)

- Contains four chapters.
  - 1 — Administration (Scope/Purpose).
  - 2 — Referenced Publications.
  - 3 — Definitions (20).
  - 4 — Fire Investigator (Requisite knowledge/ skills, JPRs).

Slide 1-13

NATIONAL FIRE PROTECTION ASSOCIATION 1033 MANDATORY PROVISIONS

Chapter 1 states that investigator shall have and maintain, at a minimum, an up-to-date basic knowledge of the following 16 topics beyond the high school level.

Slide 1-14

A. NFPA 1033 states that investigator shall have and maintain, at a minimum, an up-to-date basic knowledge of the following 16 topics beyond the high school level.

FIRE SCIENCE

The body of knowledge concerning the study of fire and related subjects (e.g., combustion, flame, heat transfer, thermodynamics, kinetics, fluid mechanics, fire safety) and their interaction with people, structures and the environment.

Slide 1-15

1. Fire science.

   The body of knowledge concerning the study of fire and related subjects (e.g., combustion, heat transfer).

FIRE CHEMISTRY

The study of chemical processes that occur in fires, including changes in state, decomposition and combustion (e.g., pyrolysis).

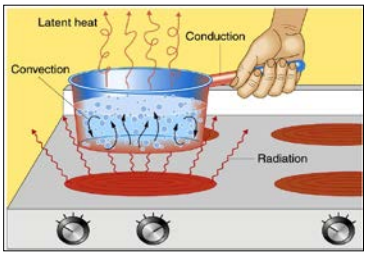
Slide 1-16

2. Fire chemistry.

   The study of chemical processes that occur in fires, including changes in state, decomposition and combustion (e.g., pyrolysis).

THERMODYNAMICS

The science of energy conversion involving heat (e.g., heat transfer).



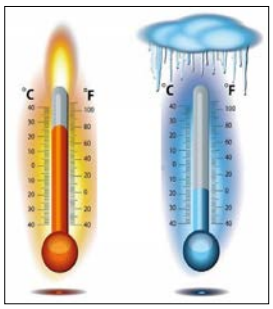
Slide 1-17

3. Thermodynamics.

   The science of energy conversion involving heat (e.g., heat transfer).

THERMOMETRY

- The science and practice of temperature measurement (heat versus temperature).
- Heat is energy.
- Temperature is a measurement of energy.
- Fahrenheit, Celsius, Rankin, Kelvin.



Slide 1-18

4. Thermometry.

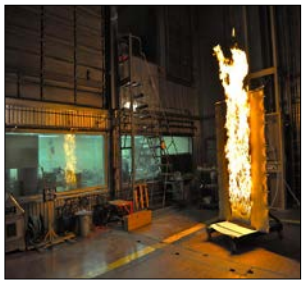
   a. The science and practice of temperature measurement (heat versus temperature).

   b. Heat refers to the amount of energy needed to change an object's temperature.

   c. Temperature is a measurement of the amount of molecular activity when compared to a reference standard (Fahrenheit scale — Celsius scale).

FIRE DYNAMICS

The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior.



Slide 1-19

5. Fire dynamics.

   The detailed study of how chemistry, fire science, and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior.

EXPLOSION DYNAMICS

The study of explosions and their associated effects.

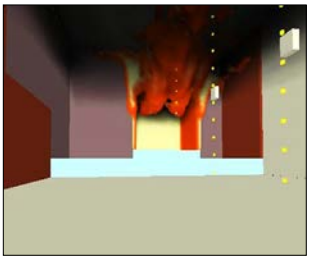
Slide 1-20

6. Explosion dynamics.

   The study of explosions and their associated effects.

COMPUTER FIRE MODELING

Using quantitative information to provide an understanding of the complexities of fire and the factors that influence fire growth and spread.



Slide 1-21

7. Computer fire modeling.

   Using quantitative information to provide an understanding of the complexities of fire and the factors that influence fire growth and spread.

FIRE INVESTIGATION

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

Slide 1-22

8. Fire investigation.

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

FIRE ANALYSIS

The process of determining the origin, cause, development, responsibility and, when required, failure analysis of a fire or an explosion.

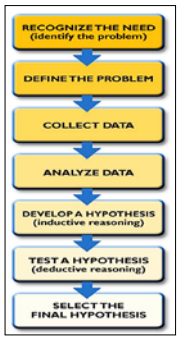
Slide 1-23

9. Fire analysis.

   The process of determining the origin, cause, development, responsibility and, when required, failure analysis of a fire or an explosion.

FIRE INVESTIGATION METHODOLOGY

The organizational and analytical process necessary in a successful fire investigation (i.e., scientific method).



Slide 1-24

10. Fire investigation methodology.

    a. The organizational and analytical process necessary in a successful fire investigation (i.e., scientific method).

    b. The scientific method is the fundamental framework that is required to be used by investigators throughout the investigative process.

    c. The systematic collection of data and analysis of data are the cornerstone of the investigative process and the most critical steps in the application of the scientific method.

FIRE INVESTIGATION TECHNOLOGY

Describe what equipment is used to process the scene, and analyze evidence collected from the scene (e.g., cameras, thermocouples and meters).

Slide 1-25

11. Fire investigation technology.

    Describe what equipment is used to process the scene, and analyze evidence collected from the scene (e.g., cameras, thermocouples and meters).

HAZARDOUS MATERIALS

Safety recommendations for environments containing hazardous substances and proper personal protective equipment (PPE).

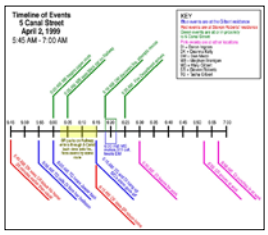
Slide 1-26

12. Hazardous materials.

    Safety recommendations for environments containing hazardous substances and proper personal protective equipment (PPE).

FIRE ANALYSIS AND ANALYTICAL TOOLS

Methods and tools used to analyze fires of any size and organize information collected during the investigation.



Slide 1-27

13. Fire analysis and analytical tools.

    Methods and tools used to analyze fires of any size and organize information collected during the investigation. These can include timelines, fault tree analysis, and failure modes and effects analysis.

ELECTRICITY AND ELECTRICAL SYSTEMS

- An understanding of the role that electricity and electrical equipment play in fire causation (i.e., victim versus cause).
- Added in 2014.

Slide 1-28

14. Electricity and electrical systems.

    An understanding of the role that electricity and electrical equipment play in fire causation (i.e., victim versus cause).

FIRE PROTECTION SYSTEMS

- An understanding of the role that fire protection systems play in detection and suppression and how fire growth and spread were affected.
- Added in 2014.

Slide 1-29

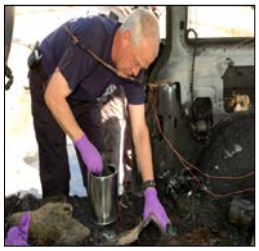
15. Fire protection systems.

    a. An understanding of the role that fire protection systems play in detection and suppression and how fire growth and spread were affected.

    b. Investigators must establish whether these systems functioned as designed, and if not, why not (e.g., malfunction, tampering)?

EVIDENCE COLLECTION, DOCUMENTATION AND PRESERVATION

- Accepted principles and practices to properly document, collect and package fire scene evidence to support origin and cause determinations.
- Added in 2014.



Slide 1-30

16. Evidence collection, documentation and preservation.

    Accepted principles and practices to properly document, collect and package fire scene evidence to support origin and cause determinations.

NATIONAL FIRE PROTECTION ASSOCIATION 1033, CHAPTER 4

JPRs.

- 4.2 — Scene Examination.
- 4.3 — Documenting the Scene.
- 4.4 — Evidence Collection.
- 4.5 — Interview.
- 4.6 — Post-Incident Investigation.
- 4.7 — Presentations.

Slide 1-31

B. NFPA 1033, Chapter 4 contains the job performance requirements (JPRs) that specify the tools, requisite knowledge and skill requirements in the following areas:

1. Scene Examination (inspecting and evaluating the fire scene to determine the area/point of origin and establish the ignition sequence).

NATIONAL FIRE PROTECTION ASSOCIATION JOB PERFORMANCE REQUIREMENT EXAMPLE

JPRs are divided into three components:

- Task — photographically document scene.
- Tools — given standard tools and equipment.
- Evaluation parameters — so that the scene is accurately depicted and the photographs support scene findings.

Slide 1-32

2. Documenting the Scene (completing a diagram, taking photographs and field notes to be used in a final report).

3. Evidence Collection (using proper physical and legal procedures and practices to identify, collect, package and retain evidence pertinent to the investigation).

4. Interview (obtain information regarding the circumstances surrounding the incident from sources through verbal and written means).

5. Post-Incident Investigation (investigation of all factors beyond the incident scene at the time of the origin and cause determination, such as gathering fire, police and insurance records).

6. Presentations (presentation of findings, including testifying in court when necessary).

NATIONAL FIRE PROTECTION ASSOCIATION JOB PERFORMANCE REQUIREMENT

JPRs additionally contain requisite knowledge and skills:

- Requisite knowledge — knowledge of camera, flash, film, media, etc.
- Requisite skills — ability to use camera, flash and accessories.

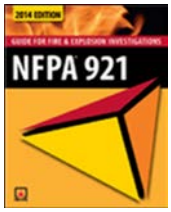
Slide 1-33

7. Each JPR contains requisite knowledge and skills. **Requisite** means the necessary knowledge and skills one must have to be able to perform the task.

III. NATIONAL FIRE PROTECTION ASSOCIATION 921

NATIONAL FIRE PROTECTION ASSOCIATION 921

- 1992 Edition (inception).
- 2014 Edition (current).
- Revised every three years.



Slide 1-34

A. The first edition of NFPA 921 was published in 1992.

1. Focus was on "current" fire science research, testing and scientific principles.

2. Established the scientific method as the fundamental approach for conducting fire and explosion investigations.

WHO USES NATIONAL FIRE PROTECTION ASSOCIATION 921?

- Used by fire investigators to support their conclusions.
- Used by attorneys to support or contest opinions.
- Used by judges to qualify witnesses.
- Used by agencies as the basis for training and education programs.

Slide 1-35

3. Used by fire investigators to support their conclusions.

4. Used by attorneys to support or contest opinions.

5. Used by judges to qualify witnesses.

NATIONAL FIRE PROTECTION ASSOCIATION 921 EVOLUTION

- 1992 — 13 chapters (158 pages).
- 1995 — 19 chapters (162 pages).
- 1998 — 20 chapters (167 pages).
- 2001 — 25 chapters (229 pages).
- 2004 — 27 chapters (262 pages).
- 2009 — 28 chapters (305 pages).
- 2011 — 28 chapters (341 pages).
- 2014 — 30 chapters (402 pages).

Slide 1-36

6. Used by agencies as the basis for training and education programs.

NATIONAL FIRE PROTECTION ASSOCIATION 921 (cont'd)

- NFPA 921 3.2.3 defines a guide as a document that is advisory or informative in nature and that contains only nonmandatory provisions. **Not** suitable for adoption into law.

Slide 1-37

B. A document that is advisory or informative in nature and that contains only nonmandatory provisions. **Not** suitable for adoption into law.

NATIONAL FIRE PROTECTION ASSOCIATION 921 (cont'd)

- 1.3 —This document is designed to produce a systematic, working framework or outline by which effective fire and explosion investigations and origin and cause analysis can be accomplished. … **Deviations from these procedures, however, are not necessarily wrong or inferior but need to be justified.**

Slide 1-38

NATIONAL FIRE PROTECTION ASSOCIATION 921 (cont'd)

- 1.3 application — **"Your Honor, but it's only a guide."**

Slide 1-39

NATIONAL FIRE PROTECTION ASSOCIATION 921 (cont'd)

- Acknowledge that you reference NFPA 921 (along with many other publications) for guidance when conducting your fire/ explosion investigations.

Slide 1-40

HOW IT'S VIEWED

Many courts and professional fire organizations recognize it as a "standard of care" even though it is a guide. (Document is peer-developed through the fire investigation community and generally accepted.)

Slide 1-41

C. Many courts and professional fire organizations recognize it as a "standard of care" even though it is a guide.

1. Purpose is to set forth recommended best practices for safe and systematic fire and explosion investigations.

2. Document is peer-developed through the fire investigation community and generally accepted.

NATIONAL FIRE PROTECTION ASSOCIATION GUIDES AND STANDARDS (cont'd)

- International Association of Arson Investigators (IAAI) position statement:
  - It is the position of the International Association of Arson Investigators that **National Fire Protection Association (NFPA) Document 921** is widely recognized as an authoritative guide for the fire investigation profession.

Slide 1-42

D. In January 2013, the International Association of Arson Investigators (IAAI) issued a position statement recognizing NFPA 921 as an authoritative guide for fire investigation.

"STANDARD OF CARE"

- The Legal Dictionary — watchfulness, caution, and prudence that a reasonable person in the circumstances would exercise.
- Black's Law Dictionary — degree of care a prudent and reasonable person will exercise under the circumstances.
- Business Dictionary — ethical or legal duty of a professional to exercise the level of care, diligence, and skill prescribed in practice.

Slide 1-43

E. "Standard of care":

1. The Legal Dictionary — watchfulness, caution, and prudence that a reasonable person in the circumstances would exercise.

2. Black's Law Dictionary — degree of care a prudent and reasonable person will exercise under the circumstances.

"STANDARD OF CARE" (cont'd)

- Do you consider NFPA 921 the "standard of care" for fire investigation?
- How do you handle this question in the courtroom?

Slide 1-44

3. Business Dictionary — ethical or legal duty of a professional to exercise the level of care, diligence, and skill prescribed in practice.

"STANDARD OF CARE" (cont'd)

- A concept, not a document.
- NFPA 921, Kirk's, Fire Protection Handbook, etc. are guidelines and reference materials that the courts, through examination of arguments by experts/attorneys use to make judgments as to whether a "standard of care" has been met.

Slide 1-45

F. "Standard of care" cannot be exclusively expressed by an individual document.

1. The "standard of care" is a concept, not a document.

2. In fire investigation, as with other professions, a certain degree of variation in conducting an investigation is possible while still meeting the "standard of care."

IF ASKED?

- Professionally ask the attorney to clarify or define what he or she means by "standard of care."
- For fire investigation, the "standard of care" may simply be the application of the scientific method.

Slide 1-46

NATIONAL FIRE PROTECTION ASSOCIATION 921 IN THE COURTROOM

Challenges in court may focus on:

- Investigator qualifications.
- Methodology used.
- Knowledge of fire science.
- Quality of documentation.
- Opinion reached and how.

Slide 1-47

G. Challenges in court usually focus on:

1. Investigator qualifications.

2. Methodology used.

3. Knowledge of fire science.

4. Quality of documentation.

5. Opinion reached and how.

   a. Investigator's qualifications will be challenged using NFPA 1033 during voir dire and when testifying to test their knowledge of key terms and definitions.

   b. The investigator's knowledge and ability to explain his or her application of the scientific method will be questioned using both NFPA 1033 and NFPA 921.

   c. The investigator's understanding of basic fire science principles such as the fire tetrahedron, heat release rate (HRR), ignition, flashover, and related fire phenomena will be challenged using the information outlined in NFPA 921.

   d. The quality of fire scene documentation will be scrutinized using NFPA 921.

   e. The investigator's opinions and conclusions will be challenged primarily using NFPA 921, but NFPA 1033 may also be included.

NATIONAL FIRE PROTECTION ASSOCIATION 921 KEY CHAPTERS

- All of the chapters are relevant and important but may not be applicable to every fire (i.e., explosions, wildfires, marine fires, etc.).
- The following are some of the key chapters that are applicable to most fires.

Slide 1-48

H. NFPA 921 key chapters.

CHAPTER 3: DEFINITIONS

Total of 192 definitions in Chapter 3.

Slide 1-49

1. Chapter 3: Definitions covers definitions that the investigator must be familiar with.

CHAPTER 4: METHODOLOGY

Slide 1-50

2. Chapter 4: Methodology covers basic methodology (i.e., the scientific method and levels of certainty).

CHAPTER 4: METHODOLOGY (cont'd)

Levels of certainty: probable versus possible.

- Probable — This is more likely true than not.
- Possible — Two or more hypotheses are equally likely (undetermined).

< 50% Possible

> 50% Probable

Slide 1-51

CHAPTER 5: BASIC FIRE SCIENCE

Slide 1-52

3. Chapter 5: Basic Fire Science.

CHAPTER 6: FIRE PATTERNS

Slide 1-53

4. Chapter 6: Fire Patterns.

CHAPTER 7: BUILDING SYSTEMS

Slide 1-54

5. Chapter 7: Building Systems.

CHAPTER 8: FIRE PROTECTION SYSTEMS

New chapter that has been added to the 2014 version.

Slide 1-55

6. Chapter 8: Fire Protection Systems.

CHAPTER 9: ELECTRICITY AND FIRE

Slide 1-56

7. Chapter 9: Electricity and Fire.

CHAPTER 12:
LEGAL CONSIDERATIONS

Slide 1-57

8. Chapter 12: Legal Considerations.

CHAPTER 16: DOCUMENTATION
OF THE INVESTIGATION

Slide 1-58

9. Chapter 16: Documentation of the Investigation.

CHAPTER 17:
PHYSICAL EVIDENCE

Slide 1-59

10. Chapter 17: Physical Evidence.

CHAPTER 18: ORIGIN DETERMINATION

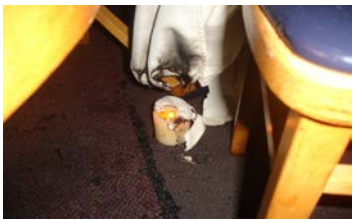
- Witness information.
- Fire patterns.
- Arc mapping.
- Fire dynamics.

Slide 1-60

11. Chapter 18: Origin Determination.

CHAPTER 19: FIRE CAUSE DETERMINATION

- Circumstances allowing ignition source, fuel and oxidant to react.



Slide 1-61

CHAPTER 19: FIRE CAUSE DETERMINATION (cont'd)

- **18.6.5 Inappropriate Use of the Process of Elimination** (2011).
- **19.6.5 Appropriate Use.** The process of elimination is an integral part of the scientific method (2014).
- Although the new text recognizes "the process of elimination is an integral part of the scientific method," the new language does not fundamentally change the current arguments/ discussions over this very controversial issue **(negative corpus).**

Slide 1-62

12. Chapter 19: Fire Cause Determination.

CHAPTER 20: CLASSIFICATION OF FIRE CAUSE

- New chapter.
- Accidental, incendiary, natural and undetermined.
- "Therefore, based upon the information known to investigators at this time, this fire is classified as **undetermined.**"

Slide 1-63

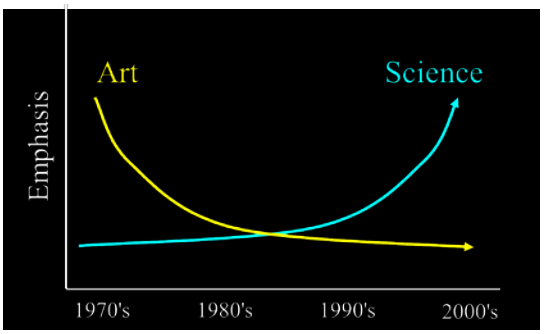
13. Chapter 20: Classification of Fire Cause.

CHAPTER 22: FIRE ANALYSIS AND ANALYTICAL TOOLS

Slide 1-64

14. Chapter 22: Fire Analysis and Analytical Tools.

FIRE INVESTIGATION: ART VERSUS SCIENCE



Slide 1-65

IV. DEFINITIONS

DEFINITIONS

- Systematic approach: the method that provides for the organizational and analytical process, which is desirable and necessary in a successful fire investigation.
- Fire investigation: the process of determining the origin, cause and development of a fire or an explosion.

Slide 1-66

A. The systematic approach is the method that provides for the organizational and analytical process, which is desirable and necessary in a successful fire investigation.

B. Fire investigation is the process of determining the origin, cause and development of a fire or an explosion.

DEFINITIONS (cont'd)

- Scientific method: the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experimentation, and the formulation and testing of a hypothesis.

Slide 1-67

C. 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 a hypothesis; and, when possible, the selection of a final hypothesis.

DEFINITIONS (cont'd)

- Empirical data: data consisting of information that can be verified or validated as true.

Slide 1-68

D. Empirical data is factual data that is based on actual measurement, observation, or direct sensory experience rather than on theory.

DEFINITIONS (cont'd)

- Hypothesis: a theory supported by data and facts.
- Cognitive testing: the use of one's thinking skills and judgment to evaluate empirical data and challenge the conclusions of the hypothesis.

Slide 1-69

E. A hypothesis is a theory supported by data and facts.

F. Cognitive testing is the use of one's thinking skills and judgment to evaluate empirical data and challenge the conclusions of the hypothesis.

V. A SYSTEMATIC APPROACH

SYSTEMATIC APPROACH

- "The systematic approach recommended is that of the scientific method, which is used in the physical sciences. This method provides for the organizational and analytical process desirable and necessary in a successful fire investigation" (Section 4.2).
  - Foundation to a methodical fire investigation.

— NFPA 921, 2011 ed.

Slide 1-70

A. The benefits of the systematic approach include a foundation for consistent documentation of mechanical systems, electrical systems, ventilation openings and structural stability.

SYSTEMATIC APPROACH (cont'd)

- "The scientific method is a principle of inquiry that forms a basis for legitimate scientific and engineering processes, including fire incident investigation" (Section 4.3).
  - Basis is to observe, theorize, test and conclude.

— NFPA 921, 2011 ed.

Slide 1-71

B. As stated before, the scientific method is one type of systematic approach.

EXAMPLES OF SYSTEMATIC APPROACH

- Working from least to most damage.
- Documenting the fire scene the same way every time.

Slide 1-72

C. Another example of a systematic approach is working from least to most damage.

1. Be careful when using the terms “working from least to most damage,” as the area with least damage may actually contain your area of origin. Attempt to keep this process language out of your reports.

2. For example, a fire starts as a stove fire in the first-floor kitchen and spreads through the ducted vent hood, eventually impacting the roof structure. The fire then spreads to and destroys the entire roof. What area would display the most damage?

EXAMPLES OF SYSTEMATIC APPROACH (cont’d)

- Decontaminating tools, equipment and footwear before entering every scene.
- Examining all potential ignition sources within the area of origin.

Slide 1-73

D. Other examples of a systematic approach include:

1. Cleaning your tools and equipment.

2. Keeping your vehicle interior storage area clean.

3. Decontaminating all tools/gear prior to re-entering your vehicle.

VI. THE SCIENTIFIC METHOD

WHAT IS THE SCIENTIFIC METHOD?

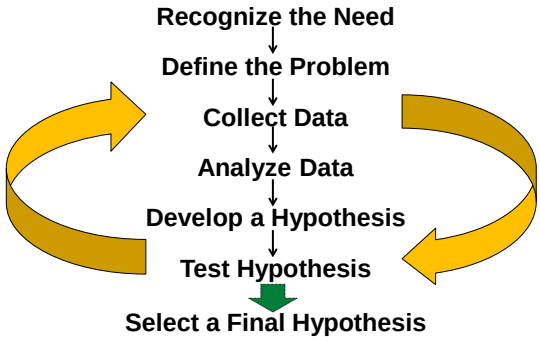
A framework for solving problems.

Slide 1-74

A. The scientific method is the systematic pursuit of knowledge involving:

1. The recognition and formulation of a problem.
2. The collection of data through observation and experimentation.
3. The formulation and testing of a hypothesis.

CHAPTER 4: METHODOLOGY (cont'd)



Slide 1-75

B. The following diagram outlines the seven steps of the scientific method as defined in NFPA 921.

C. Following the scientific method is not optional. It is mandated by NFPA 1033, Section 4.1.2. NFPA 921 is the guide that describes how the scientific method is used and what each section entails.

D. Contextual example of how to use the scientific method:

1. You arrive home late at night, unlock the door, reach in to turn the light on, and nothing happens.

2. You enter and attempt to turn on another light to see if it lights but it does not.

3. You check the first lamp to see if it is plugged in and see that it is.

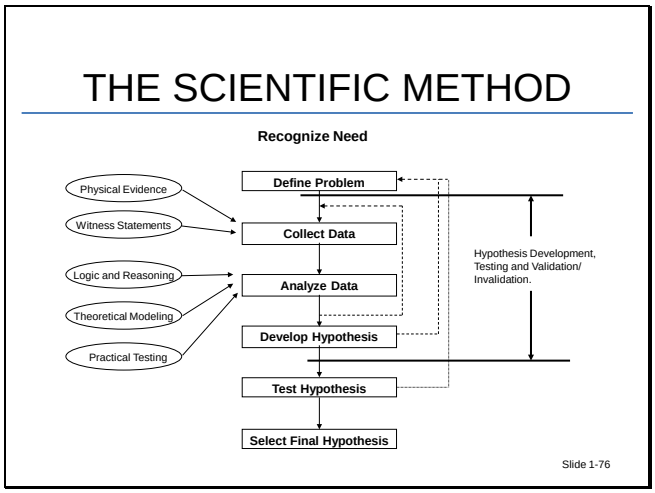
4. You check the circuit breaker for the outlet into which the lamp is plugged to see if it is tripped but it is not.

5. You think that the bulb must be loose or burned out.

6. You check to see if the light bulb is loose and find that it is.

7. You tighten it and turn the switch on, and it lights.

8. You jump with joy that you can now see, but you immediately realize that you are in your neighbor's house.



FIRE INVESTIGATION AND THE SCIENTIFIC METHOD

Essential for all fire investigations.

- Universally recognized — no debate over its relevance or use.
- Recognized in court via Daubert and Rule 702.

Slide 1-77

E. The scientific method is essential for all fire investigations.

1. It is universally recognized. There is no debate over its relevance or use.

2. It was recognized in court via Daubert and Rule 702.

THE SCIENTIFIC METHOD (cont'd)

- The most important steps in the process are data collection, analysis and evaluation.

Slide 1-78

3. The most important steps in the process are data collection, analysis and evaluation. Burn pattern analysis, fire dynamics principles, arc mapping, witness observations, statements, photographs, drawings, testing results (field testing), and laboratory results are all examples of data that is collected during the data collection step of the scientific method.

THE SCIENTIFIC METHOD (cont'd)

- The scientific method addresses both the origin and cause, and the process does not stop at the scene.

Slide 1-79

F. The scientific method addresses both the origin and cause of the fire. There is a difference between fire origin and fire cause.

1. Origin is defined per NFPA 921 as "the general location where a fire or explosion began."

2. Cause is defined per NFPA 921 as "the circumstances, conditions, or agencies that brought about or resulted in the fire or explosion incident, damage to property resulting from the fire or explosion incident, bodily injury, or loss of life resulting in a fire or explosion incident."

THE SCIENTIFIC METHOD (cont'd)

- Initial hypothesis development begins at the fire scene while gathering data.
- Consider the feasibility of future testing.

Slide 1-80

G. Items to consider when thinking about future testing:

1. What fuels are in the area of origin?

2. Is the ignition source capable or competent to ignite these fuels?

3. Was there an oxidizer present or other factors that may have increased the combustion process?

4. Are the secondary fuels/target fuels capable of supporting the growth and development of the fire?

VII. SEVEN STEPS OF THE SCIENTIFIC METHOD

STEP 1: RECOGNIZE THE NEED

- Respond to loss, protect scene and assess resources.
- Investigate to identify conditions or people responsible, prevent future losses.

Slide 1-81

A. Step 1: Recognize the need.

STEP 2: DEFINE THE PROBLEM

- What is the specific issue to resolve?
- Is there more than one issue to resolve (i.e., fatality, explosion or fire cause)?
- Are there any special needs (equipment, personnel, etc.)?

Slide 1-82

B. Step 2: Define the problem.

STEP 3: COLLECT DATA

- "Facts about the fire incident are now collected by observation, experiment, or other direct data gathering means. The data collected is called empirical data because it is based on observation or experience and is capable of being verified or known to be true."

— NFPA 921, Section 4.3.3, 2014 ed.

Slide 1-83

C. Step 3: Collect data.

STEP 3: COLLECT DATA (cont'd)

- Prescene data is any information that is or can be obtained prior to the scene examination.

Slide 1-84

STEP 3: COLLECT DATA (cont'd)

- On-scene data collection includes:
  - Witness information.
  - Fire patterns.
  - Arc mapping.
  - Fire dynamics.

Slide 1-85

STEP 3: COLLECT DATA (cont'd)

- Post-scene data collection includes:
  - Information not obtained before or during the origin and cause scene examination.
  - Residual information needed to follow up before arriving at a conclusion.

Slide 1-86

STEP 4: ANALYZE DATA

- An analysis of the data must occur before a hypothesis can be developed.
  - This requires the use of one's knowledge, training and experience.
  - If the data cannot be understood, seek assistance.

Slide 1-87

D. Step 4: Analyze data.

STEP 4: ANALYZE DATA (cont'd)

- Evaluate, where applicable, fire pattern damage, heat and flame vectoring, arc mapping, and fire engineering analysis.
- Recommend changes and working hypotheses.

Slide 1-88

STEP 4: ANALYZE DATA (cont'd)

Fire suppression efforts

Scene contamination

Slide 1-89

STEP 5: DEVELOP A HYPOTHESIS

- Theory supported by facts and data that cannot be disproven.
- Based on all empirical data collected from prescene, on-scene and post-scene examinations.

Slide 1-90

E. Step 5: Develop a hypothesis.

STEP 6: TEST THE HYPOTHESIS

- Simply, can this scenario happen?
- Purpose of hypothesis testing is to disprove your hypothesis.
- Compare hypothesis to all known facts, incidents of prior loss histories, authoritative fire test data, and experiments.
- Eliminate all other potential fire causes, if possible.

Slide 1-91

F. Step 6: Test the hypothesis.

STEP 7: SELECT FINAL HYPOTHESIS

- Once all testing and evaluation are completed, the one remaining hypothesis that is most probable (more likely than not) is selected and reported.
- Make authoritative conclusion as to area and point of fire origin and cause.

Slide 1-92

G. Step 7: Select final hypothesis.

VIII. APPLYING THE SCIENTIFIC METHOD

EXAMPLE OF TESTING YOUR HYPOTHESIS

- Recognize the need:
  - Fire occurred in Oyster Bay, New York.
  - Original cause determination: accidental — smoking on the rear deck.
  - Fire caused extensive damage to 280 condominium units, yielding a total of $28 million in damage.
  - A case study.

Slide 1-93

A. Recognize the need:

1. Fire occurred in Oyster Bay, New York.
2. The original cause determination was accidental — smoking on the rear deck.
3. Fire caused extensive damage to 280 condominium units, yielding a total of $28 million in damage.
4. A case study.

DVD PRESENTATION

"OYSTER BAY"

Slide 1-94

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- Data collection/Analyze the data:
  - Fire was on the exterior rear deck at 5 a.m.
  - Occupant was on the deck smoking fire compliant cigarettes nine hours prior to the fire.
  - Temperature was 40 F.

Slide 1-95

B. Data collection/Analyze the data:

1. Fire was on the exterior rear deck at 5 a.m.
2. Occupant was on the deck smoking fire compliant cigarettes nine hours prior to the fire.
3. Temperature was 40 F.

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- A plastic planter filled with potting soil and a live plant was located near the door.
- Exterior siding was cedar shakes.
- An exterior light fixture was 7 feet above the planter.

Slide 1-96

4. A plastic planter filled with potting soil and a live plant was located near the door.

5. Exterior siding was cedar shakes.

6. An exterior light fixture was 7 feet above the planter.

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- Develop hypotheses:
  - The origin was at the plastic planter and plant, and the cause was the discarded cigarette.
  - The origin was at the light, and drop-down burning ignited the plastic planter and plant.
  - The plastic planter with plant was intentionally set to cause damage to the structure.
- Multiple ignition scenarios.

Slide 1-97

C. Develop hypotheses:

1. The origin was at the plastic planter and plant, and the cause was the discarded cigarette.

2. The origin was at the light, and drop-down burning ignited the plastic planter and plant.

3. The plastic planter with plant was intentionally set to cause damage to the structure.

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- Methods of testing hypotheses:
  - Burn patterns — only data available.
  - Evidence of electrical activity.
  - Fire dynamics consideration.
  - Witness statements.

Slide 1-98

D. Methods of testing hypotheses:

1. Burn patterns — only data available.
2. Evidence of electrical activity.
3. Fire dynamics consideration.
4. Witness statements.

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- Selecting final hypothesis:
  - What is your opinion on final hypothesis?
  - Can you support that in a legal proceeding?
  - What should be the final classification?

Slide 1-99

E. Selecting final hypothesis:

1. What is your opinion on final hypothesis?
2. Can you support that in a legal proceeding?
3. What should be the final classification?

EXAMPLE OF TESTING YOUR HYPOTHESIS (cont'd)

- The local fire investigator selected the final hypothesis as a discarded cigarette in the plastic planter.
- The classification was "accidental."
- Is this a proper determination?

Slide 1-100

4. The local fire investigator selected the final hypothesis as a discarded cigarette in the plastic planter.

5. The classification was "accidental."

6. Is this a proper determination?

TESTING THE HYPOTHESIS

Slide 1-101

F. Photo depicts scale model of the area of origin prior to ignition test.

TESTING THE HYPOTHESIS (cont'd)

Slide 1-102

G. The left photo is of the scene. The right photo is of the test burn.

TESTING THE HYPOTHESIS (cont'd)

Slide 1-103

H. The left photo is of the scene. The right photo is of the test burn.

DVD PRESENTATION

"TEST-02-JVC-HDD"

Slide 1-104

DVD PRESENTATION

"ABC 20/20: BURNED — THREE ARSON CASES"

Slide 1-105

IX. SUMMARY

SUMMARY

- Guide versus standard.
- NFPA 921 as a "standard of care."
- Sixteen topics outlined in NFPA 1033.
- Purpose and uses of NFPA 921.
- Key chapters of NFPA 921.
- Appropriate use of the process of elimination.

Slide 1-106

SUMMARY (cont'd)

- Definitions.
- A systematic approach.
- The scientific method.
- Seven steps of the scientific method.
- Applying the scientific method.

Slide 1-107

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UNIT 2:
FIRE DYNAMICS

TERMINAL OBJECTIVE

The students will be able to:

2.1 Explain the progression of fire within a compartment and the variables that impact fire growth, development and spread.

ENABLING OBJECTIVES

The students will be able to:

2.1 Describe basic fire chemistry concepts.

2.2 Define and explain basic fire behavior and associated terminology.

2.3 Describe the ignitability potential of solids, liquids and gases.

2.4 Recognize the relationships between ignition sources and various fuel packages.

2.5 Identify the three methods of heat transfer.

2.6 Distinguish between the two types of flames.

2.7 Describe how and why various fuels contribute to fire growth development and spread.

2.8 Evaluate the effects of ventilation on fuels within a compartment.

2.9 Differentiate between temperature and heat.

2.10 Analyze fire behavior using appropriate calculations to support investigative hypotheses.

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UNIT 2:
FIRE DYNAMICS

Slide 2-1

ENABLING OBJECTIVES

- Describe basic fire chemistry concepts.
- Define and explain basic fire behavior and associated terminology.
- Describe the ignitability potential of solids, liquids and gases.
- Recognize the relationships between ignition sources and various fuel packages.

Slide 2-2

ENABLING OBJECTIVES (cont'd)

- Identify the three methods of heat transfer.
- Distinguish between the two types of flames.
- Describe how and why various fuels contribute to fire growth development and spread.
- Evaluate the effects of ventilation on fuels within a compartment.
- Differentiate between temperature and heat.

Slide 2-3

ENABLING OBJECTIVES (cont'd)

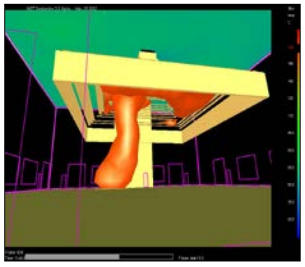
- Analyze fire behavior using appropriate calculations to support investigative hypotheses.

Slide 2-4

I. FIRE CHEMISTRY

WHAT IS FIRE DYNAMICS?

The study of fire behavior.



Slide 2-5

A. Fire dynamics.

1. It is the detailed study of how chemistry, fire science and the engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior.

2. Fire dynamics addresses the following in order to arrive at a logical conclusion as to a fire's origin and cause:

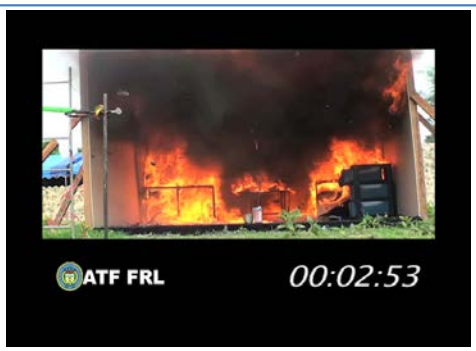
   a. Fire behavior.

   b. Fire growth.

   c. Flame spread.

   d. Smoke filling.

"ATF REVERSE FLASHOVER COMPARTMENT FIRE" VIDEO



Slide 2-6

WHAT IS FIRE?

- A rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.
- An exothermic chemical reaction that emits heat and light.
- A chemical reaction that produces physical effects (Kirk's Fire Investigation, 7th ed.).

Slide 2-7

B. Fire is a rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.

HEAT FLUX

Slide 2-8

C. Slide 2-8 depicts radiant heat energy depicting that target fuel.

D. When/Where fuel ignites depends on heat flux.

E. Critical heat flux is a threshold number — below this number, the fuel will not ignite.

F. Critical heat flux will vary depending on flux value or time value.

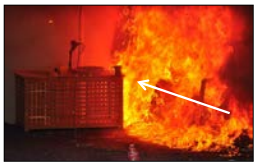
1. Longer times for lower heat fluxes.

2. Shorter times for higher heat fluxes.

WHAT BURNS IN A FIRE?

- Off-gassing of cribbed table.

- Ignition of vapors released by cribbed table.



Slide 2-9

SOLIDS AND LIQUIDS DO NOT BURN

- Liquids must evaporate into a vapor, and the vapor burns.
- Solids must chemically decompose (pyrolyze) into a gas, and the gas will burn.
- Pyrolysis — A process in which material is decomposed, or broken down, into simpler molecular compounds by the effects of heat alone; pyrolysis often precedes combustion.

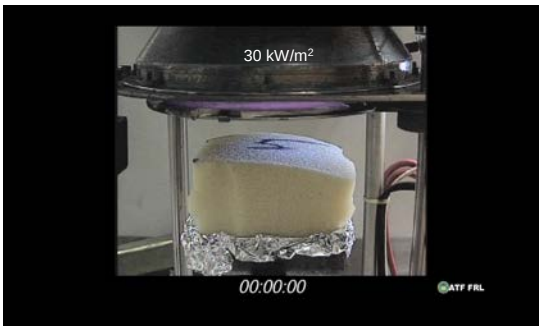
Slide 2-10

G. So when we talk about fuels, we are talking about the vapors they produce (solids and liquids).

H. **3.3.139 Pyrolysis.** A process in which material is decomposed**,** or broken down, into simpler molecular compounds by the effects of heat alone; pyrolysis often precedes combustion.

I. **5.2.2.2.** Thermal decomposition involves irreversible changes in the chemical structure of a material due to the effects of heat (pyrolysis). Thermal decomposition of a solid or liquid most often results in the production of gases. Wood decomposes to create char and vapors, some of which are flammable. Under vigorous heating, flexible polyurethane decomposes to form a liquid and flammable gases or vapors. At more moderate heating conditions, flexible polyurethane decomposes to a char and flammable gases or vapors.

"ATF PYROLYSIS OF POLYURETHANE" VIDEO

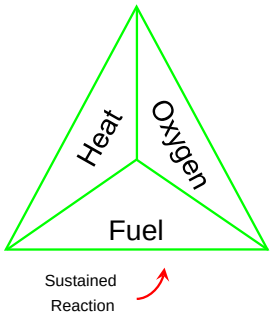


Slide 2-11

FIRE TETRAHEDRON

Combustion reaction:

- Fuel.
- Oxygen.
- Heat.
- Uninhibited chemical chain reaction.



Slide 2-12

J. **5.1.2 Fire Tetrahedron.** The combustion reaction can be characterized by four components: the fuel, the oxidizing agent, the heat, and the uninhibited chemical chain reaction.

1. These four components have been classically symbolized by a four-sided solid geometric form called a tetrahedron.

2. Fires can be prevented or suppressed by controlling or removing one or more of the sides of the tetrahedron.

II. FUELS

FUELS

- Can be in three states:
  - Solids.
  - Liquids.
  - Gases.

- Fuels are usually organic in nature.
  - Typically consist of a combination of carbon, hydrogen and oxygen.
- Inorganic fuels contain no carbon.
  - Combustible metals like magnesium or sodium.

Slide 2-13

A. A fuel is any substance that can undergo combustion.

B. The majority of fuels encountered are organic, which simply means that they are carbon-based and may contain other elements such as hydrogen, oxygen and nitrogen in varying ratios.

1. Examples of organic fuels include wood, plastics, gasoline, alcohol and natural gas.

2. Inorganic fuels contain no carbon and include combustible metals, such as magnesium or sodium.

FUELS (cont'd)

- Geometry of fuel affects how it burns.
  - Thickness (thin or thick).
  - Density (how tight the fuel is packed).
  - Shape (surface-to-mass ratio).
- Fuel location affects how it burns.
  - Compartment versus free burning.

Slide 2-14

C. How much energy is stored inside (sized in kilowatts)?

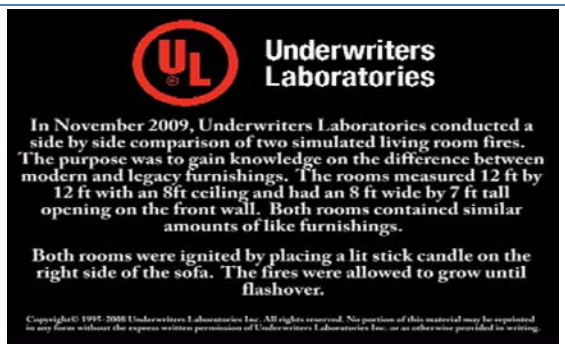
D. Geometry of fuel (gas on carpet versus gas on concrete pad)?

E. Thickness (how it absorbs energy: toothpick versus two-by-four — same material and ignition temperature but burn differently)?

F. Density (how heat travels within object itself)?

G. Thermal inertia (Kay Roo Cee kpc).

"UNDERWRITERS LABORATORIES LEGACY" VIDEO



Slide 2-15

III. OXIDIZERS

OXYGEN OR OXIDIZING AGENT

- In most fires, oxygen from the atmosphere is the oxidizer.
- Air.
  - 21 percent oxygen.
  - 79 percent nitrogen/others.
- Enriched oxygen.
  - Medical.
  - Industrial.

Slide 2-16

A. Oxygen.

1. What does 21 percent oxygen mean?

2. In fire, the fuel and air need to be heated up.

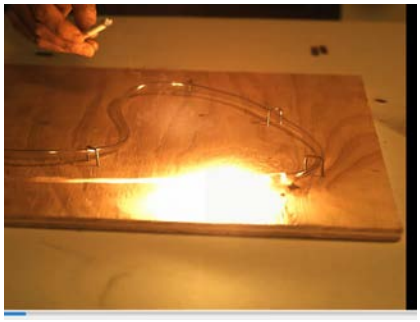
OXYGEN OR OXIDIZING AGENT (cont'd)

- Solid oxidizers.
  - Chemicals: nitrates, chlorates, sulfates, phosphates, etc.
- Flaming combustion can occur with as little as 15 percent.
- Charring/Smoldering can occur with as little as 8 percent.

Slide 2-17

3. Four-fifths of air is dead weight (nitrogen) — it doesn't burn — lower flame temperatures in air.

"ATF ENRICHED OXYGEN FIRE" VIDEO



Slide 2-18

HEAT

- Heat starts, sustains and spreads fire.
- Heat is energy that is transferred due to a difference in temperature.

Slide 2-19

B. Definition of heat.

1. It is a form of energy characterized by the vibration of molecules and capable of initiating and supporting chemical changes and changes of state (National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, Section 3.3.95, 2014 ed.).

2. Heat is one of several energy types.

   a. Thermal (heat).

   b. Light.

   c. Electrical.

HEAT (cont'd)

- Heat component of fire triangle represents heat energy above the minimum level necessary to release vapors and cause ignition (National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, 2014).

Slide 2-20

3. **5.1.2.3 Heat.** The heat component of the tetrahedron represents heat energy above the minimum level necessary to release fuel vapors and cause ignition.

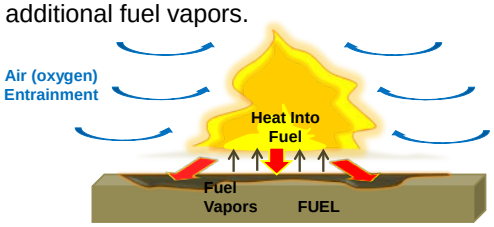
INPUT HEAT

- Liquid fuels:
  - Flash point.
  - Fire point.
- Solid fuels:
  - Ignition temperature.
- Ignition:
  - Piloted ignition.
  - Autoignition.

Slide 2-21

UNINHIBITED CHAIN REACTION

- After ignition, heat released from chemical reaction sustains fire without the need of external heat source.
- Heat radiates back toward fuel to generate additional fuel vapors.



Slide 2-22

"FM-200 EXTINGUISHMENT" VIDEO

Slide 2-23

IV. TYPES OF COMBUSTION

TYPES OF COMBUSTION

- Flaming:
  - Premixed.
  - Diffusion.
- Smoldering.
- Spontaneous combustion.

Slide 2-24

A. There are three methods of heat transfer.

FLAMING COMBUSTION

Premixed:

- Fuel and oxidizer are mixed prior to combustion.
- Deflagration:
  - Flame propagates through unburned mixture at velocity less than the speed of sound.
- Detonation:
  - Flame propagates through unburned mixture at velocity greater than the speed of sound.

Slide 2-25

B. Thermal runaway, if heat cannot be conducted away fast enough. Rate of reaction heats up as temperature increases. It smolders until it reaches the outside of the fuel; then it has enough oxygen to transition to flaming. Atmospheric conditions also play a key role. Society of Fire Protection Engineers (SFPE) handbook is a good resource on this. Very odorous smoke.

SPONTANEOUS COMBUSTION

Exothermic reaction that generates heat.

Heat unable to be dispelled by the normal mechanisms as fast as it is made, and is built up in a fuel, raising its temperature.

Reaction rate basically doubles with every increase in approximately 50 F, **thus** the reaction makes itself go faster and faster with increasing heat.

Over time, temperature may rise to the pilot of ignition of the fuel.

Slide 2-26

C. **5.7.4.1.1.5.** Spontaneous combustion due to self-heating is a special form of smoldering ignition that does not involve an external heating process. An exothermic reaction within the material is the source of the energy that leads to ignition and burning.

1. The key concept in ignition by self-heating is the ability of the material to dissipate the heat generated by the internal exothermic reactions.

2. If the heat generated by the reaction cannot be dissipated to the surroundings, the material will rise in temperature to an extent that the reaction rates accelerate (i.e., runaway), and a smolder front is formed.

3. Key variables in self-heating include the ambient temperature, the pile size, and the reaction kinetics of the exothermic process.

4. As the ambient temperature rises, the baseline reaction rate increases, and as the pile size increases, the ability to dissipate heat to the surroundings decreases.

5. Both high ambient temperatures and large pile sizes favor self-heating processes.

6. See the following section for more detailed information concerning self-heating in piles.

D. Exothermic reaction that generates heat.

1. Heat unable to be dispelled by the normal mechanisms as fast as it is made, and is built up in a fuel, raising its temperature.

2. Reaction rate basically doubles with every increase in approximately 50 F, **thus** the reaction makes itself go faster and faster with increasing heat.

3. Over time, temperature may rise to the pilot of ignition of the fuel.

SPONTANEOUS COMBUSTION (cont'd)

- Key elements that must be present are:
  - Drying oil (usually vegetable or animal origin).
  - Porous medium that allows access of oxygen to the fuel (and does not melt when the temperature rises).
- Timeline is dependent on chemistry and mass of the reactant.
- Flaming ignition is always preceded by smoke.

Slide 2-27

E. Key elements that must be present are:

1. Drying oil (usually vegetable or animal origin).

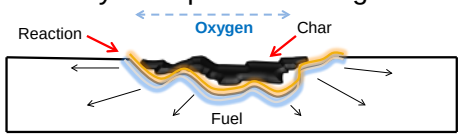
2. Porous medium that allows access of oxygen to the fuel (and does not melt when the temperature rises).

F. Timeline is dependent on chemistry and mass of the reactant.

G. Flaming ignition is always preceded by smoke.

SMOLDERING COMBUSTION

- Reaction occurs on the solid surface with oxygen diffusing to the surface.
- Thermal decomposition creates char followed by solid phase burning.



Smoldering is a solid phase burning process, which normally includes a thermal decomposition step to create a char, followed by solid phase burning of the char produced.

Slide 2-28

H. From Quintiere, "Principles of Fire Behavior," 1998 and Kirk's.

1. Smoldering occurs on the surface of the solid, and flaming occurs on the gas stage.

2. Smoldering combustion is:

   a. Slow.

   b. Low-temperature.

   c. Flameless.

3. Smoldering is a solid phase burning process, which normally includes a thermal decomposition step to create a char, followed by solid phase burning of the char produced.

SMOLDERING COMBUSTION (cont'd)

- Characterized by absence of flame.
- Hot materials on the surface — combustion is proceeding.
- May be glowing if temperature is approximately 500 C (900 F) or higher.
- Can continue even in an oxygen-deficient atmosphere (8 percent).

Slide 2-29

4. Characterized by absence of flame.

5. Hot materials on the surface — combustion is proceeding.

6. May be glowing if temperature is approximately 500 C (900 F) or higher.

7. Can continue even in an oxygen-deficient atmosphere (8 percent) (Kirk's).

SMOLDERING COMBUSTION (cont'd)

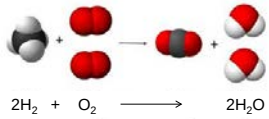
- Transition from flaming to smoldering may be seen as the oxygen level drops, which then can revert back to open flames if oxygen is introduced.

Slide 2-30

8. Transition from flaming to smoldering may be seen as the oxygen level drops, which then can revert back to open flames if oxygen is introduced.

A SMALL BIT OF FIRE CHEMISTRY

- A chemical reaction is a rearrangement of atoms into a different configuration.
- When molecules split up, new molecules arise out of the original collection of atoms.



Slide 2-31

I. "When hydrogen, an excellent fuel, two diatomic molecules of hydrogen combine with a diatomic molecule of oxygen to form two molecules of water … Because water is a more stable compound than the gases that form it, the reaction occurs with much vigor and the output of much heat and is called an exothermic reaction" (DeHaan, J. D. and Icove, D. J. (2012). Kirk's fire investigation (7th ed.). (p. 21). New Jersey: Pearson).

A SMALL BIT OF FIRE CHEMISTRY (cont'd)

- Fire is an oxidation reaction.
  - Oxygen molecules give up an electron to fuel molecules.
- Rusting is also an oxidation process, just a slow one.

Slide 2-32

A SMALL BIT OF FIRE CHEMISTRY (cont'd)

- Chemical reactions either absorb or give off energy.
- Endothermic reactions — absorb energy.
- Exothermic reactions — give off energy.
- Which one is fire?

Slide 2-33

J. Exothermic reactions — give off energy.

BASIC COMBUSTION REACTION

FUEL	+	OXIDIZER	=	COMBUSTION PRODUCTS
Carbon Nitrogen Sulfur Hydrogen		Oxygen/Air Chlorine Solid oxidizers		Carbon dioxide Water Smoke/Particulates Hydrogen cyanide (HCN) Nitrous oxide etc.

Slide 2-34

K. From the chemical reaction of a fuel and oxidizer, the common byproducts generally consist of carbon dioxide, water, smoke/particulates.

COMBUSTION REACTIONS WITH AIR

- Air ≈ 21 percent oxygen and 79 percent nitrogen.
- Only oxygen reacts with fuel.
- Nitrogen absorbs some of the heat produced by the combustion reaction.
  - Higher flame temperatures obtained in enriched oxygen environment.

Slide 2-35

V. FUEL VERSUS VENTILATION-CONTROLLED FIRES

FLAME TEMPERATURE

For most common fuels, flame temperature is essentially the same regardless of fuel type.

Fuel	Flame Temperature (F)
Gasoline	1,879
Kerosene	1,814
Methanol	2,192
Wood	1,881

Slide 2-36

STOICHIOMETRIC COMBUSTION

- Optimum ratio of fuel and air mixture.

FUEL **OXYGEN**

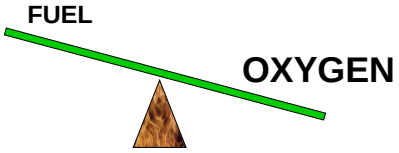
- No excess fuel or air remains after combustion.
- Combustion of hydrocarbon fuels results only in the formation of carbon dioxide (CO_2) and water vapor (H_2O).

Slide 2-37

A. NFPA 30, *Flammable and Combustible Liquids Code* regulates the storage and transportation of flammable liquid.

FUEL LIMITED FIRES

- Also known as over ventilated fires.
- More oxygen supplied to the fire than required to react with all of the fuel.
- In general, all fires start out as fuel limited fires.



Slide 2-38

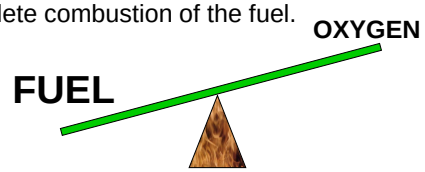
B. What happens to extra air?

1. It does not react.

2. Absorbs some of the heat produced by the combustion reaction, thereby lowering the flame temperature.

VENTILATION LIMITED FIRES

- Also known as under ventilated fires.
- Insufficient oxygen to react with all of the fuel (more fuel than air), which results in the incomplete combustion of the fuel.



- Fires may transition from fuel limited to ventilation limited if fuel is located in a compartment.

Slide 2-39

OXYGEN REQUIRED FOR COMBUSTION

- Flaming fires require at least 14 to 16 percent oxygen.
- Smoldering combustion requires as little as 8 percent oxygen.
- Recall, normal air contains about 21 percent oxygen.

Slide 2-40

C. Recall, normal air contains 21 percent oxygen.

PRODUCTS OF COMBUSTION

- Heat.
- Gases.
- Solid particles.
- Liquid aerosols.

Smoke
Visible smoke

Slide 2-41

GASES

- Primary.
  - CO_2.
  - H_2O.
- Others.
  - Carbon monoxide.
  - HCN.
  - Formaldehyde (CH_2O).
  - Etc.

Slide 2-42

SOLIDS AND LIQUIDS

- Solids.
  - Ash (noncombustible material).
  - Soot (particles of carbon).
- Liquids.
  - Aerosols (complex organic molecules resulting from pyrolysis products).
  - Small tarry droplets.

Slide 2-43

EFFECTS OF HEAT AND SMOKE ON PEOPLE

Awareness → Irritation → Impairment → Incapacitation → Death

Increasing heat and smoke exposure (concentration and/or duration).

Slide 2-44

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ACTIVITY 2.1

Candle Experiment

Purpose

Demonstrate the anatomy of a flame, and show the differences between a diffusion and premixed flame.

Safety Precautions

- Ensure that all loose clothing is tucked in and all hair is tied back.
- Ensure that all students remain a safe distance from the candle and lighter flame.

Directions

1. Clear off your table.
2. Each table will be given one candle. Ensure that your candle is secure in the pie plate.
3. Light the candle.
4. The instructor will demonstrate each exercise at the front of the classroom, one step at a time. Your table group should complete the exercise as demonstrated.

Exercises

1. Place a spoon into the blue luminous zone just above the wick. Observe how this produces little soot.
2. Hold the spoon at the tip of the candle's flame. Observe how there are large amounts of soot and carbon deposits present.
3. 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.
4. 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.
5. Extinguish the candle. Ignite the white vapors trailing off the wick, causing the flame to jump back to the candlewick.

Discussion Questions

1. Does the candle have a diffusion or premixed flame?

2. How do you explain the different soot patterns formed by holding the spoon in different positions?

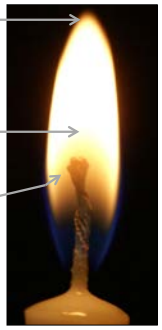
3. How did the flame structure change as you moved the screen from tip to base?

4. Why were you able to reignite the wick by lighting the vapors coming off the candle?

V. FUEL VERSUS VENTILATION-CONTROLLED FIRES (cont'd)

ANATOMY OF A CANDLE FLAME

- Outer zone: hottest part of flame, almost colorless.
- Middle zone: made luminous by the glowing carbon particles.
- Inner zone: little combustion through lack of oxygen.



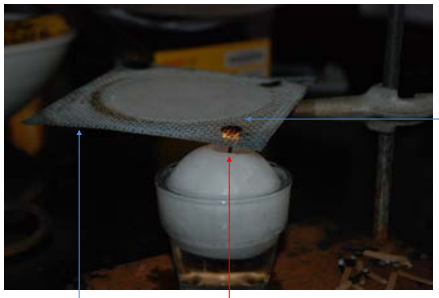
Slide 2-46

D. **3.3.74 Flame.** a body or stream of gaseous material involved in the combustion process and emitting radiant energy at specific wavelength bands determined by the combustion chemistry of the fuel. In most cases, some portion of the emitted radiant energy is visible to the human eye (NFPA 921, Section 3.3.74, 2014 ed.).

1. Outer zone: hottest part of flame, almost colorless.
2. Middle zone: made luminous by the glowing carbon particles.
3. Inner zone: little combustion through lack of oxygen.

CANDLE EXPERIMENTS

Slide 2-47

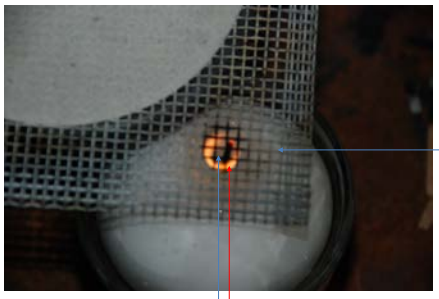


Flames are quenched above the mesh screen due to a lack of sufficient heat/energy. Note the remaining elements of the fire triangle, fuel gases and oxygen, are still present.

Below the mesh screen, there is a sufficient mix of fuel gases, heat and oxygen to support flames.

Metal mesh screen acts as a heat sink and removes the heat component of the fire triangle from the candle flame.

Slide 2-48



The flame ring consumes fuel gases. Outside the flame ring there is ample oxygen; however, there are insufficient fuel gases to support flames.

The flame ring is present where the inside fuel gases are able to mix with the outside oxygen.

Heat from the flame continues to drive off fuel gases from the wick. However, there is insufficient oxygen in this inner most region to support flames.

Slide 2-49

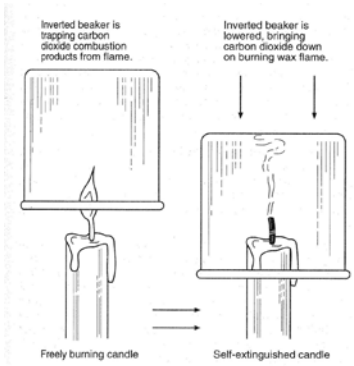
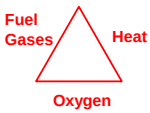


FIG. 1-8A. Flaming combustion (left) and extinguishment (right) by its own combustion products of a wax candle.

FIRE TRIANGLE:



Slide 2-50

VI. HEAT TRANSFER

FIRE IS ABOUT ENERGY

Fire is energy, not temperature.

Slide 2-51

A. By the end of this block of instruction, you should be able to look at a common household item and critically ask how much energy potential is within that item, what would be the ease of ignition, and what is the potential fire spread on the material.

WHAT IS TEMPERATURE

- Temperature expresses the degree of molecular activity relative to some reference point (e.g., freezing point of water).
- "Hotter" objects have molecules that move faster than "colder" objects.

Slide 2-52

B. Molecular activity creates energy (heat). Temperature is a measurement of the energy (heat).

RELATIVE TEMPERATURE SCALES

- Relative temperature scales are based on the freezing point and boiling point of water.
- Metric (System International (SI)).
  - Celsius (C):
    - C = (F - 32)/1.8.
- U.S. (English).
  - Fahrenheit (F):
    - F = (1.8)(C) + 32.

Slide 2-53

C. Energy types.

1. Thermal (heat).

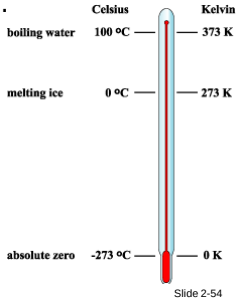
2. Light.

3. Electrical.

D. Heat is **not** the same as temperature. Temperature is a measure of molecular activity.

TEMPERATURE CONVERSIONS

- Based on the temperature at which molecular activity ceases.
- Metric (SI):
  - Kelvin: K = C + 273.
- U.S. (English):
  - Rankine: R = F + 460.



Slide 2-54

E. Based on the temperature at which molecular activity ceases.

1. Metric (System International (SI)). Kelvin: K = C + 273.

2. U.S. (English). Rankine: R = F + 460.

TEMPERATURE

	F	R	C	K
Boiling point of water	212	672	100	373
Freezing point of water	+32	492	0	273
Absolute zero	-460	0	-273	0

Slide 2-55

F. Fahrenheit.

G. Celsius.

1. Both based on the behavior of water.

2. Thus 32 F or 0 C for water freezing.

H. Rankine.

I. Kelvin — both based on one point, absolute zero.

OXIDATION

- Slow oxidation.
  - Rusting.
  - Yellowing of paper.
- Fast oxidation.
  - Explosions.
    - -- Detonations: super fast, greater than the speed of sound.
    - -- Deflagrations: fast, less than the speed of sound.

Slide 2-56

J. How do deflagrations and detonations differ from combustion? They generate a pressure wave.

1. Deflagrations — relatively low intensity pressure wave, less than speed of sound (~3,000 feet per second (ft/s) or 1,000 meters per second (m/s)).

2. Detonations — intense pressure/shock wave, greater than speed of sound (~3,000 ft/s or 1,000 m/s).

SUSTAINED REACTIONS

- Two types of fire:
  - Flaming fire.
  - Smoldering fire.
- The difference between the two is the condition of the fuel and oxygen availability.
- This, in turn, influences the rate at which heat is being produced.

Slide 2-57

K. Two types of fire:

1. Flaming fire.

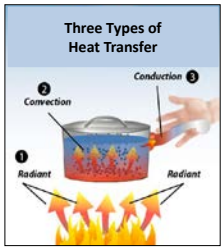
2. Smoldering fire.

L. The difference between the two is the condition of the fuel and oxygen availability.

M. This, in turn, influences the rate at which heat is being produced.

HEAT TRANSFER

- Heat transfer affects fire suppression activities and fire cause identification.
- Often helps explain how fire spreads from one location to another.



Slide 2-58

N. Rate of fire growth and fire spread to other fuels is dependent on exchange of heat energy.

O. Heat transfer is critical element in affecting the formation of fire patterns, crucial evidence used to determine a fire's origin and cause.

UNITS OF HEAT ENERGY

- Metric (SI):
  - Joule (J) — 1 watt (W) is equal to 1 joule/second.
  - Calorie (cal.) = 4 J — amount of energy needed to raise 1 gram of water by 1 degree C.
- U.S. (English):
  - British thermal unit (Btu) — energy needed to raise 1 pound of water by 1 degree F.
    - -- 1 Btu = 1,055 J ≈ 1 kJ.
    - -- 1 Btu = 252 cal.

Slide 2-59

P. 1 British thermal unit (Btu) = the amount of energy required to raise 1 pound of water by 1 degree F.

Q. 1 calorie is the amount of energy required to raise 1 gram of water by 1 degree C.

HEAT (cont'd)

- Energy that is transferred due to a difference in temperature.

Slide 2-60

R. Energy that is transferred due to a difference in temperature.

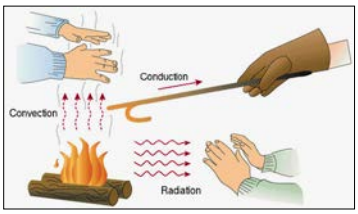
UNITS OF HEAT TRANSFER RATE

- Rate of heat transfer = energy per unit time.
- Metric (SI):
  - Watts (W) = Joule per second (J/s).
  - kilowatts (kW) = 1,000 W.
- U.S. (English):
  - Btu per hour (Btu/hr).
- $\dot{Q}$ = energy per unit time (kW).
- $\dot{q}$" = energy per unit time and area (kW/m^2).

Slide 2-61

THREE METHODS OF HEAT TRANSFER

- Conduction.
- Convection.
- Radiation (radiant heat).



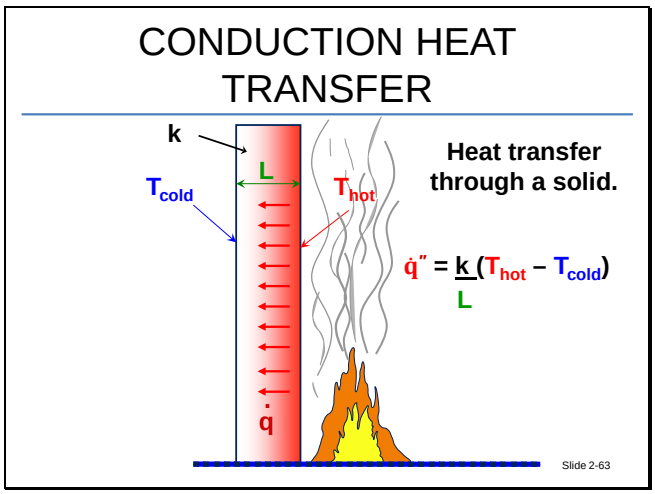
Slide 2-62

S. There are three methods of heat transfer:

1. Conduction: transfer of heat through a material by direct contact (e.g., flow of heat through a wall).

2. Convection: transfer of heat by movement of a fluid (e.g., hot smoke on the surfaces (ceilings/walls) of a room; the oven in your home).

3. Radiation: transfer of heat by electromagnetic waves (e.g., the warmth you feel from a campfire).



T. What factors influence conduction through solid:

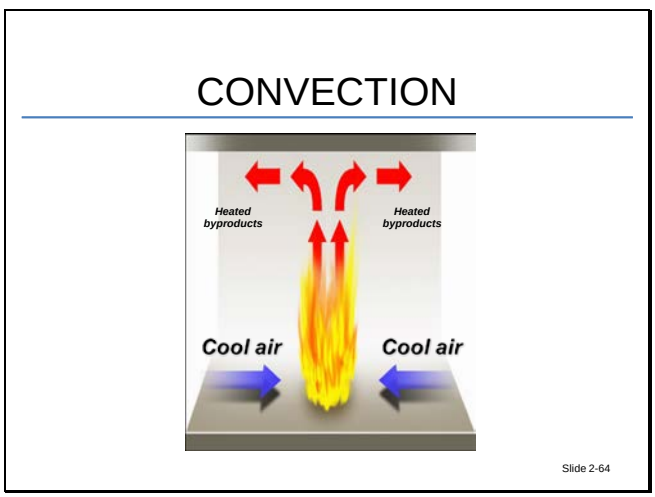
1. Area through which heat is transferred (A) — usually factored out (heat flux).

2. Material property — conductivity (k).

3. Temperatures on each side (T2 and T1).

4. Thickness of wall (L).

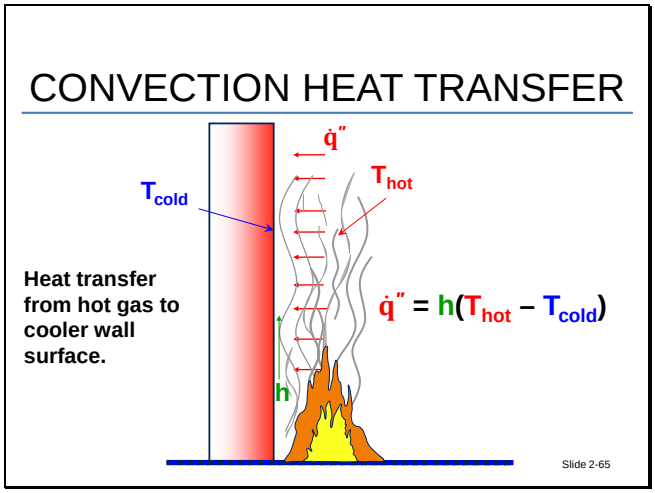
5. Q_dot = k * A * (T2-T1)/L.



U. Convection is the process of transferring heat by movement of a fluid.

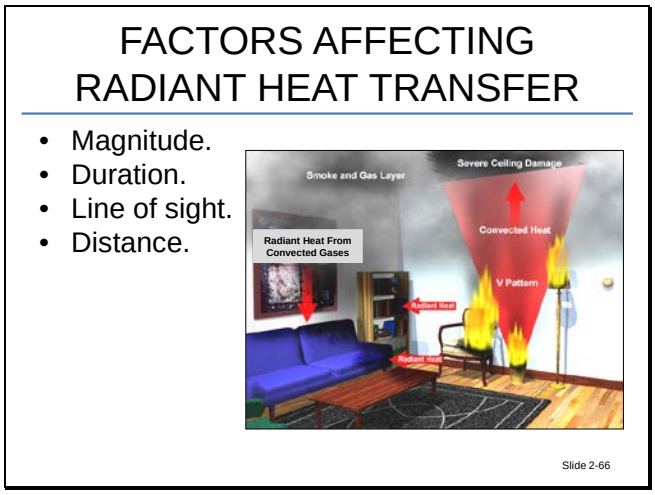
1. In convective flow, the warm fluid (heated gases) is less dense than the surrounding fluid (cool air being entrained into the fire) and rises.

2. This density difference is caused by temperature variations and called convective flows.



3. Buoyant forces in the plume result in rise of hot gas.

4. Buoyancy results from temperature differences.



V. Radiation and electromagnetic energy.

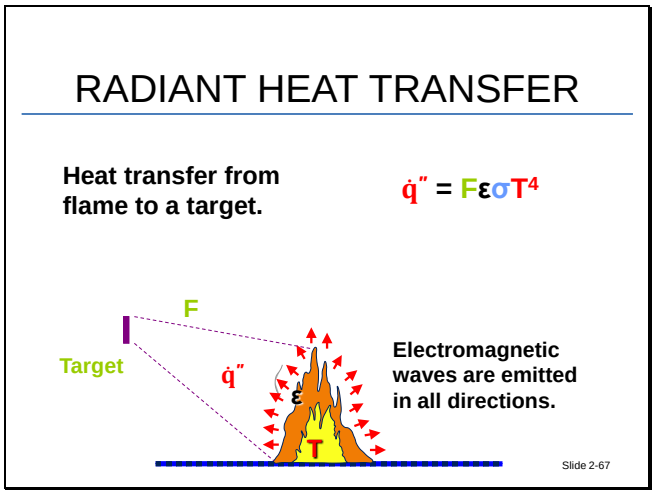
1. All objects having a temperature above absolute zero (0 K, -273 C, -460 F) radiate electromagnetic energy.

2. Electromagnetic waves are composed of undulating electrical and magnetic fields.

3. Different kinds of electromagnetic waves such as light and radio waves form the electromagnetic spectrum.

4. The heat transfer is proportional to the 4th power of the temperature. Doubling smoke temperature (in degrees K) causes a 16x increase in heat transfer.

5. The rate of transfer is affected by the distance between the hot object from its targets. The radiant intensity decreases with distance.



W. Radiation = electromagnetic waves.

1. What are other types of electromagnetic waves? X-rays, ultraviolet (UV), visible light, infrared, radio waves.

2. What is the difference — the wavelength of the radiation.

3. How fast do the waves move — speed of light.

4. Thermal radiation — extends across infrared and somewhat into the visible.

5. Thermal radiation originates due to temperature — **all master** above absolute zero emits radiation.

6. What affects thermal radiation:

   a. Temperature (4th power).

   b. Material property (emissivity).

   c. Configuration factor (geometry of the surfaces and distance).

DIRECT FLAME CONTACT

- Not a different mode of heat transfer.
- Combination of convection and radiation heat transfer.

Slide 2-68

X. Some people have been taught that there is a fourth mode of heat transfer other than conduction, convection and radiation called "direct flame contact." This is not true. Direct flame contact is not a different mode of heat transfer.

METHODS OF HEAT TRANSFER

Most fuels release the majority of their heat via convection, followed by radiation.

Slide 2-69

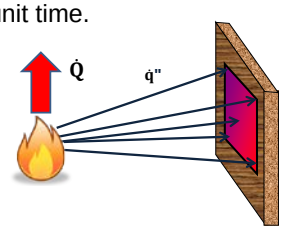
Y. Convection heat energy transfer is 60 to 75 percent, and 20 to 45 percent is typically radiative heat transfer.

VII. HEAT FLUX

HEAT FLUX

- Heat flux is the rate of heat transfer to a defined area.
- It is typically represented by symbol $\dot{q}''$, where the double prime indicates per unit area and the dot indicates per unit time.

$\dot{Q}$ = kW
$\dot{q}''$ = kW/m^2



Slide 2-70

A. Distance, fuel orientation and obstructions.

"ATF HEAT FLUX" VIDEO

Slide 2-71

HEAT FLUX VALUES

Thermal radiation from the sun.	1.0 kW/m^2
Human skin blisters in 30 seconds. Second-degree burns.	5 kW/m^2
Human skin blisters in nine seconds.	10 kW/m^2
For most materials, critical heat flux range.	10-15 kW/m^2

NFPA 921

Slide 2-72

B. NFPA 921, Section 5.5.4.2, 2014 ed.

HEAT FLUX VALUES (cont'd)

Human skin experiences pain and blisters in five seconds.	15 kW/m^2
Heat flux on a compartment floor at the onset of flashover.	20 kW/m^2
Heat flux for protective clothing thermal protective performance test.	80 kW/m^2
Maximum flux currently measured in a post-flashover fire.	220-250 kW/m^2

NFPA 921

Slide 2-73

"CHRISTMAS TREE" VIDEO

Slide 2-74

VIII. IGNITION

PRINCIPLE OF IGNITION

- Ignition depends on:
  - Form of material (gas, liquid, solid).
  - Chemical properties of material.
  - Form and intensity of heating.
- Recall, liquid and solid fuels do not burn.
  - Liquids evaporate into a vapor.
  - Most solids chemically decompose into a vapor.

Slide 2-75

A. Important for correctly interpreting patterns and doing timeline analysis.

"IGNITION OF TWO-BY-FOUR WOOD WITH LIGHTER" VIDEO

Slide 2-76

IGNITION AND TEMPERATURE

Two types of ignition.

- Piloted ignition.
- Autoignition.

Slide 2-77

B. Ignition temperature is the minimum temperature a substance should attain in order to ignite under specific test conditions.

C. Class discussion: What is this type of ignition? What is the method of heat transfer?

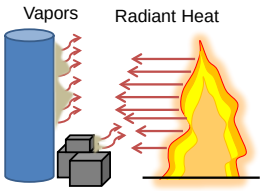
PILOTED IGNITION

- Ignition that involves open flame or sparks.
- Types:
  - Small flames.
  - Sparks.
  - Arcs.
  - Hot surfaces.

Slide 2-78

AUTOIGNITION

- Initiation of combustion by heat, without direct contact with a flame, spark, arc or hot surface.
- Highly dependent on environmental conditions, and may vary significantly depending on type of heat transfer.



Slide 2-79

D. Tied in with heat flux. Be careful of auto ignition temperature (AIT) figures: These are approximations. And, with vehicle fires, these figures can be significantly different.

1. Initiation of combustion by heat, without direct contact with a flame, spark or hot surface.

2. Highly dependent on environmental conditions, and may vary significantly depending on type of heat transfer.

IGNITION PROCESS

- Liquids:
  - Flash point and fire point.
  - Flammability limits.
  - Ignition temperature.
  - Ambient air flow.
- Gases:
  - Flammability limits.
  - Auto Ignition temperature (AIT).
  - Ignition energy (< 1 mJ).

Slide 2-80

E. Morphology — the form of the solid (e.g., saw dust, wood chips, two-by-four, log).

IGNITION PROCESS (cont'd)

- Solids:
  - Ignition temperature.
  - Incident heat flux.
  - Orientation and form.
  - Thermal inertia.

Slide 2-81

COMPETENT IGNITION SOURCE

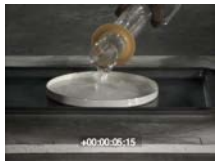
Must have:

- Sufficient temperature.
- Sufficient energy.
- In contact with fuel long enough to raise to ignition temperature.

Slide 2-82

F. Hair dryer embedded in chair: Regardless of condition of hair dryer, which would probably let you hypothesize it did not cause the fire, can the heat from it be a competent ignition source for the chair? What properties would we have to consider? What about the fuel properties? Timeline? Context?

"ATF CIGARETTE AND GASOLINE" VIDEOS



Slide 2-83

IGNITION OF GASES

- Gases require the least amount of energy to ignite because they are already in a gaseous form.
- Fuel gases and air mixture must be within the flammability limits of the fuel.

Slide 2-84

IGNITION OF GASES (cont'd)

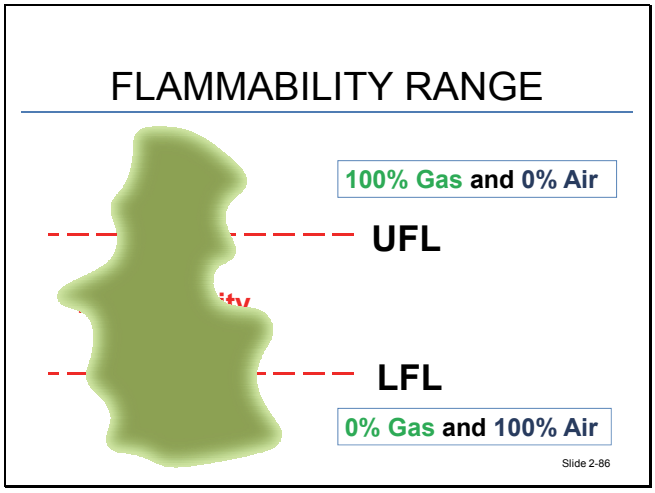
- Flammability limits affect ignition of gases:
- Lower flammability limit (LFL).
  - Lowest concentration of fuel vapors in air that will burn.
- Upper flammability limit (UFL).
  - Highest concentration of fuel vapors in air that will burn.

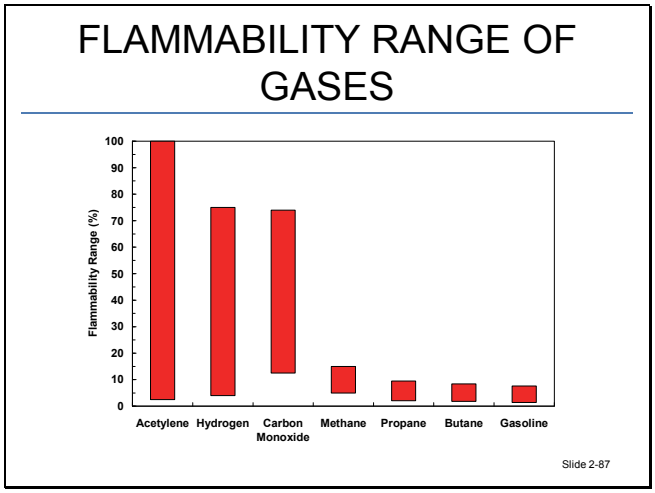
Slide 2-85

G. **5.7.2.1.** Flammable gases can only be ignited by a spark or pilot flame over specific ranges of gas concentration.

1. These limits are normally expressed as the lower flammable limit (LFL)/ lower explosive limit (LEL), the lowest concentration by volume of flammable gas in air that will support flame propagation, and the upper flammable limit (UFL)/upper explosive limit (UEL), the highest concentration of flammable gas in air that will support flame propagation.

2. These limit concentrations fluctuate with temperature and pressure changes and with changes in oxygen concentration.





H. Acetylene UFL = 100 percent. In those cases, the gas does not require oxygen to react, since the fuel molecule itself can explosively decompose.

FLAMMABLE GAS MIXTURE

	LFL %	UFL %	AIT (C)
Carbon monoxide	12.5	74	609
Gasoline	1.2	7.1	470
Hydrogen	4	75	400
JP-4	1.3	8	240
Methane	5	15	540
Propane	2.1	9.5	450

Slide 2-88

I. The chart on Slide 2-88 predicts the LFL and UFL of common gases. Additional information can be located in NFPA 921 and Kirk's.

IGNITION — GASES

- Ignition energy for gases:
  - Gases require less than 0.2 mJ of energy, or more than **1,000 times less energy** than a static shock (1 J).
  - Less energy required because gas does not need to change its state of matter.
  - Flammable gases can only be ignited by a spark or pilot flame over specific ranges of gas concentration.

Slide 2-89

1. Still need to be in the flammability range.

2. **5.7.2.1.** Flammable gases can only be ignited by a spark or pilot flame over specific ranges of gas concentration.

IGNITION — GASES (cont'd)

- Ignition temperatures for most fuel gases range from approximately 384 C to 632 C (723 F to 1,170 F).

Slide 2-90

J. **10.1.1.2 Ignition Sources.** Ignition temperatures for most fuel gases range from approximately 384 C to 632 C (723 F to 1,170 F). Minimum ignition energies are as low as 0.2 mJ. Thus, they are easily ignited from most commonly encountered ignition sources.

FIRES INVOLVING GASES

- Important to know how a gas behaves — does it rise or fall?
- Gas density is measured by comparing it to that of air (when at the same temperature).

Slide 2-91

K. Other gases can be lighter than air when heated.

L. Important to know — think of water heater scenario with an open pilot light.

VAPOR DENSITIES SPECIFIC GRAVITY (AIR)

- So, we know that vapors rise or fall — The technical term for this is specific gravity.
- Specific gravity (air) or vapor density is the ratio of the average molecular weight of a gas or vapor to the average molecular weight of an equal volume of air at the same temperature and pressure (NFPA 921, Section 3.3.160, 2014 ed.).

Slide 2-92

SPECIFIC GRAVITY

- Liquids:
  - Ratio of density of a substance compared to water.
  - Water = 1.0.
- Vapors:
  - Ratio of the weight of a gas compared to dry air.
  - Air = 1.0.

Lighter

Methane 0.6
Natural gas

Air 1

Propane 1.5
Gasoline 3.5

Heavier

Slide 2-93

M. Float or sink. Rise or fall. Is it lighter than air, such as methane, or is it heavier than air, such as propane?

FIRES INVOLVING GASES (cont'd)

- The most common gases lighter than air when at the same temperature:
  - **H**elium.
  - **A**cetylene.
  - **H**ydrogen.
  - **A**mmonia.
  - **I**lluminating gas.
  - **C**arbon monoxide.
  - **E**thylene.
  - **M**ethane.

Slide 2-94

1. Other gases can be lighter than air when heated.

2. Important to know — think of water heater scenario with an open pilot light.

"MINNESOTA IAAI NATURAL GAS IGNITION" VIDEO

Slide 2-95

"MINNESOTA IAAI PROPANE IGNITION" VIDEO

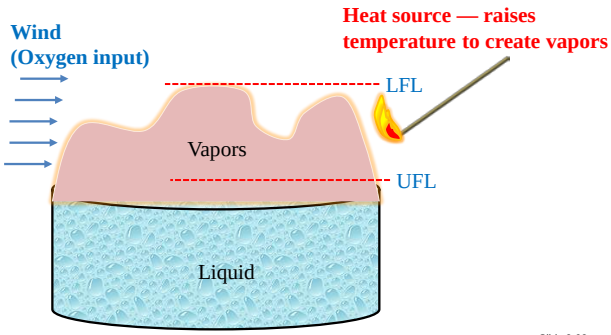
Video clip from Minnesota IAAI Gas Migration Study, 1994.

Slide 2-96

"ATF LIQUID PROPANE IGNITION" VIDEO

Slide 2-97

IGNITION — LIQUIDS



Slide 2-98

IGNITION — LIQUIDS (cont'd)

- Liquid must be at/above its flash point temperature. If it is not, enough heat must be applied to vaporize fuel.
- Ignition energy must be applied in a region of the vapors within the flammable range to start the reaction.
- Eddy currents may develop — moving the warmer liquid away from the energy source.

Slide 2-99

N. Eddy currents — convective flow within the liquid.

1. Liquid must be at/above its flash point temperature. If it is not, enough heat must be applied to vaporize fuel.

2. Ignition energy must be applied in a region of the vapors within the flammable range to start the reaction.

3. Eddy currents may develop — moving the warmer liquid away from the energy source.

IGNITION — LIQUIDS (cont'd)

- Like other fuels, geometry of the liquid plays a role.
- Mists (high surface to mass ratio) or atomized fuels ignite easily, and piloted ignition can occur below published flash point.
- Sprays (several hundred degrees C) very high flash point liquids.

Slide 2-100

O. In the case of sprays and mists, piloted ignition can occur below published flash point of bulk.

P. **5.7.3.3.** Atomized liquids or mists (those having a high surface area to mass ratio) can be more easily ignited than the same liquid in the bulk form. In the case of sprays or mists, piloted ignition can occur at temperatures below the published flash point of the bulk liquid, and even very high flash point liquids (several hundred degrees C) have been shown to be ignitable when in the form of a spray.

WHICH WILL BE GREATER?

- Flash point.
  - Lowest temperature at which solid or liquid will produce sufficient vapors to ignite.
- Fire point.
  - Lowest temperature at which solid or liquid will produce sufficient vapors to sustain burning.

Slide 2-101

1. Flash point.

   a. Open- or closed-cup test methods.

   b. A flash of flame, which consumes momentarily, consumes all the fuel vapor within the flammability limits and the flame does not persist.

2. Fire point.

   a. American Society for Testing and Materials (ASTM) D92.

   b. Normally only open-cup method used.

   c. General rule: Closed-Cup Flash Point < Open-Cup Flash Point < Fire Point.

   d. At or above fire point, enough vapors given off to sustain a flame.

FLAMMABLE LIQUIDS

- Flammable — capable of burning with a flame.
- Flammable liquids have a flash point below 37.8 C (100 F).

Slide 2-102

COMBUSTIBLE LIQUIDS

- Combustible — capable of burning.
- Combustible liquids have a flash point at or above 37.8 C (100 F).

Slide 2-103

Q. Combustible liquids.

   1. Combustible — capable of burning.

   2. Combustible liquids have a flash point at or above 37.8 C (100 F).

FLAMMABLE VERSUS COMBUSTIBLE

- Gasoline.
  - Flash point = -45 F.
  - Flammable (<100 F).
- Diesel.
  - Flash point = 110 F.
  - Combustible (>100 F).

Slide 2-104

CRITICAL TEMPERATURES FOR LIQUID FUELS

Fuel	T_{FP}		T_{Auto}	
Propane	-104°C	-155°F	450	842°F
Gasoline	~ -45°C	~ -49°F	~ 371	~ 700°F
Acrolein	-26°C	-15°F	235	455°F
Acetone	-18°C	-0.4°F	465	870°F
Methanol	-12°C	10°F	385	725°F
Ethanol	13°C	55°F	363	685°F
Kerosene	~ 49°C	120°F	~ 260	~ 500°F
M-Creosol	86°C	187°F	559	1,038°F
Formaldehyde	93°C	199°F	430	806°F

Table 4-1: Quintiere, "Principles of Fire Behavior," 1998, p. 67

Slide 2-105

R. The dotted line on Slide 2-105 signifies that the flash point temperature is above normal room temperature.

1. Combustible liquid — classification of any liquid that has a closed-cup flash point at or above 100 F.

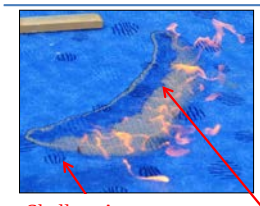
2. Flammable liquid — any liquid that has a closed-cup flash point below 100 F.

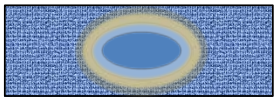
EFFECT OF DIFFERENT FLASH POINTS

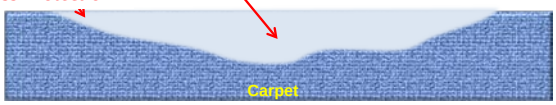
Video clip from NFPA "Fire Ignition and Development."

Slide 2-106

ANATOMY OF A POOL FIRE







Slide 2-107

S. Information depicted on Slide 2-107 is important to understand so we correctly identify patterns.

GAS CAN JETTING

Case study courtesy of Adam St. John, Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF).

Slide 2-108

T. Gas can jetting case study.

IGNITION — SOLIDS

- Relevant factors:
  - Ignition temperature.
  - Incident heat flux.
  - Orientation and form.
  - Thermal inertia.
  - Ambient conditions.

Slide 2-109

U. Relevant factors:

1. Ignition temperature.
2. Incident heat flux.
3. Orientation and form.
4. Thermal inertia.
5. Ambient conditions.

IGNITION — SOLIDS (cont'd)

- Must be vaporized/pyrolyzed into gases and vapors: It is these vapors that are burning.
- Sufficient heat must be applied to decompose and vaporize the fuel.
- Heat must be applied over a period of time.
- Fuel and oxygen molecules must bond in "oxidation" reaction.

Slide 2-110

6. Must be vaporized/pyrolyzed into gases and vapors: It is these vapors that are burning.
7. Sufficient heat must be applied to decompose and vaporize the fuel.
8. Heat must be applied over a period of time.

9. Fuel and oxygen molecules must bond in “oxidation” reaction.

IGNITION — SOLIDS (cont’d)

- Different fuels will decompose at different rates and ignite at various points.

Slide 2-111

IGNITION — SOLIDS (cont’d)

- Pyrolysis is the thermal decomposition of a material when heated.
- Irreversible chemical reaction.
- Formation of vapors and char.
- Examples:
  - Wood.
  - Wool.
  - Thermoset plastics (polyurethane foams, polyesters, phenolic foams).

Slide 2-112

V. Melting: thermoplastics, candle wax.

W. Pyrolysis: wood or thermoset plastics.

IGNITION — SOLIDS (cont'd)

- Some solid materials melt when heated.
  - They can run, drip and create a pool.
- Additional heat will produce vapors.
- Examples:
  - Candle wax.
  - Thermoplastic polymers (polyethylene, polypropylene, polystyrene, polyvinyl chloride (PVC), nylon).

Slide 2-113

"ATF THERMOPLASTICS" VIDEO

Slide 2-114

PYROLYSIS

Slide 2-115

"NIST SOFA" VIDEO

Slide 2-116

IGNITION — SOLIDS (cont'd)

- Piloted ignition temperature range.
  - Approximately 270 C to 450 C (518 F to 842 F).
    - -- (NFPA 921, Section 5.7.4.2.1, 2011).
- AIT range.
  - Approximately 400 C to 600 C (752 F to 1,112 F).
    - -- (NFPA 921, Section 5.7.4.3, 2011).

Slide 2-117

X. Kpc is most important thermal material property.

SOLID IGNITION TIME

The ignition time of a solid is a function of:

- Method of heating.
- Material properties.
- Material thickness.
- Shape of material (surface-to-mass ratio).

Slide 2-118

IGNITION TIMES — EXAMPLES

- 10-15 kW/m^2.
  - For most materials, this is critical radiant heat flux (with most test using 15-20 minutes).
- 7-8 kW/m^2.
  - Minimum radiant heat flux for smoldering ignition.

Heat Flux (KW/m^2)	Time (sec)	Material
10	300	Plexiglass PE foam
20	70 150 250	Wool carpet Gyp Brd Paper Particleboard
30	70 150	Nylon carpet Hardboard

Slide 2-119

HEAT FLUX FOR IGNITION

- Critical heat flux is the minimum radiant heat flux required for piloted ignition.
- For most materials, the critical radiant heat flux is in the range of 10 kW/m^2 to 20 kW/m^2.

Slide 2-120

HEAT FLUX — EXAMPLE

- Can an electric space heater ignite nearby combustibles?
- Must consider.
  - Heat flux from device.
  - Reflector.
  - Distance.
  - Target fuel.
  - Target fuel critical heat flux.
  - **Timeline.**

Slide 2-121

THERMALLY THIN MATERIALS

- During heating, entire thickness of solid is at about same temperature.
- Thickness — 1-2 millimeters (mm) or less.
- Examples: paper, sheer window treatments.

Slide 2-122

1. Examples of "thin" materials: single sheet of paper, drapes, garments, according to Quintiere in "Principles of Fire Behavior."

THERMALLY THICK MATERIALS

- During heating, temperature varies throughout the thickness of the material.
- Thickness — greater than 2 mm.
- Examples: wood desk, stack of papers.
- It is the same fuel, just in a different configuration.

Slide 2-123

2. Thick materials: wallpaper on plasterboard (composite assembly).

THERMAL INERTIA

- Fuel with high surface-to-mass ratio is much more readily ignitable than a fuel with a lower ratio.

Slide 2-124

3. It is the same fuel, just in a different configuration.

THERMAL INERTIA (cont'd)

- Thermal inertia.
  - Measure of how fast the surface temperature of a material will rise.
  - Related to the product of the materials:
    - Thermal conductivity (k) — capacity to conduct heat.
    - Density (ρ).
    - Heat capacity (c) — capacity to store heat.
  - Thermal inertia = kρc.

Slide 2-125

4. Polyurethane is an example of a low thermal inertia material.

   a. K — describes material's ability to conduct heat.

   b. P — describes material's density.

   c. C — describes material's ability to store heat.

SIMPLIFIED EFFECTS OF THERMAL INERTIA (KPC)

Material	kρc (kW^2-s/m^4-K^2)
Copper	1330
Polyethylene	0.625
Oak	0.324
PVC	0.235
Polyurethane	0.000952

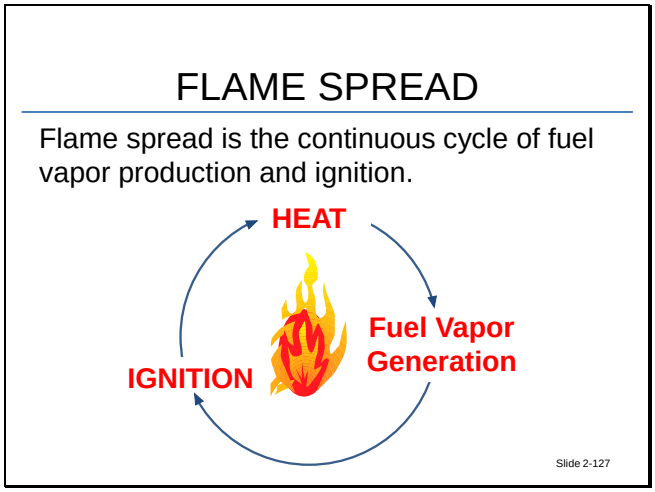
Low kρc
Surface heats rapidly
↓
Fast ignition

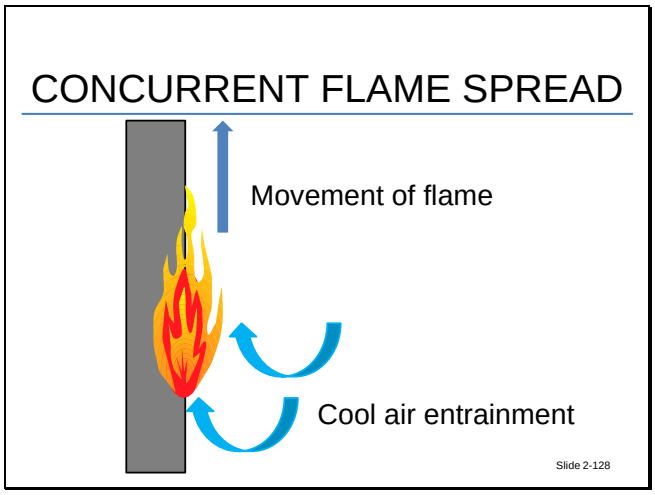
High kρc
Surface heats slowly
↓
Slow ignition

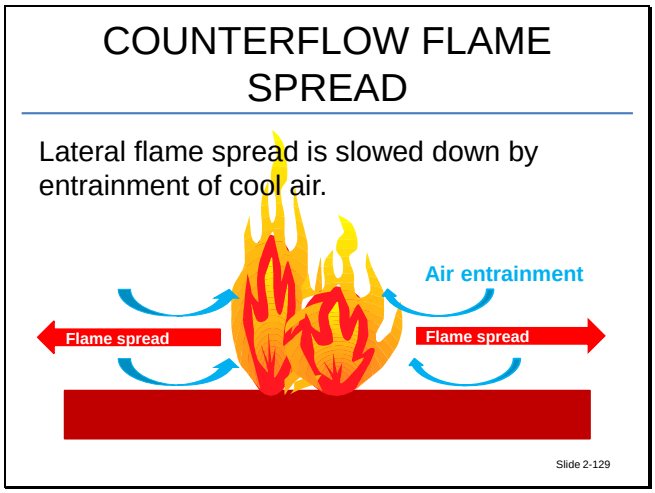
Slide 2-126

5. Materials with high thermal inertia (kρc) require more energy to raise their surface temperature.

IX. PHASES OF FIRE DEVELOPMENT







A. Lateral flame spread is slowed down by entrainment of cool air.

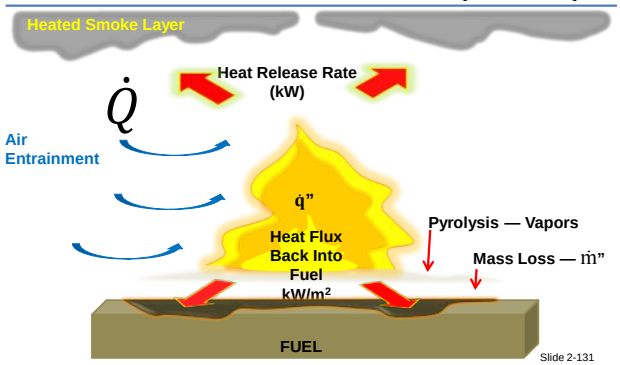
HEAT RELEASE RATE

- Heat release rate (HRR) — describes how energy in a fuel is released.
- HRR measures size of fire in watts (Joules/seconds) or kilowatts. $\dot{Q}$
- HRR is controlled by:
  - Fuel properties.
  - Fuel geometry.
  - Ventilation/Containment.

Slide 2-130

B. Heat release rate (HRR), also known as fire power, controls the size of the fire, and is measured in kilowatts, **not** temperature.

HEAT RELEASE RATE (cont'd)



Slide 2-131

WHY IS HEAT RELEASE RATE IMPORTANT TO ME?

The HRR of a fuel is important because we can use it to understand how fire conditions would change depending on the energy released from that fuel, or how it might involve adjacent nearby fuel packages.

Slide 2-132

C. Remember, a fuel is anything capable of burning (NFPA 921, Section 5.6.2, 2014 ed.). In early stages of a fire, fire growth is determined by fuel package's HRR.

TYPICAL PEAK HEAT RELEASE RATES

- Mattress (1,000 kW).
- Upholstered chair (1,500 kW).
- Sofa (3,000 kW).

Slide 2-133

SAMPLE PEAK HEAT RELEASE RATES

ITEM	kg	lbs.	HRR
Cigarette			0.005
Wastebasket, small	0.7-6.1	1.5-3	4-50
Trash bags, 42 L (11 gal) with mixed plastic/ paper trash	1.1-3.4	2½-7½	140-350
Cotton mattress	11.8-13.2	26-29	40-970
TV sets	31.3-32.7	69-72	120 to 1,500
Cotton easy chair	17.7-31.8	39-70	290-370
Gasoline/Kerosene in 0.185 m^2 (2 ft^2) pool			19-400
Christmas trees, dry	6-20	13-44	3,000-5,000
Polyurethane mattress	3.2-14.1	7-31	810-2,650
Polyurethane easy chair	12.2-27.7	27-61	1,350-1,990
Polyurethane sofa	51.3	113	3,120
Wardrobe, wood construction	70-121	154-267	1,900-6,400

Slide 2-134

D. Peak is largest possible value and should only be considered as a representative for comparison purposes.

HEAT RELEASE RATE (cont'd)

$$\dot{Q} = H_c \times \dot{m}$$

$\dot{Q}$	H_c	$\dot{m}$
HRR	Heat of combustion	Mass loss rate
kJ/sec	kJ/g	g/sec

- HRR ($\dot{Q}$) is equal to the heat of combustion of one gram of fuel times the number of grams of fuel that are burned.
- The quantity of heat released from a fuel during combustion.

Slide 2-135

1. HRR (Q) is equal to the heat of combustion of one gram of fuel times the number of grams of fuel that are burned.

2. The quantity of heat released from a fuel during combustion, according to the Babrauskas Ignition Handbook.

HEAT OF COMBUSTION

Fuel	Heat of Combustion (kJ/g)
Methane	50.0
Propane	46.5
n-Butane	45.7
Gasoline	43.7
Polypropylene	43.3
Kerosene	43.2
Polystyrene	39.8
Nylon 6/6	29.6
PVC	16.4
Wood	13-15
Carbon monoxide	10.1

(Table 6-3; Quintiere, "Principles of Fire Behavior," 1998, p. 111) Slide 2-136

E. On Slide 2-136, the materials at the top of the list have a high heat of combustion; because of their high heat of combustion values, we use them as fuels (methane, propane, butane, gasoline).

F. The materials at the bottom of the list have a lower amount of energy for the same mass.

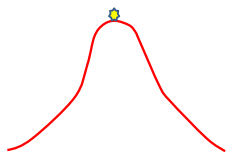
HEAT RELEASE RATE EXAMPLE

- In a gasoline fire that consumes about 8 grams of fuel per second, the HRR is 388 kilowatts.
  - $\dot{Q} = H_c \times \dot{m}$.
  - $\dot{Q}$ = 48.6 kJ/g × 8 g/sec.
  - $\dot{Q}$ = 388 kJ/s = 388 kW.

Slide 2-137

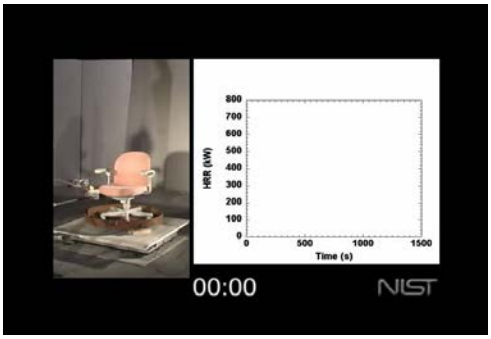
HEAT RELEASE RATE (cont'd)

- Fuels release heat in stages: an initial growth stage, a period of steady state burning, and a decay stage.
- The largest value of the HRR is defined as the peak HRR.



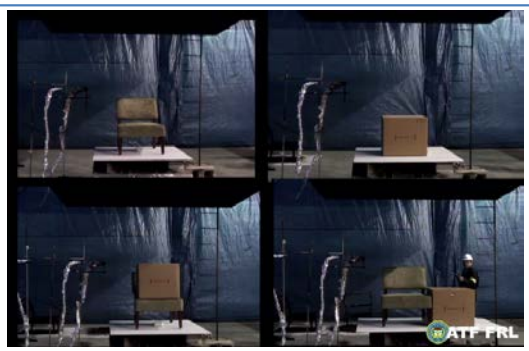
Slide 2-138

"NIST KILOWATT VALUE OF HRR" VIDEO



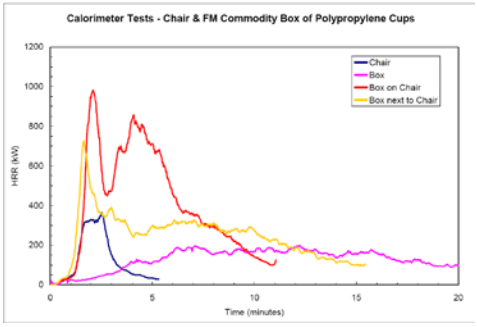
Slide 2-139

"ATF HEAT RELEASE CONFIGURATIONS" VIDEO



Slide 2-140

HEAT RELEASE RATE AND FUEL CONFIGURATION (cont'd)



Slide 2-141

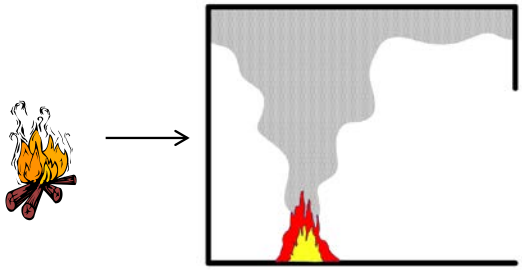
G. Note how the box on the chair peaks very high, but the burning duration is very short.

1. The packages that peak at lower values have a much longer burning duration.

2. Note the differences between the HRR of curves of the box on the chair versus the box next to the chair. The concurrent flame spread up from the chair to the box causes the peak HRR to be relatively high and overall has a short duration. The lateral flame spread when the box is placed next to the chair is slower, and therefore the peak HRR is less and the duration is longer.

X. COMPARTMENT FIRE DYNAMICS

COMPARTMENT FIRE DYNAMICS



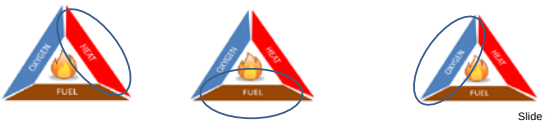
Slide 2-142

TYPICAL FIRE PROGRESSION

HEAT SOURCE REQUIRED

FUEL LIMITED FIRE

VENTILATION LIMITED FIRE



Slide 2-143

A. Note that this is the case today with modern furniture.

FACTORS THAT AFFECT FIRE GROWTH IN A COMPARTMENT

- Fuel (type, quantity, configuration).
- Ventilation.
- Volume of the enclosure.
- Ceiling height.
- Location of fuel relative to walls and corners.

Slide 2-144

COMPARTMENT FIRE DYNAMICS (cont'd)

- Compartment controls the spread and growth of the fire, its maximum burning rate, and its duration.
  - Thermal effects — increases burning rate due to additional radiation.
  - Ventilation effects — decreases burning rate due to limiting oxygen.

Slide 2-145

PLUME DEVELOPMENT

- A fire plume is the buoyant column of flame and hot combustion products rising above the fuel source (Quintiere, J. G. (1997). Principles of fire behavior. New York: Delmar Publishers).
- Characterized by:
  - Buoyancy.
  - Turbulence.
  - Entrainment.
  - Flame height.
  - Temperature.

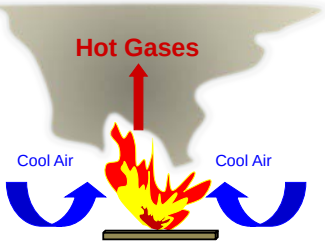
Slide 2-146

B. A fire plume is the buoyant column of flame and hot combustion products rising above the fuel source, according to Quintiere (Quintiere, J. G. (1997). Principles of fire behavior. New York: Delmar Publishers). Characterized by:

1. Buoyancy.
2. Turbulence.
3. Entrainment.
4. Flame height.
5. Temperature.

PLUME DEVELOPMENT (cont'd)

- Buoyancy and entrainment generally force a fire to move upward.



Slide 2-147

C. Fire is generally going to move upward/outward, not downward.

AIR ENTRAINMENT

- The process of air or gases being drawn into the fire plume.
- Air entrainment into the plume provides the oxygen necessary for continuing combustion.
- Controls flame height.
- Air pressure and equilibrium.

Slide 2-148

AIR ENTRAINMENT (cont'd)

- Pressure difference at neutral plane is zero.
- Neutral plane drops as hot gas layer drops.

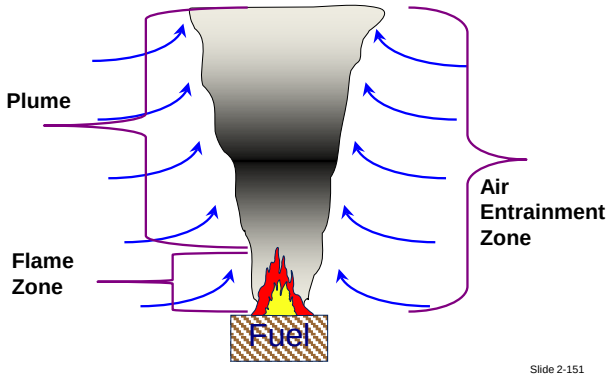
Slide 2-149

PLUME DEVELOPMENT (cont'd)

- Free burning flame.
- Development usually controlled by fuel at this point.
- Convection is dominant form of energy transfer.
- As plume develops, ventilation issues increasingly become important.

Slide 2-150

PLUME DEVELOPMENT FOR FREE BURNING FLAMES

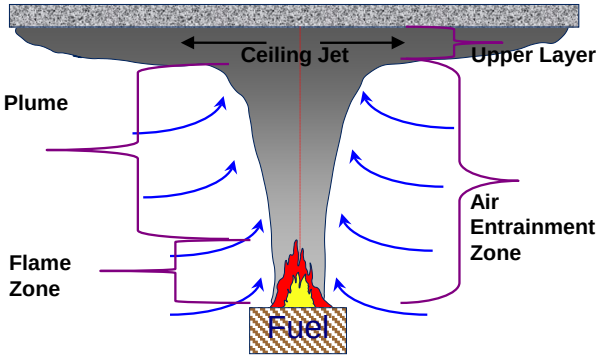


Slide 2-151

D. Plume gets wider due to entrainment. Eddy currents cause entrainment.

E. Entrainment occurs throughout the height of the plume, not just down at the base of the fire.

PLUME DEVELOPMENT FOR A FIRE IN A COMPARTMENT



Slide 2-152

F. Note symmetry — plumes and the jet created when the plume hits the ceiling are symmetric.

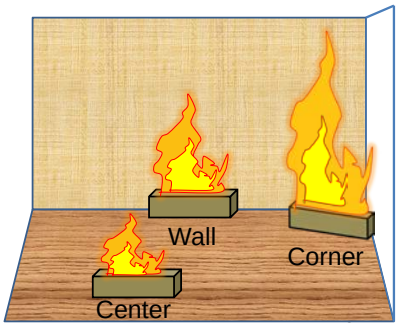
COMPARTMENT GEOMETRY AND FUEL PACKAGE LOCATION

- Air entrainment is a key factor in plume development.
- The location of a fuel package within a room will determine how much air it will entrain.
- It may also dictate flame height and development.

Slide 2-153

G. **5.6.4.6.1 Air Entrainment.** When a burning fuel package is positioned away from a wall, air is free to flow into the plume from all directions and mix with the fuel gases. If the fuel package is placed against a wall or in a corner (formed by the intersection of two walls), air entrainment into the plume can be restricted, creating an imbalance in the airflow. As a result of the imbalance in airflow, the flame and thermal plumes will bend toward the restricting surface(s).

AFFECT OF FIRE LOCATION ON FLAME LENGTH



Slide 2-154

H. The location of the burning fuel package dictates the length of the flame; the greater the flame length, the quicker the development of the ceiling layer, which rapidly aids in the onset of flashover.

1. If there is a corner configuration fire, it's reducing the airflow by three quarters.

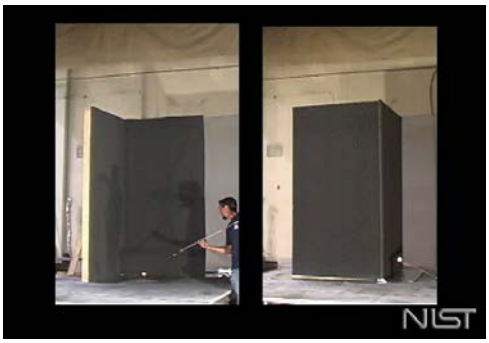
2. Fires in corner of compartment will grow more rapidly depending on oxygen availability.

3. Radiant heat will be reflected off nearby surfaces, which will further fire growth.

"VENTILATION AND FLAME HEIGHT" VIDEO

Slide 2-155

"NIST INSIDE AND OUTSIDE CORNER FIRE" VIDEO



Slide 2-156

VENTILATION

- Ventilation can significantly affect rate and area of fire spread.
- Investigators must understand the huge influence of ventilation on fires: It can create patterns and hide patterns.
- In a given fire scene, understanding ventilation is as important as understanding the fuel packages.

Slide 2-157

I. Understanding the involved fuel packages.

J. Investigators should be aware that in ventilation-controlled fires (post-flashover), ventilation plays a significant impact on the ability to see and interpret fire patterns relative to origin determination.

VENTILATION (cont'd)

- Key to ventilation is understanding buoyancy: Buoyancy will cause fire gases to travel to various places.
- Buoyant flows occur because hot gases are less dense than cooler gases.
- Air pressure may also play a small role: Gases typically flow from area of high pressure to low pressure.

Slide 2-158

VENTILATION (cont'd)

- Differences in pressure affected by:
  - Number of vents.
  - Size of vents.
  - Wind.
  - Heating, ventilating, and air conditioning (HVAC) operation.
  - Fire size and development.

Slide 2-159

MECHANICAL/NATURAL VENTILATION EFFECTS

Natural	HVAC
Ducts	Pumps air in and out of buildings
Shafts	HVAC ducts become "highways" for super heated gases
Interstitial spaces	Fans move smoke and heated gases
Nature (seeking pressure equilibrium)	
Windows, stairs, etc.	

Slide 2-160

SUPPRESSION VENTILATION EFFECTS

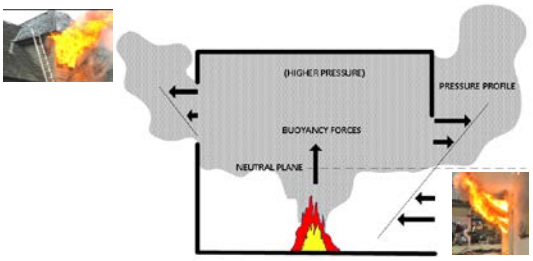
Aids in firefighting, but also affects fire gas movement as well as fire pattern production.

- Open door/windows.
- Cutting trench in roof.
- Fans.
- Fire curtains.

Slide 2-161

NEUTRAL PLANE

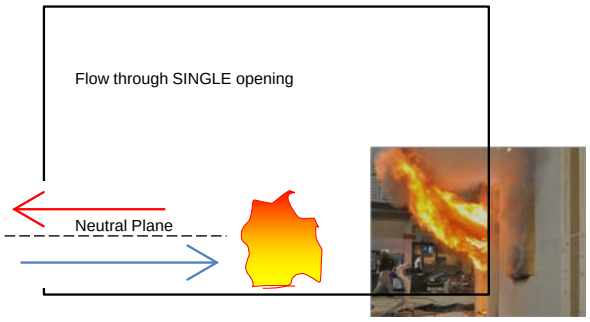
- Pressure difference at neutral plane is zero.
- Neutral plane drops as hot gas layer drops.



Slide 2-162

COMPARTMENT FIRE BIDIRECTIONAL FLOW

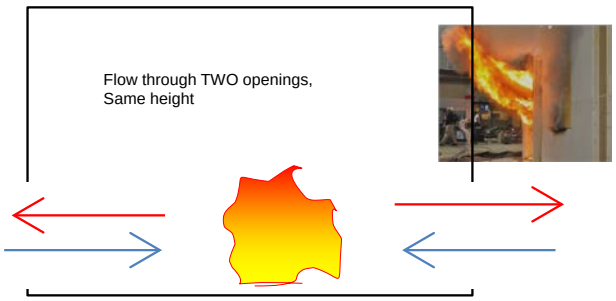
Flow through SINGLE opening



Slide 2-163

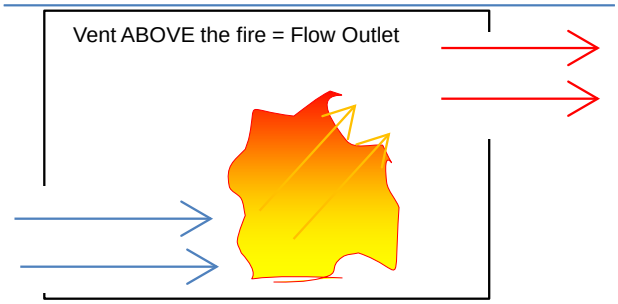
COMPARTMENT FIRE BIDIRECTIONAL FLOW (cont'd)

Flow through TWO openings,
Same height



Slide 2-164

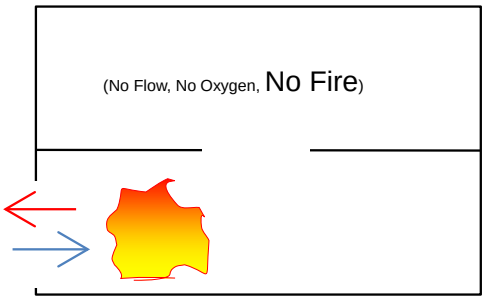
COMPARTMENT FIRE UNIDIRECTIONAL FLOW



Same two openings, Different heights

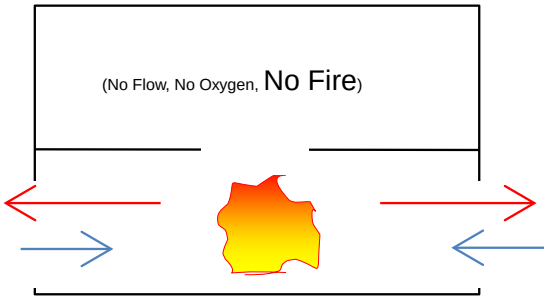
Slide 2-165

FLOW IN A STRUCTURE ONE OPENING (BIDIRECTIONAL)

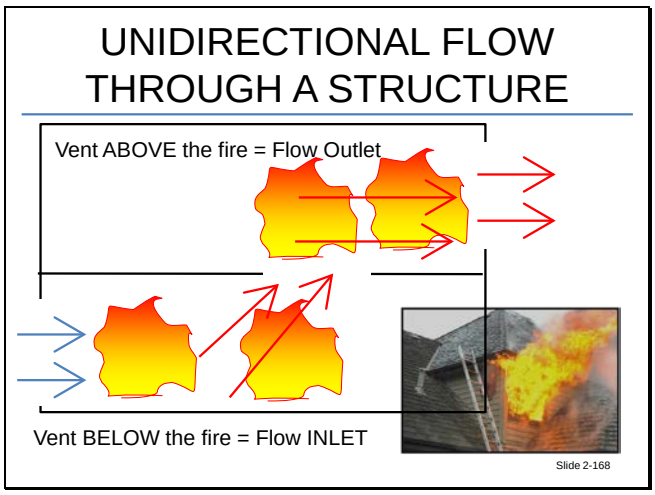


Slide 2-166

FLOW IN A STRUCTURE ONE OPENING (BIDIRECTIONAL) (cont'd)



Slide 2-167



XI. PHASES OF FIRE DEVELOPMENT (cont'd)

A. Flame spread rates for common fuels are documented in literature.

1. The rate is determined via prescribed tests using a wide variety of ignition sources.

2. Variety of valid tests.

3. Check literature for values!

FIRE GROWTH AND STAGE TERMINOLOGY

- Growth:
  - Incipient fire.
  - Established burning.
  - Preflashover (fire in a room).
  - Flashover transition (room on fire).
- Fully developed:
  - Post-flashover.
- Decay.

Note: Flashover is a game changer in the world of fire investigation.

Slide 2-171

INCIPIENT STAGE — EARLY FIRE GROWTH

Fire becomes established, plume reaches ceiling, ceiling jet begins to form.

Slide 2-172

B. "The beginning or incipient is the first stage of fire development after the moment of ignition. The flames are localized in the first fuel ignited, and a free-burning open flame is typical. The room has a normal oxygen content (about 21 percent) throughout, and the overall temperature has not yet begun to rise. There is a plume of hot gases rising from the flame. The contents of this plume will depend on the fuels being burned but usually include soot (carbon and other solids), water vapor, carbon dioxide, carbon monoxide, sulfur dioxide, and traces of other toxic gases" (Kirk's).

GROWTH — FREE BURNING

- Smoke filling may affect free burning.
- Once ceiling jet reaches walls, smoke layer banks down, filling the upper portion of the room.

Slide 2-173

C. "The fire grows in intensity as more fuel becomes involved. Convection and radiation spread the flames upward and outward from the initial fuel package until nearby fuels reach their ignition temperatures and begin to burn. Heat radiating from the flames may begin to bring other fuels to their ignition temperatures, spreading the fire laterally. The speed of this lateral spread is highly dependent on how close the other fuel packages are and their physical arrangement. The closer they are to one another, the faster the fire will spread and grow in heat release rate. Until the initial fire reaches a moderate size (around 200 kW), radiant heat transfer to target surfaces even a small distance (0.5 m) away is minimal, and most fire spread is driven by convective heat transfer above the fire and direct flame contact" (Kirk's).

SMOKE ESCAPES VENTS

Heat transfers to the wall by radiation and convection from the smoke layer.

Slide 2-174

APPROACH TO FLASHOVER

Radiant heat from smoke layer raises all fuels to near their ignition.

Slide 2-175

D. Provided enough fuel, heat and makeup air. Rollover will proceed flashover.

FLASHOVER

- Threshold for flashover is approximately 1,100 F.
- Heat flux of 20 kW/m^2 at **floor level.**

Slide 2-176

E. Threshold for flashover is approximately 1,100 F.

POST-FLASHOVER

- Ventilation controlled.
- All fuels are burning.
- HRR is controlled by ventilation now.
- In a post-flashover fire, the fire effects will be most vigorous adjacent to best ventilation, regardless of fuel package.

Slide 2-177

F. "A post-flashover fire in a typical room is usually a ventilation-controlled fire. The heat release rate of the fire is no longer controlled by how much of the exposed fuel is involved, because it is all on fire" (DeHaan and Icove, p. 61).

G. "Eventually, the available fuel is exhausted, and open-flame burning gradually becomes less and less prevalent. (During the fire, if the oxygen concentration drops much below 16 percent, open-flame combustion will decrease even in the presence of unburned fuel and may even cease completely at oxygen concentrations below 5 percent.) As an adequately ventilated fire dies down the amount of fuel vapors that remain to be pyrolyzed out of the solid fuels decreases, and the amount of flaming combustion dies back. As a result, smoldering combustion becomes predominant, which can continue as long as there is suitable fuel. This decay stage is often called the "smoldering" phase of a room fire. High temperatures may continue as long as there is suitable fuel, depending on the ventilation and insulation present. Some products continue to pyrolyze to form carbon monoxide and other gaseous fuels as well as toxic gases, solid soot, liquid aerosols, and other fuels in the form of smoke. If the room is not adequately ventilated, these combustion products can build up to form an ignitable vapor mixture. When a supply of fresh air is introduced in the presence of an ignition source, such vapor accumulations can deflagrate into a secondary fire, sometimes called a backdraft, flashback or smoke explosion. This ignition can proceed with explosive speed" (DeHaan and Icove, p. 62).

UNDERSTANDING FLASHOVER

Slide 2-179

FLASHOVER (cont'd)

- "A transition phase in the development of a compartment fire in which surfaces exposed to thermal radiation reach ignition temperature more or less simultaneously and fire spreads rapidly throughout the space, resulting in full room involvement or total involvement of the compartment or enclosed space" (NFPA 921, Section 3.3.83, 2014 ed.).

Slide 2-180

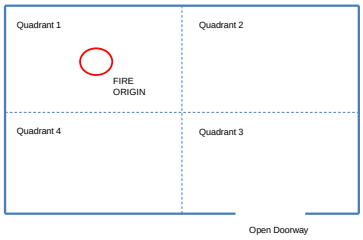
H. A more common and simpler definition that can be used by investigators to explain this phenomena is a transition from fire in a room to a room on fire.

RULE OF THUMB

Post-flashover fires	Preflashover fires
Ventilation limited	Fuel limited
Fire damage is mostly controlled by the location of **ventilation**	Fire damage is mostly controlled by the location of **fuels**

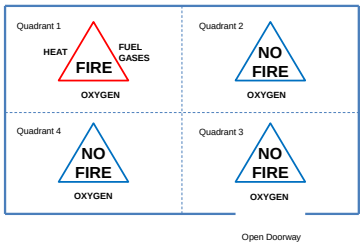
Slide 2-181

COMPARTMENT FIRE EXAMPLE



Slide 2-182

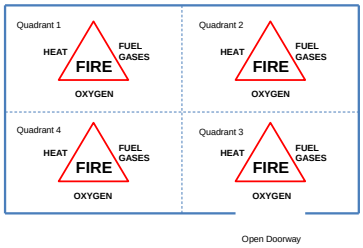
COMPARTMENT FIRE EXAMPLE (cont'd)



Preflashover Compartment Fire Conditions

Slide 2-183

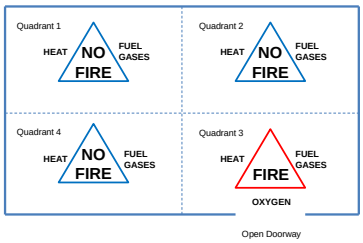
COMPARTMENT FIRE EXAMPLE (cont'd)



Flashover Compartment Fire Conditions

Slide 2-184

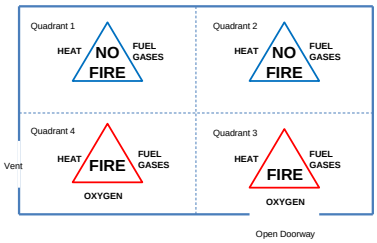
COMPARTMENT FIRE EXAMPLE (cont'd)



Post-Flashover Compartment Fire Conditions

Slide 2-185

COMPARTMENT FIRE EXAMPLE (cont'd)

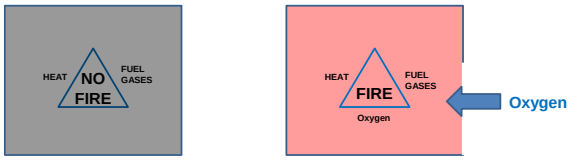


What if a new vent occurs (e.g., window breaks)?
Post-Flashover Compartment Fire Conditions

Slide 2-186

BACKDRAFT

A deflagration resulting from the sudden introduction of air into a confined space containing oxygen deficient products of incomplete combustion (NFPA 921, 2014).



Slide 2-187

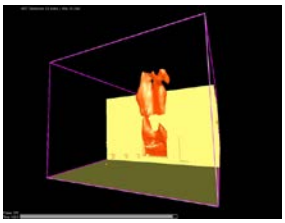
"ATF COMPARTMENT FIRE GROWTH" VIDEO

Slide 2-188

FIRE MODELS

Developed as predictive tool to estimate:

- Temperature.
- Smoke movement.
- Fire growth rate.
- Fire endurance.
- Detector or sprinkler response.
- Occupant evacuation times.



Slide 2-189

I. Developed as predictive tool to estimate:

1. Temperature.
2. Smoke movement.
3. Fire growth rate.
4. Fire endurance.
5. Detector or sprinkler response.
6. Occupant evacuation times.

USE OF FIRE MODELING

- To test if physical fire scene is consistent.
- Is witness information consistent?
- Fire dynamics — test hypothesis; could the fire start and spread in a certain manner.
- Satisfies testing under the scientific method!

Slide 2-190

FIRE MODELING

- Physical — live burns.
- Numerical — computations.

Slide 2-191

J. **Limitations of Mathematical Modeling.** Mathematical modeling, whether simplified hand calculations or computer fire models, has inherent limitations and assumptions that should be considered. Models generally rely upon empirical data and are validated via comparison with other empirical data. Care must be taken to ensure that the model is being used with due regard for limitations, assumptions and validation. While computational models can be used to test hypotheses, models should not be used as the sole basis of a fire origin and cause determination (NFPA 921, Section 20.4.1.3, 2014 ed.).

K. **20.4.1.6.** Results of mathematical models are subject to uncertainties resulting from approximations made within the model. The uncertainties introduced by modeling approximations should be considered in hypothesis testing. Information on modeling uncertainties is typically included in validation and verification (V & V) documents.

WHAT PRACTICAL HAND CALCULATIONS CAN ASSIST MY INVESTIGATION?

- Flame height.
- Conversely, estimating HRR from flame height.
- Minimum fire to cause flashover.

Slide 2-192

WHAT FLAME HEIGHT CAN BE REALIZED FROM A SPECIFIC FUEL?

For example, does your fuel release enough energy (fire) to cause the damage you are seeing?

Slide 2-193

CALCULATING FLAME HEIGHTS

$$L_f = 0.23\,\dot{Q}^{2/5} - 1.02\,D$$

- L_f = flame height in meters.
- $\dot{Q}$ = HRR in kilowatts.
- D = flame base diameter in meters.

Slide 2-194

FLAME HEIGHT EXAMPLE

What is the flame height for an 1,800 kW fire of 2 meter diameter?

- $L_{flame} = 0.23(\dot{Q})^{2/5} - 1.02(D)$.
- $L_{flame} = 0.23(1{,}800)^{2/5} - 1.02(2)$.
- $L_{flame} = 0.23(20) - 2.04$.
- $L_{flame} = 4.61 - 2.04 =$ **2.57 meters.**
- $L_{flame} = 2.57$ m x 3.3 ft/m = **8.5 feet.**

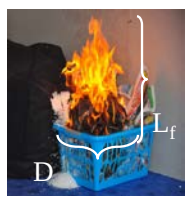
Slide 2-195

CALCULATE HEAT RELEASE RATE

Rearrange flame height equation.

$$\dot{Q} = \left[\frac{L_f + 1.02\ D}{0.23}\right]^{5/2}$$

$\dot{Q}$ = HRR in kilowatts.
L_f = flame height in meters.
D = flame diameter at base in meters.



Slide 2-196

HEAT RELEASE RATE EXAMPLE (cont'd)

- What is the HRR of a flame that is 2 meters wide by 2.6 meters tall?

$$\dot{Q} = \left[\frac{L_f + 1.02\ D}{0.23}\right]^{5/2}$$

$$\dot{Q} = \left[\frac{2.6 + 1.02\ (2)}{0.23}\right]^{5/2}$$

$$\dot{Q} \approx 1800\ \text{kW}$$

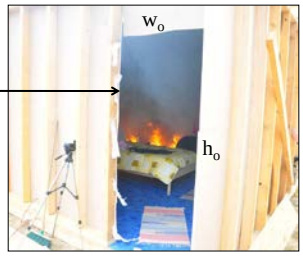
Slide 2-197

MINIMUM FIRE TO CAUSE FLASHOVER

$$\dot{Q} = (750\ A_o)\ (h_o)^{0.5}$$ (Babrauskas)

- $A_o = h_o w_o$.
- $\dot{Q}$ = kW.

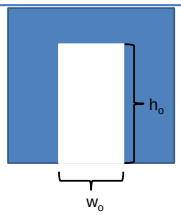
Width, height of vent in meters.



Slide 2-198

HEAT RELEASE RATE REQUIRED FOR FLASHOVER EXAMPLE

h_o = 2 m (78 inches).
w_o = 0.91 m (36 inches).



$$\dot{Q} = (750\ A_o)\ (h_o)^{0.5}$$

$$\dot{Q} = [(750\ (2)\ (0.91)](2)^{0.5} = (1365)\ (1.414)$$

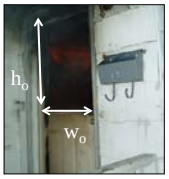
$$\dot{Q} \approx 1900\ \text{kW}$$

Slide 2-199

MINIMUM FIRE TO CAUSE FLASHOVER (cont'd)

$$\dot{Q} = (378 A_o)\ (h_o)^{0.5} + 7.8\ A_w$$

- Alternative formula where room dimensions are known (Thomas Flashover Correlation).
- Uses some elements of previous equation but adds room dimensions.
  - A_w = Area of walls, ceiling and floor (m^2).



Slide 2-200

CONCLUSION

Now you should have the basic understanding of the following items as they relate to fires:

- Energy.
- Heat transfer.
- Fire chemistry.
- Products of combustion.
- Fuels.
- Flames.
- Ignition.
- Flame spread.
- Fire growth.
- Plumes and ceiling jets.
- Compartment fires.
- Calculations.

Slide 2-201

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ACTIVITY 2.2

Flashover Demonstration Instructor-Led Burn Activity

Purpose

See the various stages of a compartment fire, growth and development, from ignition (incipient stage) to decay (smoldering stage).

Safety Precautions

Ensure that all loose clothing is tucked in and all hair is tied back.

Directions

1. You will observe two identical compartment fires; one compartment is accelerated with an ignitable liquid, and the other is nonaccelerated. Ignition for both cells is an open flame.

2. The instructor will explain the concepts within this demonstration.

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XII. SUMMARY

SUMMARY

- Fire chemistry.
- Fuels.
- Oxidizers.
- Types of combustion.
- Fuel versus ventilation-controlled fires.
- Heat transfer.
- Heat flux.
- Ignition.

Slide 2-203

SUMMARY (cont'd)

- Phases of fire development.
- Compartment fire dynamics.

Slide 2-204

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UNIT 3: ORIGIN AND CAUSE

TERMINAL OBJECTIVE

The students will be able to:

3.1 Evaluate and analyze a fire scene using a systematic method to determine the origin and cause of the fire.

ENABLING OBJECTIVES

The students will be able to:

3.1 Examine a structure from the exterior to interior in a systematic manner to identify indicators that may help determine the area of fire origin and cause.

3.2 Explain the significance of various fire patterns, fuel packages, and fire spread issues.

3.3 List the most common indicators and considerations that help identify the origin and cause of a fire.

3.4 List the four types of information that can assist in determining the origin of a fire as outlined in National Fire Protection Association (NFPA) 921, Guide for Fire and Explosion Investigations.

3.5 Explain the proper use of the process of elimination as it relates to fire cause determination.

3.6 Describe how spoliation and contamination can affect potential evidence in a fire investigation.

3.7 List common accidental and incendiary fire causes.

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UNIT 3:
ORIGIN AND CAUSE

Slide 3-1

ENABLING OBJECTIVES

- Examine a structure from the exterior to interior in a systematic manner to identify indicators that may help determine the area of fire origin and cause.
- Explain the significance of various fire patterns, fuel packages, and fire spread issues.

Slide 3-2

ENABLING OBJECTIVES (cont'd)

- List the most common indicators and considerations that help identify the origin and cause of a fire.
- List the four types of information that can assist in determining the origin of a fire as outlined in National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations.*

Slide 3-3

ENABLING OBJECTIVES (cont'd)

- Explain the proper use of the process of elimination as it relates to fire cause determination.
- Describe how spoliation and contamination can affect potential evidence in a fire investigation.
- List common accidental and incendiary fire causes.

Slide 3-4

I. WHY ARE FIRES INVESTIGATED?

WHEN PEOPLE THINK OF FIRE

Most Do Not Realize …

Slide 3-5

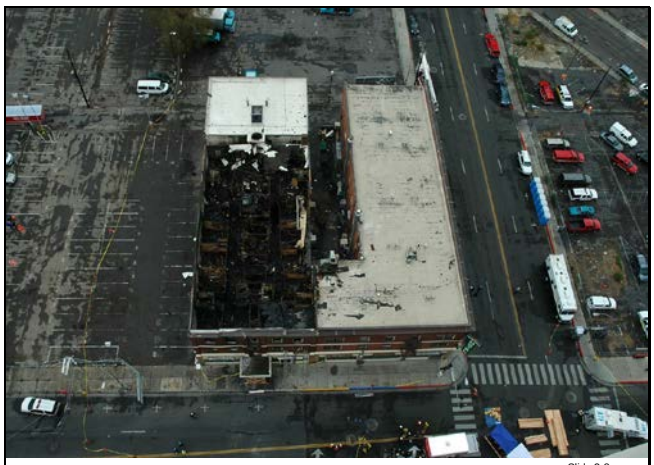
A. Most people, like the judge, jury, witnesses, prosecutors, etc., think that fire is such a devastating event that all evidence is destroyed. However, we know that this is not so. Even in large, devastating fire scenes like this one involving a firefighter fatality, a small spring from a self-contained breathing apparatus (SCBA) unit was found.

Slide 3-6

B. Garage fire — simple right? We need to bring order to the devastation and chaos; that is our job as fire investigators. See next slide to see when we bring order to the fire scene by processing this.

Slide 3-7

C. Because all that is located in area is electric in this location means the classification is accidental/electrical. Right? Wrong!



Slide 3-8

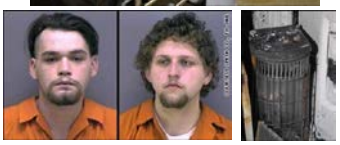
D. Again, note massive devastation inside multioccupancy. Compound this with 12 deaths. Next slide was the level to which it was processed.

Slide 3-9

E. You will learn more about processing the scene and reconstruction through this block.

WHY DO WE NEED TO INVESTIGATE FIRES?

- Criminal act.
- Fire prevention/ public safety.
- Civil liability.
- Product failures.



Slide 3-10

F. Firefighter fatality at Medical Examiner's (ME's) office, accidental fire.

1. Two suspects arrested in serial church arsons in Tyler, Texas.

2. Electric heater inside accidental fire scene.

WHAT IS A FIRE INVESTIGATOR?

Slide 3-11

G. An individual with specific knowledge, skills and abilities (KSAs) that enable the determination of fire origin and causation.

NATIONAL FIRE PROTECTION ASSOCIATION 1033, *STANDARD FOR PROFESSIONAL QUALIFICATIONS FOR FIRE INVESTIGATOR*

Fire investigator: "an individual who has demonstrated the skills and knowledge necessary to conduct, coordinate, and complete a fire investigation" (NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, Section 3.3.4, 2014 ed.).

Slide 3-12

H. A fire investigator is defined as "an individual who has demonstrated the skills and knowledge necessary to conduct, coordinate, and complete a fire investigation" (National Fire Protection Association (NFPA) 1033, *Standard for Professional Qualifications for Fire Investigator*, Section 3.3.4, 2014 ed.).

NATIONAL FIRE PROTECTION ASSOCIATION 921

An expert witness is generally defined as "someone with sufficient skill, knowledge or experience in a given field so as to be capable of drawing inferences or reaching conclusions or opinions that an average person would not be competent to reach. The expert's opinion testimony should aid the judge or the jury in their understanding of the fact at issue and thereby aid in the search for the truth" (NFPA 921, Section 12.5.2.3.2, 2014 ed.).

Slide 3-13

I. An expert witness is defined as "someone with sufficient skill, knowledge or experience in a given field so as to be capable of drawing inferences or reaching conclusions or opinions that an average person would not be competent to reach. The expert's opinion testimony should aid the judge or the jury in their understanding of the fact at issue and thereby aid in the search for the truth" (NFPA 921, Section 12.5.2.3.2, 2014 ed.).

II. DUTIES OF AN EXPERT WITNESS

DUTIES OF AN EXPERT WITNESS

- Bring the scene into the courtroom.
- Explain technical details in simple terms.
- Qualify as an expert.
- Likely face opposing experts.

Slide 3-14

A. Expert witnesses will:

1. Bring the scene into the courtroom.
2. Explain technical details in simple terms.
3. Qualify as an expert.
4. Likely face opposing experts.

POTENTIAL AUDIENCES

Slide 3-15

B. Remember, it is not just the report where you classify a fire that needs to be projected to a jury at the end of the day. Handle every fire like it will see the inside of a courthouse.

BASIS OF OPINIONS

Opinions must be based on factual data, tested and approved principles of science, and:

- Scene observations.
- Witness statements.
- Evidence.
- Testing.

Slide 3-16

C. Opinions must be based on factual data, tested and approved principles of science, and:

1. Scene observations.
2. Witness statements.
3. Evidence.
4. Testing.

III. FIRE SCENE INVESTIGATION (METHODOLOGY)

FIRE SCENE INVESTIGATION

Proper scene investigation consists of:

- Establishing area of origin.
- Identifying circumstances that brought the fuel and the ignition source together.

Slide 3-17

A. Used to be called “cause and origin,” but consciously changed to “origin and cause” to reflect a more accurate term of what we do.

SYSTEMATIC APPROACH

- Use a “systematic approach.”
  - The same method every time regardless of size or type of fire event.
- Work from areas of least to most damage (caveat applies!).
- Identify origin first, then cause.

Slide 3-18

SYSTEMATIC APPROACH (cont’d)

- Make sure your documentation reflects the systematic approach.
- You will be testifying to this “systematic approach” in court.
- You will always use the scientific method as part of your systematic approach.

Slide 3-19

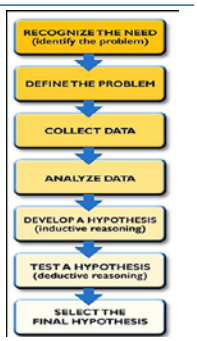
B. Make sure your documentation reflects the systematic approach.

C. You will be testifying to this “systematic approach” in court.

D. You will always use the scientific method as part of your systematic approach.

FIRE INVESTIGATION METHODOLOGY

- Use the scientific method to collect data, analyze, develop hypothesis and test hypothesis.



E. The organizational and analytical process necessary in a successful fire investigation **(i.e., scientific method).**

1. The scientific method is the fundamental framework required to be used by investigators throughout the investigative process.

2. The systematic collection and analysis of data are the cornerstone of the investigative process and the most critical steps in the application of the scientific method.

FIRE INVESTIGATION METHODOLOGY (cont'd)

- Use of the scientific method dictates that any hypothesis formed from an analysis of the data collected in an investigation must stand the challenge of examination (proof).

Slide 3-21

F. Use of the scientific method dictates that any hypothesis formed from an analysis of the data collected in an investigation must stand the challenge of examination (proof).

FIRE INVESTIGATION METHODOLOGY (cont'd)

- Investigators should document data for future testing and keep an eye out for exemplars/comparison samples.
- Avoid destructive testing.
- All investigations require testing of some kind.

Slide 3-22

G. Investigators should document data for future testing and keep an eye out for exemplars/comparison samples.

H. Avoid destructive testing.

I. All investigations require testing of some kind.

J. Comparison samples may also include exemplar appliances, devices or material. But be mindful of potential civil litigation and spoliation of evidence.

K. Hypothesis testing should be designed to disprove it. Investigators designing tests to prove a hypothesis are engaging in confirmation bias, which is unacceptable!

PRESUMPTION

"Avoid presumption. Until data has been collected, **no** specific hypothesis can be formed or tested. All fire or explosives incidents should be approached by the investigator **without** presumption as to origin or cause until the scientific method yields testable hypothesis which cannot be disproved."

— NFPA 921, Section 4.3.7, 2014 ed.

Slide 3-23

L. Remember that until you have selected a final hypothesis you are always collecting data.

M. At this time, it is with a reasonable degree of fire investigation certainty that this fire be classified as accidental per NFPA 921. The data contained in this investigation summary is true and accurate based on the information available at the time it was written. Findings, opinions and conclusion may change if additional information is discovered after this report is written. If new information is developed during the course of investigation, then conclusions should be reconsidered.

EXPECTATION BIAS

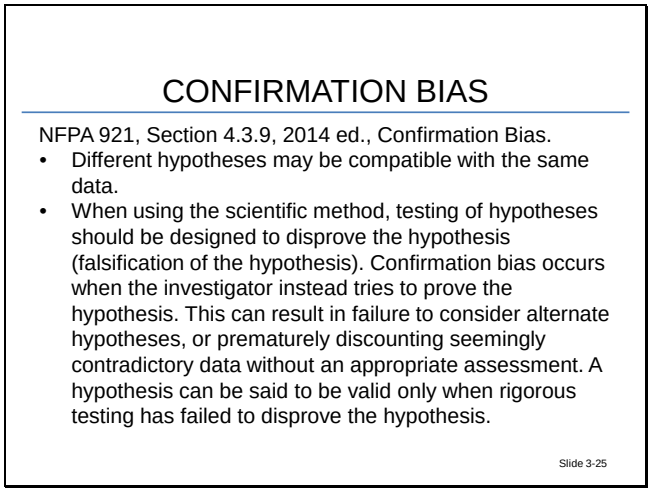
NFPA 921, Section 4.3.8, 2014 ed., Expectation Bias.

- A well-established phenomenon that occurs in scientific analysis when investigator(s) reach a premature conclusion without having examined or considered all of the relevant data.
- Expectation bias can be avoided through the proper use of the scientific method.

N. NFPA 921, Section 4.3.8, 2014 ed., Expectation Bias.

1. A well-established phenomenon that occurs in scientific analysis when investigator(s) reach a premature conclusion without having examined or considered all of the relevant data.

2. Expectation bias can be avoided through the proper use of the scientific method.



O. NFPA 921, Section 4.3.9, 2014 ed., Confirmation Bias.

1. Different hypotheses may be compatible with the same data.

2. When using the scientific method, testing of hypotheses should be designed to disprove the hypothesis (falsification of the hypothesis). Confirmation bias occurs when the investigator instead tries to prove the hypothesis. This can result in failure to consider alternate hypotheses, or prematurely discounting seemingly contradictory data without an appropriate assessment. A hypothesis can be said to be valid only when rigorous testing has failed to disprove the hypothesis.

IV. ORIGIN DETERMINATION

ORIGIN DETERMINATINON

- Origin **first,** then cause.
- Most important task of a fire investigator is to first identify where the fire started — the origin.
- May be the most difficult task in the investigation.
- Investigators cannot identify a cause until they have accurately identified the origin.

Slide 3-26

A. Origin first, then cause.

1. Most important task of a fire investigator is to first identify where the fire started — the origin.

2. May be the most difficult task in the investigation.

3. Investigators cannot identify a cause until they have accurately identified the origin.

ORIGIN DETERMINATION (cont'd)

- Methodology to be used to determine origin is the **scientific method.**
  - Hypotheses as to the area of origin should be generated and tested as data is collected and evaluated.
  - Consistency with data.

Slide 3-27

B. Methodology to be used to determine origin is the scientific method.

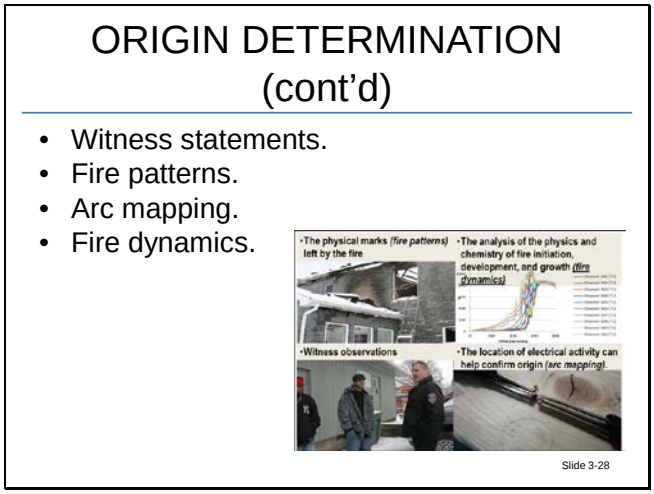
1. Hypotheses as to the area of origin should be generated and tested as data is collected and evaluated.

2. Consistency with data.

3. If hypothesis is disproved, then the investigator must test new hypotheses.

C. NFPA 921, Chapter 18, Section 18.1.1, 2014 ed.: This chapter deals primarily with the determination of origin involving structures; however, the methodology generally applies to all origin determinations. Separate chapters address the particular requirements for determining origin in nonstructure fire incidents (motor vehicles, boats, wildfire, etc.).

D. NFPA 921, Chapter 18, Section 18.1.2, 2014 ed.: Determination of the origin of the fire involves the coordination of information derived from one or more of the following:



1. Witness information — the analysis of observations reported by people who witnessed the fire or were aware of conditions present at the time of the fire.

2. Fire patterns — the analysis of effects and patterns left by the fire. (See Chapter 6.)

3. Arc mapping — the analysis of the locations where electrical arcing has caused damage and the documentation of the involved electrical circuits. (See Section 8.10.)

4. Fire dynamics — the analysis of the fire dynamics, that is, the physics and chemistry of fire initiation and growth (Chapter 5) and the interaction between the fire and the building's systems (Chapter 7).

E. Per NFPA 921, origin can be based on one of four factors. Can you think of others?

1. Ventilation.

2. Wind direction.

3. Fire suppression.

F. Do not be fooled by V patterns until you have collected all your data. That could just be a fuel package.

ORIGIN DETERMINATION WITNESS STATEMENTS

- Witness interviews are critical during the data collection phase(s).
- May occur before, during and after scene investigation.

Slide 3-29

G. Witness interviews are critical during the data collection phase(s). They may occur before, during and after scene investigation.

ORIGIN DETERMINATION WITNESS STATEMENTS (cont'd)

- Tactics.
- Fire location and spread.
- Condition of doors/windows.
- Placing evidence, people.
- Noises — smoke alarms, etc.

Slide 3-30

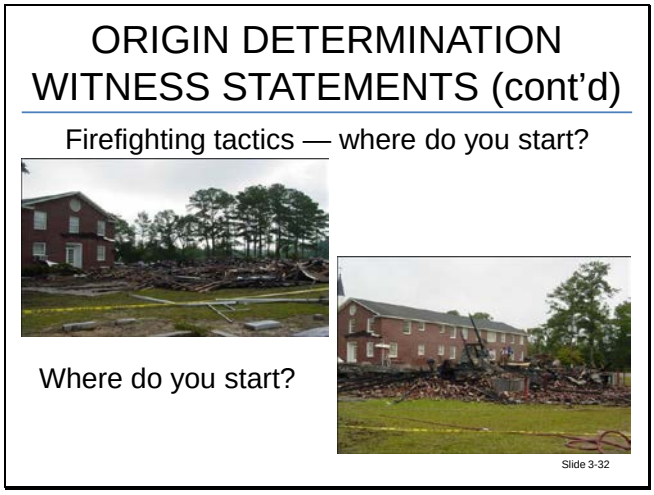
ORIGIN DETERMINATION WITNESS STATEMENTS (cont'd)

- Many firefighters have helmet cams, or their trucks have dash cams. They may hold crucial evidence that you would never have seen, the torch, area of origin, witnesses, etc.

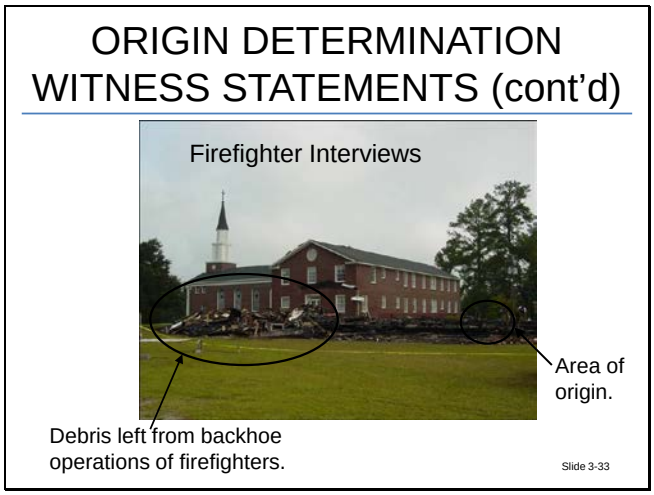
Slide 3-31

H. A copy of the fire department run report will give you responding companies and help develop a timeline from the 911 call until extinguishment.

I. Many firefighters have helmet cams, or their trucks have dash cams. They may hold crucial evidence that you would never have seen, the torch, area of origin, witnesses, etc.

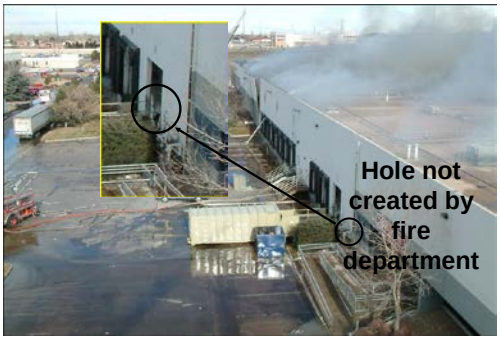


J. Without talking to firefighters, you may not realize that they brought in a backhoe during the fire and pulled the burning building away from the main sanctuary. Interview of firefighters revealed fire was initially burning in kitchen area, not at the end toward the sanctuary. Firefighters made entry into building.



K. When you conduct your walk around and work exterior to interior, you should notice the debris and the lack of damage in some of the areas around the debris. However, interviewing the firefighters can initially tell you where the fire was when they arrived.

NOTICE ANYTHING STRANGE?



Slide 3-34

L. From fireground photos, it was determined that a hole had been cut through one of the warehouse doors.

1. Interview of firefighters determined that no firefighters had cut this hole.

2. Upon arrival by investigators, this door had been torn down by firefighters so as to gain entry into building during fire suppression.

3. Without the fireground photos and the statements by the firefighters, this would have never been known or investigated.

ORIGIN DETERMINATION WITNESS STATEMENTS (cont'd)

- Prefire conditions should be documented.
- Owners, occupants, neighbors and employees are potential resources.
- Details include: contents (fuel load); state of disrepair; and status of fire detection and suppression systems, etc.

Slide 3-35

M. Prefire conditions should be documented. Make attempts to secure prefire photos for examination comparison. Owners, occupants, neighbors and employees are potential resources. Details include:

1. Contents (fuel load).

2. State of disrepair.

3. Status of fire detection and suppression systems, etc.

ORIGIN DETERMINATION WITNESS STATEMENTS (cont'd)

Slide 3-36

N. Photographs of the fireground and crowd may be crucial at another fire event or potentially a cold case.

O. Critical interviews include owners, witnesses and firefighters. These are at the heart of your circumstantial case.

ORIGIN DETERMINATION WITNESS INTERVIEWS

- Considered critical **data** — part of what is used to create or disprove hypotheses.
- Interviews are critical in composing a timeline.
- Interviews will be at the heart of any circumstantial cases.

Slide 3-37

1. Considered critical **data** — part of what is used to create or disprove hypotheses.

2. Interviews are critical in composing a timeline.

3. Interviews will be at the heart of any circumstantial cases.

ORIGIN DETERMINATION WITNESS INTERVIEWS (cont'd)

- How does the ignition scenario fit with witness observations?
- Fire dynamics.
- Ignition sources.
- Are the witness observations accurate?
- Hard versus soft times.
- Electronic verification?

Slide 3-38

ORIGIN DETERMINATION WITNESS STATEMENTS (cont'd)

- Interviewers should be those familiar with scene, investigation and dynamics.
  - May help identify other witnesses.
  - Walk through the scene.

Slide 3-39

P. Interviewers should be those familiar with scene, investigation and dynamics.

1. May help identify other witnesses.
2. Walk through the scene.

ORIGIN DETERMINATION WITNESS INTERVIEWS (cont'd)

- Must understand the motivation, background and mindset of the person being interviewed.
- How much weight should be given?
- Interviews must also be taken in context!

3. Must understand the motivation, background and mindset of the person being interviewed.

4. How much weight should be given?

5. Interviews must also be taken in context!

FIRE PATTERN IDENTIFICATION AND ANALYSIS

Slide 3-41

Q. NFPA 921, Section 17.1.2, determination of the origin of the fire involves the coordination of information derived from one or more of the following:

1. Witness information. The analysis of observations reported by people who witnessed the fire or were aware of conditions present at the time of the fire.

2. Remember: Witnesses lie; physical evidence does not.

DVD PRESENTATION

"NATIONAL FIRE PROTECTION ASSOCIATION FIRE PATTERNS"

Slide 3-42

ORIGIN DETERMINATION FIRE PATTERN ANALYSIS

- Fire effects versus fire patterns.
- Observable or measurable changes to materials.
- Fire effects create fire patterns.

Slide 3-43

R. Origin determination fire pattern analysis.

1. Fire effects versus fire patterns.
2. Observable or measurable changes to materials.
3. Fire effects create fire patterns.

V. FIRE EFFECTS

FIRE EFFECTS

Typically when wood or other combustible surfaces burn, they lose material and mass.

The surviving material often produces fire patterns, with distinct lines of demarcation/ shape/size, to be analyzed by the investigator.

Slide 3-44

FIRE EFFECTS (cont'd)

Slide 3-45

A. Example of mass loss of fuel packages.

FIRE EFFECTS (cont'd)

Slide 3-46

B. Examples of melting.

FIRE EFFECTS (cont'd)

- Thermoplastics versus thermoset plastics:
  - Thermoplastics soften and melt under exposure to heat and can reach a flowable state and maintain combustion.
  - Plastic materials that are hardened into permanent shape in the manufacturing process are not commonly subject to softening when heated. They will char but will not support flaming combustion.

Slide 3-47

C. Thermoplastics versus thermoset plastics.

1. Thermoplastics soften and melt under exposure to heat and can reach a flowable state and maintain combustion.

2. Plastic materials that are hardened into permanent shape in the manufacturing process are not commonly subject to softening when heated. They will char but will not support flaming combustion.

FIRE EFFECTS (cont'd)

Slide 3-48

D. Oxidation can form meaningful patterns that may direct one's attention to fire movement, intensity or ventilation points. Sometimes oxidation lines of demarcation become more evident over time.

FIRE EFFECTS (cont'd)

Slide 3-49

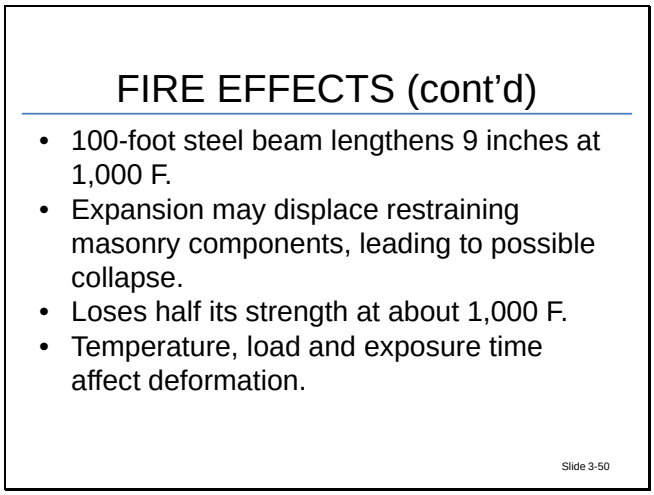
E. Quoted from NFPA 921, Section 6.2.9.1, 2014 ed.: Bending and buckling (deformation) of steel beams and columns occurs when the steel temperature exceeds approximately 500 C (900 F). At elevated temperatures, steel exhibits a progressive loss of strength. When there is a greater fire exposure, the load required to cause deformation is reduced. Deformation is not the result of melting. A deformed element is not one that has melted during the fire, and therefore the occurrence of such deformation does not indicate that the material was heated above its melting temperature. On the contrary, a deformed as opposed to melted item indicates that the material's temperature did not exceed its melting point. Thermal expansion can also be a factor in the bending of the beam, if the ends of the beam are restrained.

1. Studs, beams, columns and the construction components that are made of high-melting-point metals, such as steel, can be distorted by heating.

2. The amount and location of distortion in a particular metal construction can indicate which areas were heated to higher temperatures or for longer times.

3. Steel is the strongest material in common use, strong in both compression and tension. It will rust (oxidized) if exposed to air and moisture.

4. Steel is not fire resistive, and it is a good conductor of heat according to Malooly, 2010.



F. According to Malooly, consider things such as welds and rivets.

1. Rivets: shear failure due to expansion/displacement of adjoining members. If loose, it may have permanent deformation/strength reduction.

2. Any sagging, bending or stretching indicates immediate risk of failure!

3. Steel pipes may act in the same manner though copper takes more heat to expand.

FIRE EFFECTS (cont'd)

Materials	°F	°C
Aluminum	1,220	660
Copper	1,981	1,082
Brass (yellow)	1,710	932
Brass (red)	1,825	996
Bronze (aluminum)	1,800	982
Cast iron (gray)	2,460-2,550	1,350-1,400
Cast iron (white)	1,920-2,010	1,050-1,100
Plastic (polystyrene)	120-160	248-320
Steel	2,760	1,516

— NFPA 921, Section 6.2.8.2, 2014 ed.

Average turbulent flame = 1,500-1,800 F

Slide 3-51

G. Melting.

1. Quoted from NFPA 921, Chapter 6, Section 6.2.8.1, 2014 ed.: **General.** The melting of a material is a physical change caused by exposure to heat. The border between the melted and nonmelted portions of a fusible material can produce lines of heat and temperature demarcation that the investigator can use to define fire patterns.

2. Quoted from NFPA 921, Chapter 6, Section 6.2.8.2, 2014 ed.: Many solid materials soften or melt at elevated temperatures ranging from a little over room temperature to thousands of degrees. A specific melting temperature or range is characteristic for each material. (See Table 6.2.8.2.)

3. Quoted from NFPA 921, Chapter 6, Section 6.2.8.3, 2014 ed.: Melting temperatures of common metals range from as low as 170 C (338 F) for solder to as high as 1,460 C (2,660 F) for steel. When the metals or their residues are found in fire debris, some inferences concerning the temperatures in the fire can be drawn.

4. Quoted from NFPA 921, Chapter 6, Section 6.2.8.4, 2014 ed.: Thermoplastics soften and melt over a range of relatively low temperatures, from around 75 C (167 F) to near 400 C (750 F). Thus, the melting of plastics can give information on temperatures, but mainly where there have been hot gases and little or no flame in that immediate area. (See Figure 6.2.8.4.)

5. Quoted from NFPA 921, Chapter 6, Section 6.2.8.5, 2014 ed.: Glass softens over a range of temperatures. Nevertheless, glass can give useful information on temperatures during a fire.

FIRE EFFECTS (cont'd)

- 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 3-52

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

FIRE EFFECTS (cont'd)

- Clean burn is a term that is often used to explain effects produced by conductive heat or intense heat transfer to a noncombustible surface.
- Although clean burn can be indicative of intense heating, these areas by themselves do not necessarily indicate areas of origin.

Slide 3-53

FIRE EFFECTS (cont'd)

- Heat drives natural moisture content out of gypsum while the paper surface will char and may be consumed.

Slide 3-54

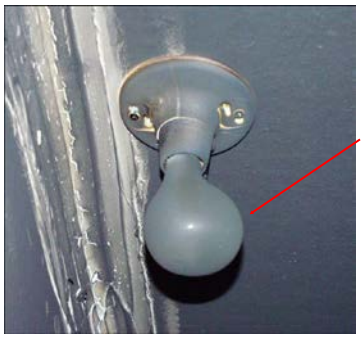
I. Note that the paper sheathing of gypsum acts as a fuel.

FIRE EFFECTS (cont'd)

- Variables affecting glass:
  - Type/Thickness of glass.
  - Rate of heating.
  - Degree of insulation to the edges of the glass provided by the glazing method.
  - Degree of restraint provided by the window frame.
  - History of the flame contact and cooling.

Slide 3-55

FIRE EFFECTS (cont'd)



Pulled toward heat source (over 25 watts)

Slide 3-56

J. Light bulbs greater than 25 watts (W) normally elongate toward the heat source. Wattages less than 25 W typically indent or "dimple inward."

FIRE EFFECTS (cont'd)

- The production of lines and areas of demarcation, and the subsequent fire patterns that they define, depend on:
  - Material properties.
  - The heat release rate (HRR) of the fire.
  - Fire suppression.
  - Ventilation.
  - Exposure time to heat.
  - Protected areas.

Slide 3-57

K. The production of lines and areas of demarcation, and the subsequent fire patterns that they define, depend on:

1. Material properties.

2. The heat release rate (HRR) of the fire.

3. Fire suppression.

4. Ventilation.

5. Exposure time to heat.

6. Protected areas.

L. Lines of demarcation are simply distinct lines between areas damaged versus undamaged.

VI. FIRE PATTERN ANALYSIS

FIRE PATTERN ANALYSIS (cont'd)

- Where fire dynamics and fire investigation meet.
- Patterns can be generated by:
  - Fire plume.
  - Ventilation effects.
  - Hot gas layer.
  - Full room involvement.
  - Suppression efforts.

Slide 3-59

A. Patterns can be generated by:

1. Fire plume.
2. Ventilation effects.
3. Hot gas layer.
4. Full room involvement.
5. Suppression efforts.

FIRE PATTERN ANALYSIS (cont'd)

- Fire patterns help record the fire event but may not be able to shed light on the sequence of pattern development.

Slide 3-60

B. Fire patterns help record the fire event but may not be able to shed light on the sequence of pattern development. Sometimes we will not be able to tell which pattern came first.

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-61

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-62

C. Damage created by flame, radiation, hot gases and smoke creates patterns that investigators use to help identify the area or point of origin.

FIRE PATTERN ANALYSIS (cont'd)

- Plume generated patterns:
  - V pattern.
  - Inverted cone pattern.
  - Hourglass pattern.
  - U-shaped patterns.
  - Pointer/Arrow patterns.
  - Circular-shaped patterns.

Slide 3-63

D. The shape of the plume is not **exclusive** proof of any one fact. Must be taken in context with other things such as fuels present, ventilation, fire intensity, etc.

FIRE PATTERN ANALYSIS (cont'd)

- Factors affecting plume patterns:
  - Fuel package.
  - Surface-to-mass ratio.
  - Fuel geometry.
  - Compartment geometry.
  - Ventilation.
  - Fire suppression.
  - Ambient conditions.

Slide 3-64

E. Factors affecting plume patterns:

1. Fuel package.
2. Surface-to-mass ratio.
3. Fuel geometry.
4. Compartment geometry.
5. Ventilation.
6. Fire suppression.
7. Ambient conditions.

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-65

F. The photograph depicts two cone patterns overlaying one another.

G. "Because the production of inverted cones, columns, and cones follows a sequence, these patterns usually overlay one another and the first pattern created is frequently obscured by the successor pattern" (Lentini).

FIRE PATTERN ANALYSIS — V PATTERN

Slide 3-66

H. Quoted from NFPA 921, Section 6.3.7.1, 2014 ed.: The V-shaped pattern is created by flames, convective or radiated heat from hot fire gases, or smoke within the fire plume … The V pattern often appears as lines of demarcation (Section 6.3.1.2) defining the borders of the fire effects.

FIRE PATTERN ANALYSIS — EXTERIOR V PATTERN

Slide 3-67

I. Example of exterior V pattern associated to fire auto ventilation.

FIRE PATTERN ANALYSIS — INVERTED CONE PATTERN

Slide 3-68

1. Quoted from NFPA 921, Section 6.3.7.2, 2014 ed.: Inverted cones are commonly caused by the vertical flame plumes not reaching the ceiling. The characteristic two-dimensional shape is triangular with the base at the bottom.

FIRE PATTERN ANALYSIS — TRUNCATED CONE PATTERN

Slide 3-69

2. Quoted from NFPA 921, Section 6.3.7.5, 2014 ed.: Truncated cone patterns, also called truncated plumes, are three-dimensional fire patterns displayed on both horizontal and vertical surfaces. It is the intersection or truncating of the natural cone-shaped or hourglass-shaped plume by these vertical and horizontal surfaces that causes the patterns to be displayed. Many fire patterns, such as V patterns, U patterns, circular patterns, and “pointer or arrow” patterns, are related directly to the three-dimensional cone of heat created by the fire.

FIRE PATTERN ANALYSIS — PLUME PATTERN

Slide 3-70

3. Quoted from NFPA 921, Section 6.3.7.3, 2014 ed.: The plume is a hot gas zone shaped like a V with a flame zone at its base. The flame zone is shaped like an inverted V. When the hot gas zone intersects a vertical surface, the typical V pattern is formed. If the fire itself is very close to or in contact with the vertical surface, the resulting pattern will show the effects of both the hot gas zone and the flame zone together as a large V above an inverted V.

FIRE PATTERN ANALYSIS — CIRCULAR PATTERN

Slide 3-71

4. Quoted from NFPA 921, Section 6.3.7.7, 2014 ed.: Patterns on the underside of horizontal surfaces, such as ceilings, tabletops, and shelves, can appear in roughly circular shapes. The farther the heat source is from the wall, the more circular the patterns may appear. Within the circular pattern, the center may show more heat degradation, such as deeper charring. By locating the center of the circular pattern, the investigator may find a valuable clue to the source of greatest heating, immediately below.

FIRE PATTERN ANALYSIS — U-SHAPED PATTERN

Slide 3-72

5. Quoted from NFPA 921, Section 6.3.7.4, 2014 ed.: U patterns are similar to the more sharply angled V patterns but display gently curved lines of demarcation and curved rather than angled lower vertices. The lowest lines of demarcation of the U patterns are generally higher than the lowest lines of demarcation of corresponding V patterns that are closer to the heat source.

FIRE PATTERN ANALYSIS — STRUCTURAL V PATTERN

- Based on consumption of material in a logical progression.
- May indicate presence of large fuel package, ventilation, and/or direction of fire travel.

Slide 3-73

6. Quoted from NFPA 921, Section 6.3.7.6, 2014 ed.: These fire patterns may be on a series of combustible elements such as wooden wall studs whose surface sheathing has been destroyed by fire. The direction of fire spread along a wall can often be identified and traced back toward its source by an examination of the relative heights and burned-away shapes of the wall studs left standing after a fire.

7. In general, shorter and more severely charred studs will be closer to a source of heat than taller studs. The heights of the remaining studs increase as distance from a source of fire increases.

FIRE PATTERN ANALYSIS — SADDLE-BURNED PATTERN

- U- or saddle-shaped patterns on top edges of floor joists.
- Caused by fire burning down through the floor above the affected joist.

Slide 3-74

8. Quoted from NFPA 921, Section 6.3.7.12, 2014 ed.: Saddle burns are distinctive U- or saddle-shaped patterns that are sometimes found on the top edges of floor joists. They are caused by fire burning downward through the floor above the affected joist. Saddle burns display deep charring, and the fire patterns are highly localized and gently curved. They also may be created by radiant heat from a burning material in close proximity to the floor, including materials that may melt and burn on the floor (e.g., polyurethane foam).

FIRE PATTERN ANALYSIS (cont'd)

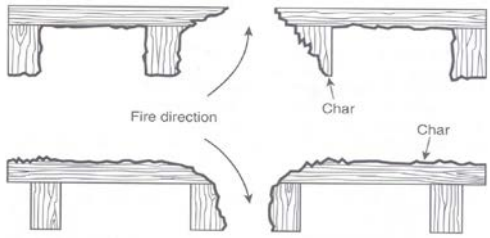


FIGURE 6.3.3.2 Burn Pattern with Fire from Above and Below.

Figure is found in NFPA 921, Section 6.3.5.2, 2014 ed.

Slide 3-75

J. Penetrations of horizontal surfaces.

1. Penetration of horizontal surfaces, from above or below, can be caused by radiant heat, direct flame impingement, or localized smoldering with or without the effects of ventilation, according to NFPA 921, Section 6.3.5., 2014 ed. (Figure is found in NFPA 921, Section 6.3.5.2, 2014 ed.)

a. Penetrations in a downward direction are often considered unusual because the more natural direction of heat movement is upward because of the buoyancy of heated gases.

b. In fully involved compartments, however, hot gases may be forced through small, pre-existing openings in a floor, resulting in a penetration.

c. Penetrations may also arise as the result of intense burning under furniture items such as polyurethane mattresses, couches or chairs.

d. Flaming or smoldering under collapsed floors or roofs can also cause floor penetrations, according to NFPA 921, Section 6.3.5.1, 2014 ed.

2. Whether a hole burned into a horizontal surface was created from above or below may be identified by an examination of the sloping sides of the hole.

a. Sides that slope downward from above toward the hole are indicators that the fire was from above.

b. Sides that are wider at the bottom and slope upward toward the center of the hole indicate that the fire was from below.

c. During the course of the fire, it is possible for both upward and downward burning to occur through a hole. The investigator should keep in mind that only the last burning direction through the hole may be evident (NFPA 921, Section 6.3.5.2, Figure 6.3.5.2, 2014 ed.).

3. Structural elements, such as studs or joists, can influence the patterns created by fire penetrating up or down or laterally through a building surface.

a. For example, a fire that moves upward through a floor may exhibit patterns significantly influenced by the joists, as opposed to a fire that moves downward through the same floor.

b. The investigator should keep in mind that only the last burning direction through the surface may be evident (NFPA 921, Section 6.3.5.3, 2014 ed.).

K. Ventilation.

FIRE PATTERN ANALYSIS (cont'd)

- Auto ventilation — caused by fire breaking through an obstruction such as window or roof.
- Mechanical ventilation — caused by fire department cutting hole in roof or breaking windows.

Slide 3-76

1. Auto ventilation — caused by fire breaking through an obstruction such as window or roof.

2. Mechanical ventilation — caused by fire department cutting hole in roof or breaking windows.

FIRE PATTERN ANALYSIS (cont'd)

- Where fresh air ventilation is available to a fire, it is not uncommon to find locally heavy damage patterns on combustible items.
- These patterns may be close to the ventilation opening, which may have no relevance to the point of origin.

Slide 3-77

3. Areas of greatest damage are indicators of a high HRR, ventilation effects, or long exposure.

4. Beware: Such areas are not always the point of fire origin!

FIRE PATTERN ANALYSIS — VENTILATION-GENERATED PATTERN

- Ventilation-generated patterns may be in areas that appear to have limited relation to other fire damage.
- Lack of ventilation may limit damage within an area of origin.

Slide 3-78

5. Ventilation-generated patterns may be in areas that appear to have limited relation to other fire damage.

6. Lack of ventilation may limit damage within an area of origin.

Heating, ventilating, and air conditioning (HVAC) unit supply and return vents may influence fire spread in a room.

What aided in the fire spread?

Slide 3-79

FIRE PATTERN ANALYSIS (cont'd)

- The investigator should identify these areas of low burning and be cognizant of their proximity to a point of origin.

Slide 3-80

L. Low burn pattern.

1. In a compartment where the fire has transitioned through flashover to the fully developed stage, burning down to floor level is not necessarily indicative of an origin at the floor level.

FIRE PATTERN ANALYSIS (cont'd)

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

Slide 3-81

2. The degree of damage generally will be uniform except where there is drop down, burning of isolated items that are easily ignited, or protected areas.

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-82

3. Fire suppression efforts may create and alter patterns on interior finishes.

FIRE PATTERN ANALYSIS (cont'd)

- Hot, burning or smoldering debris that may fall or drop down during the course of the fire event and produce observable patterns.
- May cause some investigators to misinterpret them as origin or multiple points of origin.

Slide 3-83

M. According to NFPA 921, Section 24.2.1.2, 2014 ed., separate fires that are not caused by multiple deliberate ignitions can result from the following:

1. Fire spread by conduction, convection or radiation.
2. Fire spread by flying brands.
3. Fire spread by direct flame impingement.
4. Fire spread by falling flaming materials (i.e., drop down) such as curtains.
5. Fire spread through shafts, such as pipe chases or air conditioning ducts.
6. Fire spread within wall or floor cavities within "balloon construction."
7. Overloaded electrical wiring.
8. Utility system failures.
9. Lightning.
10. Rupture and launching of aerosol containers.

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-84

N. Visual analysis of a floor pattern should not be the sole indicator of an ignitable liquid being used. Investigators should collect samples and send them to the laboratory for analysis and confirmation.

FIRE PATTERN ANALYSIS (cont'd)

Gasoline poured on carpet, ignition phase.

Pour pattern on carpet post-fire.

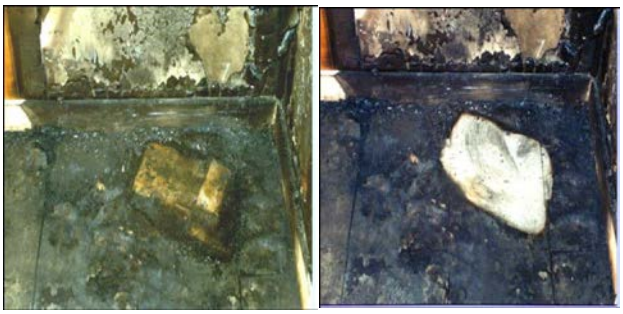
Slide 3-85

FIRE PATTERN ANALYSIS (cont'd)

Slide 3-86

O. Protected areas can be used by investigators in the fire scene reconstruction process to identify the prefire locations of various items.

FIRE PATTERN ANALYSIS (cont'd)



Slide 3-87

P. Protected areas.

1. Quoted from NFPA 921, Section 6.3.4.2, 2014 ed.: A protected area is an area that is closely related in appearance to the resulting pattern of heat shadowing. A protected area results from an object preventing the products of combustion from depositing on the material that the object protects, or prevents the protected material from burning. The object may be a solid or liquid, combustible or noncombustible. Any object that prevents the deposition of the products of combustion, or prevents the burning of the material, may produce a protected area.

FIRE PATTERN ANALYSIS (cont'd)

- The object blocking the travel of the heat energy may be solid, liquid, combustible or noncombustible.
- Any object that absorbs or reflects the heat energy may cause the production of a pattern on the material it protects.

Slide 3-88

2. The object blocking the travel of the heat energy may be solid, liquid, combustible or noncombustible.

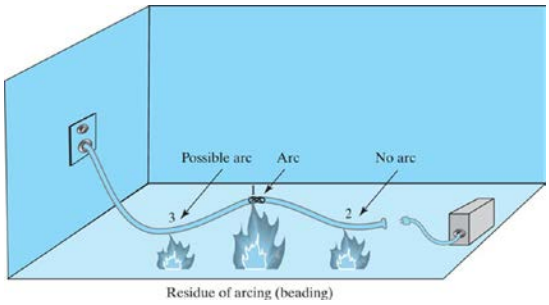
3. Any object that absorbs or reflects the heat energy may cause the production of a pattern on the material it protects.

ORIGIN DETERMINATION ARC FAULT MAPPING

Identify electrical arc sites to assist in the identification of the area of origin and analysis of fire spread.

Slide 3-89

ORIGIN DETERMINATION ARC FAULT MAPPING (cont'd)



Slide 3-90

Q. Origin determination arc fault mapping. At the arc, downstream heading toward two, there is no arc damage. However it is possible to have yet another arc at three because it is arcing back toward its power source there.

ORIGIN DETERMINATION FIRE DYNAMICS

- Fire growth and spread requires knowledge of:
  - Size and duration of fire from first fuel ignited.
  - Fuel packages present in room of origin.
  - Potential ignition sources in room of origin, including accidental sources.
  - Configuration and proximity of fuel packages.

Slide 3-91

R. Fire growth and spread requires knowledge of:

1. Size and duration of fire from first fuel ignited.
2. Fuel packages present in room of origin.
3. Potential ignition sources in room of origin, including accidental sources.
4. Configuration and proximity of fuel packages.

ORIGIN DETERMINATION FIRE DYNAMICS (cont'd)

- Fire growth and spread also requires knowledge of:
  - Floor, ceiling and wall finishes.
  - Construction methods.
  - Locations, sizes, and positions of doors and windows.
  - Room dimensions.
  - Firefighting activities.

Slide 3-92

S. Fire growth and spread also requires knowledge of:

1. Floor, ceiling and wall finishes.
2. Construction methods.
3. Locations, sizes, and positions of doors and windows.

4. Room dimensions.

5. Firefighting activities.

ORIGIN DETERMINATION FIRE DYNAMICS (cont'd)

- The characteristics of the material surface that contains the fire pattern will have a bearing on the shape and nature of the pattern itself.
- The shape and texture of the surface can affect the actual shape of the lines of demarcation displayed or increase or decrease the amount of pyrolysis.

Slide 3-93

T. Surface effects are the characteristics of the material surface that contain the fire pattern and will have a bearing on the shape and nature of the pattern itself.

U. The shape and texture of the surface can affect the actual shape of the lines of demarcation displayed or increase or decrease the amount of pyrolysis.

ORIGIN DETERMINATION FIRE DYNAMICS (cont'd)

- Post-flashover fires.
  - Ventilation limited.
  - Fire damage is mostly controlled by the location of **ventilation.**
- Preflashover fires.
  - Fuel limited.
  - Fire damage is mostly controlled by the location of **fuels.**

Slide 3-94

V. Exceptions to every rule.

1. Post-flashover fires.

   a. Ventilation limited.

   b. Fire damage is mostly controlled by the location of ventilation.

2. Preflashover fires.

   a. Fuel limited.

   b. Fire damage is mostly controlled by the location of fuels.

3. Investigators need to take into consideration the effects of post-flashover burning.

ORIGIN DETERMINATION FIRE DYNAMICS (cont'd)

- Many fires will burn into the post-flashover stage.
- Preflashover burn damage is generally dominated by the burning fuel locations.
- Areas of post-flashover burn damage are dominated by the location of vents/oxygen.

Slide 3-95

4. Many fires will burn into the post-flashover stage.

5. Preflashover burn damage is generally dominated by the burning fuel locations.

6. Areas of post-flashover burn damage are dominated by the location of vents/oxygen.

VII. FIRE INVESTIGATION CHRONOLOGY

FIRE INVESTIGATION CHRONOLOGY

Slide 3-96

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Receipt of assignment.
- Arrival at scene.
- Confer with incident command.
- Scene security.
- Assess needs.
- Scene examination.

Slide 3-97

A. Receipt of assignment.

B. Arrival at scene.

C. Confer with incident command.

D. Scene security.

E. Assess needs.

F. Scene examination.

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Scene documentation.
- Analysis, documentation and collection of evidence.
- Witness and subject interviews.
- Follow-up investigation.
- Origin-and-cause determination if possible.

Slide 3-98

G. Scene documentation.

H. Analysis, documentation and collection of evidence.

I. Witness and subject interviews.

J. Follow-up investigation.

K. Origin-and-cause determination.

FIRE INVESTIGATION CHRONOLOGY (cont'd)

Slide 3-99

L. Investigators should always **confer with incident command.**

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Fire department run report will give you responding companies and help develop a timeline from the 911 call until extinguishment.
- Many firefighters have helmet cams, or their trucks have dash cams. They may hold crucial evidence that you would never have seen, the torch, area of origin, witnesses, etc.

Slide 3-100

M. A copy of the fire department run report will give you responding companies and help develop a timeline from the 911 call until extinguishment.

N. Many firefighters have helmet cams, or their trucks have dash cams. They may hold crucial evidence that you would never have seen, the torch, area of origin, witnesses, etc.

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Arrival at the scene:
  - Report to the Incident Commander (IC).
  - Determine legal authority.
  - Establish liaison with other investigators.

Slide 3-101

O. If suppression units are still there, do not get in their way or block their equipment. They still own the scene and have a job to do.

1. Find the people who are in charge of the scene, and locate the local investigator/fire marshal.

2. Identify yourself: Offer assistance, and attempt to have the investigator or Incident Commander (IC) give you a briefing. Take notes, and get preliminary info:

   a. Address.

   b. Time of alarm.

   c. Injuries/Fatalities.

   d. Type of structure.

   e. Condition on arrival.

   f. Owner identification.

   g. Location of owner.

   h. Any suppression problems.

3. Link up with investigator, and establish legal authority to enter scene.

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Scene security:
  - Treat as a potential crime scene.
  - Set up a secure perimeter.
  - Limit access to the scene.
  - Limit overhaul.
  - Overnight security.

Slide 3-102

P. Upon your arrival if there is no perimeter, suggest one be established. Deny entry to all unauthorized:

1. Spectators.

2. Owner/Occupant.

3. News media.

FIRE INVESTIGATION CHRONOLOGY (cont'd)

- Scene safety:
  - Be aware of collapse potential.
  - Floor integrity.
  - Hazardous or explosive atmospheres.
  - Condition of utilities.
  - Follow Safety Officer's orders!

Slide 3-103

Q. Innocent looking fire scenes can change complexion rapidly and without warning.

1. The importance of checking in with incident command is not only to determine what, when and how. Ask about hazards, potential collapse, bio — It could save your life or someone else's!

   a. Do not fall in any holes.

   b. Do not step on any nails.

c. Do not let a brick fall on your head.

2. Today we take the hazards more seriously.

a. Collapse potential is very serious (World Trade Center).

b. Check electric and gas service.

c. Floors may hold some people and not others or many others.

d. Some fire scenes are a house of cards; be careful you do not cause collapse.

e. Airborne hazards are very serious, from asbestos to toxic hydrogen cyanide fumes. Chemicals on site?

ASSESS NEEDS

Resources:

- More investigators (e.g., homicide investigators)?
- Specialists?
- Aerial platforms?
- Heavy equipment?
- Note: Know your limitations.

Slide 3-104

3. A review of the size and unique factors relating to the incident allow evaluation of needs (injuries, fatalities, chemicals, etc.).

a. Some scenes require heavy equipment or cranes.

b. Most scenes will benefit from additional agents.

4. Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) normally wants ATF Combined Task Force (CTF) input.

a. National Response Team (NRT) response depending on size and significance and at the request of state and local officials.

b. Accelerant detection K-9s are effective tools — usually the decision of the Certified Fire Investigator (CFI).

5. Get basic information — address, date, time, owners' names, available witnesses, significant observations.

CROSS-CONTAMINATION ISSUES

- Cross-contamination is the unintentional contamination of evidence during examination, collection, storage or transport.
- Lab equipment can detect extremely low levels of ignitable liquids.

Slide 3-105

6. Potential sources of contamination:

   a. Tools used in the collection of evidence.

   b. Boots, gloves, clothing.

   c. Evidence containers.

   d. Fire department equipment.

   e. Outside sources.

   f. Unauthorized personnel at scene.

PREVENTING CROSS-CONTAMINATION

- Maintain secure scene.
- Use clean tools or disposable gloves.
- Use new gloves for every sample.

Slide 3-106

7. Maintain secure scene.

   a. Use clean tools or disposable gloves.

   b. Use new gloves for every sample.

PREVENTING CROSS-CONTAMINATION (cont'd)

- Never permit gasoline powered equipment in scene.
- Protect evidence containers from contaminants.
- Decontamination line at access point for scene.

Slide 3-107

   c. Never permit gasoline powered equipment in scene.

   d. Protect evidence containers from contaminants.

   e. Decontamination line at access point for scene.

DECONTAMINATION LINES

Slide 3-108

8. Directions must be simple and sometimes direct.

INITIAL RESPONSE: NOTE WEATHER

- Wind direction.
- Overcast.
- Stormy.
- Temperature.
- Humidity.
- Ambient conditions extremely relevant to future testing.

Slide 3-109

9. Information regarding weather conditions should be noted. This can include:

   a. Wind direction.

   b. Overcast.

   c. Stormy.

   d. Temperature.

   e. Humidity.

   f. Ambient conditions.

VIII. FIRE SCENE EXTERIOR EXAMINATION

FIRE SCENE EXTERIOR EXAMINATION

- Use a “systematic approach” — the same method every time regardless of size or type of fire event.
- Work from areas of least to most damage.
- Make sure your documentation reflects the systematic approach.

Slide 3-110

A. If you deviate from your systematic approach, you may not necessarily be wrong; but you must justify and articulate (i.e., building collapse impedes examination, weather-related concerns, etc.).

B. You will be testifying to this "systematic approach" in court.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Walk around the site (360 degrees).
- Observe any potential safety hazards.
- Photograph exterior on all sides.
- Obtain exterior dimensions.
- Photograph doors/locks/windows.
- Photograph utility connections.
- Consider aerial photographs.

Slide 3-111

C. Actions of fire scene exterior examination.

1. Walk around the site (360 degrees).
2. Observe any potential safety hazards.
3. Photograph exterior on all sides.
4. Obtain exterior dimensions.
5. Photograph doors/locks/windows.
6. Photograph utility connections.
7. Consider aerial photographs.
8. The exterior walk around is also to determine safety of the structure and the status of power.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Basic exterior examination will include documentation of:
  - Utilities and ignition sources.
  - Structure condition.
  - Vents — doors, windows, etc.
  - Security and access points.
  - Exposures.
  - Building construction.

Slide 3-112

D. Basic exterior examination will include documentation of:

1. Utilities and ignition sources.
2. Structure condition.
3. Vents — doors, windows, etc.
4. Security and access points.
5. Exposures.
6. Building construction.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Basic exterior examination will include examination and documentation of:
  - Fire patterns.
  - Explosion debris.

Slide 3-113

E. Basic exterior examination will include documentation of:

1. Fire patterns.

2. Explosion debris.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Fire damage patterns.
- Areas of ventilation.
- Materials and construction.

Slide 3-114

3. Fire damage patterns.

4. Areas of ventilation.

5. Materials and construction.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Areas of collapse.
- Fire venting points.
- Smoke staining areas.
- Entrance and exit points.
- Items that are out of place or unusual (evidence).

Slide 3-115

6. Areas of collapse.

7. Fire venting points.

8. Smoke staining areas.

9. Entrance and exit points.

10. Items that are out of place or unusual (evidence).

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Exterior photographs

Slide 3-116

F. Take in order of your examination: If you typically work counterclockwise around the exterior of a structure, your photos/video should reflect this.

1. Use a photograph log.
2. Fire patterns.
3. Explosion debris.
4. Utilities.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Exterior photographs

Slide 3-117

5. Roof/Structure condition.
6. Vents — doors, windows, etc.
7. Access points.
8. Security.

9. Exposures.

10. Evidence.

11. Suppression activities.

12. Location descriptor.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Exterior photographs

Slide 3-118

G. Always attempt to identify and document exposure damage. Follow department policies and procedures and guidelines for making damage estimates.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Slide 3-119

H. Condition of utilities.

1. Were they operational?

2. Remember that the utility representatives have interests that may not coincide with the investigation.

3. Watch your evidence.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Ignition sources:
  - Receptacles and extension cords.
  - Attached appliances.
  - Service entrance.
  - Gas regulators and lines.

Slide 3-120

I. Ignition sources.

1. Receptacles and extension cords.
2. Attached appliances.
3. Service entrance.
4. Gas regulators and lines.
5. Natural gas line severed by snow and ice on roof, which was subsequently ignited by a roof-mounted furnace igniter.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Fire pits.
- Garbage bins.
- Cigarettes.
- Candles.
- Lights and lighted signs.
- Grills and gas appliances.

Slide 3-121

6. Fire pits.
7. Garbage bins.

8. Cigarettes.

9. Candles.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Slide 3-122

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

- Evidence:
  - Lighter, matches, etc.
  - Devices.
  - Ignitable liquids.
  - Containers.
  - Clothing.
  - Footprints, tire tracks, etc.
  - Documents.

Slide 3-123

10. Should be secured at earliest possibility.

11. Mark so as to avoid disturbance or contamination.

12. Photograph prior to any removal and document the removal process as well.

13. Document location via your sketch.

14. Delegate someone to stand security until collected.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Slide 3-124

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Crime

Fire Department

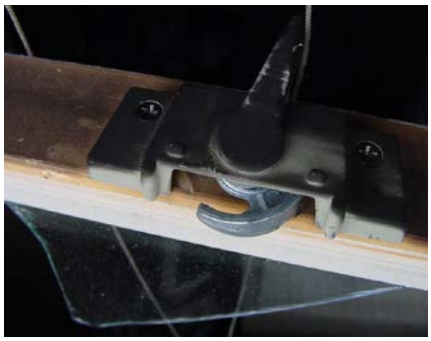
Slide 3-126

J. Document the condition of all doors and possible forced entry points. Obtain statements from first responders that may reveal that this damage was caused during fire suppression.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Slide 3-127

FIRE SCENE EXTERIOR EXAMINATION (cont'd)



Slide 3-128

K. Document the condition of all windows and possible forced entry points. Obtain statements from first responders that may reveal that this damage was caused during fire suppression.

FIRE SCENE EXTERIOR EXAMINATION (cont'd)

Exterior fire suppression system examination

Post-indicator valve (PIV) (lock cut by arsonist).

Who is familiar with the building suppression system?

Slide 3-129

IX. FIRE SCENE INTERIOR EXAMINATION

FIRE SCENE INTERIOR EXAMINATION

Slide 3-130

A. As discussed during the documentation block, every facet of the investigation should be documented.

1. During reconstruction, photos should be taken through the complete process.

2. Time and time again we see a photo of the room full of debris and the very next photo is cleaned up and reconstruction is complete.

3. All phases of the fire scene investigation are required to be documented.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Least

Most

Slide 3-131

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Interior examination should include:
  - Fire patterns.
  - All appliances.
  - All electrical and gas components.
  - All potential heat sources.
  - Floor, walls and ceiling; and building systems.
  - Fuel packages.
  - All ventilation sources.

Slide 3-132

B. Interior examination should include:

1. Fire patterns.
2. All appliances.
3. All electrical and gas components.
4. All potential heat sources.
5. Floor, walls and ceiling; building systems.
6. Fuel packages.
7. All ventilation sources.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-133

C. The depth and extent of charring can be used to evaluate direction of fire spread.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-134

D. Sometimes the analysis of charring must be taken outside of the scene to better document the damage. As always once evidence is going to be removed from the scene and reconstructed in a different location, extreme care and documentation must take place to properly mark each item and location.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Documentation and examination of ventilation points

Slide 3-135

E. Note that it is critical to document all vent openings. This aids in determining fire growth and progression.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-136

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Documentation and examination of fire patterns include:
  - Photographs.
  - Video.
  - Diagrams/Sketches.
  - Notes.
  - All may be used to "bring your audience back" into the fire scene.

Slide 3-137

F. The objective is to bring your audience back into the fire scene.

INTERIOR PHOTOGRAPHS

Slide 3-138

G. Overall photos should depict as much of the room as possible at one time.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Wood flooring.
- Carpeting.
- Furnishing.
- Wall materials.
- Paperwork.
- Clothing.
- Liquids from containers.
- Soil.

Slide 3-139

H. These samples may be necessary for future testing, such as fire modeling data, live burn testing, and laboratory analysis.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Identify fuels by type, construction, material, location, etc.
- Note damage to the fuels — mass loss, charring, melting, etc.

Slide 3-140

I. If possible, document fuel packages and potential exemplars.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Documentation and examination of ignition sources

Slide 3-141

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-142

J. All mechanicals should be documented and labeled when possible. This will also document how you may have eliminated those items at a later date. Remember, it is the photo you did not take that is needed.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Prior to collection:
  - Photograph/Video.
  - Include in diagram/sketch.
  - Notes.

Slide 3-143

K. Can of debris collected from where pink tape was originally placed.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Some fire scenes may require the use of heavy equipment to facilitate debris removal or to mitigate safety hazards.
- The scene should be fully documented prior to use and during use.

Slide 3-144

L. Some fire scenes may require the use of heavy equipment to facilitate debris removal or to mitigate safety hazards.

1. The scene should be fully documented prior to use and during use.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- If the presence of ignitable liquids is suspected, sampling should be done before heavy equipment is brought in.
- Heavy equipment should be placed outside the area of interest to limit the potential for contamination.
- May occur at various stages in the investigation — always documented.
- Avoid spoliation at all costs!

Slide 3-145

2. If the presence of ignitable liquids is suspected, sampling should be done before heavy equipment is brought in.

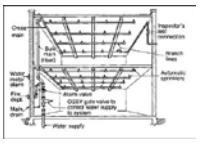
3. Heavy equipment should be placed outside the area of interest to limit the potential for contamination.

4. This may occur at various stages in the investigation — always documented.

5. Avoid spoliation at all costs!

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Documentation and examination of fire/ smoke detection and suppression systems.



Slide 3-146

6. Note missing detector over refrigerator. Detection and suppression systems are crucial to any investigation and may assist the investigator in digging deeper into why something was removed or was off at the time of the fire. This does not classify the fire for you, but it may help with uncovering any motive and intent.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Get to it early.
- Installers versus who monitors it.

Slide 3-147

M. Security sign in front yard (by Santa).

1. There may be an event buffer inside the mother board at the location that records up to a certain number of keypad entries. Also, motion detectors may record motion though not translate it to an alarm activation because the alarm was not armed. Some brands of alarm systems provide this function.

2. Alarms may monitor the following data:

   a. Individual pass codes.

b. Motion detectors at windows and doors.

c. What zone smoke detectors went off first.

d. May be centrally monitored.

e. May show a daily pattern.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Observe and note damage, evidence, possible ignition sources, ventilation.
  - Process area by removing debris in a systematic and deliberate manner.
  - May have to use a variety of tools.
  - Reconstruction may be necessary.

Slide 3-148

N. Observe and note damage, evidence, possible ignition sources, ventilation.

1. Process area by removing debris in a systematic and deliberate manner.

2. May have to use a variety of tools.

3. Reconstruction may be necessary.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-149

O. Clearing and layering debris down to floor level may assist in identifying patterns, locating evidence, and reconstructing the fire scene.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- Today's debris is tomorrow's evidence.
- Debris removal is critical in determining cause. Investigators should:
  - Uncover debris from top-down.
  - Document debris removal as it is ongoing.

Slide 3-150

1. Avoid haphazardly altering the scene, as this may potentially destroy valuable evidence.

2. Sifting of debris may be required in certain circumstances, such as necessary preservation for examination by other interested parties (e.g., insurance company).

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-151

P. Exemplars refer to identical or near-identical fuels, appliances or structures.

1. In multiunit structures, investigators may find exemplar apartments with identical appliances, etc.

2. May also provide comparison samples of carpeting, appliances, etc. for testing later.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-152

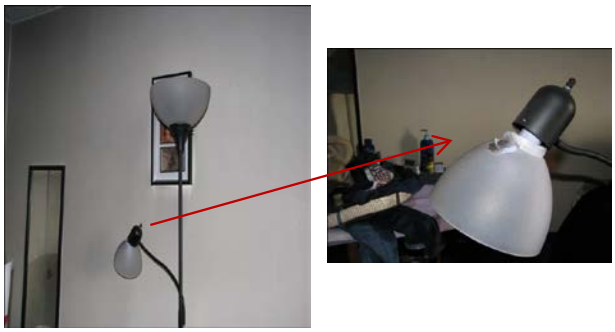
Q. During the interview and initial walk through, exemplars should be noted when possible.

1. For example, the couch may be in the living room origin area, but the matching love seat may be in the family room undamaged.

2. A potential cigarette scenario exists; you could preserve a material sample to potentially eliminate or rule in an accidental fire cause.

3. The same applies to apartments and condos when in need of inspecting a potential appliance exemplar within the other units.

FIRE SCENE INTERIOR EXAMINATION (cont'd)



Slide 3-153

4. Note melted lamp shade in identical lamp not involved in fire scenario.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-154

R. Documenting electrical activity or lack of activity is a crucial piece of evidence in origin determination.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

Slide 3-155

S. Reconstruction can be done anywhere: in the room of origin, outside in the driveway, the yard, or the lab. Proper documentation is required of the room of origin to conduct reconstruction in a different location.

FIRE SCENE INTERIOR EXAMINATION (cont'd)

- If you have found a potential area of origin:
  - Must test it as a hypothesis.
  - Must consider witness statements.
  - Must corroborate it with, if possible, fire patterns, fire dynamics, and arc mapping.

Slide 3-156

X. CAUSE DETERMINATION

CAUSE DETERMINATION

Slide 3-157

A. Ignition source, first material ignited, and ignition sequence.

B. Do not assume the cause until you identify the first fuel ignited, ignition source, and the event or circumstances that brought them together.

C. Without proper identification of these three components, the cause of the fire must be ruled as undetermined per NFPA 921.

D. Investigators should remember that NFPA 921 allows for the inference of ignition source in limited circumstances when the actual ignition source cannot be located at the point of origin.

CAUSE DETERMINATION (cont'd)

- Your employee evaluations are going to reflect your productivity, averages, timely reports, quicker arrests, and case closure rates.
  - **Undetermined case rates** will not be counted toward your productivity or tolerated.
  - You have all been trained in fire investigation and **not knowing** what caused a fire is unacceptable.

Slide 3-158

E. Your employee evaluations are going to reflect your productivity, averages, timely reports, quicker arrests, and case closure rates.

1. Undetermined case rates will not be counted toward your productivity or tolerated.

2. You have all been trained in fire investigation and not knowing what caused a fire is unacceptable.

CAUSE DETERMINATION (cont'd)

- Competent ignition source in area of origin.
- First fuel ignited.
- Oxidant.
- The circumstances that brought these together to initiate a fire (e.g., failures or human actions).

Slide 3-159

F. The cause of a fire is not the ignition source (e.g., candle, electric heater) but the circumstances that brought it together with the first fuel to be ignited.

CAUSE DETERMINATION (cont'd)

- The purpose is to identify an ignition source and a first fuel ignited and then the events that brought them together.
  - The context should be the area of origin.

Slide 3-160

G. The purpose is to identify an ignition source and a first fuel ignited and then the events that brought them together.

1. The context should be the area of origin.

2. Overall methodology is the standard: **"the scientific method."**

CAUSE DETERMINATION (cont'd)

- Fuels:
  - Composition.
  - Location.
  - Geometry.
  - HRR.
  - Must identify first fuel ignited if calling the fire accidental, incendiary or natural.

Slide 3-161

CAUSE DETERMINATION (cont'd)

- First fuel ignited is that which sustains combustion beyond the initial ignition source.
- Example: The potential ignition source is the cigarette. What is the first fuel ignited?

Slide 3-162

H. First fuel ignited is that which sustains combustion beyond the initial ignition source.

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

CAUSE DETERMINATION (cont'd)

- Separate hypothesis for each potential ignition source.
- Must also hypothesize about potential ignition sources not present at the scene.

Slide 3-163

J. Each potential ignition source should have a separate hypothesis. It also must hypothesize about reasonable absent ignition sources.

CAUSE DETERMINATION (cont'd)

- Ignition sources may be:
  - Altered.
  - Destroyed.
  - Consumed.
  - Moved.
  - Removed.

Slide 3-164

K. In an explosion, it is important to understand all potential ignition sources, the locations, and the level of the home where they may be located. Ignition source(s) may be:

1. Altered.
2. Destroyed.
3. Consumed.
4. Moved.
5. Removed.
6. Used to support an incendiary fire classification.

CAUSE DETERMINATION (cont'd)

- Any determination of fire cause should be based on evidence rather than absence of evidence.
- Sometimes there is no physical evidence of the ignition source, but an ignition source can be hypothesized (inferred) based on other data.

Slide 3-165

L. This determination of fire cause should be based on evidence rather than absence of evidence.

M. Sometimes there is no physical evidence of the ignition source, but an ignition source can be hypothesized (inferred) based on other data.

CAUSE DETERMINATION (cont'd)

- This determination may be arrived at through testing of alternate hypotheses involving potential ignition scenarios, provided that the conclusion regarding the remaining ignition sequence is consistent with all known facts.

Slide 3-166

N. This determination may be arrived at through testing of alternate hypotheses involving potential ignition scenarios, provided that the conclusion regarding the remaining ignition sequence is consistent with all known facts.

XI. PROCESS OF ELIMINATION

PROCESS OF ELIMINATION

- Eliminating all ignition sources found, known or believed to have been in the area of origin and then claiming such methodology is proof of an ignition source for which there is no evidence of its existence is referred to as "negative corpus."

Slide 3-167

A. Eliminating all ignition sources found, known or believed to have been in the area of origin and then claiming such methodology is proof of an ignition source for which there is no evidence of its existence is referred to as "negative corpus."

PROCESS OF ELIMINATION (cont'd)

- According to NFPA 921, 18.6.5, 2014 ed.:
  - This process is not consistent with the scientific method, is inappropriate, and should not be used since it generates untestable hypotheses and may result in incorrect fire cause determinations.

Slide 3-168

B. This process is not consistent with the scientific method, is inappropriate, and should not be used since it generates untestable hypotheses and may result in incorrect fire cause determinations (NFPA 921, Chapter 18, Section 18.6.5, 2014 ed.).

PROCESS OF ELIMINATION (cont'd)

- Any hypothesis formulated for the causal factors (e.g., first fuel, ignition source, and ignition sequence) must be based on facts that are derived from evidence, observations, testing, experiments, calculations and scientific principles.

Slide 3-169

C. Any hypothesis formulated for the causal factors (e.g., first fuel, ignition source, and ignition sequence) must be based on facts that are derived from evidence, observations, testing, experiments, calculations and scientific principles.

PROCESS OF ELIMINATION (cont'd)

Negative corpus versus process of elimination

Ignition source not identified but **can** be logically inferred.

Ignition source not identified, but can it be logically inferred?

Slide 3-170

XII. HYPOTHESIS DEVELOPMENT AND TESTING

HYPOTHESIS DEVELOPMENT AND TESTING

- Mandated by the scientific method.
- Can be as easy as "bouncing ideas" off other investigators.
- Can be as complex as full scale testing.

Slide 3-171

A. Mandated by the scientific method.

B. Can be as easy as "bouncing ideas" off other investigators.

C. Can be as complex as full scale testing.

D. Investigators should be prepared to testify in court as to how they tested their hypothesis.

HYPOTHESIS DEVELOPMENT AND TESTING (cont'd)

- Examples include:
  - Research in books and periodicals.
  - Debating among fire investigators.
  - Flammability tests.
  - Field tests.
  - Full scale tests.
  - Computer modeling.

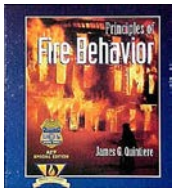
Slide 3-172

E. Examples include:

1. Research in books and periodicals.
2. Debating among fire investigators.
3. Flammability tests.
4. Field tests.
5. Full scale tests.
6. Computer modeling.

HYPOTHESIS DEVELOPMENT AND TESTING (cont'd)

- Cognitive testing:
  - Research shared and free resources.
  - Look up ignition properties, flame spread rates, melting temperatures, etc.
  - Handheld calculations.



Slide 3-173

F. Cognitive testing:

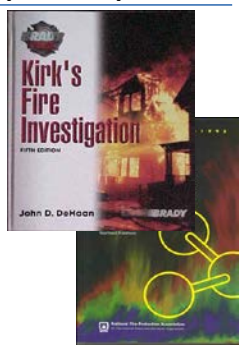
1. Research shared and free resources.

2. Look up ignition properties, flame spread rates, melting temperatures, etc.

3. Handheld calculations.

HYPOTHESIS DEVELOPMENT AND TESTING (cont'd)

- Review training handouts.
- Document or note what resources you used.
- Discuss with other trained investigators.



Slide 3-174

4. Review training handouts.

5. Document or note what resources you used.

6. Discuss with other trained investigators.

HYPOTHESIS DEVELOPMENT AND TESTING (cont'd)

- Field testing:
  - Recognize materials and construction while on scene.
  - Collect comparison samples (ensure no spoliation).
  - Basic field tests — ignition, etc.
  - Document tests before, during and after.
  - Safety/Suppression issues.

Slide 3-175

G. Field testing:

1. Recognize materials and construction while on scene.

2. Collect comparison samples (ensure no spoliation).

3. Basic field tests — ignition, etc.

4. Document tests before, during and after.

5. Safety/Suppression issues.

H. Hypothesis development and field/lab testing is mandated by the scientific method.

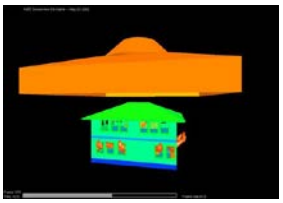
1. Can consist of “thought experiments” or actual testing.

2. Best to do with your peers.

3. Maintain a library of technical journals, etc., to help with cognitive testing.

HYPOTHESIS DEVELOPMENT AND TESTING (cont'd)

- Appliance examinations.
- Full scale models.
- Live burns — instrumentation.
- Zone models.



Slide 3-178

I. Appliance examinations.

J. Full scale models.

K. Live burns — instrumentation.

L. Zone models.

XIII. CLASSIFICATIONS

CLASSIFICATIONS

- Accidental.
- Incendiary.
- Undetermined.
- Natural.

Slide 3-179

A. Accidental.

B. Incendiary.

C. Undetermined.

D. Natural.

CLASSIFICATIONS: ACCIDENTAL

- Accidental fires involve all those for which the proven cause does not involve an intentional human act to ignite or spread fire into an area where the fire should not be. When the intent of the person's action cannot be determined or proven to an acceptable level of certainty, the correct classification is undetermined (NFPA 921, Section 20.1.1, 2014 ed.).

Slide 3-180

E. Accidental fires are not the result of a deliberate (intentional) act. This also includes friendly fires that are ignited deliberately but become hostile, such as intentionally igniting brush or trash fires that spread beyond the intended area (NFPA 921, Section 20.1.1, 2014 ed.).

CLASSIFICATIONS: ACCIDENTAL (cont'd)

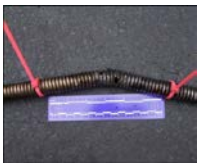
- Electrical.
- Heating equipment.
- Mechanical.
- Cooking.
- Smoking.
- Candles.
- Spontaneous heating.

Slide 3-181

F. Investigators must bear in mind that these accidental causes can be used to intentionally set a fire.

CLASSIFICATIONS: NATURAL

Natural fire cause classification: Natural fire causes involve fires caused without direct human intervention or action, such as fires resulting from lightning, earthquake, wind and flood.



Slide 3-182

G. **20.1.2 Natural Fire Cause Classification.** Natural fire causes involve fires caused without direct human intervention or action, such as fires resulting from lightning, earthquake, wind and flood.

H. **20.1.4 Undetermined Fire Cause.** Whenever the cause cannot be proven to an acceptable level of certainty, the proper classification is undetermined as follows:

1. Undetermined fire causes include those fires that have not yet been investigated or those that have been investigated, or are under investigation, and have insufficient information to classify further. However, the fire might still be under investigation and the cause may be determined later with the introduction or discovery of new information.

2. In the instance in which the investigator fails to identify the ignition source, the fire need not always be classified as undetermined. If the evidence established one factor, such as the use of an accelerant, that evidence may be sufficient to establish an incendiary fire cause classification even where other factors such as ignition source cannot be identified.

CLASSIFICATIONS: UNDETERMINED

Slide 3-183

I. Appropriate category for fires that have not yet been investigated, for fires that are under investigation, and for fires that have been investigated and the cause is not proven to an acceptable level of certainty (NFPA 921, Section 3.3.108, 2014 ed.).

J. However, the failure to determine the ignition source does not automatically require the fire investigator to rule the fire undetermined.

CLASSIFICATIONS — INCENDIARY

Incendiary: A fire that is deliberately set with the intent to cause the fire to occur in an area where the fire should not be.

— NFPA 921, Section 3.3.13, 2014 ed.

Slide 3-184

K. You pull up to the scene and this is what you see. Can you conclude what caused this fire and opine a classification? If you can, you're the best fire investigator in the country.

ARSON IS NOT A CLASSIFICATION

Arson: The crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion.

— NFPA 921, Section 3.3.13, 2014 ed.

Slide 3-185

L. Incendiary: The crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion (NFPA 921, Section 3.3.13, 2014 ed.). Often improperly used synonymously with the term "arson."

CLASSIFICATIONS (cont'd)

- Fires are not always incendiary. No assumption of cause should ever be made.
- Rule out all accidental causes before the word **"incendiary"** leaves your lips.
- If you're not sure: "Undetermined."
- You can always change "undetermined" call when more data becomes available.

Slide 3-186

SPOLIATION

- 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 3.3.167, 2014 ed.

Slide 3-187

M. Spoliation can affect potential evidence in a fire investigation.

1. The willful destruction of evidence or the failure to preserve potential evidence for another's use in pending or future litigation.

2. 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 3.3.167, 2014 ed.).

SPOLIATION (cont'd)

- To establish "spoliation" the party alleging must show that the party being grieved had a duty to preserve evidence and that it nonetheless destroyed the evidence.
- Translation: You knew that the widget caused the fire, but you still took it apart and destroyed it without notifying all responsible parties. You can be held liable: Fire departments are not exempt!

Slide 3-188

3. To establish "spoliation" the party alleging must show that the party being grieved had a duty to preserve evidence and that it nonetheless destroyed the evidence.

4. Translation: You knew that the widget caused the fire, but you still took it apart and destroyed it without notifying all responsible parties. You can be held liable: Fire departments are not exempt!

SPOLIATION (cont'd)

- Dismiss court action.
- Exclude evidence.
- Apply evidentiary inferences or limitations.
- Tort actions for destruction of evidence.
- Prosecution for obstruction of justice.
- These remedies are primarily used in civil cases not involving government entities.

Slide 3-189

5. Dismiss court action.

6. Exclude evidence.

7. Apply evidentiary inferences or limitations.

8. Tort actions for destruction of evidence.

9. Prosecution for obstruction of justice.

10. These remedies are primarily used in civil cases not involving government entities.

XIV. ACCIDENTAL IGNITION SOURCES

ACCIDENTAL IGNITION SOURCES

- Fire investigators must understand potential accidental sources of ignition before considering intentional sources.

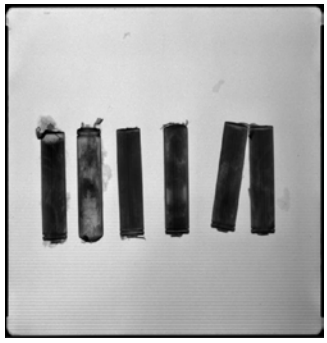
Slide 3-190

A. The mere presence of an ignition source in or near the area of origin does not mean that it is a competent ignition source.

1. The **context** of the fire scene and the fire patterns must be considered, as well as a thorough examination of the ignition source and consideration of other competent ignition sources.

2. Fire investigators must understand potential accidental sources of ignition before considering intentional sources.

DID THE APPLIANCE CAUSE THE FIRE?



Slide 3-191

B. Remains of appliance may not be identifiable at the scene. A battery-operated laptop was suspected as cause. How can the ignition source be evaluated? Is there physical evidence of failure at the scene, or is additional testing required?

C. In the case of the potential accidental fire involving an appliance, investigators should be aware that if the appliance is suspected as the cause, proper examination and documentation of the ignition sequence is critical in supporting investigator's conclusion. In the event that a qualified person (e.g., electrical engineer) is not available to conduct a failure analysis of appliance, investigators should consider classifying the fire as undetermined until such analysis can be performed.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Look for recalls.
- Attend electrical engineer examinations when applicable.
- First and secondary fuels.
- Avoid spoliation!

Slide 3-192

D. Whenever possible, a reference photo will assist in properly documenting physical evidence. The photo depicts a "pocket rocket" measuring device.

1. Look for recalls.
2. Attend electrical engineer examinations when applicable.
3. First and secondary fuels.
4. Avoid spoliation!

ACCIDENTAL IGNITION SOURCES (cont'd)

- Allows for research on recalls.
- Also helps identify trends and specific appliance failures.

Slide 3-193

E. 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.

1. This allows for research on recalls.

2. Also helps identify trends and specific appliance failures.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Usually incorporate multiple thermal cut offs (TCOs).
- Plastic underneath and the countertop should be protected if not the cause.
- Aluminum casing over heater elements should be intact if not the cause.
- May be caused by thermal runaway when TCO and thermostat fail.

Slide 3-194

F. Consider spoliation when inspecting any appliance. Remember, someone is coming in behind you. Never remove, destroy or dismantle any suspected appliance. Unless you are recognized as an expert in the court as it pertains to that individual appliance, do not overstep your level of expertise.

1. Usually incorporate multiple thermal cut offs (TCOs).

2. Plastic underneath and the countertop should be protected if not the cause.

3. Aluminum casing over heater elements should be intact if not the cause.

4. May be caused by thermal runaway when TCO and thermostat fail.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Consider X-ray examination of suspect appliances.

Slide 3-195

G. Local/State/Federal agencies may be contacted to respond to the scene for nonintrusive X-ray assistance. Appliance wiring diagrams may be available from the manufacturer for examination purposes.

ACCIDENTAL IGNITION SOURCES (cont'd)

Slide 3-196

H. Victim coffee pots may have protected areas on their underside as opposed to culprit coffee pots which will sustain thermal damages to the heating elements on the underside.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Dishwashers contain approximately 31 pounds of plastic.
  - Is jet dry system located above main wiring harness?

Slide 3-197

I. Dishwashers contain approximately 31 pounds of plastic.

1. Is jet dry system located above main wiring harness?

2. Leaking jet dry system can break down wire insulation over time causing resistive heating and subsequent ignition of combustible materials.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Bread lift electromagnetic timer may fail.
  - Food load may prevent contacts from separating.
  - Bread lifter typically fails during fire.
  - Inspect for contents.

Slide 3-198

J. Bread lift electromagnetic timer may fail.

1. Food load may prevent contacts from separating.

2. Bread lifter typically fails during fire.

3. Inspect for contents.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Ballast failures are potentially a main suspect.
  - Arcing through the ballast case may lead to an ensuing fire.
  - Loose springs/pins may be an other ignition source; consider the first fuels ignited.

Slide 3-199

K. Ballast failures are potentially a main suspect.

1. Arcing through the ballast case may lead to an ensuing fire.

2. Loose springs/pins may be another ignition source; consider your first fuels.

3. Check switches and trace circuits to verify whether it was energized!

ACCIDENTAL IGNITION SOURCES (cont'd)

- Motor heat dissipates quickly within normal designed operation.
  - If motor seizes, it will still generate heat, so consider that surrounding fuels such as lint and dust particles may provide good first fuel.

Slide 3-200

L. Motor heat dissipates quickly within normal designed operation.

1. If motor seizes, it will still generate heat, so consider that surrounding fuels such as lint and dust particles may provide good first fuel.

2. Arc mapping principles can be used for fire attack versus cause.

M. Check for electrical activity on:

1. Wiring of the heating element indicator light.
2. Indicator light contact.
3. Heating element wiring.
4. Wait for lab examinations.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Check position of knobs and control shafts.
- Check for pan type.
- Evaluate sequence of events to test hypothesis.
- Witness interviews.
- Avoid spoliation.

Slide 3-201

5. Check position of knobs and control shafts.
6. Check for pan type.
7. Articulate sequence of events to test hypothesis: Is it reasonable?
8. Witness interviews.
9. Avoid spoliation.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Lint accumulation.
- Design defect.
- Improper use.
- Spontaneous heating.
- Lack of maintenance.
- Witness statements.
- Repair history.
- Installation.

Slide 3-202

N. Just because the appliance is in the area does not mean the fire is accidental!

1. Lint accumulation.
2. Design defect.
3. Improper use.
4. Spontaneous heating.
5. Lack of maintenance.
6. Witness statements.
7. Repair history.
8. Installation.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Bearings without adequate lubrication get hot through friction.
- This can lead to fire if contact is made with a readily ignitable fuel.

Slide 3-203

O. Accidental fire at recycling facility — shredding machine jams.

1. Conveyor belts can jam or be forced to run against frozen rollers, which will lead to heating from friction.
2. Bearings without adequate lubrication get hot through friction.
3. This can lead to fire if contact is made with a readily ignitable fuel.

P. Cigarettes.

1. Consider timeline! Was the cigarette a fire-safe cigarette?

ACCIDENTAL IGNITION SOURCES (cont'd)

- Documentation of cigarettes should include:
  - Owner/Witness interview.
  - Ashtrays, containers.
  - Lighters, matches.
  - Cigarette butts.
  - Consider timeline.
  - Consider first fuel.
  - Fire-safe cigarettes.

Slide 3-204

2. Documentation of cigarettes should include:

   a. Owner/Witness interview.

   b. Ashtrays, containers.

   c. Lighters, matches.

   d. Cigarette butts.

   e. Consider timeline.

   f. Consider first fuel.

   g. Fire-safe cigarettes.

ACCIDENTAL IGNITION SOURCES (cont'd)

- One study showed that cigarettes discarded into crumpled paper trash transitioned in only about 1 percent of fires.

Slide 3-205

3. While a review of surface and auto ignition temperatures (AITs) 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.

4. There are many coupled factors that have been proposed as responsible for the lack of ignition for most ignitable liquids and gases, including flammability limits (oxygen-depleted conditions at cigarette tip), surface temperature, residence time and ignition delay, burning velocity, minimum ignition energy, quenching distance, and insulating effect of cigarette ash.

ACCIDENTAL IGNITION SOURCES (cont'd)

- Due to their low HRR, cigarettes require contact time to transfer enough heat to cause ignition of another fuel. It generally means at least 15 minutes have to elapse.

— Kirk's

Slide 3-206

Q. Due to their low HRR, cigarettes require contact time to transfer enough heat to cause ignition of another fuel. It generally means at least 15 minutes have to elapse (Kirk's).

ACCIDENTAL IGNITION SOURCES (cont'd)

- Repeated studies to cause explosions by inserting a lighted cigarette into an explosive gasoline air mixture have resulted in failure, even with the ash knocked off and the cigarette being puffed strongly.
- The ash of a burning cigarette ranges between 550 and 1,350 F (288 and 732 C).

Slide 3-207

R. Repeated studies to cause explosions by inserting a lighted cigarette into an explosive gasoline air mixture have resulted in failure, even with the ash knocked off and the cigarette being puffed strongly.

S. The ash of a burning cigarette ranges between 550 and 1,350 F (288 and 732 C).

ACCIDENTAL IGNITION SOURCES (cont'd)

- Failures and concerns:
  - Proximity to other combustibles and/or ignitable vapors.
  - Improper fuels = higher vapor.
  - Pressure = potential overflow.

Kerosene Heaters

Slide 3-208

T. The fuel is delivered to a constant flame by transport up a wick that is partially in a fuel reservoir (e.g., kerosene lamp).

1. Modern heaters have a shut-off mechanism that extinguishes the wick if the heater is tipped over.

2. The main problem with kerosene heaters is that the capacity of the tank exceeds that of the reservoir, so that if there is a loss of the vacuum in the tank, the excess fuel can flood the reservoir and create a spill external to the heater, which then ignites with catastrophic result.

3. This loss of vacuum can occur as the result of a leak in the tank or its associated parts, or as the result of fueling the heater with a fuel such as gasoline or camping fuel with a higher vapor pressure than that of kerosene.

4. In these cases, the vapor then replaces the partial vacuum that holds back the flow of fuel, resulting in a flood of fuel that overwhelms the reservoir.

5. Was the proper fuel used (gasoline versus kerosene)?

ACCIDENTAL IGNITION SOURCES (cont'd)

- Classified as radiant or convective and have:
  - Thermostats.
  - Tip over controls — 15 degrees or more.
  - High limit shut-offs or TCOs (nonresettable).
  - Convective — warms the air.
  - Radiant — warms nearby objects.

Electric Heaters

Slide 3-209

6. Make sure it is plugged in! How close was it to combustibles? Most warning labels indicate at least 3 feet from combustibles.

7. Failures and concerns:

   a. Too close to combustibles.

   b. Failure of high limit shut-offs or TCOs (nonresettable).

   c. Overheating of appliance if in combustible enclosure.

   d. Electrical problems.

   e. Arc mapping and context — examine power cord, receptacle, etc.

XV. NATURAL IGNITION SOURCES

NATURAL IGNITION SOURCES

- Lightning strike is the discharge of the huge static electric charges built up in clouds of moisture or dust.
  - Destroys any poor electrical conductor in its path.
  - Wood shattered.
  - Windows blown out.
  - Electrical appliances can be exploded.

Slide 3-210

A. Lightning strike is the discharge of the huge static electric charges built up in clouds of moisture or dust.

B. The discharge is several strokes, lasting a few millionths of a second, and the current is about 20,000 amperes.

C. Air in the path of the main stroke can be 30,000 C (54,032 F). Due to its rapid heating and expansion, a pressure shock wave can damage nearby structures with explosive force.

D. May give the appearance of multiple points of origin.

E. How do you verify the strike event? And will it stand up in court if needed?

1. Electrical conductor in its path destroyed.

2. Wood shattered.

3. Windows blown out; electrical appliances can be exploded.

NATURAL IGNITION SOURCES (cont'd)

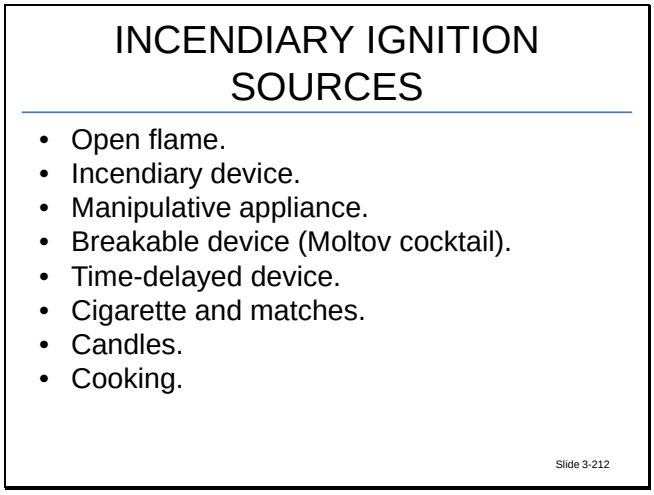
- Appliances and electronics throughout a structure hit by lightning should be thoroughly examined as all appliances plugged in at the time are likely to be damaged.
- Check for proper grounding of gas appliances and electrical system.

Slide 3-211

F. Appliances and electronics throughout a structure hit by lightning should be thoroughly examined as all appliances plugged in at the time are likely to be damaged.

G. Check for proper grounding of gas appliances and electrical system.

XVI. INCENDIARY IGNITION SOURCES



A. Incendiary ignition sources are subject to the imagination of the firesetter.

B. Incendiary ignition sources may include:

1. Open flame.
2. Incendiary device.
3. Manipulative appliance.
4. Breakable device (Moltov cocktail).
5. Time-delayed device.
6. Cigarette and matches.
7. Candles.
8. Cooking.

XVII. INCENDIARY FIRE INDICATORS

INCENDIARY FIRE INDICATORS

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

Slide 3-213

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-214

A. When fuels are intentionally distributed or "trailed" from one area to another, elongated patterns may be visible.

1. Used to connect separate fuel packages from one compartment to another.

2. Fuels used for trailers may be ignitable liquids or solids.

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-215

B. Anything can be used to accelerate the growth, speed and development of a fire.

C. The days of pouring gas all over and lighting the fire are over. Firesetters have become more sophisticated, and we as fire investigators need to increase our knowledge and understanding at a faster rate.

INCENDIARY FIRE INDICATORS (cont'd)

- Liquids may have a reasonable explanation for being in your fire scene.
- Containers can fail during fires.
- Decontamination issues.

Slide 3-216

D. Account for items: Interview occupants to see what is supposed to be there and where it is normally stored.

E. Liquids may have a reasonable explanation for being in your fire scene; containers can fail during fires.

F. Decontamination issues.

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-217

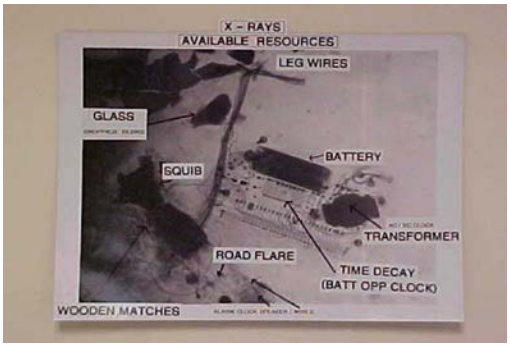
INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-218

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-219

INCENDIARY FIRE INDICATORS (cont'd)



Slide 3-220

G. X-ray of the post-fire remains of the The Earth Liberation Front (ELF) incendiary device.

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-221

H. Don't overlook the evidence in front of you. A liquid sample may still be available if the container is not totally consumed.

I. This sample and fire debris samples can then be compared to determine if the liquid remaining is the same.

INCENDIARY FIRE INDICATORS (cont'd)

Slide 3-222

J. Think latent fingerprints, DNA, and material composition of the wick. Mechanical matching of the fabric is also a possibility.

INCENDIARY FIRE INDICATORS (cont'd)

- Most difficult of fire cases to prove.
- Often requires evidence from "inside" and "outside" of the scene.
- Requires thorough understanding of fire dynamics.

Slide 3-223

K. Picture of alarm pad system.

1. Most difficult of fire cases to prove.
2. Often requires evidence from "inside" and "outside" of the scene.
3. Requires thorough understanding of fire dynamics.

INCENDIARY FIRE INDICATORS (cont'd)

- Timelines.
- Alibis.
- Evidence.
- Electronic data.
- Interviews.
- Access.
- Motives.
- Origin-and-cause examination.
- Ignition source viability.

Slide 3-224

INCENDIARY FIRE INDICATORS (cont'd)

- We must always ask:
  - Who?
  - What?
  - Where?
  - When?
  - Why?
  - How?

Slide 3-225

L. Don't forget to interview about alarm code access as well.

M. The investigator should determine the access and accountability of keys.

INCENDIARY FIRE INDICATORS (cont'd)

- The following slides represent possible indicators of an incendiary fire yet, in and of themselves, are not what makes an incendiary fire call.
- Remember: totality of circumstances!

Slide 3-226

N. The following slides represent possible indicators of an incendiary fire yet, in and of themselves, are not what makes an incendiary fire call.

O. Remember: totality of circumstances!

INCENDIARY FIRE INDICATORS (cont'd)

- Contents.
  - Contents lacking.
  - Contents obviously replaced.
  - Contents placed suspiciously.
  - Over-inflated claim of loss.
  - Condition of contents.
  - Concealment.

Slide 3-227

P. Document contents thoroughly in both damaged and undamaged areas.

1. Contents lacking.
2. Contents obviously replaced.
3. Contents placed suspiciously.
4. Over-inflated claim of loss.
5. Condition of contents.
6. Concealment.

INCENDIARY FIRE INDICATORS (cont'd)

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

Slide 3-228

Q. Multiple origins.

1. Trailers.

2. Containers.

3. Pour patterns, ignitable liquids.

4. Disabling fire protection systems.

5. Tampering with utilities.

6. Unusual fuel loads or fuel configurations.

7. Incendiary devices.

8. Crime concealment.

INCENDIARY FIRE INDICATORS (cont'd)

- Access.
  - Unlocked or unalarmed premises when normally so.
  - Incendiary fire with locked access points.
  - Suspicious timelines.
- Historical.
  - History of claims (Insurance Services Office search).
  - History of financial problems.

Slide 3-229

R. Compare contents versus witness statements and insurance documents, contents lists, and proofs of loss.

1. Access.

   a. Unlocked or unalarmed premises when normally so.

   b. Incendiary fire with locked access points.

   c. Suspicious timelines.

2. Historical.

   a. History of claims (Insurance Services Office search).

b. History of financial problems.

S. Try to ascertain when contents were received and last time they were seen.

T. Manipulation of evidence prior to the fire. In the photo above, the smoke detector was taken down and placed inside the closet away from the area of origin.

1. Smoke detector taken down and placed inside closet away from area of origin.

2. Being able to articulate why something is, or is not, where it should be is crucial to any investigation.

3. Is it believable why evidence is in an area, or could the witness have just taken it down because the battery was not working?

4. Don’t guess why it’s there. Include it in your interview.

XVIII. SUMMARY

SUMMARY

- Why are fires investigated?
- Duties of an expert witness.
- Fire scene investigation (methodology).
- Origin determination.
- Fire effects.
- Fire pattern analysis.
- Fire investigation chronology.
- Fire scene exterior examination.
- Fire scene interior examination.

Slide 3-231

SUMMARY (cont'd)

- Cause determination.
- Process of elimination.
- Hypothesis development and testing.
- Classifications.
- Accidental ignition sources.
- Natural ignition sources.
- Incendiary ignition sources.
- Incendiary fire indicators.

Slide 3-232

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UNIT 4:
MYTHS AND LEGENDS

TERMINAL OBJECTIVE

The students will be able to:

4.1 Distinguish between "old wives' tales" and modern scientific truths used in fire investigations.

ENABLING OBJECTIVES

The students will be able to:

4.1 Identify common "myths and legends" that are erroneously used in determination of the origin and cause of a fire.

4.2 Describe the proper interpretation of these fire scene indicators based on current scientific research.

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UNIT 4:
MYTHS AND LEGENDS

Slide 4-1

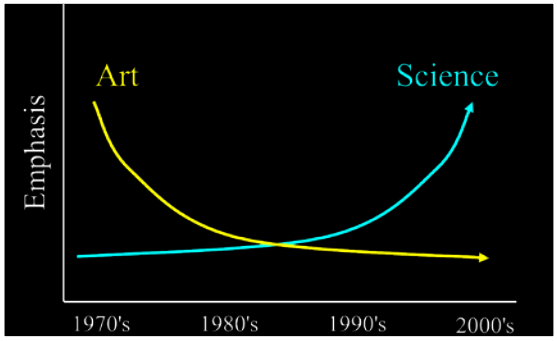
ENABLING OBJECTIVES

- Identify common “myths and legends” that are erroneously used in determination of the origin and cause of a fire.
- Describe the proper interpretation of these fire scene indicators based on current scientific research.

Slide 4-2

I. FIRE INVESTIGATION

FIRE INVESTIGATION: ART VERSUS SCIENCE



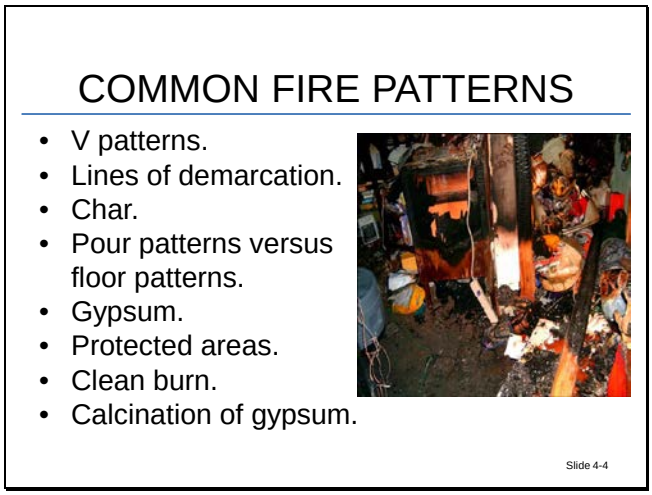
Slide 4-3

A. Fire investigation has changed throughout the years from art to science.

B. Investigators need to change also.

C. The first issue of National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations* was published in 1992; however, work on the document started years before.

II. COMMON FIRE PATTERNS



A. V patterns: They are normally found on walls, or what is left of walls, due to natural fire behavior, which is upward or downward.

B. Lines of demarcation: They are the borders between heat/smoke or flame-affected areas and unaffected areas.

C. Pours: Ignitable liquid poured on a floor can result in a distinct pattern.

1. The pattern can be obscured or destroyed by subsequent fire damage, such as post-flashover burning.

2. Natural or unnatural?

3. Gasoline in garage as opposed to gasoline in living room.

4. Melted plastic or worn areas can leave patterns that can be misinterpreted as pour patterns.

5. Items that are covering other items may protect areas. This will leave patterns.

6. Throw rugs on hardwood floors in a room subject to flashover will leave patterns that could be misinterpreted as pour patterns.

7. If a heavy piece of furniture is on carpet near a pour, it is likely that the liquid will be preserved under the furniture leg.

D. Trailers: They are a method of quickly spreading fire. Sometimes the trailer pattern or even the material will survive.

III. MYTHS, LEGENDS AND PITFALLS

MYTHS, LEGENDS AND PITFALLS

- Accidental.
- Incendiary.
- Natural.
- Undetermined.
- Suspicious is **not** a fire cause!
  - National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*.

Slide 4-5

ALLIGATORING MYTH

Accelerated

Nonaccelerated

Slide 4-6

A. Alligatoring myth: The appearance of “alligatoring” means an accelerant was used.

ALLIGATORING

- **Myth:** Shiny blistering indicates a fast-moving, rapidly burning fire, while small, dull checkering indicates a slow-moving fire.
- **Reality:** Many factors affect surface appearance as well as char depth.

Slide 4-7

1. This is the trim above a door. There is no difference in the fire, just the wood they used in construction.

2. Myth: Shiny blistering indicates a fast-moving, rapidly burning fire, while small, dull checkering indicates a slow-moving fire.

3. Reality: Many factors affect surface appearance as well as char depth.

CHAR PATTERNS

Slide 4-8

B. 6.2.4.5 Depth of Char.

1. Analysis of the depth of charring is more reliable for evaluating fire spread, rather than for the establishment of specific burn times or intensity of heat from adjacent burning materials.

2. The relative depth of char from point to point is the key to appropriate use of charring and locating the places where the damage was most severe due to exposure, ventilation or fuel placement.

3. The investigator may then deduce the direction of fire spread, with decreasing char depths farther away from the heat source.

CHAR PATTERNS (cont'd)

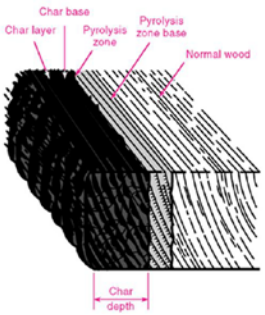
- **Myth:** Char patterns and char depth indicate how long the fire burned (e.g.,1 inch = 45 minutes).

Slide 4-9

4. The wood is the same, but the area to the right has greater damage and may be indicative of fire burning longer on the right and origin toward the right.

CHAR PATTERNS (cont'd)

- **Reality:** You must take into account the type of material, intensity of the fire, ventilation, and location of the fuel package.



Slide 4-10

C. You still must take all variables into account.

1. The rate of charring of wood varies widely depending on many variables.

   a. Rate and duration of heating.

   b. Ventilation effects.

   c. Surface area to mass ratio.

   d. Direction, orientation and size of wood grain.

e. Species of wood.

f. Moisture content.

g. Nature of surface coating.

CHAR PATTERNS AND RELATIONSHIP TO INTENSITY

- Char depth more related to heat flux than time.
- Severity of damage increases with length of exposure.

Note: difference in char on side of bed rail.

Slide 4-11

2. Char depth more related to heat flux than time.

3. Severity of damage increases with length of exposure.

SPALLING OF CONCRETE

- Aggregate liberating from concrete — contraction and expansion.
  - Can be caused by intensive heat transfer and by sudden cooling.

Slide 4-12

D. Aggregate liberating from concrete — contraction and expansion.

1. It can be caused by intensive heat transfer and by sudden cooling.

SPALLING OF CONCRETE (cont'd)

- Also caused by age and chemicals.
- Old literature/science believed it was caused by accelerant.

Slide 4-13

2. It is also caused by age and chemicals.

3. Old literature/science believed it was caused by accelerant. This is not true because the liquid keeps the surface below cool.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Spalling is a positive indicator of an ignitable liquid pour.
- **Reality:** Spalling is the fracturing of concrete or brick surfaces as a result of exposure to thermal or mechanical stress.

Slide 4-14

4. Myth: Spalling is a positive indicator of an ignitable liquid pour.

5. Reality: Spalling is the fracturing of concrete or brick surfaces as a result of exposure to thermal or mechanical stress.

MELTED ALUMINUM

Slide 4-15

E. Melted aluminum.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Melted aluminum thresholds or melted aluminum at floor level means an ignitable liquid was used.

Slide 4-16

1. Myth: Melted aluminum thresholds or melted aluminum at floor level means an ignitable liquid was used.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Reality:** Melted aluminum thresholds are commonly caused by the effects of flashover, not the use of ignitable liquid pours. (Aluminum melts at approximately 1,220 F.)

Slide 4-17

2. Reality: Melted aluminum thresholds are commonly caused by the effects of flashover, not the use of ignitable liquid pours. (Aluminum melts at approximately 1,100 to 1,200 F.)

MULTIPLE ORIGINS

Slide 4-18

F. Multiple origins can be an indication of an incendiary fire, but only if they are true independent origins (noncommunicating) and not the result of one fire.

1. Some polymer products will melt into separate puddles of burning plastic.

2. Drop-down/Fall-down of wall hangings, curtains, light diffusers, fixtures, paintings, etc. (ignited by a normal fire that spreads across the ceiling and upper half of a room) can give the appearance of separate ignition points.

3. Lightning strike or an abnormal electrical event may give the appearance of multiple points of origin.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Multiple "origins" always mean an incendiary fire cause.
- **Reality:** Multiple origins can be caused by fall-down/drop-down burning, flashover, and abnormal electrical events.

Slide 4-19

4. Myth: Multiple "origins" always mean an incendiary fire cause.

5. Reality: Multiple origins can be caused by fall-down/drop-down burning, flashover, and abnormal electrical events.

Slide 4-20

6. This photo depicts a fire pattern that developed from drop-down burning on the exterior from a sofa located above this area on the interior.

Slide 4-21

7. This photo depicts a sofa located on the interior of structure that was responsible for drop-down burning on area below on exterior.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** The area with the greatest damage is always the area of origin.
- **Reality:** Several factors must be taken into consideration when identifying areas of greatest damage, such as fuel load, ventilation, location of fuel, and geometry of fuel.

Slide 4-22

8. Myth: The area with the greatest damage is always the area of origin.

9. Reality: Several factors must be taken into consideration when identifying areas of greatest damage, such as fuel load, ventilation, location of fuel, and geometry of fuel.

Slide 4-23

G. Area of greatest damage.

1. Did the fire department put the fire out, or did it just burn out?

2. Did the fire department "write off" a certain area to concentrate on rescue operations or protection of exposures?

VENTILATION EFFECTS

Slide 4-24

POST-FLASHOVER DAMAGE

Slide 4-25

H. It is not uncommon for the flashover process to modify or obliterate many of the fire indicators that existed prior to flashover. General rules:

1. In preflashover fires, the heat flux from fuels burning in specific locations creates burn patterns near those locations.

2. In post-flashover fires, fuel gases are everywhere. The areas where these gases burn most effectively and release the most heat is where they encounter oxygen, not necessarily where they originated.

HOSE STREAM "WASH"

Slide 4-26

I. The pattern on this wall was caused by fire suppression efforts.

BURNS TO FLOOR

Slide 4-27

J. Burns to floor.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Burns to the floor are conclusive indicators that an ignitable liquid was used.
- **Reality:** Burns to the floor can result from several factors, including post-flashover burning, fall-down/drop-down, fuel load, etc.

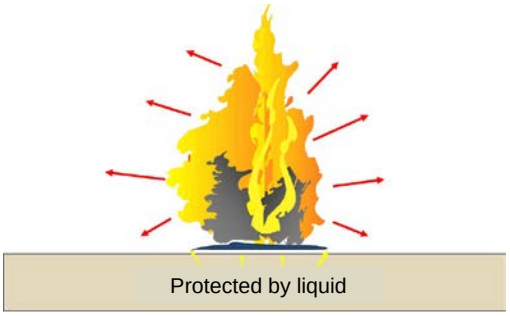
Slide 4-28

1. Myth: Burns to the floor are conclusive indicators that an ignitable liquid was used.

2. Reality: Burns to the floor can result from several factors, including post-flashover burning, fall-down/drop-down, fuel load, etc.

Slide 4-29

IGNITABLE LIQUID BURNING A HOLE THROUGH WOOD



Slide 4-30

K. The area located below the liquid pool protects the substrate from burning by a cooling effect since it is the vapors above the liquid that are actually burning.

BURNING PATTERNS THROUGH FLOORS

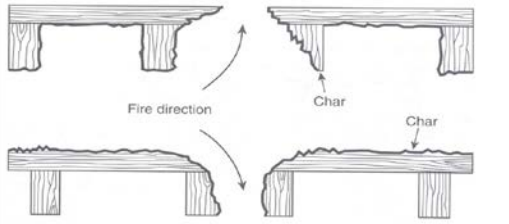


FIGURE 6.3.5.2 Burn Pattern with Fire from Above and Below.

Slide 4-31

L. 6.3.5.2 Penetrations of Horizontal Surfaces.

1. Penetration of horizontal surfaces, from above or below, can be caused by radiant heat, direct flame impingement, or localized smoldering with or without the effects of ventilation.

2. Figure 6.3.5.2 Burn Pattern with Fire from Above and Below.

   a. Whether a hole burned into a horizontal surface was created from above or below may be identified by an examination of the sloping sides of the hole.

   b. Sides that slope downward from above toward a hole are indicators that the fire was from above.

   c. Sides that are wider at the bottom and slope upward toward the center of the hole indicate that the fire was from below.

   d. During the course of a fire, it is possible for both upward and downward burning to occur through a hole.

   e. The investigator should keep in mind that only the last burning direction through the hole may be evident.

LOW BURNS

Slide 4-32

M. Low burns.

LOW BURNS (cont'd)

- **Myth:** Low burns are always indicative of an area of origin or an area in which the fire burned the longest.

Slide 4-33

1. Myth: Low burns are always indicative of an area of origin or an area in which the fire burned the longest.

LOW BURNS (cont'd)

- **Reality:** The possible causes of low burns include the following:
  - Radiant heat.
  - Drop-down/Fall-down.
  - Ventilation effects.
  - Flammable liquid at the point of origin.

Slide 4-34

2. Reality: The possible causes of low burns include the following:

   a. Radiant heat.

   b. Drop-down/Fall-down.

   c. Ventilation effects.

   d. Flammable liquid at the point of origin.

INVERTED V PATTERNS

Slide 4-35

N. Inverted V patterns.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Inverted V patterns mean that an accelerant was used.

Slide 4-36

1. Myth: Inverted V patterns mean that an accelerant was used.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Reality:** Inverted V patterns may be caused by fires of short duration or fires involving fuels that have low heat release rates (HRRs) that do not evolve into floor to ceiling flame plumes or plumes that are vertically restricted.

Slide 4-37

2. Reality: Inverted V patterns may be caused by fires of short duration or fires involving fuels that have low heat release rates (HRRs) that do not evolve into floor to ceiling flame plumes or plumes that are vertically restricted.

ANNEALING OF SPRINGS

Slide 4-38

O. Annealing is the loss of temper from steel.

1. It occurs at temperatures of approximately 1,000 F and higher, irrespective of time.

2. Partial annealing may reflect the direction of fire travel.

3. Springs can collapse from their own weight, from fall-down, or from extreme heat.

4. Uniform collapse is not indicative of an accelerated fire.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Annealing of springs is always the result of use of an accelerant.
- **Reality:** Annealing of springs is dependent on temperature and can be caused by accidental means.

Slide 4-39

5. Myth: Annealing of springs is always the result of use of an accelerant.

6. Reality: Annealing of springs is dependent on temperature and can be caused by accidental means.

TEMPERATURES AND FIRES

Slide 4-40

P. Temperatures and fires.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Temperatures in accelerated fires are higher than temperatures in nonaccelerated fires.
- **Reality:** The temperature of the fire is relatively the same based on geometry and ventilation conditions (e.g., wood and gasoline burn at approximately 1,880 F).

Slide 4-41

1. Myth: Temperatures in accelerated fires are higher than temperatures in nonaccelerated fires.

2. Reality: The temperature of the fire is relatively the same based on geometry and ventilation conditions (e.g., wood and gasoline burn at approximately 1,880 F).

CRAZING OF GLASS

Slide 4-42

Q. 6.2.13.1.4 Crazing.

1. Crazing is a term used to describe a complicated pattern of short cracks in glass. These cracks may be straight or crescent-shaped and may extend through the thickness of the glass.

2. Crazing has been claimed to be the result of very rapid heating of one side of the glass while the other side remains cool.

a. Despite widespread publication of this claim, there is no scientific basis for it.

b. In fact, published research has shown that crazing cannot be caused by rapid heating, only by rapid cooling.

c. Regardless of how rapidly it was heated, hot glass will reproducibly craze when sprayed with water.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** Crazing or spidering of glass means the fire was accelerated.
- **Reality:** Crazing or spidering of glass is the internal shattering into small, irregular areas caused by the sudden cooling of hot glass.

Slide 4-43

3. Myth: Crazing or spidering of glass means the fire was accelerated.

4. Reality: Crazing or spidering of glass is the internal shattering into small, irregular areas caused by the sudden cooling of hot glass.

GLASS AFTER FIRE

Slide 4-44

R. There are several variables that affect the condition of glass after fire.

1. The type and thickness of glass.

2. Rate of heating.

3. Degree of insulation to the edges of the glass provided by the glazing method.

4. Degree of restraint provided by the window frame.

5. History of the flame contact.

6. Cooling history.

SMOKE STAINS ON GLASS

Slide 4-45

7. Smoke stains on glass should not be used as a conclusive indicator of the burning time for any fire event.

MECHANICAL VERSUS THERMAL BREAKAGE

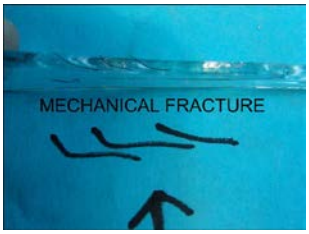
- Thermal fracture: Edges are almost mirror-smooth with no rib markings.
- Mechanical break: Edges will indicate rib markings on the cross section.

Slide 4-46

S. Thermal fracture: Edges are almost mirror-smooth with no rib markings.

T. Mechanical break: Edges will indicate rib markings on the cross section.

MECHANICAL VERSUS THERMAL BREAKAGE (cont'd)



Slide 4-47

Time and suppression are the key factors in the amount of destruction present.

TEMPERED GLASS

Slide 4-48

U. Tempered glass will fail in the same way whether the failure is caused by mechanical force or thermal shock.

1. Tempered glass, whether broken when heated by fire impact or when exploded, will break into many small, cube-shaped pieces.

2. It should not be confused with crazed glass, and it tends to be more regularly shaped than the complicated pattern of short cracks of crazing.

IV. RESIDUAL ELECTRICITY

RESIDUAL ELECTRICITY

Slide 4-49

A. Once power is disconnected from the structure, there is no remaining electricity stored within the circuit connectors.

B. Emergency generators, solar battery storage banks, and functioning uninterruptible power supply (UPS) systems are considered sources of power, not sources of residual electricity.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** After the power is removed from a building, there is "residual electricity" remaining in the wires, which can cause a fire.
- **Reality:** After the power is removed from the structure, there is no "residual electricity" in the wires.

Slide 4-50

1. Myth: After the power is removed from a building, there is "residual electricity" remaining in the wires, which can cause a fire.

2. Reality: After the power is removed from the structure, there is no "residual electricity" in the wires.

VEHICLE FIRES

Slide 4-51

C. Vehicle fires.

MYTHS, LEGENDS AND PITFALLS (cont'd)

- **Myth:** The cause of a total burnout of a vehicle is always incendiary.
- **Reality:** Based on the type and quantity of combustible materials in vehicles manufactured today, total burnout is not uncommon with any fire.

Slide 4-52

1. Myth: The cause of a total burnout of a vehicle is always incendiary.

2. Reality: Based on the type and quantity of combustible materials in vehicles manufactured today, total burnout is not uncommon with any fire.

CIGARETTE MYTHS

- Repeated attempts to cause explosions by inserting a lighted cigarette into an explosive gasoline vapor-air mixture have resulted in failure.
- Oxygen levels in the cigarette in the vicinity of the combustion zone tend to be very low.
- Carbon dioxide levels tend to be very high.
- Presence of incombustible ash may reduce the efficiency of heat transfer to the fuel vapor.

Slide 4-53

D. According to DeHaan and Icove (DeHaan, J. D. and Icove, D. J. (2012). Kirk's fire investigation (7th ed.). (pp. 205-206). New Jersey: Pearson):

1. Repeated attempts to cause explosions by inserting a lighted cigarette into an explosive gasoline vapor-air mixture have resulted in failure.

2. Oxygen levels in the cigarette in the vicinity of the combustion zone tend to be very low.

3. Carbon dioxide levels tend to be very high.

4. Presence of incombustible ash may reduce the efficiency of heat transfer to the fuel vapor.

CELLULAR TELEPHONE MYTHS

- See www.snopes.com.
- No validated reports of it ever occurring.
- Tests have been unsuccessful.
- Use audio tone not ringer.
- Battery is 12-volt — same as a car battery with much less current.

Slide 4-54

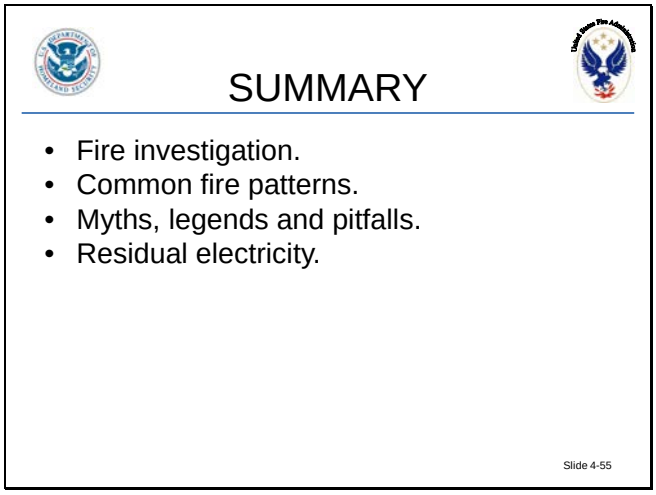
E. No validated reports of it ever occurring.

F. Tests have been unsuccessful.

G. Use audio tone not ringer.

H. Battery is 12-volt — same as a car battery with much less current.

V. SUMMARY



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UNIT 5: COMPLEX FIRE SCENE

TERMINAL OBJECTIVE

The students will be able to:

5.1 Evaluate the fire origin determination after being given a set of photos and a written report.

ENABLING OBJECTIVES

The students will be able to:

5.1 Examine a set of photos.

5.2 Review a written report.

5.3 Either agree or disagree with the origin of the fire established in the written report.

5.4 If you agree with the report, explain why you agree, and explain how the fire progressed.

5.5 If you disagree with the report, explain where you think the fire started and how you think the fire progressed.

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UNIT 5:
COMPLEX FIRE SCENE

Slide 5-1

ENABLING OBJECTIVES

- Examine a set of photos and a written report.
- Review a written report.
- Either agree or disagree with the origin of the fire established in the written report.

Slide 5-2

ENABLING OBJECTIVES (cont'd)

- If you agree with the report, explain why you agree, and explain how the fire progressed.
- If you disagree with the report, explain where you think the fire started and how you think the fire progressed.

Slide 5-3

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ACTIVITY 5.1

Complex Scenario Exercise

Purpose

Given a set of photos and a written report, evaluate the fire origin determination.

Directions

1. Examine a set of photos.
2. Review a written report.
3. Either agree or disagree with the origin of the fire established in the written report.
4. If you agree with the report, explain why you agree, and explain how the fire progressed.
5. If you disagree with the report, explain where you think the fire started and how you think the fire progressed.

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ACTIVITY 5.1 (cont'd)

Incident Report

Shady Brook Fire Department
Incident Report

Date: 02-05-2005 **Day:** Saturday **Incident #:** 2005-0123
Alarm Time: 02:30 **In Route:** 02:38 **On Scene:** 02:48 **Control:** 03:55

Location: 2899 Elm Road, dirt driveway past the barn that burned last July

Method of Alarm: 911 call
Situation Reported: Structure fire with occupants fleeing the building. Mr. Smith, neighbor, reports flames coming from end of house.

Units Responding: E234, E236
Tanker 231
Rescue 239
Car 230

Type of Structure: Residential **Occupancy:** Single Family

Construction: Wood Frame **# Of Floors:** 1 **Injury-Civilian:** 0

Room of Origin: Living Room **Material First Ignited:** Padding

Method of Ignition: Undetermined **Injury-Firefighter:** 0

Narrative of Situation Found:

Units responded to reported structure fire. Prior to arrival, on scene E234 reports orange glow visible. On arrival reports structure fully involved, with fire extending from the north end of the residence. E236 and Tanker 231 established water supply and assisted with extinguishment. Fire extinguished with tank water and two hand lines.

Reporting Officer: Scott Rhodes **Title:** Capt. **Signature:** _____

Shady Brook Fire Department
Report of Fire Investigation

Date: 02-10-2005 Location: 2899 Elm Road Incident#: 2005-0123

Report by: Acting Fire Marshal L. Rich

Synopsis:
On February 5, 2005, at 02:48 hrs, the Shady Brook Fire Department responded to a structure fire at 2899 Elm Road, Shady Brook, SC. Firefighters reported finding the structure heavily involved with fire. This fire is accidental and the result of careless smoking.

Statements or Interviews:
On February 5, 2005, the occupant, Ms. Mary Jane Pilchin, who indicated she was awoken by the smoke detector and fled the building through the door in her bedroom. She said they had been partying the night before. Then she went to lie on the bed and must have fallen asleep about 11:00 pm, there were still one or two people there. She did not know when they left. She doesn't know what may have started the fire.

Building Construction:
The residence is a single story wood frame building built on a concrete slab. It is serviced by electricity and natural gas. The electrical and gas service was active at the time of the fire. The building has 3 exterior doors; 2 in the living room one in the bedroom. It appears the sliding glass door in the living room was open during the fire.

Scene Processing:
The scene was processed on February 5, 2005 pursuant to exigent circumstances by Acting Fire Marshal Rich.

The exterior examination noted all windows and doors were closed at the time of the fire except for the sliding glass door leading from the living room. There was some fire damage on the exterior above the sliding glass door.

The interior examination showed significant fire damage to the living room which also exhibited evidence of flashover. The fire extended down the hall to the bedroom. There was heavy smoke staining on the bed room walls and some evidence of radiant heat damage to the contents of the room.

There was heavy fire damage to the hall way, a result of fire movement from the living room. This was sped by the clothing hanging in the hall, the wood paneling wall coverings and the decorative tree at the end of the hallway.

1

The examination of the living room indicated the most fire damage occurred around the two seat couch. Facing the couch, the cushion to the right suffered complete destruction as well as the back of the couch.

The second larger couch sustained damage consistent with a fire originating on the two seat couch.

The large screen TV suffered damage consistent with radiant heat damage to the front. Additionally, a V pattern was noted next to the TV. Although this V appeared to be area of lowest burn it was eliminated as the point of origin due to the remains of the fuel load located in that location.

There was no evidence of electrical activity in the area of origin nor did any wires pass through this area.

There was evidence discovered of smoking materials being used in the living room.

Evidence:
Two samples were collected form this fire scene.

Sample 1 – A control sample of unburned carpet and flooring from under dinette table.

Sample 2 – A sample of burnt carpet and flooring debris from in front of and adjacent to the front of the two seat couch.

Photographs were taken by J. Golder, Third Driver, Engine 236, who was assisting with this investigation.

A crime scene sketch was also completed depicting the fire scene.

Fire Extension to Other Structures:
None

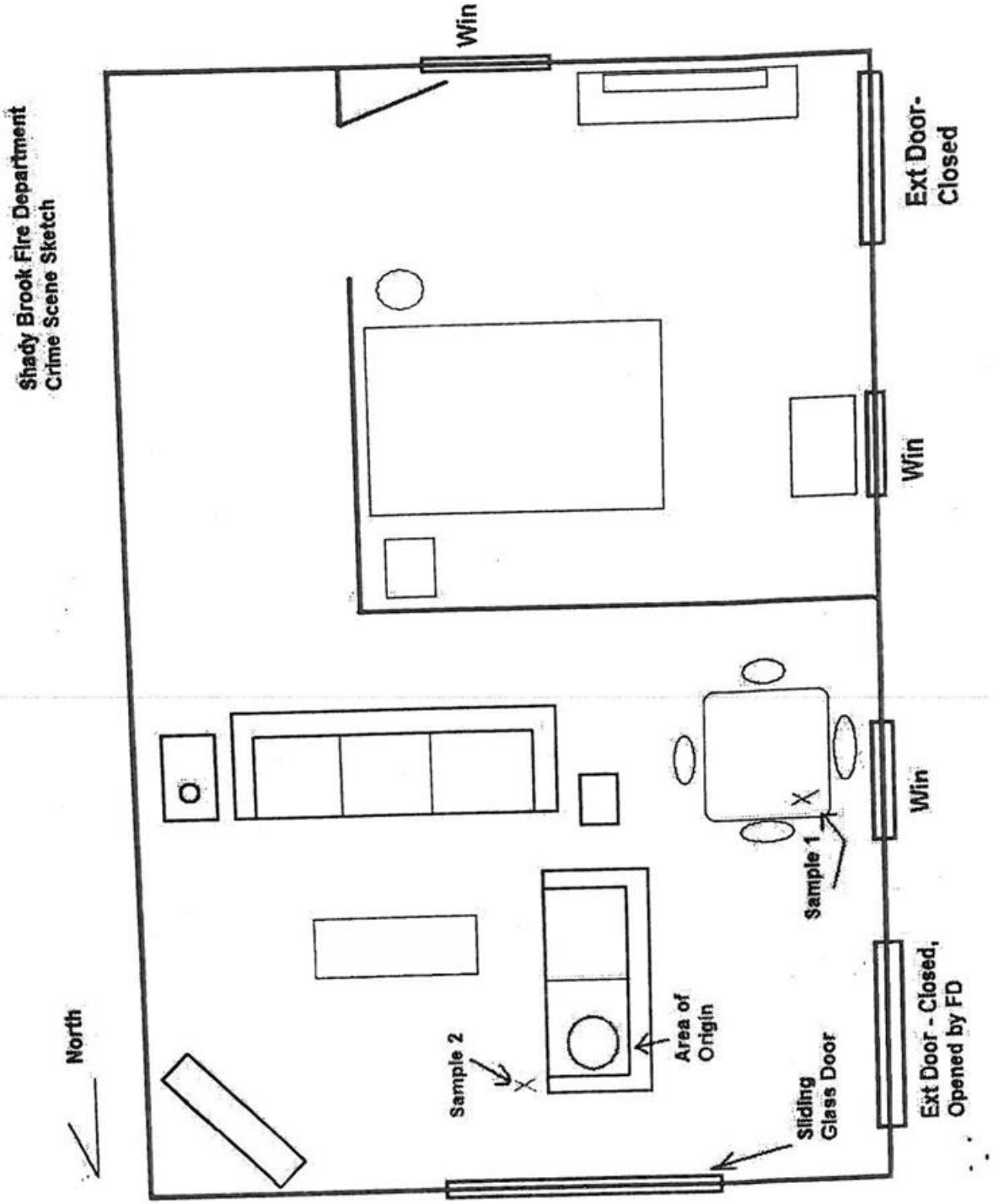
Total Value of Loss:
$ 95,000.00

Weather Information:
There were no thunderstorms in the area prior to the fire and no indication of weather involvement in this fire cause.

Conclusion:
After a through examination of this fire scene, considering the witness and firefighters statements and natural fire progression it is determined that this fire is the result of discarded smoking materials and originated on the end of the two seat couch, nearest the sliding glass door.

Submitted By: L. Rich, Acting Fire Marshall

2


Shady Brook Fire Department
Crime Scene Sketch
North
Win
Ext Door-
Closed
Win
Win
Sample 1
Ext Door - Closed,
Opened by FD
Sliding
Glass Door
Area of
Origin
Sample 2

I. SUMMARY

SUMMARY

- You should now understand the importance of ventilation and how it can effect the fire's progression and development.
- You should also understand how ventilation impacts burn patterns and thermal damage to various items.

Slide 5-87

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UNIT 6: EVIDENCE COLLECTION AND PRESERVATION

TERMINAL OBJECTIVE

The students will be able to:

6.1 Explain the importance of using proper evidence collection procedures for use in legal proceedings.

ENABLING OBJECTIVES

The students will be able to:

6.1 Define terminology relevant to evidence collection and preservation.

6.2 Explain proper collection and packaging techniques to avoid contamination.

6.3 List the most common sources of evidence contamination and how to avoid them.

6.4 Describe proper standard operating procedures (SOPs) for maintaining chain of custody.

6.5 Identify the proper procedure for submitting evidence for laboratory examination.

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UNIT 6: EVIDENCE COLLECTION AND PRESERVATION

Slide 6-1

ENABLING OBJECTIVES

- Define terminology relevant to evidence collection and preservation.
- Explain proper collection and packaging techniques to avoid contamination.
- List the most common sources of evidence contamination and how to avoid them.

Slide 6-2

ENABLING OBJECTIVES (cont'd)

- Describe proper standard operating procedures (SOPs) for maintaining chain of custody.
- Identify the proper procedures for submitting evidence for laboratory examination.

Slide 6-3

I. TOPICS TO BE DISCUSSED

FIRE DEBRIS EVIDENCE — TOPICS

- Terminology and definitions.
- Fire scene investigation.
- Contamination prevention.
- Sample selection.
  - Comparison sample?
- Sample collection and preservation.
  - Proper packaging and sealing.
- Laboratory examination.

Slide 6-4

TERMINOLOGY

- Ignitable liquid.
  - Replaces accelerant.
- Fire debris analysis.
  - Replaces accelerant or arson analysis.

Slide 6-5

DEFINITIONS

- Flash point.
  - Lowest temperature of a liquid at which the liquid gives off vapors at a sufficient rate to support a momentary flame across its surface.
- **Ignitable liquid** includes both flammable and combustible liquids.
  - Flammable: flash point < 37.8 C (100 F).
  - Combustible: flash point ≥ 37.8 C (100 F).

Slide 6-6

A. Determining flash point requires specific instrumentation and actual liquid samples.

1. Most laboratories do not have flash point testers, thus ignitable liquid covers a range of temperatures.

2. Flash point testing cannot be done on debris samples.

FIRE DEBRIS EXAMINATIONS

Identification of:

- Ignitable liquids.
- Oils (lubricating, vegetable) and waxes.
- Incendiary mixtures.
- Incendiary device components.

Slide 6-7

B. Fire debris chemists typically examine and identify:

1. Ignitable liquids.

2. Oils (lubricating, vegetable) and waxes.

3. Incendiary mixtures.

4. Incendiary device components.

C. Not all laboratories have these capabilities.

FIRE SUPPRESSION

Avoid this happening to you. …

Slide 6-8

D. Investigators do not have control of the scene until firefighters have finished their work. This may affect evidence collection, but saving lives and mitigating the hazard are the most important, immediate concerns.

PRELIMINARY INVESTIGATION

Avoid this happening to you. …

Slide 6-9

E. Once the fire is out, the fire investigators may enter and take control of the scene. They must maintain control until they are finished processing the scene and collecting any evidence.

FIRE SCENE INVESTIGATION

- Fire scene evidence is unique.
  - In some cases, not immediately identifiable.
  - Usually discovered near completion of fire scene investigation.
  - Until scene is completed, it should be viewed as a "large" piece of evidence.

Slide 6-10

F. Fire scene evidence is unique.

1. In some cases, not immediately identifiable.
2. Usually discovered near completion of fire scene investigation.
3. Until scene is completed, it should be viewed as a "large" piece of evidence.

FIRE SCENE INVESTIGATION (cont'd)

- Determining area of origin.
- Determining cause.
- Indications of ignitable liquid use:
  - Visual signs.
  - Sniffers.
  - Canines.

Slide 6-11

G. The first thing that will need to be done is to find out if, in fact, a crime was committed. In order to do that, you'll need to process the scene.

1. In order to find out how the fire started, you first need to establish **where** it started.

2. Then you can begin to try to understand what caused the fire. Was it an accident, or was it intentionally set (incendiary)?

3. When you are examining the scene, you will want to look for indications of ignitable liquid use, either visually, with instruments (like electronic sniffers), or with canines/K-9s.

4. Remember that electronic sniffers are not necessarily specific to ignitable liquids (they detect hydrocarbons), whereas trained canines are specific and sensitive to ignitable liquids.

II. RECOGNIZING EVIDENCE

FIRE SCENE EVIDENCE

- Used to corroborate an incendiary cause.
  - Is an ignitable liquid present? What is it?
- Associate suspects with fire scenes.

Slide 6-12

A. Fire debris analysis is used to corroborate an incendiary cause because it can determine if an accelerant is present and it can determine the type. It can also be used to help associate suspects to fire scenes if those accelerants are found on their person or clothing or in their possession.

ASSOCIATIVE EVIDENCE

- Physical evidence.
  - Cigarette butts.
  - Torn matches.
  - Cloth.
  - Tape.
- DNA samples.
- Latent fingerprints.
- Tool marks.

Slide 6-13

B. Associative evidence has value: DNA (touch specifically), prints, tool marks, shoe and tire impressions.

ASSOCIATIVE EVIDENCE (cont'd)

- Tire impressions.
  - Vehicles at scene.
- Shoe impressions.
  - May provide leads regarding individual(s) at fire scene.

Slide 6-14

C. Tire impressions — vehicles at scene.

D. Shoe impressions — may provide leads regarding individual(s) at fire scene.

WHAT IS CONTAMINATION?

The unintended transfer of a material onto the scene and/or onto evidence collected.

Slide 6-15

E. Contamination: the unintended transfer of a material onto the scene and/or onto evidence collected.

HOW CAN CONTAMINATION OCCUR?

Locard's Exchange Principle.

- When two materials come into contact with one another, there will be a transfer of each material to the other.
- Demonstrated through laboratory tests.

Slide 6-16

F. Locard's Exchange Principle is one of the basic premises of forensic science. It states in general terms that "every contact leaves a trace."

MECHANISMS FOR CONTAMINATION

- Personnel.
- Equipment.
- Improper packaging/storage.

Slide 6-17

G. Contamination could come from the people processing the scene if they're working one fire scene right after another.

1. Another major source of contamination could be the use of dirty tools.

2. Because of the volatility of common ignitable liquids, it's important that this type of debris is packaged and stored in an airtight container.

MECHANISMS FOR CONTAMINATION (cont'd)

Slide 6-18

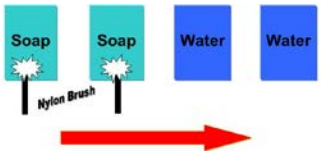
H. The potential areas for contamination are circled.

POSSIBLE CONTAMINATION?

Slide 6-19

MINIMIZING ON-SCENE CONTAMINATION

Do not bring ignitable liquid residues into scene. (Consider decontamination line.)



Slide 6-20

I. One simple practice that the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) National Response Team (NRT) has employed is the concept of a single point of entry into a fire scene.

1. By having a single point of entry, access (even to investigators) is limited.

2. At this point of entry, investigators can wash their boots to ensure that no foreign material is tracked in.

TOOLS

- Change gloves between samples.
- Use clean or disposable tools for:
  - Evidence collection.
  - Scene processing.
- Tools should be cleaned after each use.
  - Avoid wooden and wood-handled tools.
- Dish washing soap and water are recommended for cleaning.

Slide 6-21

J. Remember that porous materials soak up ignitable liquids; therefore, leather gloves, wooden tools, and other similar collection materials may become grossly contaminated.

1. Nonporous material, like metal, is best for tools, as it can be cleaned easily without fear of ignitable liquids being left behind.

2. Whatever soap is used, be certain that it does not contain ignitable liquids. (ATF recommends Dawn® dish washing liquid.)

3. Ask your laboratory if you are unsure of the ingredients.

POWER TOOLS

- Avoid use of gas-powered tools to collect evidence.
- Check with fire chief or Incident Commander (IC) and find out if gas-powered tools were used during suppression.
  - Location used.
  - Location filled.

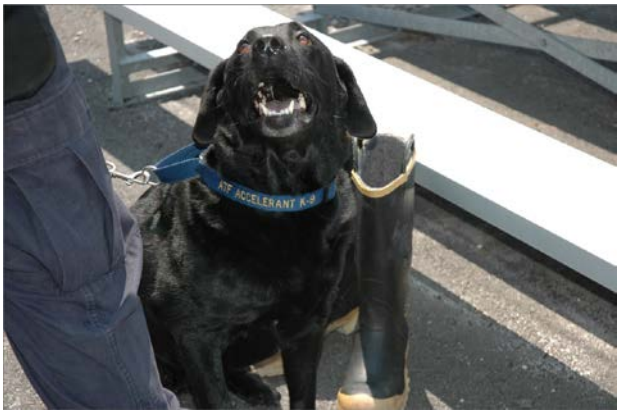
Slide 6-22

K. Gas-powered tools may leak and contaminate scenes.

1. It is best to use electric, battery-powered or manual tools to collect evidence.

2. Large, heavy equipment has been known to leak onto scenes as well.

3. Collecting a sample of the equipment fuel may be useful to the laboratory chemist.



Avoid this happening to you. …

Slide 6-23

L. Canines can be used to test your equipment prior to use. This is an ATF canine alerting to a pair of work boots.

IGNITABLE LIQUIDS DETECTION CANINES

- Dogs are a tool that allows you to select the best samples.
- Just because the dog alerts, it does not mean that it was a set fire.

Slide 6-24

M. There are a variety of indicators and tools that can be used to help you get good samples, which are samples that have a high probability of confirmation. The most important indicators in the sample selection process will be visual cues that you get from looking at the scene.

N. There are ATF-trained canines available in every region to provide you with assistance in locating the remains of ignitable liquids at a crime scene. The dogs are specially trained to detect ignitable liquids.

LARGE FIRE SCENES

Slide 6-25

1. These dogs are very useful when you have a large fire scene and it is hard to pinpoint the areas where ignitable liquids could be present.

IGNITABLE LIQUIDS DETECTION CANINES (cont'd)

- Sensitive.
- Selective.
- But they can't testify!

Slide 6-26

2. Canines can be extremely helpful in finding an ignitable liquid in the fire scene; however, they alone cannot be used to state that an ignitable liquid is indeed present. Remember that even though canines are both sensitive and selective, **they can't testify**!

DISCRIMINATION LINE

Slide 6-27

O. One way of ensuring that the sample collected represents what the dog alerted to is to run a discrimination line after collecting the samples.

1. A discrimination line involves placing all the K-9 alert samples in a line, along with some negative controls of burned material from the scene. Hopefully, when the dog works the cans, it will alert to the items of evidence collected from where it alerted at the scene. If not, maybe the right sample wasn't collected; maybe we collected next to the area alerted on, instead of right at it. Maybe there was drop-down on top of the debris of interest, and we collected only the top layer, not the deeper layer that actually contained the ignitable liquid.

2. If this happens, go back to the area, and rework the dog through it. The idea is to get the best sample possible; you need to take advantage of the dog's superior olfactory capabilities to get the best sample.

INTERNATIONAL ASSOCIATON OF ARSON INVESTIGATORS AND NATIONAL FIRE PROTECTION ASSOCIATION 921 POSITION ON CANINES

- Both endorse the use of ignitable liquid detection canines for the purposes of locating and selecting samples.
- A canine alert must be confirmed by the laboratory.

Slide 6-28

3. One thing that you'll want to keep in mind, however, is the limitations of the dogs: how they can be used and how they shouldn't be used.

SAMPLE SELECTION

- Location.
  - From area of suspected pour.
  - Not from an area of extreme charring.
- Consider the matrix.
  - Porosity.
  - Contributions from pyrolysis.

Slide 6-29

P. The location from which the evidence is collected is very important. You want to get a sample from an area where you believe that an ignitable liquid may have been, and you want to not be in an area of extreme charring, otherwise you won't have any residue left.

Q. The other important thing to keep in mind is the type of material that you're collecting. Porous materials, things that are spongy, can really hold onto the sample. Think about pouring some alcohol on a mirror and into a sponge. Where will it last longer? Where will it evaporate from first? The same principle will apply with ignitable liquids at a fire scene. If they soaked into something, like carpet or padding, they will be protected and have a greater chance of surviving the fire. The only problem with porous materials is that they tend to contribute their own combustion and pyrolysis products to the extract, which can sometimes make data interpretation a little more difficult. Samples of this nature are not as "clean" as something like glass.

BEST EVIDENCE TO COLLECT FROM FIRE SCENE

- Use burn patterns and protected areas to locate best sample.

Slide 6-30

R. In summary, collect the evidence from the location where the ignitable liquid could be retained, such as under the flooring or from a porous material, that is least affected by fire.

BEST EVIDENCE TO COLLECT FROM FIRE SCENE (cont'd)

- Flooring and porous materials are the best areas for retaining ignitable liquids.
  - Carpet and padding.
  - Soil.
  - Cloth or rags.

Slide 6-31

S. Flooring and porous materials are the best areas for retaining ignitable liquids.

COMPARISON SAMPLES

- What are they?
  - Comparison samples identify and may minimize or eliminate sources of interference in the analysis process.
- When are they needed?
  - Almost always.

Slide 6-32

T. Comparison samples.

1. A comparison sample consists of a sample taken that is not expected to have an ignitable liquid on it but is comprised of the same sample material as evidence taken. It gives the laboratory analyst some information about the chemicals present in the sample matrix and what is most likely foreign to it.

COLLECTING COMPARISON SAMPLES

Slide 6-33

COMPARISON SAMPLES (cont'd)

- They should be collected at the time of the initial investigation, because it is usually impossible for an investigator to return to a scene to collect a comparison sample.

Slide 6-34

2. The chemist determines whether or not a comparison sample is needed, and by the time the laboratory receives and analyzes the evidence, it is too late to go back to the scene to collect a comparison.

COMPARISON SAMPLES (cont'd)

- They should be collected when submitting:
  - Carpet and padding.
  - Vinyl flooring.
  - Soil.
  - Wood.
  - Shoes.

- Submit them with instructions.
  - "Comparison samples — test if needed."

Slide 6-35

3. It is a good idea to collect comparison samples when evidence includes carpet/padding, vinyl flooring, polished wood, shoes or similar items. When collecting shoes, package each in a separate container so that they can be compared against each other.

COMPARISON SAMPLES (cont'd)

- Comparison samples are not always available.
  - Extensively damaged scenes.
  - Amount of ignitable liquid overwhelms scene.

Slide 6-36

4. Examples of when comparison samples are not always possible:

   a. Completely burned out black hole.

   b. Gas station.

   c. Mechanic's garage.

   d. Houses with standing gas poured inside — not possible to get a clean comparison!

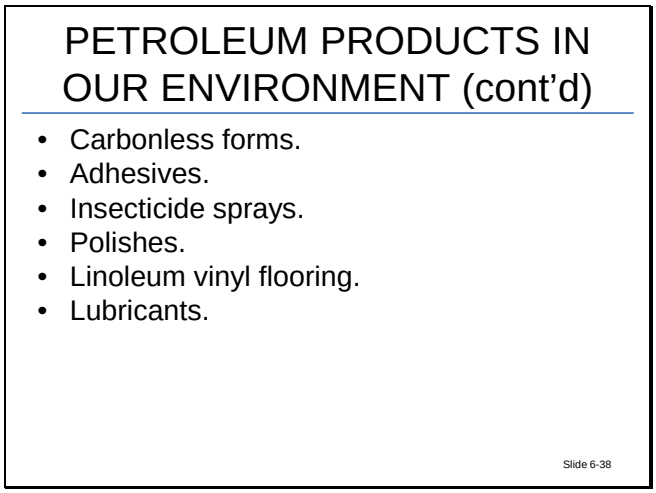
   e. Unidentifiable debris — not possible to collect a comparison when you don't know what the material was originally.

PETROLEUM PRODUCTS IN OUR ENVIRONMENT

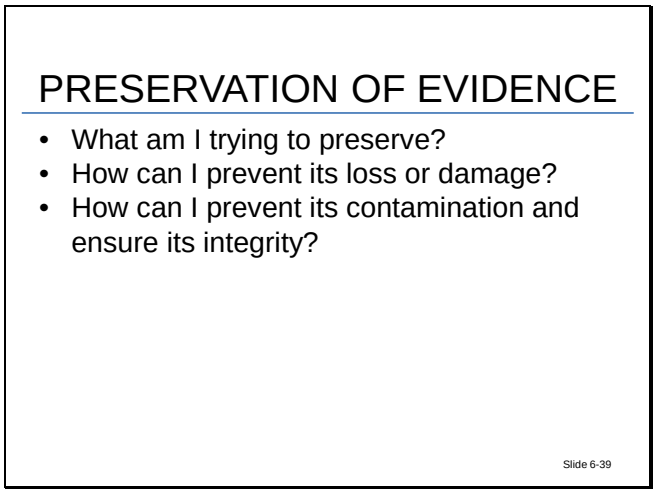
- Shoes.
- Flooring products.
- Printing inks.
- Copier toners.
- Waterless hand cleaners.
- Clothing.
- Newspapers.

Slide 6-37

5. Our world is made up of petroleum products. This is just a sampling from the literature of “ignitable liquids” in everyday products.



III. EVIDENCE PACKAGING AND SHIPPING



A. Preservation of evidence.

1. No matter what type of evidence you’re dealing with — fire debris, fingerprints or DNA — you can get a pretty good idea of the best way to preserve it by asking yourself some questions.

2. Ask yourself the following questions:

a. What am I trying to preserve?

b. How can I prevent its loss or damage?

c. How can I prevent its contamination and ensure its integrity?

FIRE DEBRIS PACKAGING

- Vapor-tight packaging is most important.
- Limit sample handling until after ignitable liquid extraction.
- Prior processing for prints/DNA/explosives may affect recovery of ignitable liquids.

Slide 6-40

EVIDENCE CONTAINERS

- Metal cans.
- Special evidence bags.
- Glass jars and vials.

Slide 6-41

B. Depending on the type of evidence you are collecting, you can use:

1. Metal cans.
2. Special evidence bags.
3. Glass jars and vials.

PAINT CANS

- Paint cans are recommended.
  - Lined or unlined acceptable.
- Clean and unused.
- No more than two-thirds full.

Slide 6-42

PAINT CANS (cont'd)

- Pros:
  - Durable.
  - Readily available.
- Cons:
  - Rapid deterioration (rust) in unlined cans.
  - Leakage of vapors (if **not** sealed properly).
  - Bulky.

Slide 6-43

SPECIAL EVIDENCE BAGS

- Ampac Fire Debris bags (tubular).
  - Cut from roll to needed size.
  - Require heat sealer on two ends.
- Nylon bags.
  - Available in various sizes.
  - Require **high temperature** heat sealer.
- May be taped, folded over multiple times, and retaped.
- **No common plastic bags!**

Slide 6-44

C. Ampac used to be Kapak, and, along with nylon bags, these are the only acceptable plastic bags for packaging fire debris evidence.

1. Heat sealing is the best method to seal the bags, but note that nylon bags require a higher temperature to properly seal.

2. Bags should be checked for proper sealing before sending to the laboratory.

SPECIAL EVIDENCE BAGS (cont'd)

- Pros:
  - Ability to see evidence.
  - Good for large, bulky items.
  - No deterioration.
- Cons:
  - Not puncture resistant.
  - Bad for heavy, wet items.
  - Leakage of vapors (if **not** sealed properly).

Slide 6-45

D. No common plastic bags (Ziploc®, trash bags, grocery bags, etc.) should be used under any circumstances for fire debris evidence. Common plastic bags are made of a different polymer that is not considered vapor-tight.

GLASS JARS

- Pros:
  - Ability to see evidence.
  - Readily available.
- Cons:
  - Breakable.
  - Ignitable liquids can destroy rubber seals and glued cap liners.

Slide 6-46

E. Unused and clean glass jars may also be used. Use Teflon® (polytetrafluoroethylene (PTFE)) lids with no glued cap liners or rubber seals.

PACKAGING RESOURCES

- Cans, bottles, vials.
  - Southpak Container Corp (www.southpakcontainer.com).
  - US Container Corp (www.uscontainer.com).
  - Freund Container (www.freundcontainer.com).

Slide 6-47

F. Southpak and US Container are likely the same company. Southpak has a minimum order of $500 and only sells in pallets.

PACKAGING RESOURCES (cont'd)

- Vials (polytetrafluoroethylene (PTFE)-lined caps).
  - Fisher Scientific (www.fishersci.com).
  - Sigma Aldrich (www.sigmaaldrich.com).
  - Government Scientific Source (GSS) (www.govsci.com).
- Bags.
  - Ampac Fire Debris (www.ampaconline.com).
  - Grand River Products (313-881-7861).

Slide 6-48

1. The brand name for PTFE is Teflon.

PACKAGING RESOURCES (cont'd)

- Evidence collection.
  - Evident Crime Scene Products (www.evidentcrimescene.com).
  - Lynn Peavey Company (www.lynnpeavey.com).

Slide 6-49

2. Evidence collection.

   a. Evident Crime Scene Products (www.evidentcrimescene.com).

   b. Lynn Peavey Company (www.lynnpeavey.com).

COLLECTION OF SOLID SCENE SAMPLES

- Preferred method.
  - Scoop samples into metal cans.
  - Do not exceed two-thirds full (loosely packed).
  - Use multiple containers rather than overpacking.
- Alternative method.
  - Scoop samples into fire debris evidence bags.
  - Not puncture resistant, which may compromise evidence.

Slide 6-50

G. Solid samples should be in clean cans or glass bottles and should not be more than two-thirds full.

   1. Use multiple containers, if necessary, rather than overpacking.

   2. Nylon bags may also be used if the debris is not likely to puncture the bag.

SOIL SAMPLES

- Hydrocarbon-eating microbes.
- Degradation within 24 hours.
- Refrigerate samples quickly.
- **Always** collect comparison sample.

Slide 6-51

H. Soil contains microbes that will quickly degrade accelerants if present. Refrigerate samples quickly to slow down the degradation, and always collect a sample of soil away from the possible origin for comparison purposes.

COLLECTION OF LIQUID SAMPLES

- Sources:
  - Cans, bottles, containers.
  - Porous objects wrung out.
  - Pooled liquids.
  - Sheen on puddles.

Slide 6-52

I. Liquid samples may be encountered at fire scenes in bottles or containers; they may be wrung out of porous materials, they may be pooled, or they may be observed as a sheen on a puddle.

COLLECTION OF LIQUID SAMPLES (cont'd)

- Preferred method.
  - Pipette 2 to 4 milliliters (mL) into clean glass vials.
  - Place vials in metal can or evidence bag with packing material to prevent breakage.
- Alternative method.
  - Absorb onto gauze or cotton and place in metal can or fire debris evidence bag.
  - Submit comparison sample of absorbent.

Slide 6-53

J. Pipette liquid samples into clean glass vials, wrap to prevent breakage, and place in a metal can or evidence bag.

1. Liquids may also be absorbed onto gauze or cotton and then placed into a can, bottle or nylon bag.

2. A comparison sample of the gauze or cotton should also be submitted.

COLLECTION DEVICES

- Gauze pads.
  - **Not** nonstick.
- Cotton balls.
- Absorbents.
  - Flour that is not self-rising.
  - Activated charcoal.
  - Diatomaceous earth.
  - Calcium carbonate.
- Pipettes.
- Eye droppers.

Slide 6-54

K. Remember that no matter what collection device you use, you must submit a comparison sample of it.

Do not leave samples in pipettes or eye droppers, as they will evaporate.

PRESERVATION OF LIQUID CONTAINERS

- Photograph container.
- Note all manufacturer's markings.
  - Brand.
  - Lot.
  - Production location.
- Provide information with submission documentation.
- Only submit container if it is nearly empty.

Slide 6-55

L. If a container with liquid is found, you should photograph the container, note all manufacturer's markings, and place a small amount of the liquid in a glass vial.

Collect all layers of liquid if two or more layers are present. Only submit the container if it is nearly empty.

EVIDENCE OF SUSPECTS: RESIDUES

Skin is absorbent; however, clothing is much better.

- If absolutely necessary, swab skin.
- Submit unused swab as a comparison sample.

Slide 6-56

M. Skin may have small amounts of residues on it, although clothing is probably a better source.

1. If necessary, swab the suspect with a wipe and package in a can, bottle or special bag.

2. An unused wipe should also be submitted for comparison.

EVIDENCE FROM SUSPECTS: CLOTHING

- Package each garment individually — even shoes.
- Package in container that allows for sufficient headspace.

Slide 6-57

N. Evidence from suspects may include clothing. Package each garment separately in an airtight container.

EVIDENCE FROM SUSPECTS: CLOTHING (cont'd)

- Large airtight volatile-free evidence bags or 5-gallon metal cans are recommended.
- Cut clothing if necessary.
- Use canine to locate best sample area to cut.
- **Note that 5-gallon cans are exception, not rule.**

Slide 6-58

1. Cut clothing if necessary to get it to fit into a container.

2. Either package the pieces separately into several containers or use a canine to locate the best area and submit only that piece to the lab.

EVIDENCE FROM VICTIMS

- Clothing — package each item separately.
- Be cognizant of other forensic evidence.
  - DNA.
  - Trace.
- Biological tissues — collect at autopsy.
  - Lung.
  - Skin sections.
- Label as biohazard; observe precautions.

Slide 6-59

3. Evidence from victims may include clothing or biological tissues. Package in airtight containers as previously mentioned, and label as a biohazard. Observe universal precautions.

EVIDENCE FROM DEVICES

- Remember that the entire device is important!
- Submit device for:
  - Prints.
  - DNA.
  - Trace (hairs, fibers, etc.).
  - Tool marks.
  - Ignitable liquids.

Slide 6-60

O. In an effort to preserve evidence, do not remove tape or take apart a device (other than to render it safe). If the device is destroyed, there will be limited value in court.

EVIDENCE FROM DEVICES (cont'd)

- Package liquids and wicks separately from container fragments.
- If **only** fingerprints or DNA is desired, items should be dried and packaged in breathable containers.

Slide 6-61

IMPROPER PACKAGING OF EVIDENCE

- Not airtight containers.
- Rubber stoppers.

Slide 6-62

P. Improper packaging of evidence.

1. Photo on left: wood submitted in paper envelope for ignitable liquid testing (not airtight).

2. Photo on right: two items submitted in tubes (one glass and one plastic) with rubber stoppers (not airtight).

IMPROPER PACKAGING OF EVIDENCE (cont'd)

Can is corroded — not airtight.

Friction lid seal is damaged from stepping on lid to close it — not airtight.

Slide 6-63

Q. Improper packaging of evidence.

1. Don't put cans in water at scene. When ash is burned and mixed with water, it makes lye, which reacts with steel (causing rust).

IMPROPER PACKAGING OF EVIDENCE (cont'd)

Liquid in plastic container, which dissolved

Slide 6-64

2. The liquid was packaged in a container, and that container was placed in a can.

3. The liquid, in this case kerosene, dissolved the plastic container, causing it to breach and leak its contents into the can.

IMPROPER PACKAGING OF EVIDENCE (cont'd)

Used container

Slide 6-65

4. Container was a used, toxic tear gas canister. Evidence inside was from a Molotov cocktail.

IMPROPER PACKAGING CONTAINERS

- No paper bags for fire debris.
- No plastic or Ziploc® bags.
- No plastic bottles/containers.
- No used containers.
- Improper packaging results in leakage and evaporation of ignitable liquids.

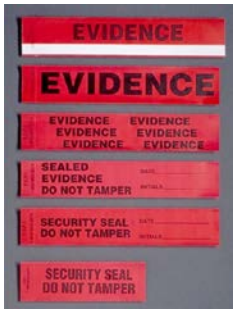
Slide 6-66

R. Examples of improper packaging containers:

1. Paper bags for fire debris.
2. Plastic or Ziploc bags.
3. Plastic bottles/containers.
4. Used containers.
5. Improper packaging results in leakage and evaporation of ignitable liquids.

EVIDENCE SEAL AND LABEL

- Sealing of evidence prevents tampering of the sample or evidence (legal).
  - Tamper-proof seal required.
  - Evidence tape or heat seal.
  - Must seal across entire opening.



Slide 6-67

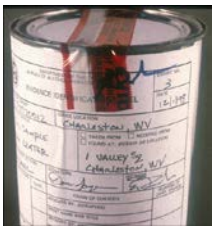
S. Sealing of evidence prevents tampering of the sample or evidence.

1. Tamper-proof seal is required across the entire opening or on two opposite sides of a can.

2. Must seal across the entire opening.

EVIDENCE SEAL AND LABEL (cont'd)

- Labeling.
  - Initials and date on seal.
  - Case number.
  - Description of evidence.
  - Inventory number and item number.
  - Custom-made inventory labels.



Slide 6-68

T. Labeling.

1. Initials and date on seal.

2. Case number.

3. Description of evidence.

4. Inventory number and item number.

5. Custom-made inventory labels.

CHAIN OF CUSTODY

- Each person who handles the evidence becomes a “link” in the chain.
- Each person who handles the evidence should document his or her involvement in the chain of custody.
- Written record accounts for storage and movement of the evidence.

Slide 6-69

STORAGE OF EVIDENCE

- Proper storage is important in maintaining chain of custody.
- Having evidence stored in law enforcement agencies is the best option.
- Store evidence in fire investigator’s office as a last resort.
- Follow local policy for evidence storage.

Slide 6-70

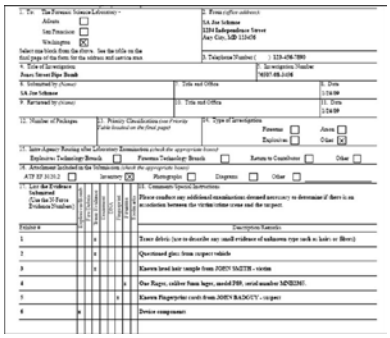
TRANSPORTING AND SUBMITTING EVIDENCE

- Hand delivery recommended.
- Shipping.
  - Tracking system required.
    - -- FedEx, UPS, Certified Mail, etc.
  - Be aware of hazmat policies and labels.
- Paperwork.
  - Follow agency and laboratory policies for submission.

Slide 6-71

U. ATF uses overnight shipping with tracking number, but investigators must remember to follow their own agency and laboratory policies for evidence delivery.

EVIDENCE TRANSMITTAL



Slide 6-72

V. This is an example of ATF's laboratory evidence transmittal document.

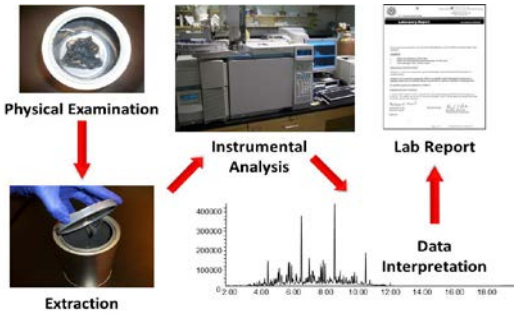
1. When describing items, you can be general (e.g., fire debris) or more specific (e.g., sample of carpet from master bedroom).

2. Most laboratories consider this type of document to be a "contract" for services.

3. Laboratories should work with you to make sure that the appropriate exams are performed.

IV. LABORATORY EXAMINATION

OVERVIEW OF LABORATORY PROCESSING



Slide 6-73

A. The laboratory analysis of fire debris can be considered as a five-step process.

1. Physical examination, extraction, instrumental analysis, data interpretation and writing the report.

2. Each of these will be discussed in turn.

SAMPLE ANALYSIS — DEBRIS

- What is burning at the scene is the evaporated liquid. Some liquid may remain after the fire.
- Isolate residues using passive headspace extraction.

Slide 6-74

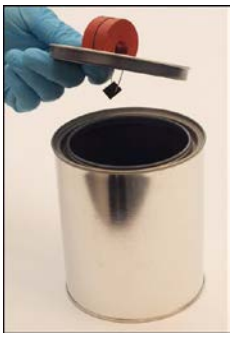
B. Usually debris is submitted to us.

1. In debris samples, the ignitable liquid on the surface may have burned during the fire, but there may be some left in the nooks and crannies.

2. We use passive headspace extraction to get those ignitable liquid residues.

PASSIVE ADSORPTION — ELUTION

- Also known as:
  - Passive Headspace Concentration (PHC).
  - Passive Charcoal Adsorption (PCA).



American Society for Testing and Materials (ASTM) E 1412

Slide 6-75

C. Passive Adsorption — Elution.

Different names for the C-strip method:

1. Passive Headspace Concentration (PHC).

2. Passive Charcoal Adsorption (PCA).

PASSIVE ADSORPTION — ELUTION (cont'd)

- Samples extracted via PHC.
  - Activated Charcoal Strip (ACS) is suspended in container.
  - Kept in oven or ambient (overnight).
  - ACS eluted with carbon disulfide.

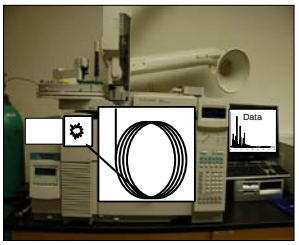
ASTM E 1412

Slide 6-76

INSTRUMENTATION

Gas chromatograph/Mass spectrometer (GC/MS).

- Separation of components (GC).
- Detection and identification of compounds (MS).



Slide 6-77

D. Gas chromatograph/Mass spectrometer (GC/MS) does two functions:

1. GC separates the components of an ignitable liquid.
2. MS detects and identifies each compound.

IGNITABLE LIQUID CLASSIFICATION

- Petroleum products are classified, not identified.
- Marketing practices.
  - Same product may be marketed under a variety of end uses or brand names.
- Classified by comparing patterns to reference ignitable liquids.

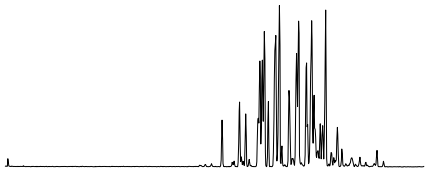
Slide 6-78

E. Ignitable liquid classification.

1. Petroleum products are classified, not identified. This is because of the distribution and marketing strategies of the petroleum industry.

IGNITABLE LIQUID CLASSIFICATION (cont'd)

- Based on boiling point range or "cut" and on chemical composition.
  - Gasoline.
  - Light, medium and heavy distillates.
  - Other (isoparaffins, alcohols, etc.)

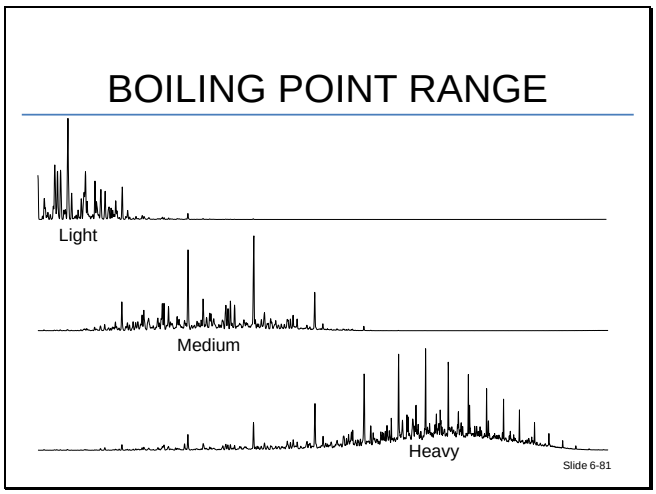


Slide 6-79

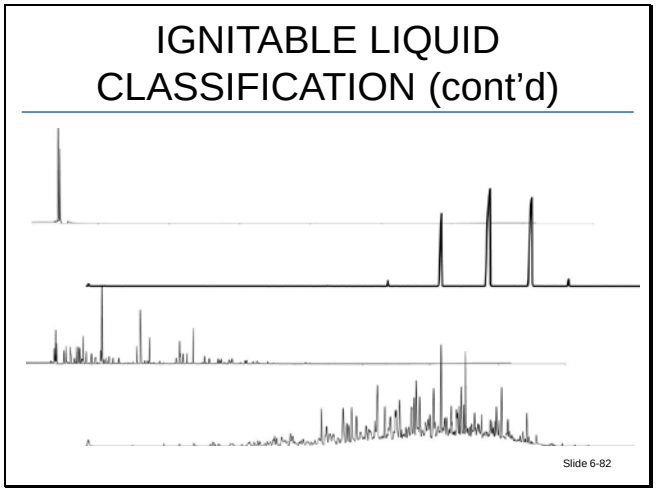
2. The ignitable liquid classification scheme is based on the boiling point range and chemical composition of the product. The various classes are listed on the next slide.

Class	Light (C_4-C_9)	Medium (C_8-C_{13})	Heavy (C_8-C_{20}+)
Gasoline	Fresh gasoline is typically in the range C_4-C_{12}		
Petroleum Distillates	Petroleum Ether Some Cigarette Lighter Fluids Some Camping Fuels	Some Charcoal Starters Some Paint Thinners Some Dry Cleaning Solvents	Kerosene Diesel Fuel Some Jet Fuels Some Charcoal Starters
Isoparaffinic Products	Aviation Gas Some Specialty Solvents	Some Charcoal Starters Some Paint Thinners Some Copier Toners	Some Commercial Specialty Solvents
Aromatic Products	Some Paint and Varnish Removers Some Automotive Parts Cleaners Xylenes, Toluene-Based Products	Some Automotive Parts Cleaners Specialty Cleaning Solvents Some Insecticide Vehicles Fuel Additives	Some Insecticide Vehicles Industrial Cleaning Solvents
Naphthenic/Paraffinic Products	Cyclohexane-Based Solvents/Products	Some Charcoal Starters Some Insecticide Vehicles Some Lamp Oils	Some Insecticide Vehicles Some Lamp Oils Industrial Solvents
Normal Alkane Products	Solvents Pentane Hexane Heptane	Some Candle Oils Some Copier Toners	Some Candle Oils Carbonless Forms Some Copier Toners
Oxygenated Solvents	Alcohols Ketones Some Lacquer Thinners Fuel Additives Surface Preparation Solvents	Some Lacquer Thinners Some Industrial Solvents Metal Cleaners/Gloss Removers	
Others — Miscellaneous	Single Component Products Some Blended Products Some Enamel Reducers	Turpentine Products Some Blended Products Some Specialty Products	Some Blended Products Some Specialty Products

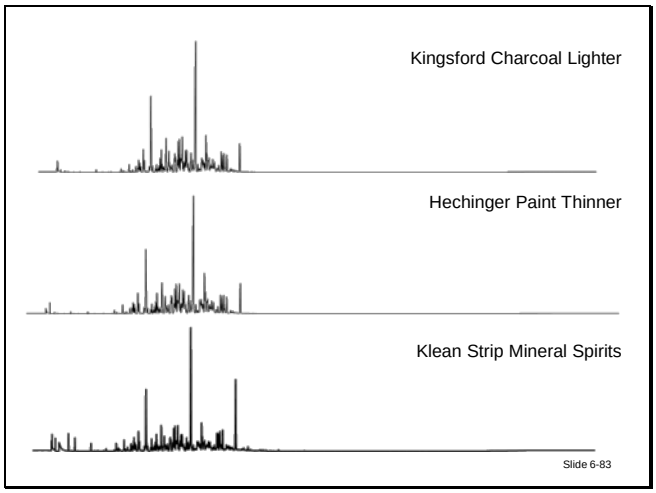
Slide 6-80



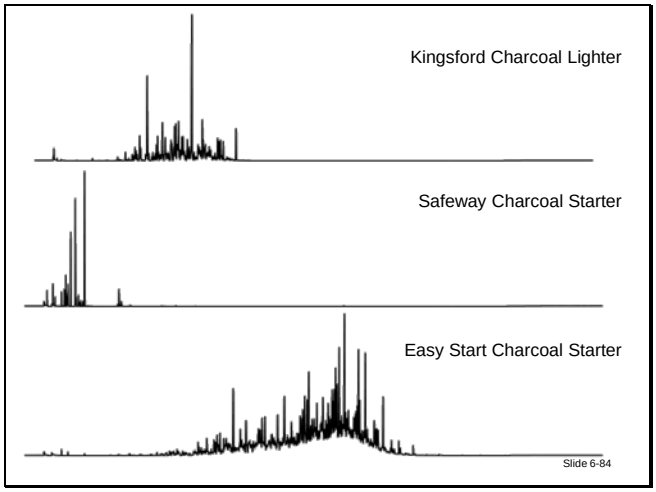
F. Boiling point range.



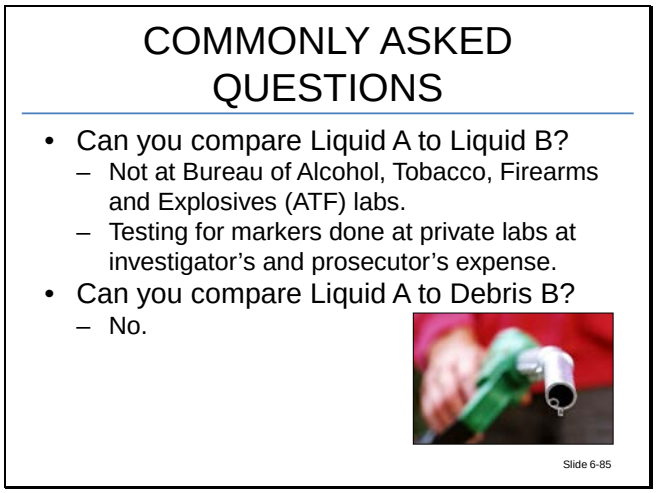
G. Ignitable liquid classification.



H. Different end uses, same chemical profiles.

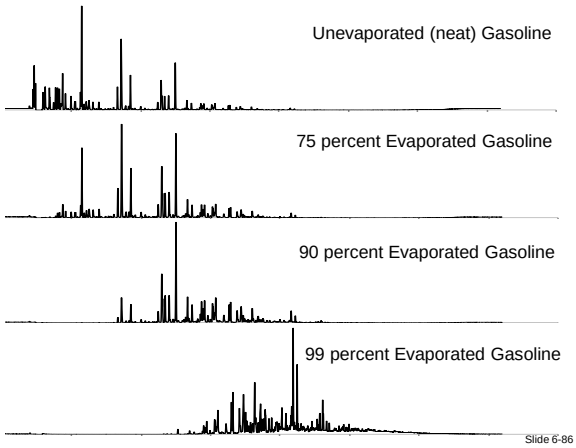


I. Same use, different chemical profiles.



J. Liquid to liquid comparisons of ignitable liquids are not generally performed at most public laboratories. Specific proprietary markers for certain ignitable liquids can be identified by private laboratories.

K. Liquid to debris comparisons of ignitable liquids are generally not possible, primarily because of the effect of heat/fire on ignitable liquids.



L. Notice the shift in the pattern, despite these samples all being gasoline.

1. The reason for this is that the most volatile components evaporate the easiest, so they are lost first.

2. This means that the remaining liquid has a higher concentration of the heavier components — but notice how the ratios of peaks within the groups stay the same.

3. This is what allows us to still identify a petroleum product, even if it has evaporated.

COMMONLY ASKED QUESTIONS (cont'd)

- When can I expect results?
  - Best scenario is three days from submission to result, depending on:
    - -- Current backlog.
    - -- Number of items submitted.
    - -- Number of items in 5-gallon cans.
    - **-- Reminder that 5-gallon cans are the exception not the rule.**

Slide 6-87

M. Best case scenario for most laboratories is three days from submission to result, but most laboratories also have a large backlog.

COMMONLY ASKED QUESTIONS (cont'd)

- Why three or more days?
  - -- Most evidence requires overnight extraction.
  - -- Oven space is limited.
  - -- One GC/MS run takes 45 minutes.
- Allow at least one week to receive final written report.
  - Consider time needed for other exams.

Slide 6-88

COMMON FIRE DEBRIS ISSUES

- Re-examining evidence.
  - Analyzing preserved C-strip.
    - -- Usually saved for defense.
  - Complete re-extraction (PHC) of evidence.
    - -- Potential degradation over time (packaging, ignitable liquid).
- Most labs will not re-examine evidence from another laboratory.
  - Unless examination is not possible.
    - -- Lab does not have DNA capabilities.
    - -- Lab cannot analyze for vegetable oils.

Slide 6-89

N. Re-examining evidence can involve extraction of the preserved C-strip or re-extraction of the evidence. Most laboratories will not re-examine evidence that has already been processed by another laboratory.

V. REPORTING GUIDELINES

REPORTING GUIDELINES

What should you expect in a fire debris analysis report?

Slide 6-90

LABORATORY REPORT WORDING

Results of an examination.

- Exhibit 3 contained a medium petroleum distillate (MPD), which is an ignitable liquid.
- Examples of MPDs include some charcoal starters, some brands of paint thinners, and mineral spirits.
- Gasoline, an ignitable liquid, was identified in Exhibit 4.
- No ignitable liquids were identified in Exhibits 1 and 2.

Slide 6-91

A. In our laboratory report, we identify an ignitable liquid based on the American Society for Testing and Materials (ASTM) or similar ATF Classification System and give at least three examples of the products that are commonly present in that class.

B. Gasoline is reported as such because of its unique composition.

NEGATIVE REPORTS

- No ignitable liquid in sample.
  - None used.
  - Not in sample collected.
- Below limits of detection due to:
  - Consumption by fire.
  - Evaporation before/after collection.
- Matrix interferences.
  - Native to substrate.
  - Right compounds, not the right pattern.

Slide 6-92

C. There are a variety of reasons why ignitable liquids may not be detected.

1. No ignitable liquid in sample.

   a. None used.

   b. Not in sample collected.

2. Below limits of detection due to:

   a. Consumption by fire.

   b. Evaporation prior to collection.

   c. Evaporation after collection.

3. Matrix interferences.

   a. Native to substrate.

   b. Right compounds, not the right pattern.

NEGATIVE REPORTS (cont'd)

- Degradation — started out as an ignitable liquid, but changed while in the can.
- Fire suppression techniques.
- Lack of appropriate reference.
- Low signal.
- Examiner discretion/error.
- Lab protocol.

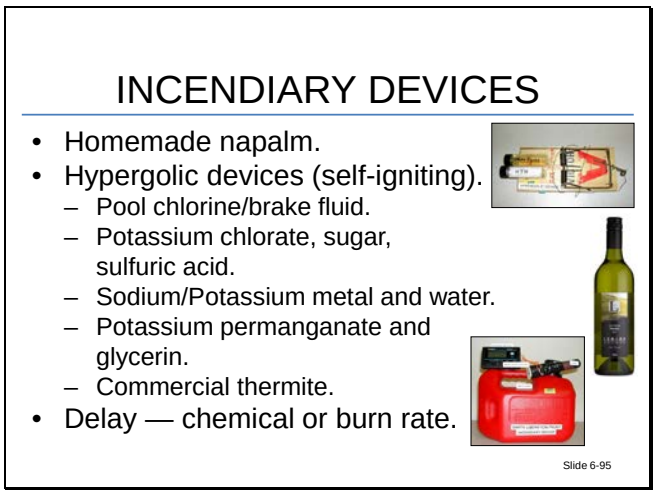
Slide 6-93

4. Degradation — started out as an ignitable liquid, but changed while in the can.
5. Fire suppression techniques.
6. Lack of appropriate reference.
7. Low signal.
8. Examiner discretion/error.
9. Lab protocol.

OTHER RELATED ANALYSES

Incendiary devices, lubricating oils, vegetable/animal oils and alternative fuels.

Slide 6-94



D. Homemade napalm may be added to some Molotovs to make the fuel tacky and to stick to walls or furniture.

1. There are all sorts of variations on homemade napalm, including gasoline with packing peanuts, rubber bands, dish soap, blood, etc.

2. Modern Molotovs can be more complicated, including a class of self-igniting ones also known as hypergolics.

3. One of these uses a mixture of ignitable liquid (i.e., gasoline) and strong acid on the interior and a sugar/chlorate mixture on the exterior.

   a. When the container breaks, the acid comes into contact with the sugar/chlorate mixture, causing immediate ignition.

   b. Allows arsonists to be more covert. There are various other chemical incendiaries that may be used to start a fire and may leave a residue, such as sodium or potassium metal and water, white phosphorous, and thermite.

   c. With some of these more complex devices, other components may be involved, such as fuses or flares for ignition, time delay devices, and various types of containers.

PACKAGING OF CHEMICAL INCENDIARIES

- Polyethylene or nylon bag.
- No direct contact with metal.
- Plastic bag may be placed in metal paint can.

Slide 6-96

E. Chemical incendiaries should be packaged in polyethylene or nylon bags. Do not package them in metal, or a reaction may take place.

LUBRICATING OILS

- Examples include:
  - Motor oil.
  - Baby oil.
  - Mineral oil.
  - Power steering fluid.
  - Oils in explosives (Composition C-4).
- Q and K comparisons possible on a variety of evidence (scene, clothes, car, ground, etc.).

Slide 6-97

F. Lubricating oils cover a wide variety of petroleum products.

1. These oils are heavier than ignitable liquids, thus they do not change as much (if at all) when exposed to heat/fire.

2. Comparisons are possible between lubricating oils, although not every lab has this capability.

VEGETABLE AND ANIMAL FATS/OILS

- Some are prone to spontaneous ignition.
  - Linseed oil.
  - Tung oil.
- Although not flammable and therefore not good accelerants, they are **ignitable.**
- Extract debris to look for specific compounds indicative of vegetable oils.
- **Must refrigerate immediately.**

Slide 6-98

G. Solvent extract debris to look for fatty acids, which are present in vegetable oils. Spontaneous ignition occurs due to the amount of specific polyunsaturated fatty acids.

H. Because solvent extraction is required, examining debris for vegetable oils is not routine.

1. Thus, the investigator must suspect their presence and note this on the transmittal.

2. Otherwise, this type of analysis will not occur. Not every laboratory has the capability to identify vegetable oils.

BIODIESEL

- Manufactured from vegetable oils, animal fats or recycled restaurant greases.
- Grades.
  - B100 — 100 percent biodiesel.
  - B20 — 20 percent biodiesel blended with petroleum diesel.

Slide 6-99

I. Biodiesel is an alternative fuel that uses modified vegetable oils, animal fats or restaurant greases.

BIODIESEL (cont'd)

- Production.
  - Base catalyzed transesterification of vegetable oil with methanol.
  - Raw vegetable oils will not work!

Slide 6-100

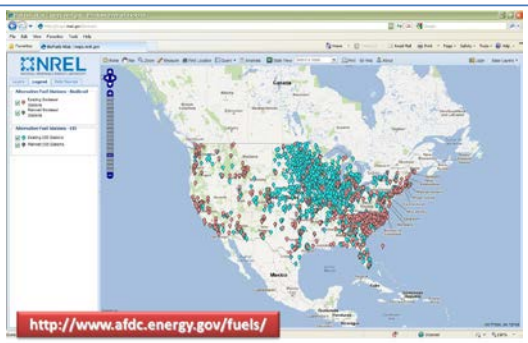
E85

- E85 is 85 percent ethanol, 15 percent gasoline.
  - Regular gasoline contains up to 10 percent ethanol.
- Need special engine for E85.
- Produced from starch-based crops (corn).

Slide 6-101

J. E85 is another alternative fuel. It contains 85 percent ethanol, as opposed to regular gasoline that contains up to 10 percent ethanol.

ALTERNATIVE FUEL AVAILABILITY



Slide 6-102

K. This website offers information on how alternative fuels are produced and where fueling stations are located.

1. This map shows existing E85 stations (blue) and biodiesel stations (pink).

2. The site allows you to search by state, which may be helpful for investigative purposes.

3. This data is current as of August 2012.

LAB ANALYSIS

- Biodiesel and E85 can be analyzed in fire debris laboratories.
- Ethanol in E85 can be detected with appropriate instrumental conditions.
- Studies show means of suppression may reduce or eliminate presence of ethanol.
- Ethanol is water soluble!

Slide 6-103

VI. SUMMARY

SUMMARY

- Topics to be discussed.
- Recognizing evidence.
- Preservation of evidence.
- Classification of ignitable liquids.
- Reporting guidelines.

Slide 6-104

UNIT 7: DOCUMENTING THE INVESTIGATION

TERMINAL OBJECTIVE

The students will be able to:

7.1 Describe the process of documenting a fire investigation with the use of notes, sketching, diagrams, video, photography and report writing.

ENABLING OBJECTIVES

The students will be able to:

7.1 Follow a systematic approach in documenting a fire investigation.

7.2 Identify the proper procedures for documenting and recording fire scene data.

7.3 Explain the key information that should be included in an origin-and-cause report.

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UNIT 7: DOCUMENTING THE INVESTIGATION

Slide 7-1

ENABLING OBJECTIVES

- Follow a systematic approach in documenting a fire investigation.
- Identify the proper procedures for documenting and recording fire scene data.
- Explain the key information that should be included in an origin-and-cause report.

Slide 7-2

I. DOCUMENTATION

DOCUMENTATION AND THE COURTROOM

- Documenting the scene properly will defend fire science and the expert's opinion in the courtroom.

Slide 7-3

A. Documenting the scene properly will defend fire science and the expert's opinion in the courtroom.

DOCUMENTATION AND THE COURTROOM (cont'd)

- Documentation educates the jury.

Slide 7-4

DOCUMENTATION AND THE COURTROOM (cont'd)

- There has never been a better time to present forensic evidence to juries through documentation.

Slide 7-5

DOCUMENTATION AND THE COURTROOM (cont'd)

- Some recent news articles cite a CSI effect.
- Juries will expect investigators to present evidence in the manner in which they see it on TV (e.g., videotape evidence, DNA).

Slide 7-6

B. Investigators need to be aware of the CSI effect.

1. In 2006, the Elmira, New York, Star-Gazette published an article called "CSI Effect Found in Classrooms and Courtrooms."

2. That article contained some interesting observations.

II. THE IMPORTANCE OF DOCUMENTATION

THE IMPORTANCE OF DOCUMENTATION

Slide 7-7

A. Whether civil or criminal, our duties and responsibilities as fire investigators are the same.

1. Recognize the differences and ensure that each case is handled properly. Investigations are to **always** be thorough and complete.

2. We are truth **seekers,** not case-makers.

NATIONAL FIRE PROTECTION ASSOCIATION 921, *GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS*, CHAPTER 16

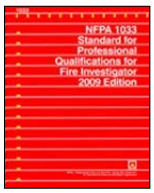
The goal in documenting any fire or explosion investigation is to accurately record the investigation through media that will allow investigators to recall and communicate their observations at a later date. Common methods of accomplishing this goal include the use of photographs, videotapes, diagrams, maps, overlays, audio recordings, notes and reports, according to Section 16.1.1.

Slide 7-8

B. The goal in documenting any fire or explosion investigation is to accurately record the investigation through media that will allow investigators to recall and communicate their observations at a later date. Common methods of accomplishing this goal include the use of photographs, videotapes, diagrams, maps, overlays, audio recordings, notes and reports, according to National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, Chapter 16, Section 16.1.1.

NATIONAL FIRE PROTECTION ASSOCIATION 1033, *STANDARD FOR PROFESSIONAL QUALIFICATIONS FOR FIRE INVESTIGATOR*

Duties shall include diagramming the scene, photographing, and taking field notes to be used to compile a final report, according to Section 4.3 "Documenting the Scene."

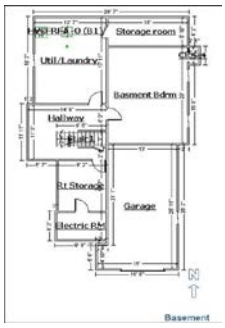


Slide 7-9

C. Duties shall include diagramming the scene, photographing, and taking field notes to be used to compile a final report, according to NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, Chapter 4, Section 4.3 "Documenting the Scene."

NATIONAL FIRE PROTECTION ASSOCIATION 1033, CHAPTER 4

- Diagram the scene, given standard tools and equipment, so that the scene is accurately represented and evidence, pertinent contents, significant patterns, and area(s) or point(s) of origin are identified, according to Section 4.3.1.



Slide 7-10

D. Effective means for an investigator to communicate ideas and theories at depositions and civil and criminal trials, according to NFPA 1033, Chapter 4, Section 4.3.1.

NATIONAL FIRE PROTECTION ASSOCIATION 1033, CHAPTER 4 (cont'd)

- **Requisite knowledge:** commonly used symbols and legends that clarify the diagram, types of evidence and patterns that need to be documented, and formats for diagramming the scene.
- **Requisite skills:** ability to sketch the scene, basic drafting skills, and evidence recognition and observational skills.

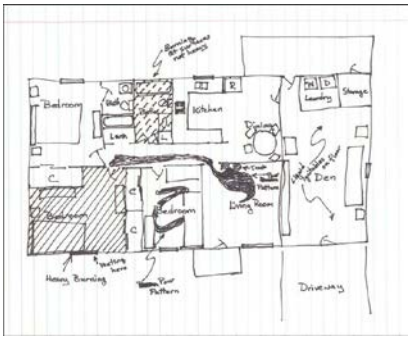
Slide 7-11

E. **Requisite knowledge:** commonly used symbols and legends that clarify the diagram, types of evidence and patterns that need to be documented, and formats for diagramming the scene.

F. **Requisite skills:** ability to sketch the scene, basic drafting skills, and evidence recognition and observational skills.

III. SKETCHING AND DIAGRAMMING

ROUGH SKETCH



Slide 7-12

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. When it is necessary to move or remove items prior to completing a sketch, photographs must be taken.

E. Objects are not drawn with infinite detail.

F. Choose and use symbols when drawing sketches.

1. When investigators use letters or numbers in the sketch or diagram, they may place them in a circular or rectangular box.

2. Use common fire service or diagramming symbols for notations, and show a legend.

FINISHED DIAGRAMS/SKETCHES

The finished product is one of many diagrams to show the detail of the fire scene, based on the rough sketch.

Slide 7-13

G. Finished diagrams/sketches.

1. It is prepared after the investigator has left the scene.

2. It is created from the information recorded on the rough sketch.

3. It could serve as a possible court document.

4. It should not match the quality of either an architectural rendering or engineered floor plan.

5. It depicts conditions and observations that are not easily interpreted from photographs and reports.

FINISHED DIAGRAM

- A finished diagram is a diagram of the fire's origin and spread.
- Always include "not to scale."

Slide 7-14

6. A finished diagram is a diagram of the fire's origin and spread.

7. Always include "not to scale."

TWO-DIMENSIONAL VERSUS THREE-DIMENSIONAL

- Help the jury understand the scene.
- Help the investigator review for court.
- Help the district attorney/prosecutor understand the scene.
- Quality will sometimes take away the defense's ammunition about the scene and your "shortcomings."

Slide 7-15

H. Two-dimensional (2-D) versus three-dimensional (3-D).

1. 2-D displays the length and width of an area from above.

   a. It is referred to as the "bird's eye view."

   b. It permits movement of the viewing plane.

   c. The height of the section is assumed to be 8 feet.

   d. It displays a length, width and height.

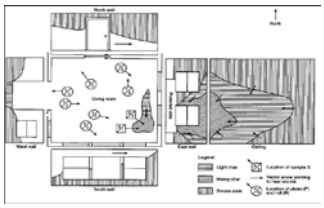
2. Use of the 3-D sketch or "perspective" drawing in fire investigation is rare.

   a. The investigator's lack of knowledge and experience in drawing may not permit using this type of drawing.

   b. Many of the effects of perspective can be best captured by photography.

EXPLODED DIAGRAM

Convenient way to show all of the interior surfaces of the room and relationship between burn patterns on interior surfaces, furniture, etc.

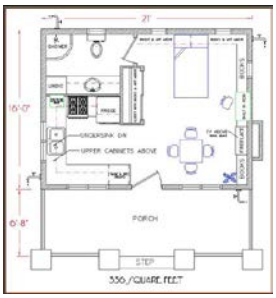


Slide 7-16

   c. Exploded room diagram showing damage patterns, sample locations and photo locations.

FLOOR PLANS

- Can be used to support conclusions as to layout and location of utilities.
- Used to establish or confirm measurements.



Slide 7-17

I. Can be used to support conclusions as to layout and location of utilities.

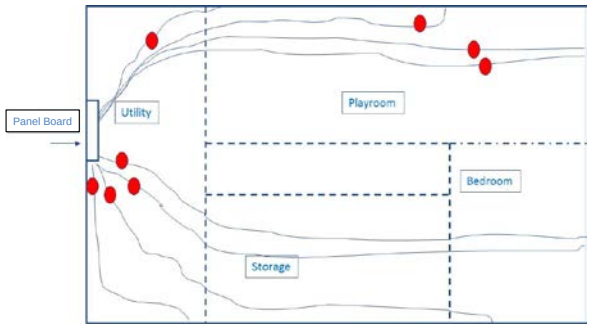
J. Used to establish or confirm measurements.

FLOOR PLANS (cont'd)

- Support witness statements.
- Provide suspect with detailed drawing to relate prefire actions and activities.

Slide 7-18

ARC MAPPING SURVEY



Slide 7-19

K. Consider adding directly to your diagrams.

L. Notice this diagram does not depict windows or door openings. All openings should be documented so consideration can be made for vent openings and fire dynamics as they relate to your arc mapping survey.

DOCUMENTING AN ARC SURVEY

Slide 7-20

M. Consider the following methods:

1. Crime scene tents.
2. Colored zip ties.
3. Colored survey tape.

N. When diagramming an arc survey, consider different colored pens on graph paper to dictate multiple circuits.

IV. DATA COLLECTION PROCESS

DATA COLLECTION PROCESS

- Goal is to record the scene through a medium that will allow the investigator to recall his or her observations at a later date.
- Conducted from the areas of the exterior to interior, areas of least damage to the areas of greatest damage.

Slide 7-21

A. Goal is to record the scene through a medium that will allow the investigator to recall his or her observations at a later date.

B. Conducted from the areas of the exterior to interior, areas of least damage to the areas of greatest damage.

DATA COLLECTION PROCESS (cont'd)

- Victim, witness, tenant, suspect and any other person/people with information should be interviewed using a standard protocol.

Slide 7-22

C. Victim, witness, tenant, suspect and any other person/people with information should be interviewed using a standard protocol.

V. PHOTOGRAPHY

PHOTOGRAPHICALLY DOCUMENT

- Photographically document the scene, given standard tools and equipment, so that the scene is accurately depicted and the photographs support scene findings, according to National Fire Protection Association (NFPA) 1033, Section 4.3.2.

Slide 7-23

A. Types of photos.

1. Crowd photos.
2. Fire suppression.
3. Aerial photos.

PHOTOGRAPHICALLY DOCUMENT (cont'd)

- **Requisite knowledge:** working knowledge of high-resolution camera and flash; the types of film, media and flash available; and the strengths and limitations of each.
- **Requisite skills:** ability to use a high-resolution camera, flash and accessories.

Slide 7-24

4. Exterior.

5. Interior.

6. Victims.

7. Witness viewpoint.

8. Evidence.

PHOTOGRAPHS

Photographs may be some of the most persuasive factors in the acceptance of the fire investigator's theory as to origin and cause. Complete documentation includes:

- Exterior and interior.
- Area/Point of origin.
- Victim and injuries.
- Witnesses (including the crowd).
- Evidence.

Slide 7-25

B. Photographs may be some of the most persuasive factors in the acceptance of the fire investigator's theory as to origin and cause. Complete documentation includes:

1. Exterior and interior.

2. Area/Point of origin.

PHOTOGRAPHY OF THE SCENE

- Know how to use your camera — Attend a photography course if needed.
- Take as many photographs as needed.
- You can never take too many.

Slide 7-26

3. Victim and injuries.

4. Witnesses (including the crowd).

5. Evidence.

PHOTOGRAPHY OF THE SCENE (cont'd)

- Every fire scene should be photographed in a logical (systematic) manner.
- "A picture is worth a thousand words."
- Effective reminders of what the investigator observed while at the scene.
- Photographs can also help substantiate reports and witness statements.

Slide 7-27

PHOTOGRAPHY OF THE SCENE (cont'd)

- Investigators should include:
  - The area of origin.
  - The point of origin.
  - Record of any factor contributing to the ignition, growth and development of the fire.

Slide 7-28

C. Usual rules of crime scene photography apply.

1. Is the photograph that is being presented a fair and accurate depiction of the scene as you saw it at the time you were there?

2. Content and context?

3. Does the photograph tell the story of the scene?

4. Is it a clear image?

5. Do not delete photos.

PHOTOGRAPHING RECONSTRUCTION

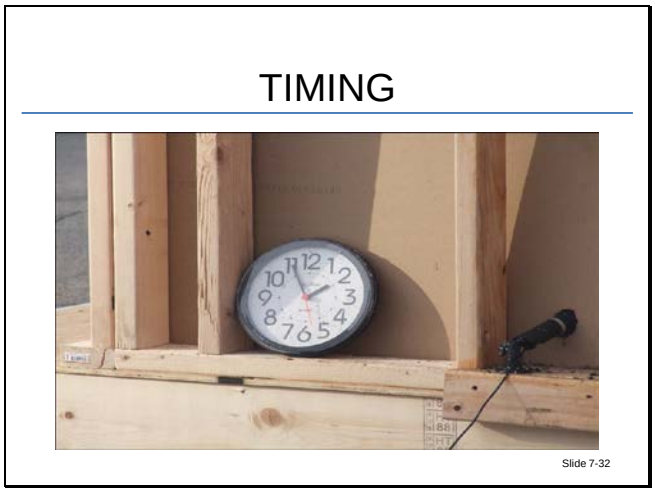
Slide 7-29

D. What is beneath this pile of debris? A car, maybe a boat? Maybe both!

PHOTOGRAPH ALL PHASES OF RECONSTRUCTION

Slide 7-30

E. A systematic approach to photographing all aspects of your fire scene is crucial to telling your story. Not to mention showing the court and jury that you did your job and you did it well!



F. Timing.

1. Prompt photography is important since the scene may become altered or destroyed.

2. Some conditions may place an emphasis on photographing the scene as early as possible.

3. The structure collapse is imminent.

4. There could be a risk of loss or damage to building contents.

5. Make immediate documentation of evidence if there is a risk of loss or contamination.

PHOTOGRAPHS DURING THE FIRE EVENT

Slide 7-33

G. Photographs during the fire event.

1. Take photographs of the fire in its progression, if possible.
2. You may document an early indicator of the area of origin.
3. You may document suppression efforts affecting the scene.
4. You may document why certain fire patterns exist within the dwelling.
5. Document vent openings.
6. The need for photographs becomes even more essential prior to the overhaul phase.
7. Assist the investigator in scene reconstruction.

PHOTOGRAPHS OF BYSTANDERS

Slide 7-34

H. Photographing people within an observing crowd can often be valuable in identifying individuals who may have additional knowledge that can be valuable to the overall outcome of the investigation.

1. Crowd photos allow for the potential identification of witnesses.

2. They also allow for the potential identification of individuals frequently seen at fire scenes.

WITNESS VIEWPOINT

- Photographs should be taken from the exact location where the witness described seeing the incident.
- Reveals the reliability of the witness's statement, if the case goes to trial.

Slide 7-35

I. This should always be included when you have a witness who may be used in the future.

1. What could he/she see at the time of the fire?

2. Maps and Google Earth may be good sources.

3. Always consider news helicopter to specifically identify locations of witnesses, equipment and obstructers.

EXTERIOR PHOTOGRAPHS

Slide 7-36

J. Exterior photographs.

1. All sides of the structure.
2. Doors and windows (open, ajar or closed).
3. Reveal all structural members and their relation to each other.
4. Ventilation points.
5. Utilities.
6. Vehicles.
7. Fire department point of entry of fire attack.
8. Address.

EXTERIOR PHOTOGRAPHS (cont'd)

- Establish the location of the fire.
  - Street signs.
  - House numbers.
  - Mailboxes.
  - Landmarks.
  - Fire exposures.
- All sides and corners of the structure.

Slide 7-37

K. Location and extent of damage to the structure.

1. Extension from an outside source.
2. Construction type and occupancy use.
3. Condition of utilities.
4. Indication of fire origin and spread.

INTERIOR PHOTOGRAPHS

All rooms and areas should be photographed.

- Contents.
- Storage.
- Living conditions.
- Closet, dresser contents.
- All utilities within the area of origin.
- Ignition sources.

Slide 7-38

L. Interior photographs.

1. Systematic approach progressing toward the area/point of origin.
2. Include rooms/areas immediately adjacent to the area or point of origin.
3. Areas such as closet and dresser contents.
4. All utilities within the area of origin.
5. Ignition sources.

EVIDENCE PHOTOGRAPHS

Slide 7-39

M. Evidence photographs.

1. Reveal the relative nature of the evidence to other items in proximity.
2. Taken without a scale or marker next to it, then the next photo should include the marker.

EVIDENCE PHOTOGRAPHS (cont'd)

Slide 7-40

3. Photograph item, after collected, in evidence container.

4. Items of evidence can be criminal and/or accidental in nature. Just because the fire may be accidental in nature doesn't mean someone doesn't have an interest in the evidence or the potential.

VICTIM PHOTOGRAPHS

Slide 7-41

N. Location of victims.

1. Any actions of the victims.

2. Impressions on wall.

3. Protected areas where the victims were discovered.

O. Condition of the victims.

1. Clothing.

2. Burns.

3. Property (jewelry).

P. Investigators can use the following:

1. Neighboring tall building.

2. A fire department aerial ladder or platform.

3. An airplane or a helicopter.

4. Remote control helicopter: It is inexpensive and capable of flying lower to get more overall detail.

PHOTOGRAPHIC TECHNIQUES

- Methodical order.
  - Exterior to interior.
    - -- Capture exterior of structure, utilities, fuels and exposures.

Slide 7-44

PHOTOGRAPHIC TECHNIQUES (cont'd)

- Capture interior of structure, including all rooms, doors (positioning), windows (positioning), utilities, fire protection devices, appliances, signs of housekeeping and signs of habits.

Slide 7-45

Q. Capture interior of structure, including all rooms, doors (positioning), windows (positioning), utilities, fire protection devices, appliances, signs of housekeeping and signs of habits.

PHOTOGRAPHIC TECHNIQUES (cont'd)

- **Sequencing:** wide area, narrowing in to the subject.
- **Stitching:** using multiple photos to create a panoramic.
- Conclude with the origin and cause of the fire.

Slide 7-46

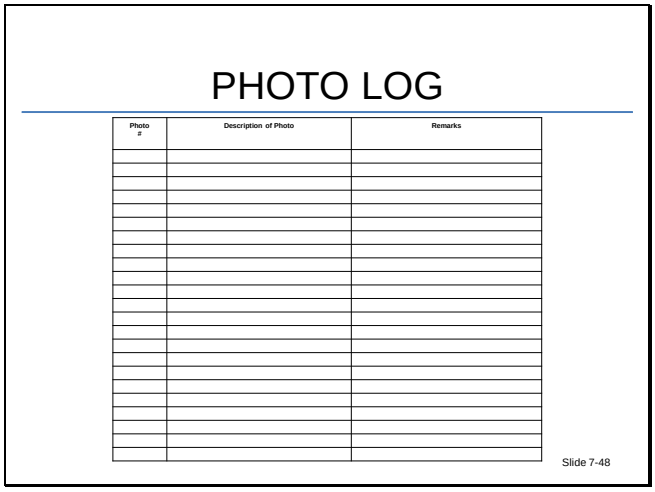
R. Sequential photographs.

1. Essential in revealing smaller pieces of evidence within a large area.

2. The item of evidence or subject to be photographed is first photographed from a distance.

3. Additional photographs are then taken as the investigator narrows the gap between himself or herself and the subject being photographed.

4. The final photograph is then taken with the subject area encompassing the entire frame.



S. Photo log.

1. The SD card number (if applicable).

2. The agency's name.

3. Incident number assigned to the case.

4. Picture number.

5. The description of the item being photographed.

6. A section for miscellaneous remarks.

REMEMBER …

No matter which style you use, it is the photographer, **not** the medium, that defines quality.

Slide 7-49

T. No matter which style you use, it is the photographer, **not** the medium, that defines quality.

MOSAICS OR COLLAGE

- Useful when the overall size of the scene exceeds the width of your camera lens.
- Taken in sequential order, allowing a slight overlap of each area being photographed.
- Gives a clear, peripheral view of a large area.

Slide 7-50

U. Mosaics or collage.

1. Useful when the overall size of the scene exceeds the width of your camera lens.

2. Taken in sequential order, allowing a slight overlap of each area being photographed.

3. Gives a clear, peripheral view of a large area.

MOSAICS OR COLLAGE (cont'd)

Slide 7-51

INVESTIGATIVE PHOTO TIPS

- Carry extra batteries.
- Remember to turn your camera **off** after completing your pictures.
- Limit the amount of time your camera is exposed to water or other adverse environmental conditions.
- Label the SD card as soon as it is removed from the camera (if applicable).

Slide 7-52

V. Investigative photo tips.

1. Carry extra batteries.

2. Remember to turn your camera **off** after completing your pictures.

3. Limit the amount of time your camera is exposed to water or other adverse environmental conditions.

4. Label the SD card as soon as it is removed from the camera (if applicable).

INVESTIGATIVE PHOTO TIPS (cont'd)

- Make a copy (archival) of original photographs and store in case file.
- Do not combine multiple fire cases on one digital card.

Slide 7-53

5. Make a copy (archival) of original photographs and store in case of fire.

6. Do not combine multiple cases on one digital card.

TOTAL STATIONS

Slide 7-54

TOTAL STATIONS (cont'd)

Slide 7-55

W. The resulting diagrams can be plan (overhead view), elevations (side views) or a 3-D combination.

TABLETS

Can be used with a wide range of apps for crime scene sketching, evidence collection, report writing and photo/video presentation.

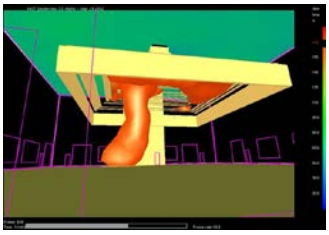
Slide 7-56

X. Can be used with a wide range of apps for crime scene sketching, evidence collection, report writing and photo/video presentation.

VI. FIRE MODELING DATA

FIRE MODELING DATA

- Geometry.
- Building.
- Room.
- Materials.
- Walls, floors and ceiling.
- Furnishings.

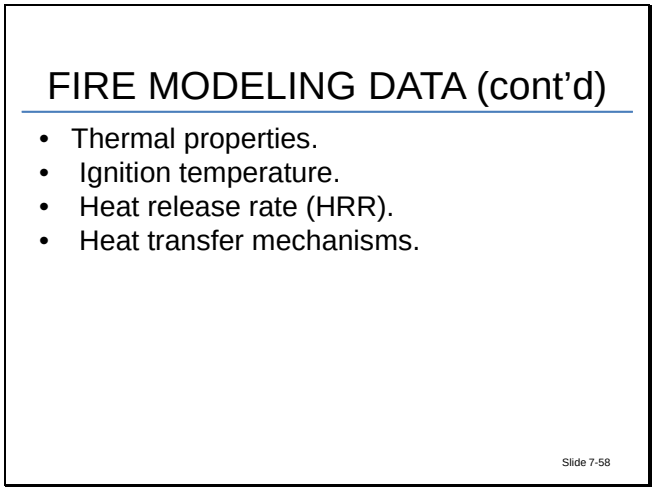


Slide 7-57

A. Documentation of the following is needed:

1. Ceiling height.
2. Sill height of windows.
3. Soffit height of window.
4. Doorway/Window heights and widths.

5. Document type of door/window and what type of position it was in.



B. Fire models require input to describe:

1. The geometry of the building compartments being modeled.

2. The ignition source.

3. Heat release rate (HRR).

4. Properties of interior finish materials of the fire building as well as the contents of the building.

C. Investigators need to make detailed measurements of compartment geometry, construction features and interior contents (e.g., ventilation openings, fuel load).

D. The ventilation openings to the building are critical to the ability of a fire to grow and spread.

VII. VIDEO DOCUMENTATION

VIDEO DOCUMENTATION

- There may be times when you want to video the scene.
  - Remember the audio function.
- Video has applications in very large scenes or capital cases.
  - It helps avoid “mosaic” photography.

Slide 7-59

A. There may be times when you want to video the scene. In such cases, remember the audio function.

B. Video has applications in very large scenes or capital cases.

1. It helps avoid “mosaic” photography.

VIDEO DOCUMENTATION (cont’d)

  - It captures the entire scene and movement throughout.
- Consult local prosecutor for final determination.

Slide 7-60

2. It captures the entire scene and movement throughout.

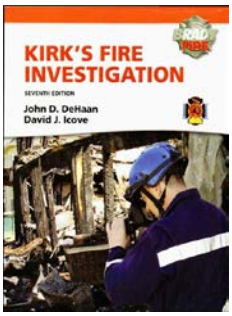
C. Consult local prosecutor for final determination.

VIII. INVESTIGATIVE NOTES

INVESTIGATIVE NOTES

Many sources.

- NFPA 921, *Guide for Fire and Explosion Investigations*.
- Kirk's Fire Investigation.
- Department or company forms.
- Commercially available forms, templates and software.



Slide 7-61

NOTES

- Construct investigative notes, given a fire scene, available documents (e.g., prefire plans and inspection reports) and interview information, so that the notes are accurate, provide further documentation of the scene, and represent complete documentation of the scene findings, according to NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, Section *4.3.3*.

Slide 7-62

A. Notes are used to supplement the investigator's photos, sketches and diagrams.

B. Commonly referred to as "field notes" to memorialize:

1. Names.
2. Dates/Times.
3. Addresses.
4. Observations.
5. Utilities.
6. Measurements.

7. Witness statements.

8. Products.

9. Serial/Model numbers.

NOTES (cont'd)

- **Requisite knowledge:** relationship between notes, diagrams and photos; how to reduce scene information into concise notes; and the use of notes during report writing and legal proceedings.
- **Requisite skills:** data-reduction skills, note-taking skills, and observational and correlating skills.

Slide 7-63

C. Investigator observations (e.g., burn patterns, building conditions, position of switches and controls).

D. Types of materials (e.g., wood paneling, foam plastic, carpet).

E. Data that was needed to produce an accurate computer model.

F. Serial/Model numbers.

G. Type of building/description.

H. Identification of contents.

IX. INVESTIGATIVE REPORTS

INVESTIGATIVE REPORTS

- "The reporting procedure may take many written or oral forms, depending on the specific responsibility of the investigator. Pertinent information should be reported in a proper form and forum to help prevent recurrence," according to NFPA 921.

Slide 7-64

A. You get as many opinions on how much to place in a report as how many investigators you ask.

IMPORTANCE OF INVESTIGATIVE REPORTS

- "The effectiveness of an investigator is judged in large measure by the reports of investigations. If an otherwise satisfactory investigation is poorly reported, the reputation of the investigator suffers," according to Charles O'Hara in "Fundamentals of Criminal Investigations."

Slide 7-65

B. "The effectiveness of an investigator is judged in large measure by the reports of investigations. If an otherwise satisfactory investigation is poorly reported, the reputation of the investigator suffers," according to Charles O'Hara in "Fundamentals of Criminal Investigations."

INVESTIGATIVE REPORTS (cont'd)

- **NFPA 921, Chapter 16.5.1, Descriptive Information**. Generally, reports should contain the following, preferably in the introduction:
  - Date, time and location of incident.
  - Date and location of examination.
  - Date the report was prepared.

Slide 7-66

C. NFPA 921, Chapter 16.5.1, Descriptive Information. Generally, reports should contain the following, preferably in the introduction:

1. Date, time and location of incident.
2. Date and location of examination.
3. Date the report was prepared.

INVESTIGATIVE REPORTS (cont'd)

- Name of the person or entity requesting the report.
- The scope of the investigation (tasks completed).
- Nature of the report (preliminary, interim, final, summary, supplementary).

Slide 7-67

4. Name of the person or entity requesting the report.
5. The scope of the investigation (tasks completed).
6. Nature of the report (preliminary, interim, final, summary, supplementary).

INVESTIGATIVE REPORTS (cont'd)

- **NFPA 921, Chapter 16.5.2, Pertinent Facts**. A description of the incident scene, items examined and evidence collected should be provided. The report should contain observations and information relevant to the opinions. Photographs, diagrams and laboratory reports may be referenced.

Slide 7-68

INVESTIGATIVE REPORTS (cont'd)

- **NFPA 921, Chapter 16.5.3, Opinions and Conclusions.** The report should contain the opinions and conclusions rendered by the investigator. The report should also contain the foundation(s) on which the opinions and conclusions are based. The name, address and affiliation of each person who has rendered an opinion contained in the report should be provided.

Slide 7-69

PURPOSE OF INVESTIGATIVE REPORTS

- Record/Document relevant information and findings.
- Information sharing: Communicate findings.
  - Other investigative agencies.
  - Prosecutors.
  - Insurance companies.
  - Property owners.

Slide 7-70

D. Record/Document relevant information and findings.

E. Information sharing: Communicate findings.

1. Other investigative agencies.

2. Prosecutors.

3. Insurance companies.

4. Property owners.

5. Reports.

6. Reports should include who, what, where, when, why and how.

COMMON REPORTS USED IN FIRE INVESTIGATIONS

- Fire incident run report.
- Prelimiary investigation.
- Final report of investigation.
- Expert report.
- Laboratory report.

Slide 7-71

F. Common reports in fire investigations.

1. Fire incident run report.

2. Preliminary investigation.

3. Final report of investigation.

4. Expert report.

5. Laboratory report.

COMMON REPORTS USED IN FIRE INVESTIGATIONS (cont'd)

- Emergency Medical Services (EMS) reports.
- Police reports.
- Insurance documents.
- Insurance origin-and-cause reports.
- News clips, photos or video.

Slide 7-72

6. Emergency Medical Services (EMS) reports.

7. Police reports.

8. Insurance documents.

9. Insurance origin-and-cause reports.

10. News clips.

11. News photos or video.

QUALITIES OF A GOOD INVESTIGATIVE REPORT

- Accurately represents the facts as known to the investigator.
- Favorable and unfavorable information about a suspect should be included.
- People and locations should be fully identified.
- Statements of witnesses should be clearly presented as such.

Slide 7-73

G. Qualities of a good investigative report.

1. Accurately represents the facts as known to the investigator.

2. Favorable and unfavorable information about a suspect should be included.

3. People and locations should be fully identified.

4. Statements of witnesses should be clearly presented as such.

QUALITIES OF A GOOD INVESTIGATIVE REPORT (cont'd)

- Completeness, clarity and brevity.
- Document findings of all leads (even negative findings).
- Attach or include witness statements, diagrams, reports, letters, etc.
- Follow a logical (chronological) order so that the reader can easily understand.

Slide 7-74

5. Completeness, clarity and brevity.

6. Document findings of all leads (even negative findings).

7. Attach or include witness statements, diagrams, reports, letters, etc.

8. Follow a logical (chronological) order so that the reader can easily understand.

QUALITIES OF A GOOD INVESTIGATIVE REPORT (cont'd)

- Include any testing you completed (no matter what the outcome).
- Do not report unsupported allegations.
- Professional in appearance.
- Avoid errors in spelling or grammar.
- Use a dictionary or spell check.
- Administrative and technical review.

Slide 7-75

9. Include any testing you completed (no matter what the outcome).

10. Do not report unsupported allegations.

11. Professional in appearance.

12. Avoid errors in spelling or grammar.

13. Use a dictionary or spell check.

14. Administrative and technical review.

KEY POINTS

- Once the scene is finished, it's gone.
- The report is only as good as the original documentation made of the scene and post-scene (e.g., photographs, rough sketches, notes, testing).
- Each part should be able to stand on its own.

Slide 7-76

H. Once the scene is finished, it's gone.

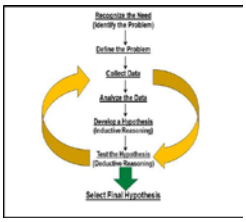
1. The report is only as good as the original documentation made of the scene and post-scene (e.g., photographs, rough sketches, notes, testing).

2. Each part should be able to stand on its own.

X. ORIGIN-AND-CAUSE REPORT FORMAT

ORIGIN-AND-CAUSE REPORT FORMAT

- Section I — Fire Overview (identify/define problem).
- Section II — Scene Processing/ Observations (analyze data).
- Section III — Witness Statements (collect data).



Slide 7-77

A. Date (if different than dispatch date).

B. Time in 24-hour clock format (time that fire investigation unit arrives on-scene).

C. Address (corrected when applicable).

D. Status (fire out or still in progress).

E. Further identifications: Describe physical characteristics of what burned (type of structure, vehicle identification, wildland).

1. Give dimensions when possible and detailed descriptions.

2. Describe main streets and access to building or property.

3. Participating fire investigators.

4. Owner/Occupant.

5. Firefighters.

6. Neighbor.

7. Eyewitness.

8. Neighbors (neighborhood canvass).

9. Contractors.

10. Police officers.

11. Alarm company representatives or technicians.

12. Obtain witness identification, such as driver's license, employee ID card, check-cashing card, etc., to determine that they are who they say they are.

13. Determine where witness(es) can be located for future interview (home/work/cell numbers).

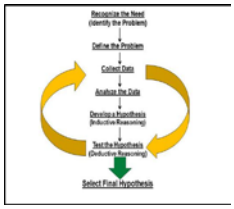
14. Identify location/time where the interview took place.

15. Identify how the interview took place (in person/by telephone).

16. Identify witnesses by last name throughout report.

ORIGIN-AND-CAUSE REPORT FORMAT (cont'd)

- Section IV — Documentation (analyze data and form working hypothesis).
- Section V — Conclusion (opinion) — (select final hypothesis).



Slide 7-78

17. Describe patterns/factors that substantiate area/point of origin.

18. Localize area/point of origin by using references within structure, vehicle or wildland.

19. Describe what actually burned (focusing on an area/point of origin).

20. Describe unique factors that may exist (trailers, devices, multiple fires, etc.).

21. Establish fire cause.

22. Type of structure (residential, commercial).

23. Number of stories.

24. Type of construction (wood frame, ordinary, etc.).

25. Compass directions (N, S, E, W) or Incident Management System (IMS) designations (A, B, C, D).

26. Fire protection systems present? Working?

27. Interior finish (gypsum, plaster, paneling, etc.).

28. Room sizes (width, length and height).

29. Openings (doors, windows or other).

30. Utilities (gas, water and electric). Were they active? When were they disconnected? Who disconnected the utilities? Unauthorized use of electricity from adjacent structures?

31. List all items of evidence separately on the evidence report. Give location where items were recovered, and attach the evidence log.

32. Give physical description of items of evidence.

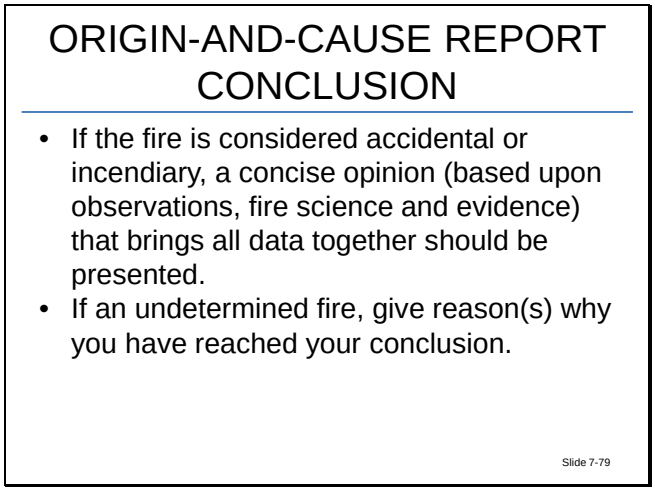
33. Indicate the items to be analyzed, and where they are sent for analysis, in the evidence report. (Lab analysis reports, if completed, can be attached here.)

34. Make your entries in the Evidence Room Log.

35. Make entries if any specialized forensic work is to be completed (prints, photos, blood, etc.).

36. Do not allow the fire department to turn off all breakers, turn off the main breaker, or cut the power at the street. Always consider conducting arc mapping.

37. Never rely on a third party to shut off power. Confirm for yourself. Think safety!



F. If the fire is considered accidental or incendiary, a concise opinion (based upon observations, fire science and evidence) that brings all data together should be presented.

G. If an undetermined fire, give reason(s) why you have reached your conclusion.

ORIGIN-AND-CAUSE REPORT CONCLUSION (cont'd)

- If the fire is a natural fire, give reason(s) for your conclusion.

Slide 7-80

H. If the fire is a natural fire, give reason(s) for your conclusion.

ORIGIN-AND-CAUSE REPORT FORMAT (cont'd)

- The **ignition sequence** should identify the following:
  - The **cause** should include the following:
    - -- The first fuel ignited.
    - -- The ignition source.
    - -- The action, event or circumstances that brought the fuel and ignition source together.

Slide 7-81

I. The **ignition sequence** should identify the following:

The **cause** should include the following:

1. The first fuel ignited.
2. The ignition source.
3. The action, event or circumstances that brought the fuel and ignition source together.

J. Fire progression to other structures (note any exposure issues).

K. Weather. (Note the weather conditions: Did weather impact the fire?)

L. Number of fatalities.

ORIGIN-AND-CAUSE REPORT FORMAT (cont'd)

- Based upon the fire patterns, witnesses' statements, arc mapping and fire dynamics, it is the opinion of the fire investigator(s) that the fire originated (describe place in detail) and was caused by the (describe ignition sequence). This fire is ruled as (accidental, incendiary, undetermined, natural).

Slide 7-82

M. Based upon the fire patterns, witnesses' statements, arc mapping and fire dynamics, it is the opinion of the fire investigator(s) that the fire originated (describe place in detail) and was caused by the (describe ignition sequence). This fire is ruled as (accidental, incendiary, undetermined, natural).

N. If you cannot identify the first material ignited, competent ignition source, and the sequence of events that brought those items together, your fire is undetermined.

ORIGIN-AND-CAUSE REPORT FORMAT (cont'd)

- Remember: The level of scientific certainty for any cause determination should be based on the guidance provided in NFPA 921.

Slide 7-83

O. Remember: The level of scientific certainty for any cause determination should be based on the guidance provided in NFPA 921.

ORIGIN-AND-CAUSE REPORT ATTACHMENTS

- List any information that may not have been appropriate under other headings.
- List additional work to be completed.
- List status of case and reasons for that determination.
- List agencies/people notified who are associated with your case.

Slide 7-84

P. Attachments:

1. List any information that may not have been appropriate under other headings.

2. List additional work to be completed.

3. List status of case and reasons for that determination.

4. List agencies/people notified who are associated with your case.

ORIGIN-AND-CAUSE REPORT ATTACHMENTS (cont'd)

- Reference reports/records of other agencies and attach copies if appropriate.
- List prior fire incidents involving the same address/people. Attach pertinent copies to the report.
- Contain findings, witness observations, diagrams/photographic documentation, conclusions, recommendations and references.

Slide 7-85

5. Reference reports/records of other agencies and attach copies if appropriate.

6. List prior fire incidents involving the same address/people. Attach pertinent copies to the report.

7. Contain findings, witness observations, diagrams/photographic documentation, conclusions, recommendations and references.

WORDING IN THE ORIGIN-AND-CAUSE REPORT

- "… The cause of this fire is undetermined."
- "… At this time, and in accordance with NFPA 921, this fire must be categorized as 'undetermined.' However, as the investigation of this fire is ongoing we reserve the right to change or supplement this finding based on new or additional information which may subsequently be determined. An undetermined fire classification does not mean this fire was not caused by an intentional human act, and further investigation of this loss may be warranted."

Slide 7-86

XI. REVIEW PROCEDURE

REVIEW PROCEDURE

Slide 7-87

A. A review of a fire investigator's work product (reports, documentation, notes, diagrams, photos, etc.) by other people may be helpful.

ADMINISTRATIVE REVIEW

- An administrative review is one typically carried out **within an organization** to ensure that the investigator's work product meets the organization's quality assurance requirements.

Slide 7-88

B. An administrative review is one typically carried out **within an organization** to ensure that the investigator's work product meets the organization's quality assurance requirements.

ADMINISTRATIVE REVIEW (cont'd)

- The steps outlined in an organization's procedure manual, or required by agency policy, have been followed and checked for typographical or grammatical errors.

Slide 7-89

C. The steps outlined in an organization's procedure manual, or required by agency policy, have been followed and checked for typographical or grammatical errors.

TECHNICAL REVIEW

- A technical review can have multiple facets.
- An individual, commonly a supervisor, who is qualified and familiar with all aspects of proper fire investigation and has access to all of the documentation available.
- A technical review can serve as an additional test of the various aspects of the investigator's work product.

Slide 7-90

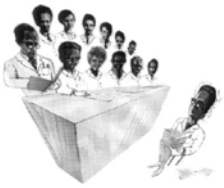
D. A technical review can have multiple facets.

E. An individual, commonly a supervisor, who is qualified and familiar with all aspects of proper fire investigation and has access to all of the documentation available.

F. A technical review can serve as an additional test of the various aspects of the investigator's work product.

PEER REVIEW

- Peer review is a formal procedure generally employed in prepublication review of scientific or technical material.
- Peer review carries with it connotations of both independence and objectivity.
- Peer reviewers should not have any interest in the outcome of the review.



Slide 7-91

G. Peer review is a formal procedure generally employed in prepublication review of scientific or technical material.

H. Peer review carries with it connotations of both independence and objectivity.

I. Peer reviewers should not have any interest in the outcome of the review.

XII. AMERICAN SOCIETY FOR TESTING AND MATERIALS STANDARDS FOR EXPERT REPORTS

AMERICAN STANDARDS FOR TESTING AND MATERIALS STANDARDS FOR EXPERT REPORTS

- American Standards for Testing and Materials (ASTM) E620, *Standard Practice for Reporting Opinions of Scientific and Technical Experts.*
- ASTM E678, *Standard Practice for Evaluation of Scientific or Technical Data.*

Slide 7-92

A. American Society for Testing and Materials (ASTM).

AMERICAN STANDARDS FOR TESTING AND MATERIALS STANDARDS FOR EXPERT REPORTS (cont'd)

- ASTM E620.
  - This practice covers the scope of information to be contained in formal written technical reports that express the opinions of the scientific or technical expert with respect to the study of items that are or may reasonably be expected to be the subject of criminal or civil litigation.

Slide 7-93

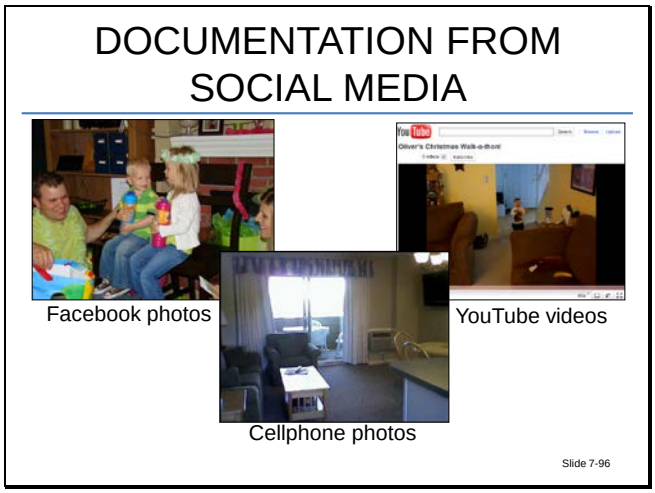
AMERICAN STANDARDS FOR TESTING AND MATERIALS STANDARDS FOR EXPERT REPORTS (cont'd)

- ASTM E678.
  - This practice establishes criteria for evaluating scientific and technical data used for forming scientific or technical expert opinions.
  - This practice is intended to serve as a guideline for the scientific or technical expert in conducting an investigation, which includes analyzing and evaluating facts.

Slide 7-94

B. These standards and others are the very reason you should always consider attending any evidence exam or destructive testing prior to any classification, when appropriate.

XIII. DOCUMENTATION FROM SOCIAL MEDIA



A. Documentation obtained from social media can provide investigators with valuable information.

B. Examples: Facebook or cellphone photos, YouTube videos.

XIV. OTHER SOURCES OF DOCUMENTATION

SECURING INFORMATION FROM REALTORS

Slide 7-97

A. Valuable information includes:

1. Content location.
2. Assist with reconstruction.
3. Condition of structure/residence, etc.
4. Utilities locations.
5. Potential ignition sources.

SECURING INFORMATION FROM REALTORS (cont'd)

Slide 7-98

6. Tax information.
7. Property maintenance.

8. Utility entrance locations.

9. Assessed value.

10. Recent sales.

11. Neighborhood values.

USE OF THE INTERNET IN FIRE INVESTIGATIONS

Slide 7-99

B. Examples:

1. Facebook.

2. Twitter.

3. Instagram.

4. Google.

RETRIEVAL OF DATA FROM CELLPHONES AND SMARTPHONES

Slide 7-100

C. Examples of data:

1. Phone locations.
2. Text messages.
3. Contacts.
4. Phone number history.
5. Internet search history.
6. Phone logs.

CELLPHONE PICTURES FOR INFORMATION

Slide 7-101

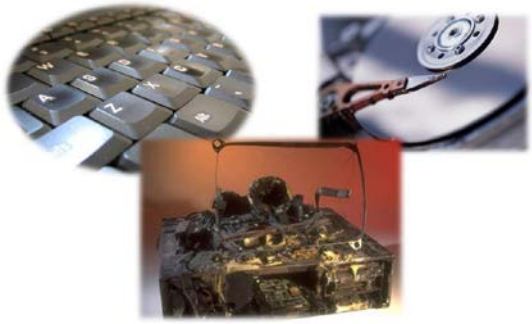
D. Picture privacy.

E. The location where the photo was taken.

F. GPS data.

G. Travel routines.

REVIEW AND RETRIEVAL FROM COMPUTER HARD DRIVES



Slide 7-102

H. The presence of digital evidence should be considered in all cases. It can provide valuable leads for investigators that can help identify witnesses, suspects and other sources of information.

I. Investigators should consult with proper agencies or organizations for assistance in proper evidence collection and processing (e.g., computer forensic examiners or laboratory).

VIDEO TECHNOLOGY AS AN INVESTIGATIVE TOOL

- Residential/Commercial video surveillance systems.
- ATMs.
- Traffic cameras.
- Toll booth cameras.
- Mobile video.

Slide 7-103

XV. SUMMARY

SUMMARY

- Documentation.
- The importance of documentation.
- Sketching and diagramming.
- Data collection process.
- Photography.
- Fire modeling data.
- Video documentation.

Slide 7-104

SUMMARY (cont'd)

- Investigative notes.
- Investigative reports.
- Origin-and-cause report format.
- Review procedure.
- ASTM standards for expert reports.
- Documentation from social media.
- Other sources of documentation.

Slide 7-105

UNIT 8: ELECTRICAL FIRE INVESTIGATION

TERMINAL OBJECTIVE

The students will be able to:

8.1 Identify and describe the components of electrical service, circuitry, modes of failure and arc mapping.

ENABLING OBJECTIVES

The students will be able to:

8.1 Define basic electrical terms.

8.2 Describe an electrical system from generation to distribution.

8.3 Identify the basic safety considerations when evaluating an electrical system.

8.4 Apply Ohm's law/Joule's law to evaluating electrical circuits.

8.5 Differentiate between electrical and thermal damage on energized and nonenergized conductors.

8.6 Identify common modes of electrical failure to systems, components and appliances.

8.7 Identify resources available to assist in evaluation of an electrical system or components.

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UNIT 8: ELECTRICAL FIRE INVESTIGATION

Slide 8-1

ENABLING OBJECTIVES

- Define basic electrical terms.
- Describe an electrical system from generation to distribution.
- Identify the basic safety considerations when evaluating an electrical system.
- Apply Ohm's law/Joule's law to evaluating electrical circuits.

Slide 8-2

ENABLING OBJECTIVES (cont'd)

- Differentiate between electrical and thermal damage on energized and nonenergized conductors.
- Identify common modes of electrical failure to systems, components and appliances.
- Identify resources available to assist in evaluation of an electrical system or components.

Slide 8-3

I. NATIONAL FIRE PROTECTION ASSOCIATION 921, *GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS*

NATIONAL FIRE PROTECTION ASSOCIATION 921 — 2014

- **National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, Chapter 9, Section 9.9.1.1.** Ignition by electrical energy involves transferring sufficient heat to a fuel (i.e., competent ignition source) by passage of electrical current to ignite material that is close.

Slide 8-4

A. The requirement for ignition is that the temperature of the electrical source be maintained long enough to bring the adjacent fuel up to its ignition temperature. There must be air present to allow combustion.

NATIONAL FIRE PROTECTION ASSOCIATION 921 — 2014 (cont'd)

- Sufficient heat may be generated by a wide variety of means, such as short-circuit and ground-fault parting arcs, excessive current through wiring or equipment, resistance heating, or by ordinary sources such as lightbulbs, heaters, and cooking equipment.

Slide 8-5

B. Sufficient heat may be generated by a wide variety of means, such as short-circuit and ground-fault parting arcs, excessive current through wiring or equipment, resistance heating, or by ordinary sources such as lightbulbs, heaters, and cooking equipment.

NATIONAL FIRE PROTECTION ASSOCIATION 921 — 2014 (cont'd)

- The requirement for ignition is that the heat transfer from the electric source be maintained long enough to bring the adjacent fuel up to its ignition temperature, with air present to allow combustion.

Slide 8-6

II. SAFETY

SAFETY

- Equipment labeling.

Slide 8-7

A. The fire department and the investigators on-scene do not have flash protection on, and they often work recklessly because they don't realize that there is a specific one.

B. There is no need for a firefighter to work in an energized, electrical piece of equipment, panel box or circuit.

SAFETY (cont'd)

Slide 8-8

C. This photo shows two workers in an energized, 580-volt switchgear cabinet "racking in" a breaker experience arc flash. Neither worker had the appropriate personal protective equipment (PPE) to be working in that energized cabinet.

SAFETY (cont'd)

Slide 8-9

D. In this photo, arc flash occurs. One worker is killed from thermal burns, and the other worker sustains third-degree burns.

SAFETY (cont'd)

- Electrical hazards may be present on a fire scene long after fire ends.
- Never assume that just because the structure suffered heavy damage, all sources of electrical energy have been eliminated.

Slide 8-10

E. Electrical hazards.

1. They may be present on a fire scene long after the fire ends.

2. Never assume that just because the structure suffered heavy damage, all sources of electrical energy have been safeguarded against.

SAFETY (cont'd)

- Electrical energy can be present in the form of energized circuits or stored energy.
- Never attempt to disconnect electrical utility service from the structure. Only the utility representative should do so.
- Multiple sources may bring electrical service to a structure, from overhead or underground.

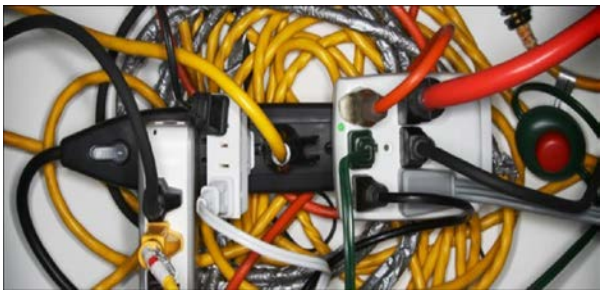
Slide 8-11

F. Electrical energy can be present in the form of energized circuits or stored energy.

G. Never attempt to disconnect electrical utility service from the structure. Only the utility representative should do so.

H. Multiple sources may bring electrical service to a structure, from overhead or underground.

SAFETY (cont'd)



Slide 8-12

SAFETY (cont'd)

- Use observations and testing equipment to verify that electricity is disconnected.
- Never assume that power has been disconnected.

Slide 8-13

I. Make observations to ensure that there is a disconnect from the utility system to the involved structure.

SAFETY (cont'd)

- Effects of 60 hertz electricity.

1 milliamp	Threshold of perception.
5 milliamps	Maximum "harmless" current.
10-20 milliamps	Maximum "let go" current.
50 milliamps	Pain, possible fainting, mechanical injury. Heart and respiratory functions continue.
100-300 milliamps	Ventricular fibrillation will start, respiratory center remains intact.
>300 milliamps	Sustained myocardial contraction. Temporary respiratory paralysis. Burns if current density is high.

Slide 8-14

SAFETY (cont'd)

- Proximity noncontact tester:
  - Also known as "tic tracers."
  - They detect the electrostatic field generated around an alternating current (AC) conductor.
  - Provide an audible signal as voltage is detected.

Slide 8-15

J. Proximity noncontact testers.

1. They are also known as "tic tracers."

2. They detect the electrostatic field generated around an alternating current (AC) conductor.

3. The device provides an audible signal as voltage is detected.

SAFETY (cont'd)

- Needs to check against a known source.
- Needs to check batteries.
- The operator needs to have physical contact with ground.

Slide 8-16

4. The operator needs to check against a known source.

5. The operator needs to check batteries.

6. The operator needs to have physical contact with the ground.

7. In a noncontact tester, there is a battery but no moving parts.

   a. Take this device, and place it near an electrical source.

b. If energized, the red tip will light up and emit an audible tone.

SAFETY (cont'd)

- Digital multimeter:
  - A contact measurement device.
  - That means that the device probes must come into physical contact with the conductors or surfaces to be measured.

Slide 8-17

K. Digital multimeters.

SAFETY (cont'd)

- Wiggy:
  - This is also a contact measurement device.
  - Does not require batteries.
  - The readings are not as accurate.
  - Vibrates when an electric field is detected to provide tactile feedback.

Slide 8-18

L. Wiggy.

1. In a wiggy, there is a cellunoid.
2. It works for both AC and direct current (DC) voltage.
3. It will start to shake when someone is using it. (The cellunoid slide will shake in your hand.)
4. There are no batteries.
5. The readings are not very accurate.

SAFETY (cont'd)

- Digital voltage and continuity tester:
  - This is a contact measurement device.
  - It automatically determines range and function.

Slide 8-19

M. Digital voltage and continuity tester.

1. This is a contact measurement device.

2. It automatically determines range and function.

SAFETY (cont'd)

- Measures AC/direct current (DC) voltage from 12 to 600 volts and detects voltage when the battery dies.

Slide 8-20

3. It measures AC/DC voltage from 12 to 600 volts and detects voltage when the battery dies.

4. The liquid-crystal display (LCD) does not display values.

SAFETY (cont'd)

- Three notifications for voltage detected:
  - Light.
  - Sound.
  - Vibration.
- Continuity is reported by light and sound.

Slide 8-21

5. There are three notifications for voltage detected.

   a. Light.

   b. Sound.

   c. Vibration.

6. Continuity is reported by light and sound.

SAFETY (cont'd)

- Equipment must be locked out and tagged out before examination, preventative maintenance or servicing is performed.
- Lock outs and tag outs do not, by themselves, remove power from a circuit.
- Must follow approved procedure.

Slide 8-22

N. Lock out/Tag out.

1. Equipment must be locked out and tagged out prior to examination, preventative maintenance or servicing.

2. Lock outs and tag outs do not remove power from a circuit.

3. You must follow the approved procedure.

SAFETY (cont'd)

- Lock outs and tag outs are attached only after the equipment is turned **off** and tested to ensure that power is **off.**

Slide 8-23

4. Once you ensure that the equipment is de-energized, you lock out/tag out.

III. BASIC TERMS

BASIC TERMS

- Just like in every other aspect of fire investigations, there are terms and principles that need to be understood.
- For some, these will be new; for others, this will be a refresher.

Slide 8-24

BASIC TERMS (cont'd)

- Electricity:
  - "The physical phenomena arising from the behavior of electrons and protons that is caused by the attraction of particles with opposite changes and the repulsion of particles with the same charge."
  - "Electric current used or regarded as a source of power."

— excerpted from The American Heritage Dictionary of the English Language

Slide 8-25

A. Electricity.

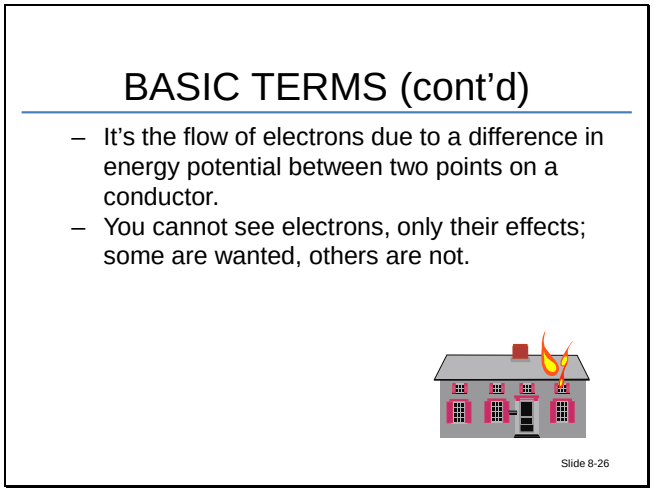
1. "The physical phenomena arising from the behavior of electrons and protons that is caused by the attraction of particles with opposite charges and the repulsion of particles with the same charge."

2. "Electric current used or regarded as a source of power."

   — excerpted from The American Heritage Dictionary of the English Language

3. The physical science of such phenomena.

4. Intense, contagious emotional excitement.



5. In plain language, electricity is the flow of electrons due to a difference in energy potential between two points on a conductor.

6. You cannot see electrons, only their effects. Some are wanted; others are not.

BASIC TERMS (cont'd)

- Voltage (V) or electric magnetic force (E).
- Current (I) or amperes or amps (A).
- Power (P) or watts (W).
- Resistance (R).
- Inductance (L).

Slide 8-27

7. Voltage or electric magnetic force (E).

   a. The pressure behind the electrons, measured in volts.

   b. You may see the electrical symbol "V" or, scientifically written, "E."

8. Current.

   a. The rate at which electrons are going to pass a given rate in one second.

   b. It is measured in amperes or amps.

   c. The electrical symbol is "I," which stands for intensity of electrons in conductors.

9. Power.

   a. A product of how much voltage and current is in the circuit.

   b. It is measured in watts (W).

10. W — the heating component that must be identified.

11. Resistance.

    a. The opposition to current flow.

    b. Measured in ohms or the Greek symbol, Ω.

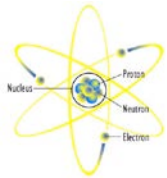
12. Inductance.

a. The influx of a magnetic field on a conductor, which causes electrons to begin to flow.

b. This is the basic principle of a generator, as well as a transformer.

BASIC TERMS (cont'd)

- Matter:
  - Has weight and takes up space.
  - Atoms.
  - Nucleus = + charged protons and neutrons.



Slide 8-28

B. Matter.

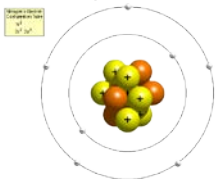
1. Has weight and takes up space.

2. Atoms.

3. Nucleus = + charged protons and neutrons.

BASIC TERMS (cont'd)

- Atomic theory:
  - All matter is made of atoms.
  - Protons + neutrons = nucleus.
  - Electrons form valance rings.
  - Number of electrons = number of protons.



Slide 8-29

C. Atomic theory.

1. Depending on what the material is made of, there are different valances outside.

2. Closest to nucleus: two electrons.

3. Outermost ring will identify type of conductor.

BASIC TERMS (cont'd)

- Outer ring has one to eight electrons.
- One to two electrons in outer ring = unstable ring (conductor).
  - -- Examples: silver, copper, gold, aluminum.

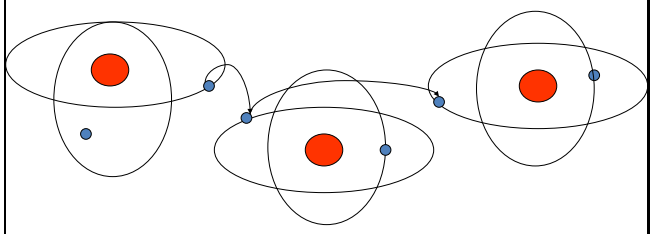
Slide 8-30

4. Materials that are good conductors have either one or two electrons in the outer valance and are considered very unstable.

5. Conductors easily give up those outer electrons and take outer electrons when energy is transferred to them.

BASIC TERMS (cont'd)

- When ring is unstable, electrons will bump other electrons from other similar atoms.

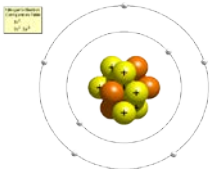


Slide 8-31

6. We excite them through a magnetic field, and they'll give and take an electron.

BASIC TERMS (cont'd)

- Four electrons in outer ring = semiconductor.
- Resistance varies with temperature.
- Increased temperatures lead to decreased resistance.
- Elements are silicon and germanium.
- Used in transistors and diodes.



Slide 8-32

7. If it has four electrons in the outer ring, it's considered a semiconductor.

8. Resistance varies with temperature.

9. Increased temperatures lead to decreased resistance.

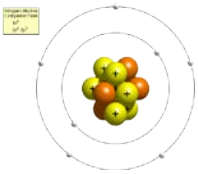
10. Typically, silicon and germanium are ideal conductors.

11. We see them in computer equipment.

12. Used in transistors and diodes.

BASIC TERMS (cont'd)

- Seven to eight electrons in the outer ring = stable ring (insulator).
- Examples include various carbon molecules such as rubber, plastics and wood.



Slide 8-33

13. Something that is an insulator has a nearly saturated outer ring, with seven or eight electrons.

    a. It reluctantly will give or take an electron.

b. Examples include various carbon molecules, such as rubber, plastics and wood.

BASIC TERMS (cont'd)

- This movement of electrons from one atom to another is known as electricity.
- Energy is required to initiate and continue this movement.

Slide 8-34

BASIC TERMS (cont'd)

- Energy is transformed during this movement to heat and magnetism.
- Heat and magnetism always accompany electron flow in some amount.

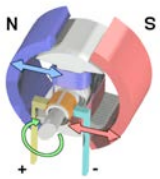
Slide 8-35

14. Important: Heat and magnetism are two things that will always accompany current flow.

15. Oxidation and corrosion are often seen on aluminum conductors and may be caused by weather reaction, moisture or heat.

BASIC TERMS (cont'd)

- Magnetic field:
  - When current flows, a magnetic field is generated; this is the principle of a motor.
  - Conversely, when a conductor is put into a magnetic field, current will flow; this is the principle of a generator.



Slide 8-36

D. Magnetic field.

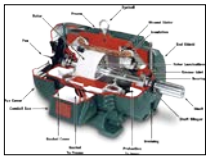
1. If we look at the way a motor functions when current flows, the magnetic field is generated.

2. When current flows, a magnetic field is generated; that is the principle of a motor.

3. Conversely, when a conductor is put into a magnetic field, current will flow; that is the principle of a generator.

BASIC TERMS (cont'd)

- Conductors:
  - Materials that allow current to flow freely with minimal resistance.
  - Copper and aluminum — two of the most recognized; both are used in electrical systems.
  - Gold and silver also used, usually at point of contact.



Slide 8-37

E. Conductors.

1. Rated by the National Electric Code (NEC) for size and ampacity.

2. Every conductor has some degree of resistance.

BASIC TERMS (cont'd)

- Insulators:
  - They work the opposite of conductors; they oppose or stop the flow of current.
  - Some insulators are glass, porcelain, air and pure water.
  - However, a high enough voltage may defeat the insulator.

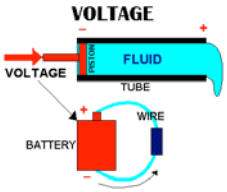
Slide 8-38

F. Insulators.

1. They work the opposite way of conductors; they stop the flow of current.
2. Some common insulators are glass, porcelain, air and pure water.
3. However, a high enough voltage may defeat the insulator.

BASIC TERMS (cont'd)

- Voltage (volts):
  - Electrical pressure that moves the electrons through the conductor.
  - Also known as electromagnetic field (EMF).
  - Shown in formulas as E.
  - Measured in volts.



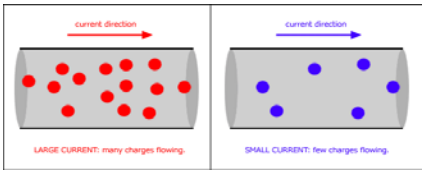
Slide 8-39

G. Voltage.

1. Electrical pressure that moves through the conductor.
2. Also known as EMF.
3. Shown in formulas as "E."
4. Measured in volts.

BASIC TERMS (cont'd)

- Current (amperes):
  - The rate at which electrons flow through a conductor. It is determined by measuring the amount of electrons flowing past a single point in one second.



Slide 8-40

H. Current.

1. The rate at which electrons flow through a conductor.

2. It is determined by measuring the amount of electrons flowing past a single point in one second.

BASIC TERMS (cont'd)

- Shown in formulas as "I" (intensity).
- Measured in amperes (amps).

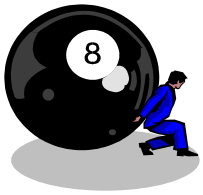
Slide 8-41

3. Shown in formulas as "I" (intensity).

4. Measured in amperes (amps).

BASIC TERMS (cont'd)

- Resistance:
  - This is the opposition to current flow.
  - Shown in formulas as "R."
  - Measured in ohms.
    - -- Greek Omega Ω.



Slide 8-42

I. Resistance.

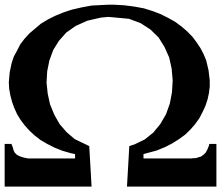
1. The opposition to current flow.

2. Shown in formulas as "R."

3. Measured in ohms — Greek Omega Ω.

BASIC TERMS (cont'd)

- When current flows through resistance, heat is generated.
  - -- Every conductor offers resistance.
  - -- Excess resistance can create high temperatures.



Slide 8-43

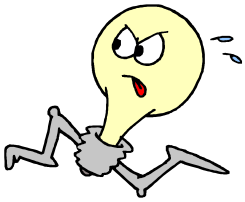
4. When current flows through resistance, heat is generated.

   a. Every conductor offers resistance.

   b. Excess resistance can create high temperatures.

BASIC TERMS (cont'd)

- Power (W or kilowatts (kW)):
  - This is the quantitative measurement of work done consumed in an electrical circuit.
  - Power is a larger issue over a period of time.



Slide 8-44

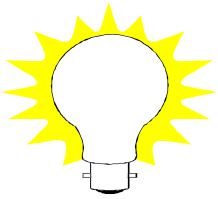
J. Power (W or kilowatts (kW)).

1. The quantitative measurement of work done consumed in an electrical circuit.

2. Power is a larger issue over a period of time.

BASIC TERMS (cont'd)

- 100-W light bulb:
  - Turn it on for only one second.
  - Touch it.
  - No problem.

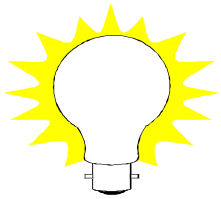


Slide 8-45

K. Turn a 100-W light bulb on for one second, touch it, and you're fine.

BASIC TERMS (cont'd)

- Leave it on for an hour.
- Touch it.
- Big problem.



Slide 8-46

L. An hour after illumination would be much worse: Time is an issue with amount of heat generated.

IV. ELECTRICAL THEORY

ELECTRICAL THEORY

Hydraulic	Electrical
Water/Fluid	Electrons
Pump	Generator
Pressure	Voltage
Pounds per square inch (psi)	Volts
Flow	Current
Gallons per minute (gpm)	Amperes
Friction loss	Resistance

Slide 8-47

A. Hydraulic versus electrical.

ELECTRICAL THEORY (cont'd)

- Ohm's law.
- Joule's law.

Slide 8-48

B. Two laws that govern electrical theory and are often used by investigators to model what is happening in the circuit.

ELECTRICAL THEORY (cont'd)

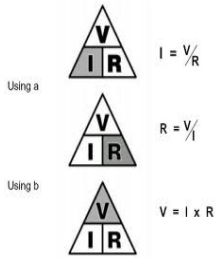
- Ohm's law was named after Georg Simon Ohm (1787-1854). Ohm's law is stated as:
  - "The amount of current flowing in a circuit made up of pure resistance is directly proportional to the electromotive forces impressed on the circuit and inversely proportional to the total resistance of the circuit."

Slide 8-49

C. Ohm's law was named after Georg Simon Ohm (1787-1854). Ohm's law is stated as: "The amount of current flowing in a circuit made up of pure resistance is directly proportional to the electromotive forces impressed on the circuit and inversely proportional to the total resistance of the circuit."

ELECTRICAL THEORY (cont'd)

- E (volts) = I (current) x R (resistance)
- R (resistance) = E (volts) / I (current)
- I (current) = E (volts) / R (resistance)



Slide 8-50

ELECTRICAL THEORY (cont'd)

- James Prescott Joule (1818-1889) formulated a relationship between the heat generated in an electric wire and the voltage across and current through that wire.

Slide 8-51

D. James Prescott Joule formulated a relationship between the heat generated in an electric wire and the voltage across and current through that wire.

1. This is applicable to a fire investigator because it deals with wattage. It refers to how much heat and power are associated with it.

2. All electrical appliances that are rated in the United States are rated in wattage.

ELECTRICAL THEORY (cont'd)

- P (power) = I (current) x E (voltage)
- I (current) = $\frac{\text{P (power)}}{\text{E (voltage)}}$
- E (voltage) = $\frac{\text{P (power)}}{\text{I (current)}}$
- By substituting Ohm's law for voltage:
  - P (power) = I^2 (current squared) x R (resistance)

Slide 8-52

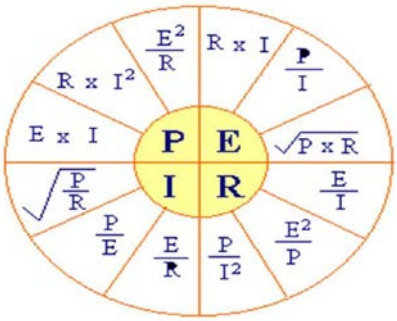
V. OHM'S AND JOULE'S LAWS

PRACTICAL DEMONSTRATION OF OHM'S AND JOULE'S LAWS

- Used to determine load on the circuit.
- Can prove if overload condition existed on circuit or circuit components.
- Basically, "model" what was occurring in the circuit provided you have proper input data (e.g., resistance, voltage, wattage).

Slide 8-53

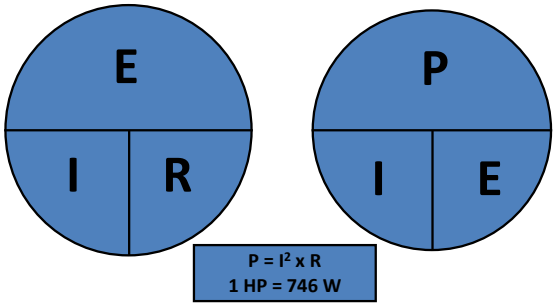
OHM'S LAW AND JOULE'S LAW



Slide 8-54

OHM'S LAW AND JOULE'S LAW (cont'd)

Cheat sheet:



Slide 8-55

VI. ALTERNATING CURRENT/DIRECT CURRENT THEORY

ALTERNATING CURRENT/ DIRECT CURRENT THEORY

- Types of electrical currents:
  - DC.
  - AC.
- DC:
  - Mechanically or chemically generated.
  - Chemical = batteries or photovoltaic.
  - Mechanical = generator.
  - Electrons flow in one direction only.
  - Positive and negative terminals on equipment.

Slide 8-56

A. Types of electrical current — DC and AC.

1. DC.

a. Mechanically or chemically generated.

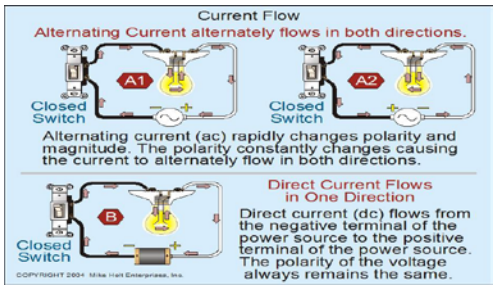
- Chemical = batteries or photovoltaic.
- Mechanical = generator.

b. Electrons flow in one direction only.

c. Positive and negative terminals on equipment.

ALTERNATING CURRENT/DIRECT CURRENT THEORY (cont'd)

- DC versus AC.



Slide 8-57

d. DC flow is going from negative to positive and completing its circuit, and voltage will remain the same.

2. AC flow will change its direction 60 times in one second.

ALTERNATING CURRENT/DIRECT CURRENT THEORY (cont'd)

- AC:
  - Mechanically generated.
  - Electrons reverse flow many times per second (frequency).
  - Ungrounded (hot) and grounded (neutral) terminals on equipment.
  - Voltages can be changed with transformers.

Slide 8-58

B. AC.

1. Refer to the example of the copper conductor moving through a magnetic field.

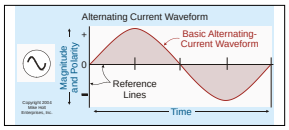
2. Electrons will reverse flow 60 times per second.

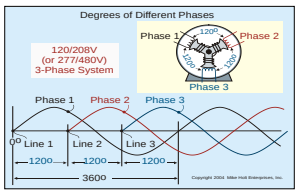
3. With AC circuits, we have two key components: ungrounded or grounded, not positive or negative.

4. An advantage of an AC circuit is that you can change voltages through transformers. That cannot be done with DC circuits.

ALTERNATING CURRENT/DIRECT CURRENT THEORY (cont'd)

- Found predominantly in structures.
- 120, 240, 208, 277, 480 volts.
- Vehicle inverter.





Slide 8-59

C. This picture is called a sine wave. AC flows negative to positive, then back to negative at a rate of 60 times per second.

1. The frequency of U.S. power systems is 60 hertz.
2. Usually found overseas: 50 hertz.
3. Some small appliances have a 50 to 60 hertz selection switch.
4. The left picture shows a single phase; the right shows three phases mechanically generated at 120 degrees out of phase.
5. It is found predominantly in structures.
6. 120, 240, 208, 277, 480 volts.
7. Vehicle inverter.

ALTERNATING CURRENT/DIRECT CURRENT THEORY (cont'd)

- Frequency is the number of times the flow of electricity reverses itself in the span of one second.
- It is measured in hertz.
- In United States, frequency is most often 60 hertz.
- Foreign countries use 50 hertz systems.

Slide 8-60

D. Frequency.

1. Frequency is the number of times the flow of electricity reverses itself in the span of one second.

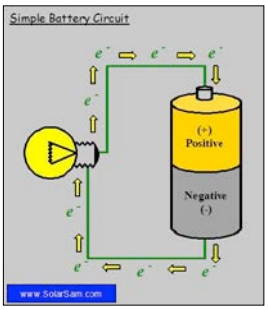
2. It is measured in hertz.

3. In the U.S., frequency is most often 60 hertz.

4. Foreign countries use 50 hertz systems.

ALTERNATING CURRENT/DIRECT CURRENT THEORY (cont'd)

- Most recognized as a battery; found in power supplies, DC generators. Some industrial applications.
- DC is used for numerous operations.



Slide 8-61

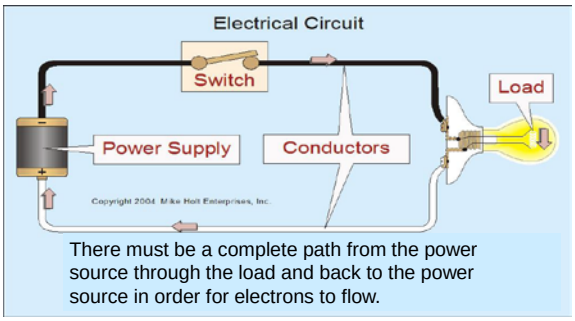
E. Vehicle systems are DC-operated; the same basic principles apply.

1. Most recognized as a battery; found in power supplies, DC generators, some industrial applications.

2. DC is used for numerous operations.

VII. ELECTRICAL CIRCUITS

ELECTRICAL CIRCUITS



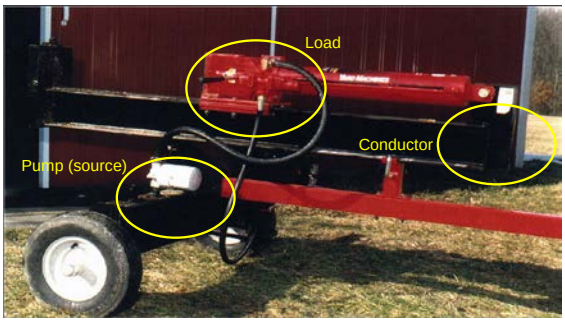
Slide 8-62

A. We need a power supply, pathway (conductors) and load.

1. There must be usage; that load must be on for an actual electrical circuit.

2. Without power supply, pathway or load, there is no electrical circuit.

ELECTRICAL CIRCUITS (cont'd)



Slide 8-63

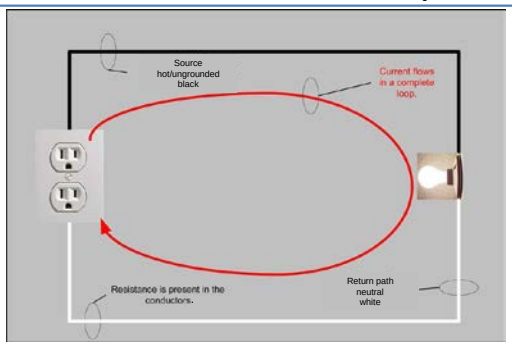
B. Note the mechanical equivalent when it actually splits the log. The load is on the circuit.

ELECTRICAL CIRCUITS (cont'd)

Slide 8-64

C. The circuit consists of source, path, load. It shows the current flowing and shows DC.

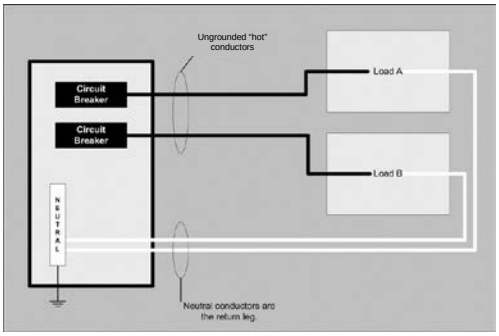
ELECTRICAL CIRCUITS (cont'd)



Slide 8-65

D. This shows an AC basic branch circuit.

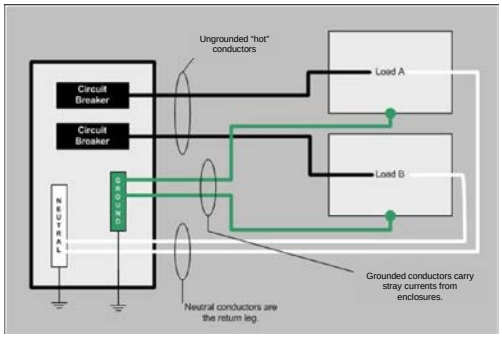
ELECTRICAL CIRCUITS (cont'd)



Slide 8-66

E. This shows a circuit breaker, load and return pathway.

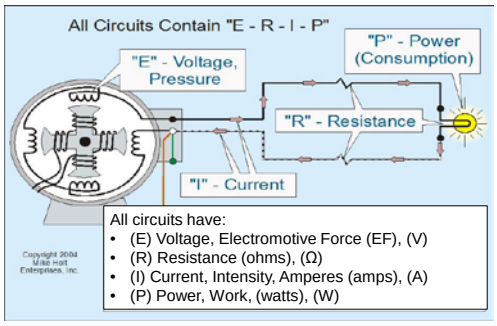
ELECTRICAL CIRCUITS (cont'd)



Slide 8-67

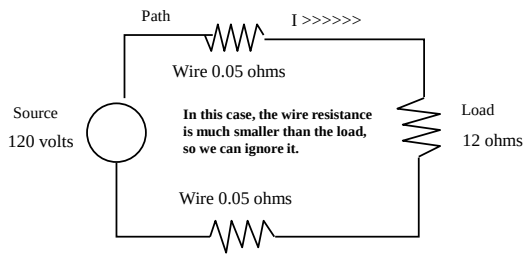
F. This shows a grounding conductor. The green or bare wire is not needed for operation; it is used as a life safety line to take lightning and fault currents to earth ground.

ELECTRICAL CIRCUITS (cont'd)



Slide 8-68

ELECTRICAL CIRCUITS (cont'd)



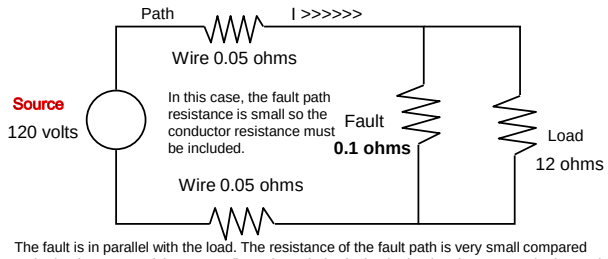
For this simple circuit, calculate the current, I:

Using Ohm's law I = V/R

120V/12Ω = 10A

Slide 8-69

ELECTRICAL CIRCUITS (cont'd)



The fault is in parallel with the load. The resistance of the fault path is very small compared to the load, so most of the current flows through the fault. The load resistance can be ignored.

Calculate the current in this circuit resulting from a fault using Ohm's law:

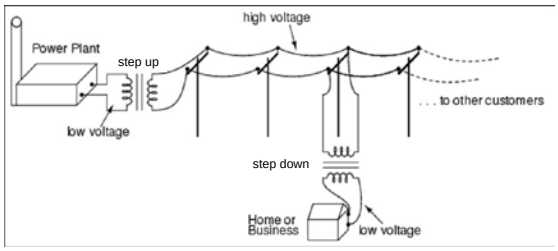
I = 120V/(0.1 + 0.05 + 0.05) = 600A

Slide 8-70

VIII. ALTERNATING CURRENT POWER DISTRIBUTION

ALTERNATING CURRENT POWER DISTRIBUTION

- Typical distribution model for AC systems.



Slide 8-71

A. Refer to generation stations.

1. We are taking copper conductor and moving it through a magnetic field.

2. It is coming out of the power plant, possibly at 1,000 volts, depending on the system.

3. Eventually it will come into communities and step into distribution voltage, distributed throughout the community, and then it becomes used voltage.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- Typically, transmission voltages between power generators and substations are 69,000, 138,000, 345,000, 500,000 and 1,100,000.
- **Danger:** The wires are not insulated.

Slide 8-72

B. Typically, transmission voltages between power generators and substations are:

1. 69,000.

2. 138,000.

3. 345,000.

4. 500,000.

5. 1,100,000.

If we wanted to transmit 1.2 megawatts (MW) of power to a neighborhood using 120 volts, how much current would it take?

Slide 8-73

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

Slide 8-74

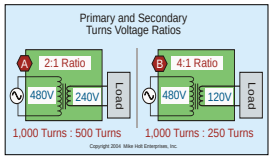
C. Voltages are "stepped down" to distribution voltages and then sent back out at a lower voltage.

1. Distribution can be either overhead or underground.

2. The voltage is still considered high-voltage at this point: It is still considered primary voltage.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- A transformer is used to increase or decrease voltage.
- Consists of two isolated coils of wire around an iron core.
- Primary coil is the input voltage coil.
- Secondary coil is the output voltage coil.

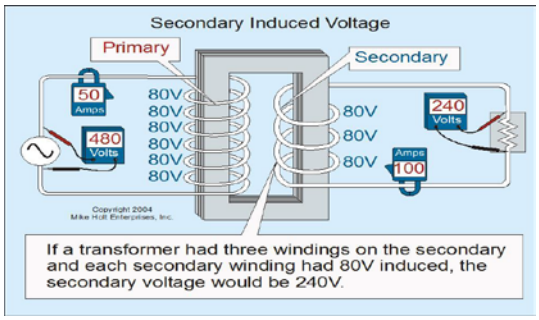


Slide 8-75

D. Transformers.

1. Used to increase or decrease voltage.
2. Consist of two isolated coils of wire around an iron core.
3. Primary coil is the input voltage coil.
4. Secondary coil is the output voltage coil.

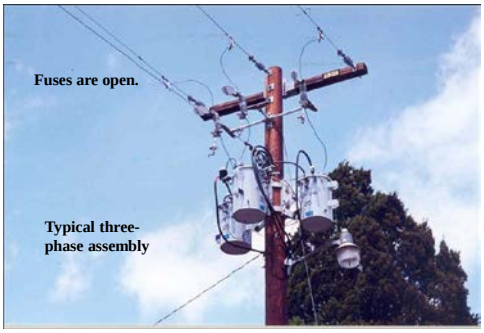
ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)



Slide 8-76

5. There is no electrical connection between primary and secondary windings.
6. Transformers work using magnetic properties.
7. Transformers change voltage (pressure) and current (flow).

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)



Slide 8-77

8. Primary and secondary side of transformer. Tree transformers on the pole means three-phase power.

9. The number "25" indicates that the transformer is rated to produce 25,000 W of power. Once that wattage is exceeded, the fuse actually opens.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- In U.S., three-phase power is typically generated.
- Used in larger occupancies where lighting and motor loads are greater than a residential occupancy.
- Motors are less costly and run more efficiently.

Slide 8-78

E. In the U.S., three-phase power is typically generated.

F. Used in larger occupancies where lighting and motor loads are greater than a residential occupancy.

G. Motors are less costly and run more efficiently.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- Common voltages are:
  - 120/240 with a 208 "high leg." Orange in color … Phase B.
  - 120/208.
  - 277/480.

Slide 8-79

H. Common voltages.

1. An open delta system: 120/240 with 208 "high leg" on Phase B.

2. The building you're sitting in is 120/208 volts.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- Three-phase 120/240 volt system with 208 volts to ground "high leg."
- Two transformers are indicative of this "open delta" transformer configuration.

Slide 8-80

I. This is what it would look like if you got back to the distribution pole. One may be larger than the other; it does not matter.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

- Pad-mounted transformer.
  - Can be single- or three-phase.
  - Accompanied by underground lateral.

Slide 8-81

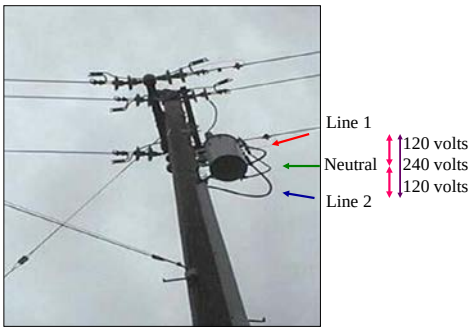
J. Pad-mounted transformer.

1. Can be single- or three-phase.
2. Accompanied by underground lateral.
3. Conceptually, these transformers function the same way, but mechanically, they are shaped differently.
4. There is a high-voltage side of this enclosure as well as a low-voltage side.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)

Slide 8-82

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)



Slide 8-83

K. Distribution voltages are usually 12,470 volts, 7,200 volts or 4,800 volts.

1. Danger: The high voltage wires are bare or covered — not insulated.

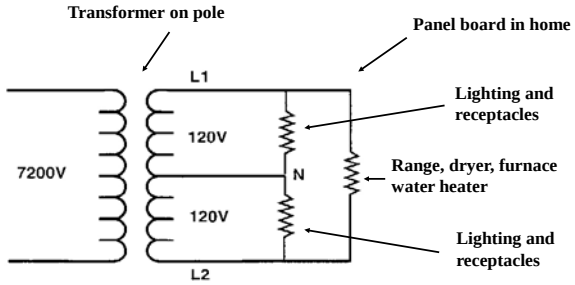
2. A transformer is provided to step the voltage down to safer voltages.

3. This is for household use. Industrial and commercial use is usually three-phase 120/208 V or 277/480 V.

4. Even though there may be a black coding on these black wires, they are not insulated.

5. Primary, neutral, three wires.

ALTERNATING CURRENT POWER DISTRIBUTION (cont'd)



Slide 8-84

L. Lightning and receptacles are on 120-volt circuits.

1. Because of the greater current requirements, dryers and furnaces are on 240-volt circuits.

2. Notice: No ground (dirt) connection is shown. Ground is not required for operation.

3. Ground is for lightning and fault protection.

4. The neutral wire maintains 120 volts between the two 120-volt legs.

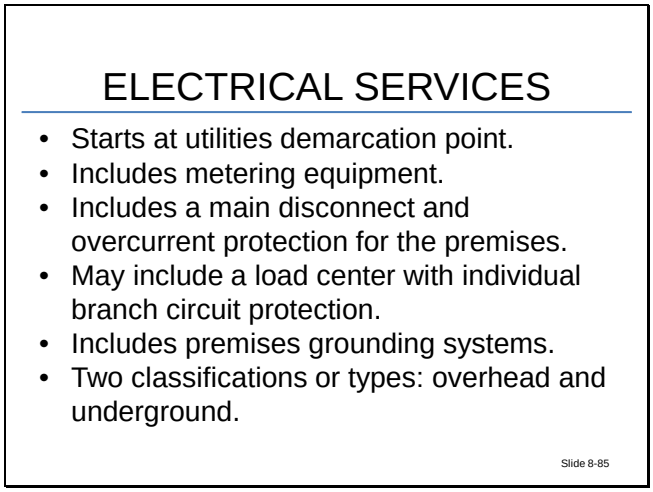
5. What's coming to your house is a three-wire Edison system.

6. Primary side, secondary side.

7. At the exact "center of the transformer winding" is the no voltage central point, which is connected to the neutral.

8. The utility company supplies the neutral conductor, and the installer provides the grounding conductor. It is the neutral wire that maintains the voltage difference of 120 and 240.

IX. ELECTRICAL SERVICES



A. Starts at utilities demarcation point.

B. Includes metering equipment.

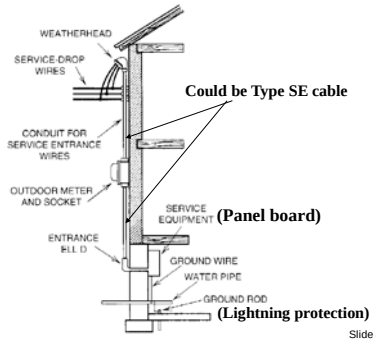
C. Includes a main disconnect and overcurrent protection for the premises.

D. It may include a load center with individual branch circuit protection.

E. It includes premises grounding systems.

F. Two classifications or types: overhead and underground.

ELECTRICAL SERVICES (cont'd)



Slide 8-86

G. The service drop wires are the most likely place for an open neutral to occur from trees and conductors.

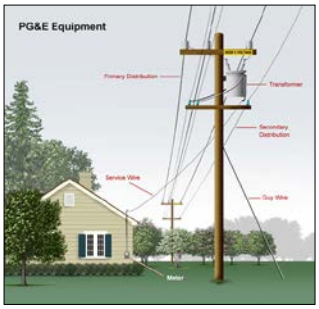
H. No overcurrent protection is provided between the transformer and the home.

1. The utility only provides protection on the primary side of the transformer.

2. This protection is for the transformer only, not the home.

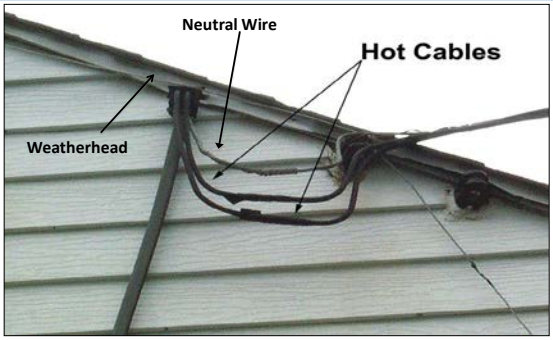
3. Underground utility feeds are called service laterals.

ELECTRICAL SERVICES (cont'd)



Slide 8-87

ELECTRICAL SERVICES (cont'd)



Slide 8-88

I. Between two hot legs: 240-volt potential.

J. Between hot leg to neutral: 120-volt potential.

ELECTRICAL SERVICES (cont'd)

Slide 8-89

K. High voltage is stepped down to secondary voltage, and service enters the house underground. It's entered underground via a service lateral.

1. This is not an underground transformer; it's a pad-mounted transformer for an underground distribution system.

2. This transformer is fused, but the fuse is not visible unless it is removed by the utility company.

3. Additionally, document any numbers of identification that may be on that transformer.

ELECTRICAL SERVICES (cont'd)

Slide 8-90

L. The utility company's responsibility is to the top side of the meter lugs. This location is considered the "line side" of the meter.

ELECTRICAL SERVICES (cont'd)

Slide 8-91

M. In some multifamily applications, the main disconnect and/or individual apartments may be located on the exterior on the meter enclosure assembly.

ELECTRICAL SERVICES (cont'd)

"Booted" meters

Slide 8-92

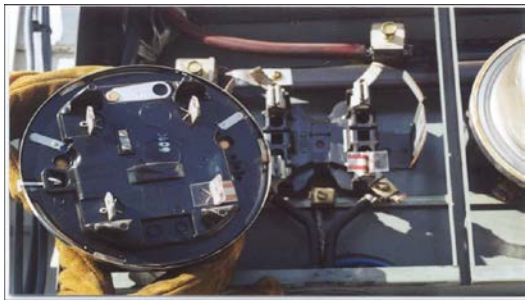
N. "Booted" meters.

1. For nonpayment of service, many utilities have gone to the process of "booting the meter" to disconnect power to the structure.

   a. A booted meter will be reinserted into the socket with no evidence that the blades are booted.

ELECTRICAL SERVICES (cont'd)

"Booted" meters



Slide 8-93

   b. If you do not pay your bill, the utility company will slide boots onto the blades.

ELECTRICAL SERVICES (cont'd)

"Booted" meters

Slide 8-94

2. This is what a boot looks like.

ELECTRICAL SERVICES (cont'd)

- Exposed current transformer (CT) metering.
- Can also be found in an enclosure.
- Used when service is greater than 400 amps.

Slide 8-95

O. Exposed current transformer (CT) metering.

1. Services greater than 400 amps have a different type of metering system.

2. CTs are used to take a sample of the overall power and send it to the meter.

3. Pulling a meter, in this instance, does not disconnect power.

4. Service disconnect must be accomplished by the utility company.

ELECTRICAL SERVICES (cont'd)

- CT meter — no disconnection means.

Slide 8-96

P. CT meter.

1. The meter base will appear different; typically, it is hinged, or there is a separation.

   a. The meter itself is generally longer.

   b. In looking at the meter base, there are no large conductors connected to it.

ELECTRICAL SERVICES (cont'd)

- Meter is found in this style of enclosure.
- Removing meter **does not** disconnect power.
- CT can also be in an enclosure, which can be found indoors or out.

Slide 8-97

2. Meter is found in this style of enclosure.

3. Removing meter does not disconnect power.

4. CT can also be in an enclosure, which can be found indoors or out.

ELECTRICAL SERVICES (cont'd)

- Two functional types:
  - CT.
  - Socket mount watt-hour transformer.

Slide 8-98

5. Two functional types.

   a. CT.

   b. Socket mount watt-hour transformer.

   c. When you generate current, you generate heat and magnetism. The magnetic field being generated is being picked up by the transformer and sent back to the meter.

ELECTRICAL SERVICES (cont'd)

Slide 8-99

6. Opening a CT cabinet may kill you. There is no means of disconnect within that cabinet.

ELECTRICAL SERVICES (cont'd)

- Main disconnects.
  - Used when service panel is distant from location where service conductors enter the building.
  - Used to supply multiple panels.

Slide 8-100

Q. Main disconnects.

1. In some electrical installations, disconnects may be found.

2. In commercial/industrial applications, there is a code requirement that stipulates a means of disconnect within that motor.

3. You may run into multiple disconnects within a structure.

4. Disconnects are used when the service panel is distant from the location where service conductors enter the building.

5. It is used to supply multiple panels.

ELECTRICAL SERVICES (cont'd)

- Fuses, circuit breakers or a combination of both.
- Provide overcurrent protection for building and branch circuits.

Slide 8-101

R. Service panels.

1. Fuses, circuit breakers or a combination of both.

2. They provide overcurrent protection for building and branch circuits.

3. Service panels may be single-phase or three-phase depending on type of occupancy.

X. OVERCURRENT PROTECTION DEVICES

OVERCURRENT PROTECTION DEVICES

Slide 8-102

A. You may encounter a combination system that has breakers and/or fuses.

1. Older systems typically have fuses as their means of protection.

2. Edison fuses and pull-out cartridge fuses.

OVERCURRENT PROTECTION DEVICES (cont'd)

Slide 8-103

B. Fuses.

1. Blue is rated for 15 amps and has a hexagon window.

2. Yellow is rated for 20 amps and has a round window.

3. Green is rated for 30 amps and has a round window.

4. Circuit breaker-type fuse is shown at the top, and cartridge fuse is on the bottom.

5. Part of your data collection process when evaluating your electrical system should be the identification of ampacities and types.

6. Fuses operate on a thermal concept only.

OVERCURRENT PROTECTION DEVICES (cont'd)

- Cartridge fuse.

Slide 8-104

C. Cartridge fuse.

1. Contains a fusible link that opens when an electrical fault occurs.

2. Size/Rating is marked on the fuse itself. It is usually over 30 amps.

3. Also inside the cartridge is an arc-suppressing compound.

4. It mechanically creates a barrier between the fusible links as it is separating under fault.

5. It takes a minimum of 350 volts to cross an air gap to create an arc.

6. Oftentimes, cartridge fuses are found in applications greater than 350 volts.

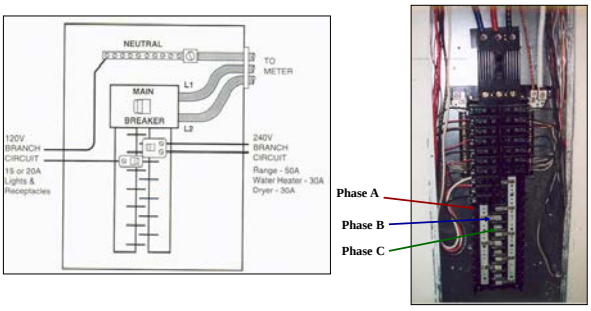
OVERCURRENT PROTECTION DEVICES (cont'd)

Slide 8-105

D. Circuit breaker panel.

1. They come in many different designs.
2. This shows an older Bryant system.
   a. Bryant color-coded its breakers.
   b. Blue is 15, red is 20, green is 30, and black is greater than 30.

OVERCURRENT PROTECTION DEVICES (cont'd)



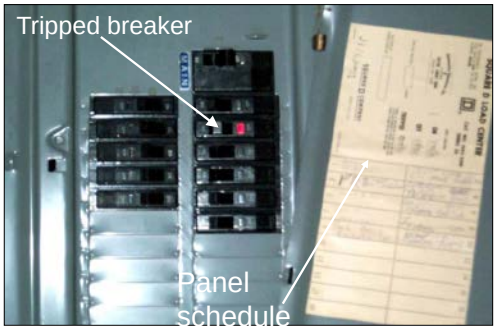
Slide 8-106

E. This is a three-phase panel board with the cover removed.

1. Notice the exposed bus connections.
2. The phases alternate from top to bottom.
3. The ground is bonded to neutral in the service panel only.

4. Separate ground and neutral wires are required from here out.

OVERCURRENT PROTECTION DEVICES (cont'd)



Slide 8-107

F. Schedule should determine what each circuit breaker controls.

1. Note the tripped breaker. Some breakers have indicators; others do not.

2. They can be identified by the handle location: "Tripped" will center the handle in most cases.

3. A panel schedule should be a benchmark; the circuit location will still have to be verified because it may not be filled out properly.

4. The breaker shown in this photo is a Square D QO-style breaker. This is the only breaker in the industry that has a trip indicator window.

OVERCURRENT PROTECTION DEVICES (cont'd)

Slide 8-108

G. Circuit breakers.

1. They should have their ampacity identified on the handle. Breakers that are designed to be used as switches need to be rated as switch breakers (SWD).

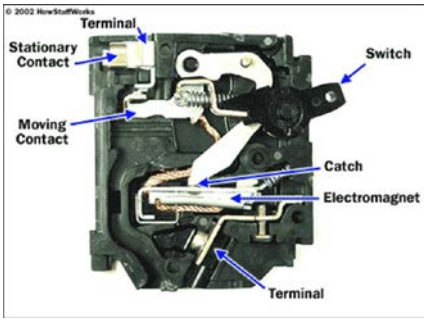
2. Breakers are also rated to operate in a thermal environment and need to be rated as such.

3. Breakers with black handles without trip indicators will trip to a midline position.

4. Tan-colored breaker handle “cutler-hammer, Crouse-Hines” will trip to an “off” position.

5. Breakers operate on both a thermal and magnetic concept.

OVERCURRENT PROTECTION DEVICES (cont’d)



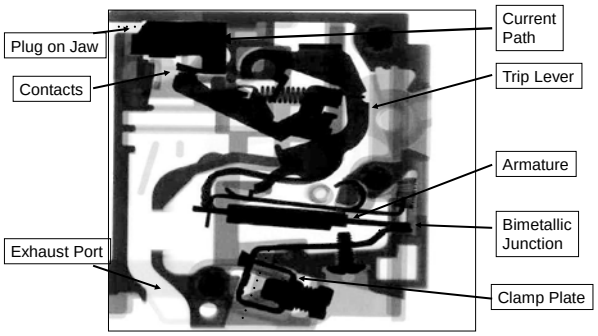
Slide 8-109

H. The electromagnet is actually the device that causes the trip.

1. Inside this electromagnet is a bimetallic element that, on a thermal principle, will expand and cause breaker to trip.

2. On a high in-rush current, this electromagnetic catch will actually shift, allowing it to operate.

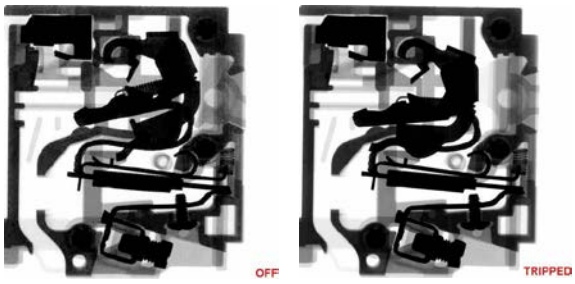
OVERCURRENT PROTECTION DEVICES (cont'd)



Slide 8-110

OVERCURRENT PROTECTION DEVICES (cont'd)

- Observe the contacts and the trip lever.

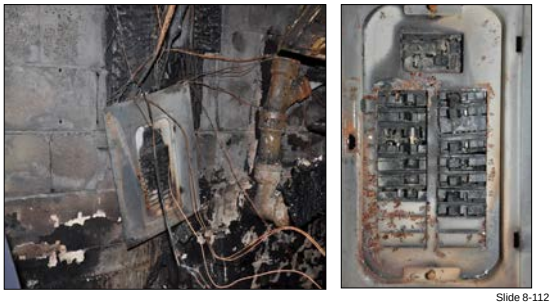


Slide 8-111

I. Breakers will trip from an on position. Breakers can also trip from an off position.

OVERCURRENT PROTECTION DEVICES (cont'd)

- Effects of fire.



Slide 8-112

J. Effects of fire.

1. In the panel on the right, all of the breakers are in the tripped position.

2. The investigator must still arc map those conductors; however, the trips identified in the panel may be associated to the thermal environment that the box was in.

3. In other words, many of those breakers may have tripped due to the temperature of the compartment in which the panel box was located.

OVERCURRENT PROTECTION DEVICES (cont'd)

- A panel board that has been impinged by flames will generally have all of the circuit breakers tripped.
  - Only check the circuit breaker by turning it **on.**

Slide 8-113

K. A panel board that has been impinged by flame will generally have all of the circuit breakers tripped.

1. Only check the circuit breaker by turning it **on.**

2. If you are not sure which direction is on, leave it alone!

OVERCURRENT PROTECTION DEVICES (cont'd)

A GFCI is designed to protect people against electric shock. It operates on the principle of monitoring the unbalanced current between the ungrounded and grounded (neutral) conductor.

Slide 8-114

L. Ground fault circuit breakers.

1. Have a test button on them.

2. Ground-fault circuit-interrupter (GFCI).

3. Can be found in either outlet or breaker or in appliance form.

   a. Functions on numeric difference between hot and neutral conductor.

   b. When a numeric difference of 3 to 5 milliamps is observed, the GFCI functions, opening the circuit and stopping the flow of power.

4. A GFCI is designed to protect people against electric shock. It operates on the principle of monitoring the unbalanced current between the ungrounded and grounded (neutral) conductor.

OVERCURRENT PROTECTION DEVICES (cont'd)

- A small coil observes the difference between currents in the neutral and ungrounded legs.
- If more than 5 milliamps are observed, the outlet or circuit breaker is tripped.

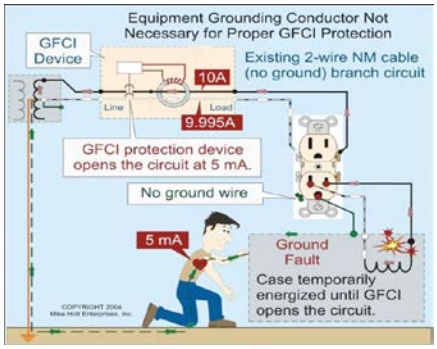
Slide 8-115

M. A small coil observes the difference between currents in the neutral and ungrounded legs.

   1. If more than 5 milliamps are observed, then the outlet or circuit breaker is tripped.

   2. The pigtail attached to the breaker needs to be connected to the neutral busbar in order for the circuit breaker to function.

OVERCURRENT PROTECTION DEVICES (cont'd)



Slide 8-116

OVERCURRENT PROTECTION DEVICES (cont'd)

- Combination Arc Fault Circuit Interrupter (AFCI) circuit breakers sense and respond to both parallel and series arcing incidents.
- It is a thermal magnetic circuit breaker with a computer to sense arc activity.

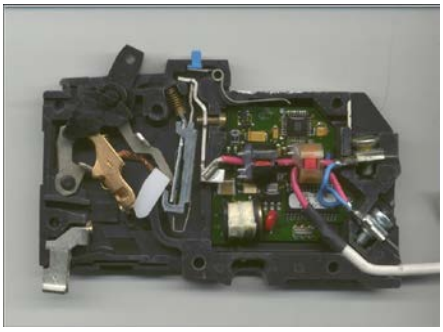
Slide 8-117

N. Arc Fault Circuit Interrupter (AFCI).

1. Combination AFCI circuit breakers sense and respond to both parallel and series arcing incidents.

2. It is a thermal magnetic circuit breaker with a computer to sense arc activity.

OVERCURRENT PROTECTION DEVICES (cont'd)



Slide 8-118

3. An AFCI has a microprocessor inside of it.

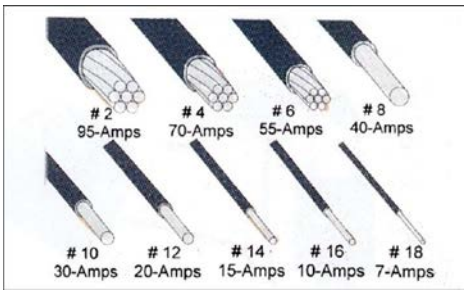
   a. The microprocessor monitors the sine wave.

   b. Once it sees an erratic sine wave caused by arcing, the circuit breaker opens.

4. The AFCI also gives you additional breaker protection as well — thermal **and** magnetic.

XI. WIRING METHODS AND MATERIALS

WIRING METHODS AND MATERIALS



Slide 8-119

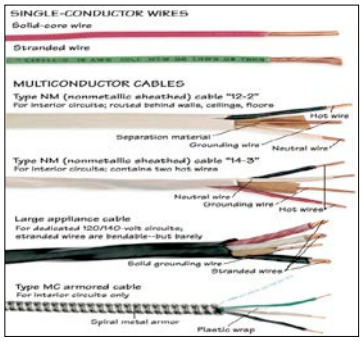
A. The larger the conductor, the smaller the ampacity. The ampacity of conductors is dictated by the size of the conductor and the size of the insulation around it.

   1. The listed conductors are identified for a polyvinyl chloride (PVC) type of insulation.

2. Many of the conductors and ampacities listed on this slide identify jacketed conductors.

WIRING METHODS AND MATERIALS (cont'd)

- Nonmetallic sheathed cable.



Slide 8-120

B. Even though many of the conductors show three and four wires in them, the actual cable count is only associated with the wires that would be insulated.

1. "12-2" actually shows three conductors; the two insulated conductors are the ones that count.

2. The bottom conductor with the metal jacket is called "metal-clad armored cable." This is not Base Exchange (BX) cable. (This is a brand of armor-clad conductor.)

3. BX cable had a steel metal jacket and did not have a separate insulated, isolated grounding conductor.

WIRING METHODS AND MATERIALS (cont'd)

- Conduit.

Slide 8-121

C. Conduit.

1. Comes in various sizes and materials.

2. Used to serve as protection and as a raceway for the conductors.

3. NEC dictates what type of conduit can be installed in various environments.

4. Additionally, there are fill requirements associated with conduit.

WIRING METHODS AND MATERIALS (cont'd)

- Knob and tube.

Slide 8-122

D. Knob and tube.

1. Consists of single-strand conductors run throughout the home.

2. Porcelain knobs and tubes where conductors either went through a combustible framing member or were attached to the combustible framing member.

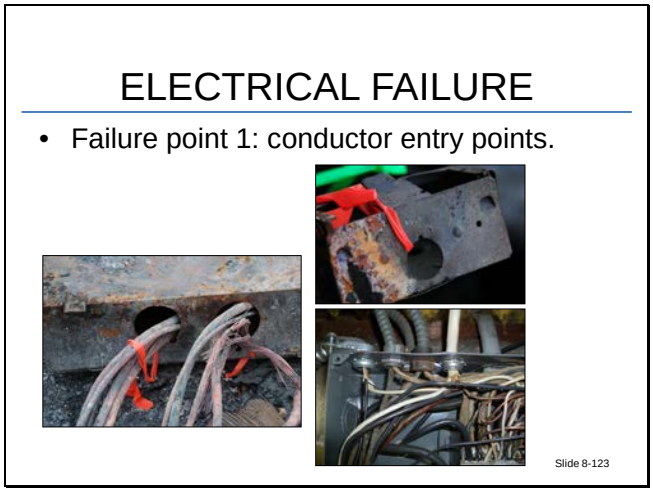
3. The biggest problem with knob and tube wiring systems is the splices.

   a. There was no requirement to have these splices within an enclosure; oftentimes they were made interstitial spaces.

   b. The splice was simply a matter of wrapping one wire around another, applying solder, and covering with tape.

4. Over time, the heat generated from current flow breaks down the solder and causes a loose connection at that point.

XII. ELECTRICAL FAILURE



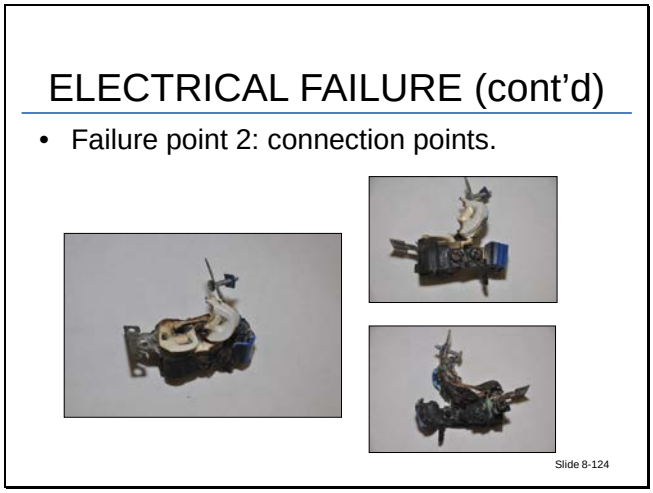
A. Failure point 1: conductor entry points.

1. Investigators should examine the conductors and the enclosure where they enter overtightening of clamps.

2. Not using the appropriate connector can cause failure at these points.

3. Additionally, many of these connectors have melting temperatures lower than copper and have a tendency to melt out, exposing the energized conductors.

4. Arced conductors are often found at this location.



B. Failure point 2: connection points.

1. This failure is typically known as a high resistance connection (HRC).

2. The cause is associated with a loose or improperly made connection at a point of termination.

ELECTRICAL FAILURE (cont'd)

- Failure point 3: transition points.

Slide 8-125

C. Failure point 3: transition points.

1. Failures in a straight run of conductors are extremely rare. However, at times, larger conductors, such as service entrance cable, can become damaged at points of transition.

2. Branch circuits may also become damaged at points of transition.

3. The investigator needs to show that the conductor was grossly bent or that we have an area in which there was physical impact. You may have a failure to that point.

ELECTRICAL FAILURE (cont'd)

- Transition point: service entrance area.

Slide 8-126

D. Transition point: service entrance area.

ELECTRICAL FAILURE (cont'd)

- Transition point: branch circuit.

Slide 8-127

E. Transition point: branch circuit.

ELECTRICAL FAILURE (cont'd)

- Wiring in conduit or behind walls normally will not fail in the middle of a run without some sort of mechanical event.
- Focus on points of entry, connection and transition.

Slide 8-128

F. Wiring in conduit or behind walls normally will not fail in the middle of a run without some sort of mechanical event. Focus on:

1. Entry points.
2. Connection points.
3. Transition points.

XIII. SOURCES OF ELECTRICAL HEAT ENERGY

SOURCES OF ELECTRICAL HEAT ENERGY

- Electricity is one of four sources of heat energy.
- Five forms of electrical heating:
  - Resistance.
  - Arcing.
  - Sparking.
  - Static electric charge.
  - Lightning.

Slide 8-129

A. Common forms of electrical heating.

1. Arcing.
2. Sparking.
3. Static.
4. Lightning.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Arcing:
  - Caused by electricity traveling through an air space from one conducting point to another.
  - Temperatures are between 5,000 and 15,000 F.

Slide 8-130

B. Arcing.

1. Caused by electricity traveling through an air space from one conducting point to another.
2. Temperatures are between 5,000 and 15,000 F.

3. This picture shows 238,000 arc.

4. A minimum of 350 volts is needed to cross an air gap to begin an arc.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Expel small particles.
- Often of short duration.
- Can be continual or intermittent.

Slide 8-131

5. Expel small particles.

6. Often of short duration.

7. Can be continual or intermittent.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Sparking:
  - Produced by conversion of metals to vapors and liquids from exposure to intense heat.
  - Can occur only once.
  - Metal is displaced from origin.

Slide 8-132

C. Sparking.

1. Produced by conversion of metals to vapors and liquids from exposure to intense heat.

2. It can only occur once.

3. Metal is displaced from origin.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Substantial heating effect.
- Extremely dangerous in flammable atmospheres.

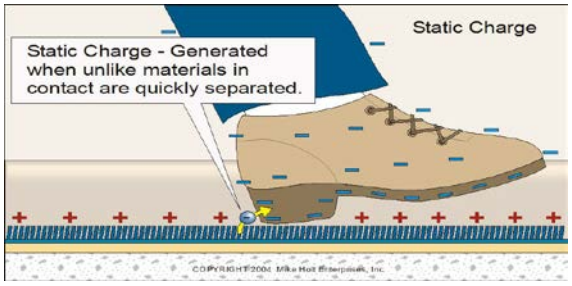
Slide 8-133

4. Creates substantial heating effect.

5. It is extremely dangerous in flammable atmospheres.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Static electric charge.



Slide 8-134

D. Static electric charge.

1. Temperature from a static electric discharge will not ignite liquids or solids.

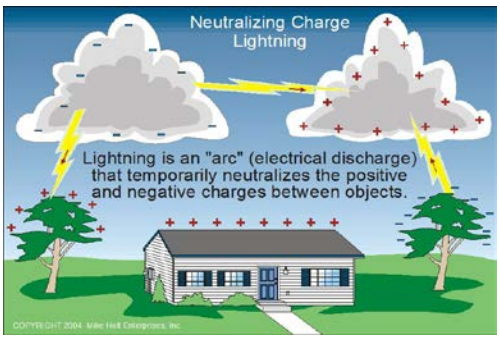
2. However, it may ignite flammable vapors and solid dust particles.

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)

- Lightning is a naturally and frequently occurring source of powerful electrical energy.
  - Extreme temperatures and damage associated with strikes.
  - Damage prevented with proper grounding techniques.
  - Damage can be distant from strike location.

Slide 8-135

SOURCES OF ELECTRICAL HEAT ENERGY (cont'd)



Slide 8-136

E. Lightning.

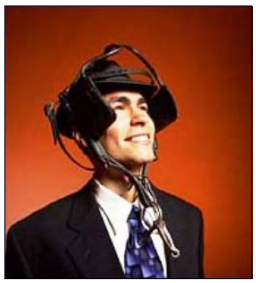
1. An "arc" (electrical discharge) that temporarily neutralizes the positive and negative charges between objects.

2. The lightning strike should be verified through some meteorological source or service, such as National Oceanic and Atmospheric Administration (NOAA), Visaila or STRIKEnet.

XIV. CONDUCTING AN ELECTRICAL SCENE EXAMINATION

CONDUCTING AN ELECTRICAL SCENE EXAMINATION

- The electrical scene examination will only focus on the electrical systems and **nothing** else.
- In effect, act like it is a separate investigation.



Slide 8-137

A. The electrical scene examination will only focus on the electrical systems and **nothing** else.

B. In effect, act like it is a separate investigation.

CONDUCTING AN ELECTRICAL SCENE EXAMINATION (cont'd)

- If something appears to be an electrical failure, wait and see how it fits with the remainder of the scene before drawing a conclusion.

Slide 8-138

C. If something appears to be an electrical failure, wait and see how it fits with the remainder of the scene before drawing a conclusion.

CONDUCTING AN ELECTRICAL SCENE EXAMINATION (cont'd)

Slide 8-139

D. Arc damage shows that the equipment was energized at the time of the fire.

CONDUCTING AN ELECTRICAL SCENE EXAMINATION (cont'd)

- Forensic examination alone will not tell you if the thermal damage is a cause or result of the fire.
- We need to practice identifying thermal damage to be able to identify thermal damage.

Slide 8-140

E. Forensic examination alone will not tell you if the arc melting is a cause or result of the fire.

F. We need to practice identifying arc melting in order to successfully do so.

METHODOLOGY

- Start outside.
  - Document the primary distribution transformer.
  - Get information about the service from the utility provider.
  - Determine when the scene was de-energized.
  - Examine and document the service entrance.

Slide 8-141

G. Start outside.

1. Document the primary distribution transformer.
2. Get information about the service from the utility provider.
3. Determine when the scene was de-energized.
4. Examine and document the service entrance.

METHODOLOGY (cont'd)

- Conduct interviews.
  - Obtain information about facility status, wiring, maintenance, etc., from interviews.
  - Obtain information about what was/should have been energized.

Slide 8-142

H. Conduct interviews.

1. Obtain information about facility status, wiring, maintenance, etc., from interviews.
2. Obtain information about what was/should have been energized.

METHODOLOGY (cont'd)

- Move inside.
  - Trace the system throughout the facility, starting at the service entrance.
  - Emphasis is placed on feeders and branch circuits that are tripped or open.
  - Identify all instances of arc melting.
  - Obtain information from the alarm system.

Slide 8-143

I. Move inside.

1. Trace the system throughout the facility, starting at the service entrance.
2. Emphasis is placed on feeders and branch circuits that are tripped or open.
3. Identify all instances of arc melting.
4. Obtain information from the alarm system.

XV. PANEL BOARD DOCUMENTATION

PANEL BOARD DOCUMENTATION

Slide 8-144

PANEL BOARD DOCUMENTATION (cont'd)

- Tripped circuit breakers in a panel board that has not been impinged may provide a basis for tracing circuits.
  - Watch for potential thermal trip patterns that may be misleading.
  - Use the interview process to determine what should have been on/what was observed to be on.

Slide 8-145

A. Tripped circuit breakers in a panel board that has not been impinged may provide a basis for tracing circuits.

1. Watch for potential thermal trip patterns that may be misleading.

2. Use the interview process to determine what should have been on/what was observed to be on.

PANEL BOARD DOCUMENTATION (cont'd)

- Identify fuses or breakers.
  - Note any blown fuses or "tripped breakers."
  - Breakers can be removed to check busbars for evidence of pitting or signs of arcing.
  - **Warning:** This may damage or destroy breaker.

Slide 8-146

B. Identify fuses or breakers.

1. Note any blown fuses or "tripped breakers."

2. Breakers can be removed to check busbars for evidence of pitting or signs of arcing.

3. **Warning:** This may damage or destroy any chance of civil recovery. Consult with the insurance company; they may provide an electrical engineer.

PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-147

C. It is important to document the panel board looking for signs of electrical ability within the conductors sustained to the enclosure, the position of the breakers, and whether it was on or off. In this case, it appears that all of the breakers were in a tripped position.

1. Examine the conductors for evidence of arc damage.

2. Examine your points of connection for failure or loss of connection or bust.

PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-148

PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-149

PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-150

D. Points of connection: Note the position of all of the breakers. Is it possible that they all tripped from the environment where the panel was located?

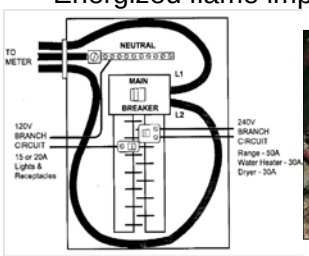
PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-151

E. Points of entry: Look for any evidence of arcing or failure at the points where the conductors enter the enclosure.

PANEL BOARD DOCUMENTATION (cont'd)

- Energized flame impingement.



Slide 8-152

F. Energized flame impingement.

PANEL BOARD DOCUMENTATION (cont'd)

- Often, the investigator will observe arc damage to the load center.
- That fact alone does not equate to cause of fire.
- In single phase installations, more often than not, that damage through the metal enclosure is attributed to fire attack.

Slide 8-153

1. Often, the investigator will observe arc damage to the load center.

2. That fact alone does not equate to cause of fire.

3. In single phase installations, more often than not, that damage through the metal enclosure is attributed to fire attack.

PANEL BOARD DOCUMENTATION (cont'd)

- As the fire attacks the panel, the metal begins to heat up, and the insulation between the metal enclosure and the supply conductors melts, allowing the conductor to arc the enclosure.

Slide 8-154

4. As the fire attacks the panel, the metal begins to heat up, and the insulation between the metal enclosure and the supply conductors melts, allowing the conductor to arc the enclosure.

PANEL BOARD DOCUMENTATION (cont'd)

- Since there is no overcurrent device, the arcing can occur in multiple locations and for long periods.
- The result is long, snaky arc burn holes in the enclosure adjacent to the conductors.

Slide 8-155

5. Since there is no overcurrent device, the arcing can occur in multiple locations and for long periods.

6. The result is long, snaky arc burn holes in the enclosure adjacent to the conductors.

PANEL BOARD DOCUMENTATION (cont'd)

- The conductors exhibit arcing and melting and are commonly mistaken for fire causation, but this is almost always the result of an external attack by fire.

Slide 8-156

7. The conductors exhibit arcing and melting and are commonly mistaken for fire causation, but this is almost always the result of an external attack by fire.

PANEL BOARD DOCUMENTATION (cont'd)

Slide 8-157

G. This is an example of snake mark.

1. Remember, the service entrance conductors coming from the meter are not fused.

2. Therefore, they may blow out, burn, or arc through the metal enclosure at numerous points because there is no breaker to trip.

PANEL BOARD DOCUMENTATION (cont'd)

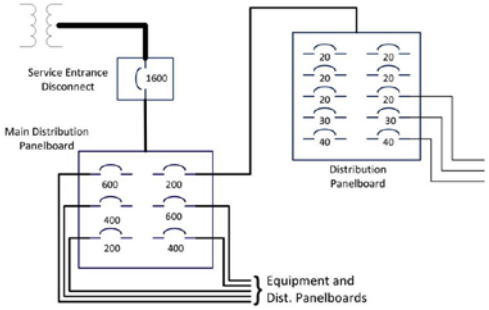
- Using the same methodology, follow the distribution system from the main distribution panel (MDP) to the individual distribution panel boards, and then decide what is important.

Slide 8-158

H. Using the same methodology, follow the distribution system from the main distribution panel (MDP) to the individual d istribution panel boards, and then decide what is important. If you cannot find anything, you will have at least documented the majority of the electrical system.

XVI. BRANCH CIRCUIT EXAMINATION

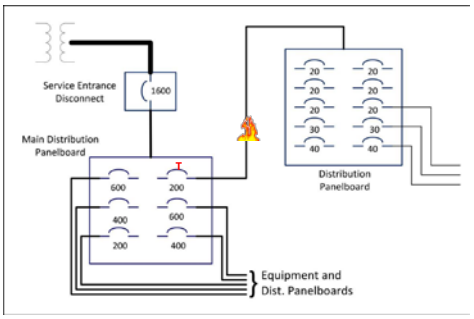
BRANCH CIRCUIT EXAMINATION



Slide 8-159

BRANCH CIRCUIT EXAMINATION (cont'd)

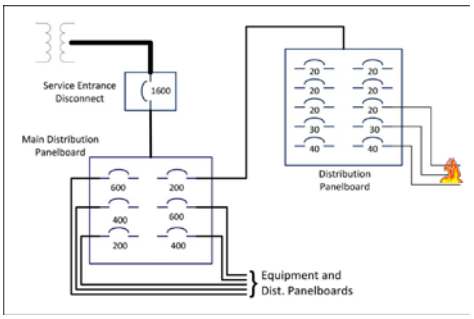
- What is the effect of this?



Slide 8-160

BRANCH CIRCUIT EXAMINATION (cont'd)

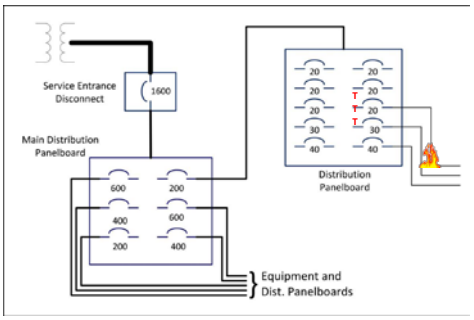
- What is the effect of this?



Slide 8-161

BRANCH CIRCUIT EXAMINATION (cont'd)

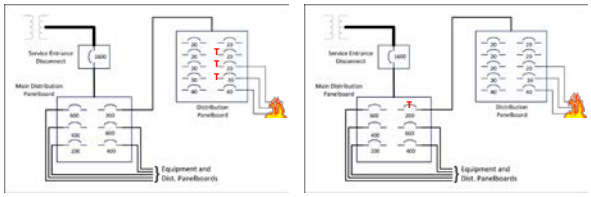
- Cascading Breakers Scenario 1.



Slide 8-162

BRANCH CIRCUIT EXAMINATION (cont'd)

- Cascading Breakers Scenario 1.



Slide 8-163

A. The current is so great that the main is seeing it before the original breakers react.

BRANCH CIRCUIT EXAMINATION (cont'd)

- When conductors are removed from conduit, they need to be visually examined for arc damage.

Slide 8-164

B. When conductors are removed from conduit, they need to be visually examined for arc damage.

BRANCH CIRCUIT EXAMINATION (cont'd)

- Smaller conductors should be felt as well as visually examined.

Slide 8-165

C. Smaller conductors should be felt as well as visually examined.

BRANCH CIRCUIT EXAMINATION (cont'd)

- Don't be greedy: Extra sets of eyes on each conductor are always a plus.
- You cannot arc map the arc that you don't find!

Slide 8-166

D. Don't be greedy: Extra sets of eyes on each conductor are always a plus.

E. You cannot arc map the arc that you don't find!

XVII. ALARM AND SURVEILLANCE SYSTEMS

ALARM AND SURVEILLANCE SYSTEMS

- Recommended approach to gathering data.

Slide 8-167

A. Recommended approach to gathering data.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)

- Intrusion alarms:
  - Thermal impingement of a key pad can result in multiple keys being simultaneously shorted.
  - This can present itself as a panic alarm or an attempt to change status.

Slide 8-168

B. Intrusion alarms.

1. Thermal impingement of a key pad can result in multiple keys being simultaneously shorted.

2. This can present itself as a panic alarm or an attempt to change status.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)

- Unless the main alarm panel is destroyed, you should call the alarm company to attempt to download any data from the panel's memory.
- In many cases, the panel will collect more data than is monitored.

Slide 8-169

3. Unless the main alarm panel is destroyed, you should call the alarm company to attempt to download any data from the panel's memory.

4. In many cases, the panel will collect more data than is monitored.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)

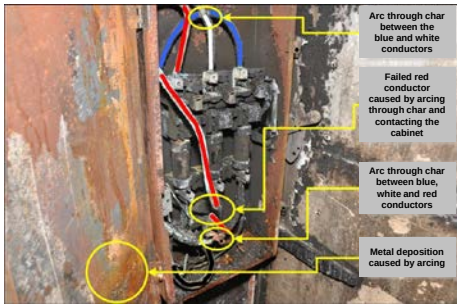
Slide 8-170

C. Any type of surveillance video that may depict a scene should be looked at for any evidence of electrical activity, such as this light going out, which would indicate that the power circuit is being interrupted by fire attack.

D. Another good benchmark in buildings are exit signs. Remember, the emergency lights activate on an exit sign once the power is lost. These are good circuits to trace throughout the building to depict fire attacking them.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)

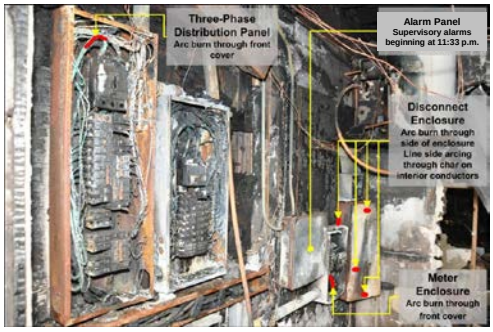
- Main disconnect.



Slide 8-171

E. Three-phase disconnect examination.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)



Slide 8-172

F. Incident Command System (ICS).

1. Identify your three-phase panel, alarm panel, arc through conductors.

2. Use this to discern fire progression, fire attack, which side it was on, where it occurred, and why.

ALARM AND SURVEILLANCE SYSTEMS (cont'd)

- The amount of heat required to cause arcing through charred and melted insulation within conduit is more consistent with direct flame impingement or direct contact with a hot gas layer.

Slide 8-173

G. The amount of heat required to cause arcing through char and melt insulation within conduit is more consistent with direct flame impingement or direct contact with a hot gas layer.

XVIII. CIRCUIT EVALUATION

CIRCUIT EVALUATION

- Branch circuit feeders are circuits that run the length of a building and may yield helpful results.

Slide 8-174

A. A circuit that runs the length of a building may yield helpful results. These are good conductors to trace initially to identify failure because they hone in on origin more quickly.

CIRCUIT EVALUATION (cont'd)

- Conductors will tend to be in contact with conduit at and near bends and near fittings.
- That can present easier access to the conduit and a good location for evidence of arc melting.

Slide 8-175

B. Conductors will tend to be in contact with conduit at and near bends and near fittings, which can facilitate easier access to the conduit and a good location to find evidence of arc melting.

CIRCUIT EVALUATION (cont'd)

- Emergency exit lights will normally always be energized.

Slide 8-176

C. Emergency exit lights will normally always be energized.

1. Emergency exit lights/signs once power is interrupted.
2. A good circuit to trace.
3. It works well if you have corresponding video.

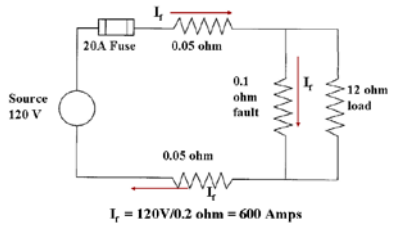
CIRCUIT EVALUATION (cont'd)

- Cherry red conductors are more about oxidation and impurities than failure.

Slide 8-177

CIRCUIT EVALUATION (cont'd)

- In a properly installed and operating electrical system, short circuits (faults) cause tripped breakers and blown fuses.



Slide 8-178

D. In a properly installed and operating electrical system, short circuits (faults) cause tripped breakers and blown fuses.

XIX. ARC MAPPING

ARC MAPPING

Slide 8-179

ORIGIN DETERMINATION

- NFPA 921, Chapter 9:
  - Determination of the origin of the fire involves the coordination of information derived from one or more of the following:
    - -- Witness information.
    - -- Fire patterns.
    - -- Arc mapping.

Slide 8-180

A. NFPA 921, Chapter 9, Section 17.1.2, 2014 ed.: Determination of the origin of the fire involves the coordination of information derived from one or more of the following:

1. Witness information: the analysis of observations reported by people who witnessed the fire or were aware of conditions present at the time of the fire.

2. Fire patterns: the analysis of effects and patterns left by the fire. (See Chapter 6.)

3. Arc mapping: the analysis of the locations where electrical arcing has caused damage and the documentation of the involved electrical circuits. (See Section 8.10.)

ORIGIN DETERMINATION (cont'd)

- Arc fault mapping:
  - Locating and mapping all faults that occurred in the electrical wiring.
  - Using arc fault mapping techniques, the area of origin can sometimes be narrowed to a very specific area that may not have been possible using conventional means.

Slide 8-181

4. Arc fault mapping.

a. Locating and mapping all faults that occurred in the electrical wiring.

b. Using arc fault mapping techniques, the area of origin can sometimes be narrowed to a very specific area that may not have been possible using conventional means.

ORIGIN DETERMINATION (cont'd)

- Fire progression through a structure can be verified using this technique.
- In some cases, the location or absence of faults can disprove that a particular area was the fire origin.

Slide 8-182

c. Fire progression through a structure can be verified using this technique.

d. In some cases, the location or absence of faults can disprove that a particular area was the fire origin.

ARC MELTING

Slide 8-183

ARC MELTING (cont'd)

Slide 8-184

B. Arc melting.

1. Note the bead on the end of the conductor.

2. Electrically damaged conductors have a very distinct line of demarcation.

3. There is often a bead or ball at the end with an association notch to another conductor.

4. Arc mapping is very labor-intensive and requires the investigator to hand-search the end of each conductor, looking for small electrical artifacts.

ARC MELTING (cont'd)

Slide 8-185

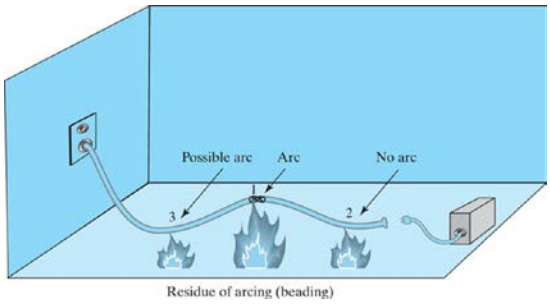
5. Many times, conductors in conduits need to be removed and hand-searched.

6. Depending on voltage and amperage, there may not be enough electrical energy to blow through the conduit.

7. Many conduits will not exhibit blowout from electrical activity due to the voltage and current of the circuit at the time of the fault.

8. Conduit will have to be preheated in a thermal environment (cherry red) before it will allow a burnout.

ARC FAULT MAPPING

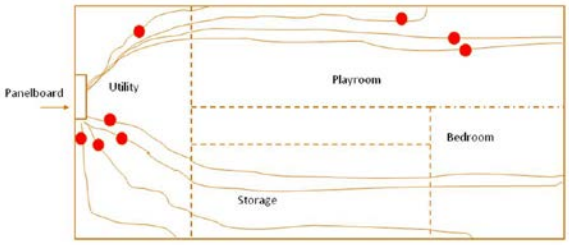


Slide 8-186

C. Arc fault mapping.

1. At the arc, downstream heading toward 2, there is no arc damage. However, it is possible to have yet another arc at 3 because it is arcing back toward the power source at that point.

ARC FAULT MAPPING (cont'd)



Slide 8-187

2. Knowing how many tripped breakers or blown fuses there are can give you an idea of how many circuits have faults — but not always.

3. Locate all faults, and tag them with tape. Then, plot the locations on a drawing of each floor.

4. In this case, the fire could not have started in the utility room. Taking into account concealment of wires, etc., the arc faults in the playroom indicate that the fire attacked the energized conductors here first.

5. Had the fire started in the utility room first, the conductors would have been de-energized there and no downstream arcing would have been found in the playroom.

ARC FAULT MAPPING (cont'd)

- Keys to success:
  - Understand the electrical service and specifics on how it was distributed throughout the facility.
  - Use the interview process to identify what circuits should have been energized or were observed to be de-energized.

Slide 8-188

6. Keys to success.

   a. Understand the electrical service and specifics on how it was distributed throughout the facility.

   b. Use the interview process to identify what circuits should have been energized or were observed to be de-energized.

ARC FAULT MAPPING (cont'd)

- Start the evaluation at the primary distribution system and follow it to the end, regardless of the fire dynamics.
- Compare all observations with the remaining investigative tools before making a final conclusion.
- Arc mapping needs to support the entire investigation.

Slide 8-189

   c. Start the evaluation at the primary distribution system and follow it to the end, regardless of the fire dynamics.

d. Compare all observations with the remaining investigative tools before making a final conclusion.

e. Arc mapping needs to support the entire investigation.

ARC FAULT MAPPING (cont'd)

- Limitations:
  - Failure to identify the key components of the distribution system.
  - Failure to identify arc damage on conductors.
  - Complete destruction of the branch circuits (can be impacted by collapse or extreme heat).

Slide 8-190

7. Limitations.

a. Failure to identify the key components of the distribution system.

b. Failure to identify arc damage on conductors.

c. Complete destruction of the branch circuits (can be impacted by collapse or extreme heat).

ARC FAULT MAPPING (cont'd)

- Inability to trace circuits back to the source (multistory building with collapse makes this very difficult).
- Melting of conductors from fire exposure.
- Post-fire re-energizing of the electrical system.

Slide 8-191

d. Inability to trace circuits back to the source (multistory building with collapse makes this very difficult).

e. Melting of conductors from fire exposure.

f. Post-fire re-energizing of the electrical system.

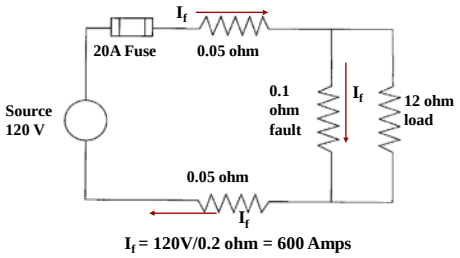
ARC FAULT MAPPING (cont'd)

Slide 8-192

XX. MYTHS AND LEGENDS OF FIRE CAUSES

MYTHS AND LEGENDS OF FIRE CAUSES

Myth: Short circuits cause fires.



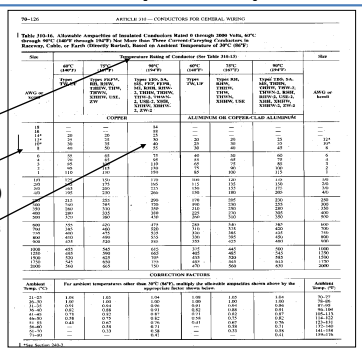
Slide 8-193

A. At 600 amps, the fuse blows (or the circuit breaker trips) instantly.

1. Even if a penny was placed in the fuse holder, the 60 amp main fuse would trip.

2. Short circuits rarely cause fires. They are short-duration events that cause overcurrent devices to operate.

MYTHS AND LEGENDS OF FIRE CAUSES (cont'd)



70–126 ARTICLE 310 — CONDUCTORS FOR GENERAL WIRING

Table 310-16. Allowable Ampacities of Insulated Conductors Rated 0 through 2000 Volts, 60°C through 90°C (140°F through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size AWG or kcmil	Temperature Rating of Conductor (See Table 310-13) 60°C (140°F) Types TW,UF	75°C (167°F) Types FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	90°C (194°F) Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	60°C (140°F) Types TW, UF	75°C (167°F) Types RH, RHW, THHW, THW, THWN, XHHW, USE	90°C (194°F) Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Size AWG or kcmil
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
17	—	—	18	—	—	—	—
14*	20	20	25	20	20	25	12*
12*	25	25	30	25	25	30	10*
10*	30	35	40	30	35	40	8
8	40	50	55	35	40	45	6
6	55	65	75	40	50	60	4
4	70	85	95	55	65	75	2
3	85	100	110	65	75	85	1
2	95	115	130	75	90	100	1/0
1	110	130	150	85	100	115	2/0
1/0	125	150	170	100	120	135	3/0
2/0	145	175	195	115	135	150	4/0
3/0	165	200	225	130	155	175	250
4/0	195	230	260	150	180	205	300
250	215	255	290	170	205	230	350
300	240	285	320	190	230	255	400
350	260	310	350	210	250	280	500
400	280	335	380	230	270	305	600
500	320	380	430	255	310	350	700
600	355	420	475	285	340	385	800
700	385	460	520	310	375	420	900
750	400	475	535	320	385	435	1000
800	410	490	555	330	395	450	1100
900	435	520	585	355	425	480	1200
1000	455	545	615	375	445	500	1300
1100	480	575	645	395	465	525	1400
1200	495	595	665	405	485	545	1500
1300	520	620	700	425	505	570	1600
1400	535	645	735	435	525	595	1700
1500	555	665	750	450	540	610	1800
1600	570	685	770	460	555	620	1900
1700	585	705	785	470	570	630	2000
1800	615	730	815	490	585	660	
1900	625	750	835	500	600	670	
2000	660	765	850	515	615	685	
	CORRECTION FACTORS						
Ambient Temp. (°C)	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. (°F)
21–25	1.08	1.05	1.04	1.08	1.05	1.04	70–77
26–30	1.00	1.00	1.00	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	—	0.58	0.71	132–140
61–65	—	0.41	0.58	—	0.41	0.58	141–149
66–70	—	—	0.41	—	—	0.41	150–158

* See Section 240-3.

Insulation temperature rating

12 American Wire Gauge (AWG) wire

Rated for 30 amps

The tables for wire sizing from the National Electrical Code (NEC) are extremely conservative.

Slide 8-194

B. A 12 American Wire Gauge (AWG) wire will not even begin to smoke until it is carrying 100 amps.

1. However, you cannot connect 100 amps to a branch circuit that is properly protected if it is wired at 12 AWG. The breaker or fuse will trip long before the wire burns.

2. Overcurrent damage to a wire occurs along the entire length from the panel board to the load. If the overcurrent protective device is incorrectly sized, or fails to operate, a fire can result from an overloaded conductor.

MYTHS AND LEGENDS OF FIRE CAUSES (cont'd)

Slide 8-195

C. This was a 16 AWG extension cord.

1. This cord had a 10-ampere rating.

2. The load that was plugged in was 25 amperes, which is 2.5 times the rating of the cord.

3. The cord was wrapped 80 percent around the plastic reel, which trapped heat.

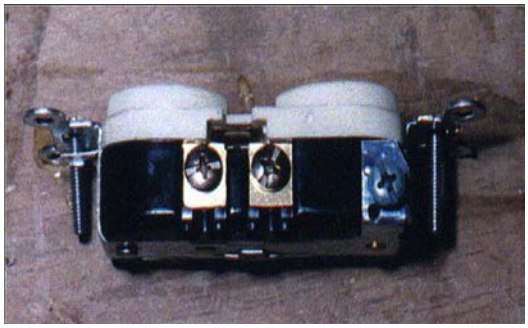
4. Even with this, only melting and light charring occurred. The cord produced heavy smoke.

   a. Had it continued undetected, the insulation between conductors would have melted.

   b. If this had occurred, an arc fault between conductors would have probably tripped the breaker.

XXI. ELECTRICAL FAULTS AND FAILURES

ELECTRICAL FAULTS AND FAILURES



Slide 8-196

A. Loose or failed connections.

1. A standard receptacle can be screw terminal or push terminal (back-stabbed) connected. Back-stabbing of connections has caused fires in the past.

2. Not because this is a bad way to connect wires.

   a. Instead, the terminals allowed the use of the 12 AWG wire.

   b. When the receptacles were pushed back into the outlet box, the heavy gauge wire placed pressure on the plastic body.

   c. Many bodies fractured, resulting in loose and failed connections.

   d. These terminals will now only accept 14 AWG or smaller wires.

e. In fact, more fires result from loose or improperly made screw terminal connections.

ELECTRICAL FAULTS AND FAILURES (cont'd)

A splice requires electrical continuity and mechanical security. (This requires the use of proper terminals or connectors.)

Slide 8-197

3. A splice requires electrical continuity and mechanical security.

   a. This requires the use of proper terminals or connectors.

   b. Wire nuts are one way to maintain electrical contact and mechanical integrity. Duct tape is **not.**

ELECTRICAL FAULTS AND FAILURES (cont'd)

Slide 8-198

4. This picture shows evidence of a loose and failed connection, a more common failure.

ELECTRICAL FIRE CAUSE

Slide 8-199

5. This picture shows evidence of a loose and failed connection at a plug-in fusible disconnect.

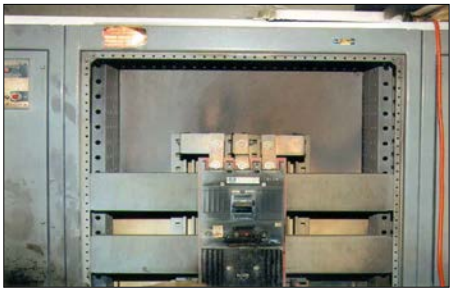
ELECTRICAL FIRE CAUSE (cont'd)

- Examination.

Slide 8-200

B. The picture on the left depicts the failure of Federal Pacific breaker that occurred at STAB-LOK, and panel box on the right shows evidence of moisture incursion.

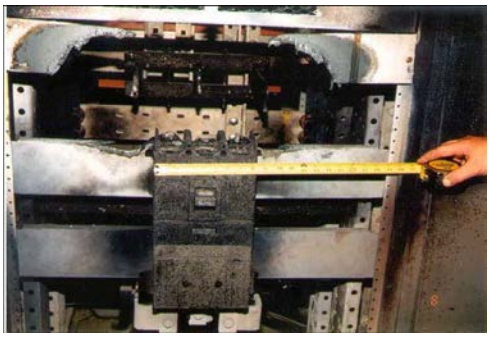
ELECTRICAL FIRE CAUSE (cont'd)



Slide 8-201

C. Many times, you have to step back and look for an exemplar of what you're looking at or need to find.

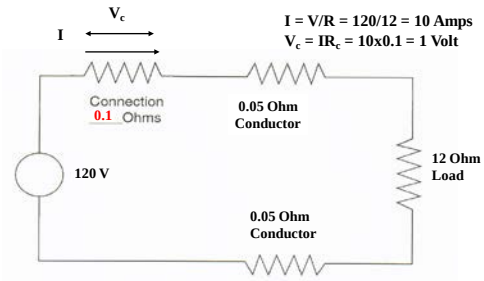
ELECTRICAL FIRE CAUSE (cont'd)



Slide 8-202

ELECTRICAL FIRE CAUSE (cont'd)

- Why loose connections cause fires:



Slide 8-203

D. Why loose connections cause fires.

1. This is a circuit showing a loose connection with only 0.1 ohms of resistance.

2. This is a very small resistance, which you would think would not cause a problem.

3. The power dissipated at the loose connection is $P_c = IV_c = 10Ax1V = 10$ W.

4. This 10 W is dissipated at the 1/4-inch of the screw head.

DYNAMICS OF A LOOSE CONNECTION

The temperature at the screw is raised by 10 W of heat being dissipated at the screw head.

- As the temperature increases, the resistance increases.
- As the resistance increases, the power being lost at the screw head increases.

Slide 8-204

E. The temperature at the screw is raised by 10 W of heat being dissipated at the screw head.

1. As the temperature increases, the resistance increases.

2. As the resistance increases, the power lost at the screw head increases.

DYNAMICS OF A LOOSE CONNECTION (cont'd)

- This happens until the temperature stabilizes when all of the heat generated on the screw can be radiated or conducted away.
- Studies have shown that the temperature can stabilize when the screw head is red hot.
- The screw head can reach temperatures over 1,000 F.

Slide 8-205

3. This happens until the temperature stabilizes when all of the heat generated on the screw can be radiated or conducted away.

4. Studies have shown that the temperature can stabilize when the screw head is red hot.

5. The screw head can reach temperatures over 1,000 F.

DYNAMICS OF A LOOSE CONNECTION (cont'd)

- The result of long-term heating breaks down the plastic receptacle body. As the plastic breaks down into carbon, a current-limited fault path can occur.
- This results in excessive heating that can ignite nearby combustible materials.

Slide 8-206

6. The result of long-term heating breaks down the plastic receptacle body. As the plastic breaks down into carbon, a current-limited fault path can occur.

7. This results in excessive heating that can ignite nearby combustible materials.

EXAMINATION OF POTENTIAL CAUSES

Slide 8-207

F. Are you an expert on these items? If not, then don't take them apart. And if you are, be prepared to defend your actions!

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Spoliation of evidence can occur whenever you overstep your responsibility and expertise at a fire scene and take or break apart evidence intentionally that you are not trained in disassembling.
  - As a fire investigator, there is no need to go any further than to document the loss at that point.

Slide 8-208

G. Spoliation of evidence can occur whenever you overstep your responsibility and expertise at a fire scene and take or break apart evidence intentionally that you are not expertly trained in handling.

1. As a fire investigator, there is no need to go any further than to document the loss at that point.

2. Breaking apart a heating, ventilation and air conditioning (HVAC) unit could make the fire investigator liable.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- What to look for:

Slide 8-209

H. What to look for:

1. Screw terminals.

   a. Melted or missing parts.

   b. Evidence of severe overheating of one screw with no similar evidence of heating to the adjacent screw.

c. Heavy damage to the receptacle body adjacent to the screw terminal.

2. Plug blades and receptacle contacts — one blade or contact melted or missing.

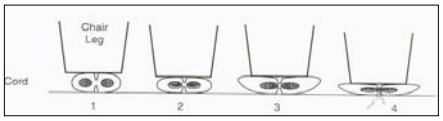
3. Splices.

a. One of two or three splices melted or missing.

b. Heavy damage to one splice without corresponding damage to adjacent splices.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- This type of damage can occur over long periods. As the weight of the chair squeezes the cord, the insulation is compressed.
- Eventually the insulation can migrate from between the conductors.



Slide 8-210

I. Pinched cord fault.

1. This type of damage can occur over long periods.

2. As the weight of the chair squeezes the insulation cord, the insulation is compressed.

3. Eventually the insulation can migrate from between the conductors.

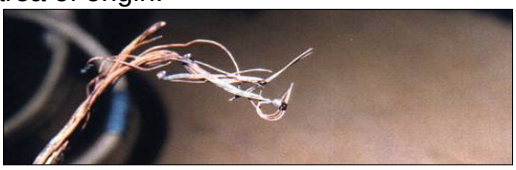
4. When this happens, one or two strands can contact each other.

5. If they blow apart during the arc, and the breaker does not trip, a current-limited carbon path can be created.

6. The result is a current-limited fault that can reach temperatures that can ignite nearby combustible materials.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Look for balls and beads on individual strands. Unfortunately, external fire attack can leave the same balls and beads, so you need a pinch point and location in the area of origin.



Slide 8-211

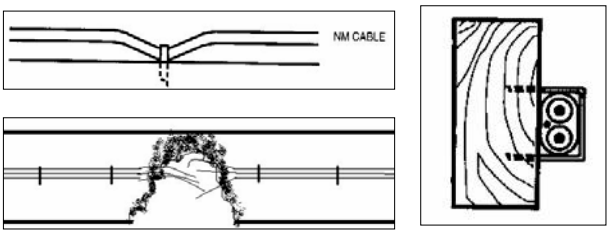
7. Look for balls and beads on individual strands. Unfortunately, external fire attack can leave the same balls and beads, so you need a pinch point and location in the area of origin.

8. Balls and beads at point of origin are supported by the mechanical impact of the chair leg. However, keep in mind that a competent, thermally thin fuel needs to be present to take that heat energy.

9. At times, cords become severed from appliances. It may be possible to confirm the cord to the appliance by counting individual strands.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Staple faults.



Slide 8-212

J. Staple faults.

1. Similar to the pinched cord fault, overdriven staples can also cause faults.

   a. This type of fault can take years to occur.

b. The tight staple crushes the insulation and eventually bridges the conductors.

2. The initial contact can vaporize part of the staple or conductor and leave a current-limited carbon fault path.

3. Temperatures can be generated that can easily ignite nearby combustible materials.

4. What to look for:

a. Tight staples at other locations.

b. Evenly spaced staples with a burn area where a staple should have been.

c. Arc-severed conductors with balls and beads on the severed ends.

d. Location of damage in area of origin.

e. Staples are used to position cable, not squeeze it.

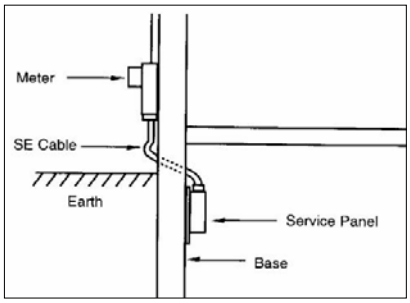
f. In properly installed staples, the cable should be able to be moved under the staple.

5. It is extremely difficult because you can experience similar damage during fire attack.

6. Common construction of staples manufactured for the past 10 years has been a plastic bridge with two finishing nails.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Service panel faults.



Slide 8-213

K. Service panel faults.

1. Moisture incursion.

   a. If water enters the service panel through the service entrance cable, it can run or wick into the service panel.

   b. The water can then bridge the connections between phases or between phase and the grounded metal enclosure.

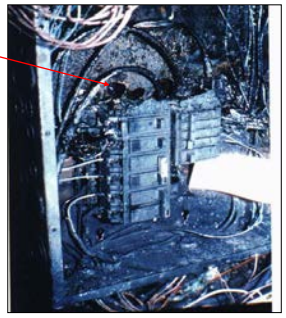
2. Lightning.

   a. Lightning damage can impose very high voltages on the electrical service.

   b. The high voltage can arc between parts with adequate separation for normal voltages.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Look at arc holes behind the main lugs — path for water to enter the enclosure.



Slide 8-214

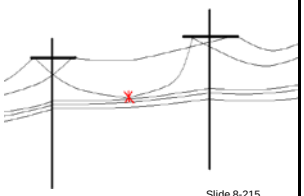
3. Look for arc holes behind the main lugs — path for water to enter the enclosure.

4. Lightning may create several holes, whereas moisture may only create one.

5. Lightning may also destroy the main breaker.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Hot cross faults.
- Occur when high-voltage lines contact low-voltage power lines.
- Can occur when a tree limb falls on the high-voltage line, a car damages a power pole, etc.



Slide 8-215

L. Hot cross faults.

1. They occur when high-voltage lines contact low-voltage lines.

   a. This can occur when a tree limb falls on the high-voltage line, a car damages a power pole, etc.

   b. Remember, most power wire on a pole is not insulated (bare).

2. What to look for:

   a. Catastrophic panel failures.

   b. Multiple appliance failures.

   c. Destroyed power strips ("fire and sparks were shooting out of the receptacles").

   d. Multiple points of origin. Multiple structures may be involved.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Power strips:
  - Power strips, surge protectors, or their official name, "relocatable power taps," have been known to cause fires.
  - Power strips can have switches and many internal connections. Each of these connections is subject to failure.
  - Power strips can also have surge protection.

Slide 8-216

M. Power strips.

1. Power strips, surge protectors, or their official name, "relocatable power taps," have been known to cause fires.

2. They can have switches and many internal connections.

3. Each of these connections is subject to failure.

4. Power strips can also have surge protection.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Older power strips just used a metal oxide varistor (MOV) between conductors.
- These MOVs are sacrificial. The MOVs conduct when voltages exceed their ratings. The excess voltage is dissipated as heat in the MOV.

Slide 8-217

5. Older power strips just used a metal oxide varistor (MOV) between conductors.

6. These MOVs are sacrificial. The MOVs conduct when voltages exceed their ratings, and the excess voltage is dissipated as heat in the MOV.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Some MOVs were found to fail as shorts.
- They then generated severe heat and burned through the plastic body of the power strip, igniting nearby combustibles.
- Newer surge protectors have a thermal fuse attached to the body of the MOV.

Slide 8-218

7. Some MOVs were found to fail as shorts.

8. They then generated severe heat and burned through the plastic body of the power strip, igniting nearby combustibles.

9. Newer surge protectors have a thermal fuse attached to the body of the MOV.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- If the MOV overheats, the thermal fuse opens, removing the MOV from the circuit and preventing a fire.

Slide 8-219

10. If the MOV overheats, the thermal fuse opens, removing the MOV from the circuit and preventing a fire.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

Slide 8-220

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- What to look for — origin at the power strip. Melted blades or receptacles.

Slide 8-221

11. Several types of power strips have been recalled. Go to www.cpsc.gov, and compare the strip to those under recall.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Neon signs:
  - Operate with voltages of up to 15,000 between outputs and 7,500 volts to ground.
  - Once installed, neon lighting may not be properly maintained.
  - Neon operates at high voltage but low current.

Slide 8-222

N. Neon signs:

1. Operate with voltages of up to 15,000 between outputs and 7,500 volts to ground.

2. Once installed, neon lighting may not be properly maintained.

3. Neon operates at high voltage but low current.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- The arcing is hot enough to ignite material, but there is not enough power to melt the copper wires.
- No arc-severed secondary conductors are usually found.

Slide 8-223

4. The arcing is hot enough to ignite material, but there is not enough power to melt the copper wires.

5. No arc-severed secondary conductors are usually found.

EXAMINATION OF POTENTIAL CAUSES (cont'd)

- Look for poorly made connections; look for connections with no insulation.
- Exposure to moisture without proper protection.
- Separated connections at area of origin.

Slide 8-224

6. Neon failures. Look for:

   a. Poorly made connections.

   b. Connections with no insulation.

c. Exposure to rain or moisture without proper protection.

d. Separated connections at area of origin.

APPLIANCE FIRES

- Ground faults.
- Origin between freezer and refrigerator compartment.

Slide 8-225

O. Refrigerator fires. Look for:

1. Ground faults.

2. Origin between freezer and refrigerator compartment.

3. Defrost heater.

   a. Origin in back of freezer.

   b. Heater tube has arc holes or burned in half.

4. Compressor.

   a. Evidence of connection failure. Origin under refrigerator in compressor compartment.

   b. It has been scientifically supported that the outside temperature of compressor will not generate sufficient ignition energy to ignite light combustibles, such as dust or lint, but you can have a connection failure under there.

5. Supply cord.

   a. Arc-severed cord, evidence of arcing on conductors.

   b. Area of origin behind refrigerator.

APPLIANCE FIRES (cont'd)

Slide 8-226

P. Stoves and ranges.

1. By far, the most common cause of fires with cooking appliances is the careless cook fire.

2. It is also the most denied cause since cooks think their insurance will not pay for their stupidity.

3. A typical gas range can raise 2 to 3 pints of oil to ignition in less than 15 minutes.

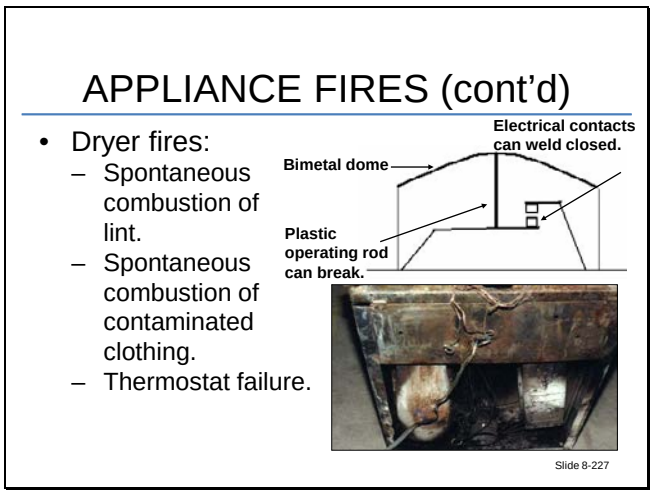
4. Two to three minutes after ignition, the flames are into the cabinets.

5. Ignition occurs at 600 to 700 F.

6. Switches.

   a. Connection failure at the high-current burner switch can incinerate the plastic switch body and produce heavy smoke damage.

   b. This rarely results in a fire spreading outside the metal enclosure.



Q. Clothes dryer fires.

1. Spontaneous combustion of lint: Natural fibers (cotton, wool) can ignite spontaneously.

2. Lint accumulates in the trap, vent tube and interior of the cabinet and is subjected to repeated heating and cooling.

3. Spontaneous combustion of contaminated clothing: Vegetable oil and animal fat contaminated clothing can spontaneously combust.

   a. Towels and aprons are often contaminated by these types of oil.

   b. Use of cold water in cleaning is less effective at removing buildup of these types of oils.

4. Thermostat failure.

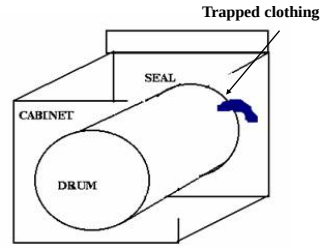
   a. This type of failure is more uncommon.

   b. Dryers employ several thermostats in their construction.

   c. For a fire to result, the control and high-limit thermostat must fail.

APPLIANCE FIRES (cont'd)

- Trapped clothing.
- Supply cord and plug.



Slide 8-228

5. Trapped clothing.

   a. Clothing can become trapped between the drum and the inside of the cabinet.

   b. Friction from the rotating drum can ignite the clothing.

6. Supply cord and plug.

   a. A pinched or damaged cord can result in a fire.

   b. Also, due to the high currents, the plug and receptacle are prone to failure due to loose or failed connections.

   c. This results in a glowing fault that can easily ignite nearby combustible material.

ELECTRONIC DEVICE FIRES

- Power supply failures.
- Switch and connection failures.
- Pinched or damaged cords and plugs.

Slide 8-229

R. Electronic device fires.

1. There are too many types of devices to cover here. However, there are a few common failure modes that result in fires.

2. Look for local damage at the switch or power supply.

3. Signs that the enclosure burned from the interior out. Location in area of origin.

4. Look at your power cords; look where the battery component was connected.

COFFEE MAKER FIRES

- Failure modes.
- Control component failure.
- Pinched or damaged cord fault.

Slide 8-230

S. Coffee maker fires.

1. Coffee maker fires are less common today than in the past.

2. Current designs employ redundant thermal overloads to prevent failure of one to result in thermal runaway.

3. Failure modes.

   a. Heater energized with no water or continuously energized.

   b. Control component failure.

4. Look for:

   a. Device clearly in area of origin.

   b. Heating elements show severe melting damage.

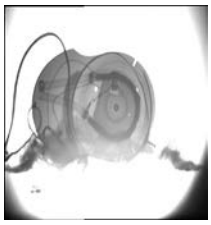
   c. Removed or tampered with thermal overloads.

d. Burning to enclosure clearly emanating from interior.

e. Destructive examination and X-ray analysis can detect signs of component failure that may not be visible.

COFEE MAKER FIRES (cont'd)

- Nondestructive X-ray examination analysis can detect signs of component failure or tampering that may not be visible.



Slide 8-231

5. Nondestructive X-ray examination analysis can detect signs of component failure or tampering that may not be visible.

PORTABLE HEATER FIRES

Switch contact failure, thermostat failure, pinched or damaged cord, intentional tampering.

Slide 8-232

T. Many fires caused by portable heaters can be traced to incorrect operation. Placing the heater too close to combustible materials can result in their ignition.

1. Some failure modes that can also result in fire causation are:

a. Switch contact failure.

b. Thermostat failure.

c. Pinched or damaged cord.

d. Intentional tampering.

2. Signs to look for:

a. Heater is clearly in area of origin.

b. Location in area too close to combustible material.

c. Damage to enclosure clearly emanating from the interior.

MICROWAVE OVEN FIRES

- Pinched or damaged cord and plug.
- Component failure.

Slide 8-233

U. Microwave oven fires.

1. Failure mechanisms.

a. Food or container left too long in cavity.

b. Many microwave ovens have cooking sensors to automatically shut off when the food is cooked.

c. If food is placed in the oven wrapped in plastic or in a container, these sensors cannot detect when the food is cooked.

d. The result is overcooking and dehydration of the food. In severe cases, the food can ignite and fire can spread outside the enclosure.

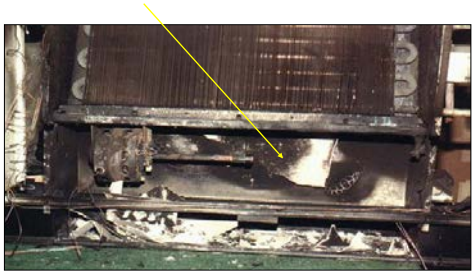
e. Accidentally or intentionally programmed to come on.

f. Pinched or damaged cord and plug. Component failure.

2. Look for origin inside of oven cavity or control compartment.

FAN FIRES

Fan blade may be the only thing that burned.



Slide 8-234

V. Fan fires.

1. The use of plastic fan blades has resulted in several fires.

2. The actual failure mechanism is a loose blade.

3. If the plastic fan blade becomes loose on the shaft, the friction from the spinning shaft can ignite the blade hub.

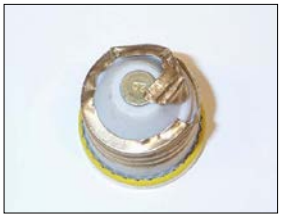
4. Look for origin in the area of the fan blade. Partial or complete consumption of the blade.

EVIDENCE OF TAMPERING

Slide 8-235

W. You are looking for evidence of tampering.

EVIDENCE OF TAMPERING (cont'd)



Slide 8-236

EVIDENCE OF TAMPERING (cont'd)

Slide 8-237

XXII. SUMMARY

SUMMARY

- NFPA 921.
- Safety.
- Basic terms.
- Electrical theory.
- Ohm's and Joule's laws.
- AC/DC theory.
- Electrical circuits.

Slide 8-238

SUMMARY (cont'd)

- AC power distribution.
- Electrical services.
- Overcurrent protection devices.
- Wiring methods and materials.
- Electrical failure.
- Sources of electrical heat energy.
- Conducting an electrical scene examination.

Slide 8-239

SUMMARY (cont'd)

- Panel board documentation.
- Branch circuit examination.
- Alarm and surveillance systems.
- Circuit evaluation.
- Arc mapping.
- Myths and legends of fire causes.
- Electrical faults and failures.

Slide 8-240

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ACTIVITY 8.1

Instructor-Led Practical Demonstration

Purpose

Observe various live demonstrations presented by the instructor. These demonstrations will reinforce principles of electricity, electrical failure and failure analysis to help investigators identify victim versus causation related to origin-and-cause investigation.

Materials

Equipment set up at burn range by Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)/ National Fire Academy (NFA) staff.

Safety Precautions

Instructor will wear required PPE during demonstrations.

ACTIVITY 8.1 NOTES

UNIT 9: HEALTH AND SAFETY

TERMINAL OBJECTIVE

The students will be able to:

9.1 Identify and evaluate hazards and safety precautions as they apply to fire investigation.

ENABLING OBJECTIVES

The students will be able to:

9.1 Define and explain essential investigative health and safety principles.

9.2 Identify and describe primary safety and health hazards.

9.3 Explain hazard and risk assessment factors during fire investigations.

9.4 Identify and describe the 10 deadly errors of fire scene investigation.

9.5 Identify the relevant National Fire Protection Association (NFPA) standards and Occupational Safety and Health Administration (OSHA) regulations as they apply to fire investigations.

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UNIT 9:
HEALTH AND SAFETY

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ENABLING OBJECTIVES

- Define and explain essential investigative health and safety principles.
- Identify and describe primary safety and health hazards.
- Explain hazard and risk assessment factors during fire investigations.

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ENABLING OBJECTIVES (cont'd)

- Identify and describe the 10 deadly errors of fire scene investigation.
- Identify the relevant National Fire Protection Association (NFPA) standards and Occupational Safety and Health Administration (OSHA) regulations as they apply to fire investigations.

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I. PRIMARY SAFETY AND HEALTH HAZARDS

PRIMARY SAFETY AND HEALTH HAZARDS

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PRIMARY SAFETY AND HEALTH HAZARDS (cont'd)

- Chemical/Biological/Toxicological.
- Damaged structural members, utilities and equipment.
- Exposed electrical wiring.
- Environmental factors.
  - Noise, weather, etc.
- Unsecured objects, falling debris, standing water.

Slide 9-5

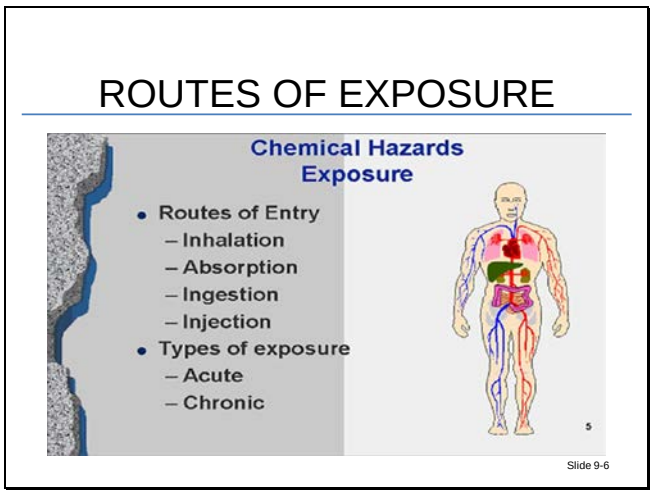
A. Chemical/Biological/Toxicological.

B. Damaged structural members, utilities and equipment.

C. Exposed electrical wiring.

D. Environmental factors (noise, weather, etc.).

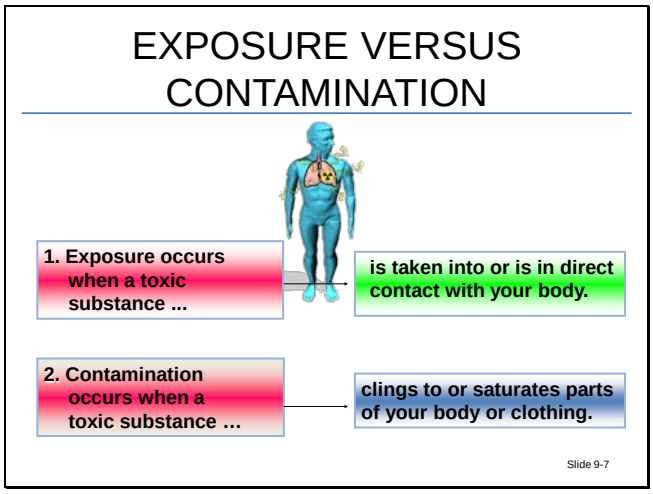
E. Unsecured objects, falling debris, standing water.



F. The primary route of exposure to hazardous substances is via inhalation. Exposures may also occur due to skin absorption. For example, benzene is a respiratory hazard and a skin absorption hazard. Therefore, all exposed skin of investigators should be covered to prevent potential exposure.

1. Exposures can also occur by ingestion when investigators eat or drink in potentially contaminated areas and do not wash their hands and face. Investigators stepping in nails that penetrate their footwear can suffer an exposure due to injection, or this can happen if they cut themselves on glass or sharp metal that penetrates the skin.

2. Acute exposures occur immediately, while chronic exposures occur over an extended period of time (generally months or years).



G. Contamination is the transfer of a hazardous material outside of a contaminated area in quantities that are greater than what is acceptable and pose a risk to those outside the area.

1. Contamination can occur by direct contact with the dusts, particles, gases, vapors, fumes, mists and runoff of hazardous material(s) or smoke and products of combustion.

2. Tools used to process the scene may become contaminated, or investigators may drive their vehicles through a contaminated area.

3. Contamination can generally be controlled by proper decontamination procedures (e.g., washing and rinsing with large quantities of soap and water).

BASIC SAFETY PRINCIPLES

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H. Exposure is the process that occurs when people, equipment or the environment come in direct contact with a hazardous material(s) via any of the routes of entry into the body (inhalation, absorption, ingestion or injection). An exposure's severity depends on the material's concentration and length of exposure.

BASIC SAFETY PRINCIPLES (cont'd)

- Always assume fire and explosion scenes to be hazardous.
- Always take the time to assess the potential hazards and risks at **all** scenes before taking action.
- Don't attempt to use personal protective equipment (PPE) unless you have been properly trained and certified by your employer.

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I. All scenes must be considered potentially hazardous until confirmed otherwise.

1. Regardless of when investigators arrive, the potential always exists for physical or toxicological hazards to be present.

2. Investigators must always assess the hazards and risks based on the available information and personal protective equipment (PPE) provided by their agency before engaging in any scene activities.

II. HAZARD AND RISK ASSESSMENT

HAZARD AND RISK ASSESSMENT

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A. This is the most important link in the health and safety chain that dictates the actions that can be safely undertaken at all fire and explosion scenes.

B. The basic goal of this process is to collect data that can be analyzed to make informed decisions with regard to the hazard(s) present, associated risk(s), control measures, PPE requirements and decontamination procedures.

HAZARD AND RISK ASSESSMENT (cont'd)

- Assess hazards and risks.
  - Hazards refer to the potential danger posed to personnel.
    - -- Physical, chemical, biological, environmental, etc.
  - Risks refer to the probability of suffering injury, illness, exposure or death from hazards.

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C. All fire scenes should be assumed to have some hazards present regardless of the extent of damage.

1. Some of these hazards may not be visible; however, they still need to be documented so that appropriate measures to manage them can be implemented.

2. Risks are incident-specific. Although the risks at a fire or explosion incident cannot be completely eliminated, they can be successfully managed, controlled, eliminated or avoided.

3. Investigators should keep in mind that fire and explosion scene conditions can change rapidly; therefore, the hazard and risk assessment process needs to be ongoing to ensure the most accurate and up-to-date information is available for attempting to identify hazards and quantify risk.

HAZARD AND RISK ASSESSMENT (cont'd)

- Once this information is obtained and evaluated, ask:
  - What is the potential threat to personnel?
  - What is the probability of exposure or harm?
  - Will engineering controls or work practices help reduce the hazard(s)?
  - What documentation/action plan should investigators have on hand?
  - Will waiting a reasonable period of time help to reduce the hazard(s)?

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D. The foundation of the hazard and risk assessment process is to collect and evaluate information to enable sound decision-making.

1. In the case of fire investigation, this means obtaining accurate information from sources on-scene such as the Incident Commander (IC), officer in charge, property owner and any other witnesses to help characterize the extent of the hazards so decisions can be made with regard to entry, PPE and decon requirements.

2. If a hazard and risk assessment has been completed by others prior to the arrival of investigators, the results should be reassessed and verified before relying on the information for decision-making.

3. Engine ventilation can help reduce the level of harmful atmospheric contaminants; however, no general time frame can be used to classify an area as "safe" requiring no respiratory protection.

4. Each scene is unique and presents unique hazards, especially in terms of toxic hazards due to the type of structure involved, building construction, location of fire, extent of damage and presence of hazardous materials.

HAZARD AND RISK ASSESSMENT (cont'd)

- Always be a risk evaluator and not a risk taker.

An accident waiting to happen?

Slide 9-13

E. Investigators should always evaluate the risks associated with any incident and refrain from taking any unnecessary risks, regardless of peer pressure or other influences. The information gathered during the hazard and risk assessment process is critical to the safe and successful investigation of all fires and explosions.

III. THE 10 DEADLY ERRORS OF FIRE AND EXPLOSION SCENE INVESTIGATION

FIRE AND EXPLOSION SCENE INVESTIGATION

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The 10 deadly errors of fire and explosion scene investigation are based on a fundamental set of safety and survival principles and tactics that will help to reduce the potential for injury, illness, exposure and death at fire and explosion scenes.

FIRE AND EXPLOSION SCENE INVESTIGATION (cont'd)

The 10 deadly errors of scene investigation:

1. Poor attitude.
2. Working when suffering from fatigue or illness.
3. Failure to note and heed danger signs.
4. Failure to perform a comprehensive hazard and risk assessment.

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A. Poor attitude: Nothing is as important to the safety of any operation as the attitude of the investigator. Regardless of the amount of money spent on equipment or training by an organization, it is always up to the individual to follow established policies and procedures to remain safe.

B. Working when suffering from fatigue or illness: Investigators should not place themselves at an increased risk of injury or exposure by working when they do not feel well or are sick.

C. Failure to note and heed danger signs: Investigators must avoid becoming complacent with respect to their surroundings. They must always maintain a heightened sense of situational awareness to avoid potential safety and health hazards.

D. Failure to perform a comprehensive hazard and risk assessment: A hazard and risk assessment must be performed at all scenes. Investigators should integrate this process into their initial action plan at all scenes. This can be easily accomplished while performing basic investigative steps on the exterior of the scene as part of the data collection process by asking basic questions concerning the building (e.g., structural integrity, storage of hazardous materials, status of utilities, physical hazards).

FIRE AND EXPLOSION SCENE INVESTIGATION (cont'd)

5. Lack of proper training and equipment.
6. Poor care and use of equipment.
7. Failure to follow standard operating procedures (SOPs).
8. Lack of Incident Management System (IMS).
9. Relaxing too soon.
10. "It can't happen to me" attitude.

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E. Lack of proper training and equipment: All personnel should be properly trained and certified on all safety-related equipment issued to them by their agency. Agencies also need to ensure that they issue their employees the necessary and required safety equipment to allow them to safely execute their duties and responsibilities.

F. Poor care and use of equipment: Investigators need to properly use, maintain, inspect and clean all their equipment to ensure that it will provide an adequate level of protection when needed.

G. Failure to follow standard operating procedures (SOPs): All personnel must follow established SOPs and ensure that they are thoroughly familiar with their SOPs to ensure the highest possible level of safety.

H. Lack of Incident Management System (IMS): All incidents, regardless of size or complexity, must be managed within the framework of the IMS. Lack of an IMS often results in freelancing, which increases the risk of injury.

I. Relaxing too soon: The only time an investigator should feel any level of relaxation is when he or she is safely back in the office or at home.

J. Tombstone courage: Many experienced investigators have the attitude that "it can't happen to me," and therefore, they do not believe that fire scenes present any risk to them or others.

IV. SUMMARY

SUMMARY

- Primary safety and health hazards.
- Hazard and risk assessment.
- The 10 deadly errors of fire and explosion scene investigation.

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SUMMARY (cont'd)

These required readings will reinforce the materials and are covered in the exam:

- Essential health and safety principles.
- SOPs and regulations.
- Information sources.

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APPENDIX

HEALTH AND SAFETY

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CONTENTS

The Appendix contains the following reading materials:

1. Essential health and safety principles.
2. Federal health and safety regulations for investigators.
3. Common incident scene health hazards.
4. Medical surveillance plans.
5. Standard operating procedures and regulations.
6. Respiratory protection information.
7. Health monitoring case studies.
8. Links to additional resources.

I. ESSENTIAL HEALTH AND SAFETY PRINCIPLES

The fundamental basis for any health and safety program is attitude and behavior of both managers/supervisors and employees.

A. Some negative attitudes and behaviors that may affect health and safety are:

1. Procrastination — waiting to make a decision or implement new policies or procedures can place employees at risk.

2. Overconfidence — no matter how much experience and knowledge someone has, the potential for injury or exposure always exists. Being overconfident can create an environment that may lead to not paying attention to basic safety measures that otherwise would not be taken for granted.

3. Inexperience — individuals who have no idea about proper safety and health procedures should **not** be working at fire scenes unsupervised. Many of these individuals wind up in emergency rooms or cause others to be injured due to their unfamiliarity with safety and operating procedures.

4. Acquiescence — accepting or “going along” with something without objection even though it may be the wrong (and unsafe) thing to do.

5. Complicity — knowingly engaging in unsafe behavior due to peer pressure in many cases.

6. Denial — refusing to admit the truth or the fact that there may be a problem or situation that requires action to prevent needless injury.

7. Complacency — “letting your guard down,” which is the number one threat to personnel at any fire or explosion scene; being unaware of potential trouble.

II. FEDERAL HEALTH AND SAFETY REGULATIONS FOR INVESTIGATORS

Fire investigators are individuals responsible for responding to fire explosion incidents to determine origin, cause, and responsibility. Because of the potential dangers at incident scenes, investigators must be aware of the national standards and regulations that affect their work.

The National Fire Protection Association (NFPA) is a non-profit organization whose members develop voluntary consensus standards for fire protection and safety. These standards are voluntary in that they are not legally enforceable unless legislatively adopted by a jurisdiction. However, as nationally recognized documents, they do establilsh a recognized "standard of care" that may be referenced in court.

1. NFPA 921 – "Guide for Fire and Explosion Investigations"

    a. Addresses key health and safety guidelines to help prevent investigator injury, exposure and death at fire and explosion scenes.

    b. Hazard and risk assessment, site safety plans and procedures, decontamination, personnel protective equipment, and the need for respiratory protection are some of the important subjects outlined in the document.

2. NFPA 1033 – "Standard for Professional Qualifications for Fire Investigator"

    a. Describes the need for all investigators to conduct a site safety assessment at all scenes as part of the job performance requirements.

3. NFPA 1500 – "Standard on Fire Department Occupational Safety"

    a. Appendix B contains a checklist that can be used to audit an agency's Risk Management Program or to develop one if needed that complies with applicable OSHA requirements.

The Federal government, through the Department of Labor Occupational Safety and Health Administration (OSHA), promulgates regulations that affect workplace safety.

It is important to note that OSHA regulations do not apply in all states, so you should be aware of your own state's requirements. In those states where OSHA does not have authority:

1. OSHA approves and monitors state plans and provides up to 50 percent of an approved plan's operating costs.

2. States must set job safety and health standards that are "at least as effective as" comparable federal standards. (Most states adopt standards identical to federal ones.)

3. States have the option to promulgate standards covering hazards not addressed by federal standards.

4. A state must conduct inspections to enforce its standards, cover public (state and local government) employees, and operate occupational safety and health training and education programs.

5. In addition, most states provide free on-site consultation to help employers identify and correct workplace hazards.

NOTE: The Connecticut, Illinois, New Jersey, New York, and Virgin Islands plans cover public sector (state and local government) employment only.

Federal OSHA requirements include:

Electrical Safety Work Practices (29 CFR* 1910.331-335)

Apply to situations where investigators may be evaluating and documenting the electrical system in residential or commercial occupancies. For example, basic safety measures such as using proper test equipment to verify that electrical circuits and/or equipment has been de-energized are outlined.

Personal Protective Equipment (PPE) (29 CFR 1910.132-138)

Outlines the various PPE requirements for personnel working in potentially hazardous environments including head, eye, foot, and respiratory protection.

Control of Hazardous Energy Sources (29 CFR 1910.147)

Provides guidance for locking out/tagging out sources of hazardous energy such as machines and equipment in which the unexpected energization or start up of the machines or equipment, or release of stored energy, could harm employees. This includes electrical, pneumatic, and hydraulic hazards.

Bloodborne Pathogens (29 CFR 1910.1030)

Defines personal protective measures for all occupational exposure to blood or other potentially infectious materials that personnel may encounter (e.g., fire death or bomb victim).

Hazardous Waste Operations and Emergency Response (29 CFR 1910.120)

Specifies minimum training requirements and protective measures for personnel working at a scenes where hazardous materials or hazardous wastes may be present.

* CFR refers to the Code of Federal Regulations, the codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal government.

Respiratory Protection Program (29 CFR 1910.134)

Provides requirements for measures to prevent occupational exposure/diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. (Respiratory protection will be discussed in greater detail below.)

Additional information can be found at http://www.osha.gov/dcsp/osp/

III. COMMON INCIDENT SCENE HEALTH HAZARDS

There are countless health hazards to which you might be exposed at an incident scene. Many of the common building materials and products used today in buildings and vehicles are manufactured from synthetic materials (e.g., plastics).

When these materials burn, a wide range of potentially harmful substances are generated. Some of these byproducts are carcinogenic (cancer causing). Exposures to these substances can be presented by burning eyes, nose, throat, runny nose, dizziness, fatigue, and nausea. Table A-9 provides a summary of a few materials and their byproducts of combustion.

Table A-9
Common Materials and Their Combustion Byproducts

MATERIALS	BYPRODUCTS
Plastics – waste baskets, trash bags, houseware, televisions, plumbing, electrical wiring and fixtures, automobile parts.	Vinyl chloride, benzene, acrylonitrile and carbon monoxide.
Polyvinyl chlorides in piping, electrical insulation, furniture, dyes and wall coverings.	Hydrogen chloride, phosgene, chlorine and carbon monoxide.
Nylon, wool, silk, polyurethane used in furniture and clothing.	Hydrogen cyanide, phosgene, acrylonitrile, arsenic, chromium, vinyl chloride and carbon monoxide.
Petroleum-based products such as telephones, carpeting, paints, upholstery, pillows, blankets, shoes, clocks, shower curtains, linoleum and bedding.	Benzene and polycyclic aromatic hydrocarbons, formic acid, acrolein sulfur dioxide and carbon monoxide.
Creosote used as a wood preservative and pitch for roofing.	Benzopyrene and polycyclic aromatic hydrocarbons.
Polychlorinated biphenyls (PCB) in electrical equipment.	Dioxin.
Wood, cotton, paper products.	Acrolein, formic acid, benzopyrene and carbon monoxide.

These substances may remain in the atmosphere for a considerable amount of time, therefore good ventilation practices must be employed and proper respiratory protection should be maintained at all times. The synergistic effects from fires involving these materials may contain complex mixtures of approximately 40 to 50 known or suspected carcinogenic compounds.

Investigators must remember that many of the atmospheric hazards and contaminants are prevalent after fire suppression and during and after overhaul. Therefore, appropriate respiratory protective measures must be taken to avoid inhalation exposures. These hazards may persist for hours and days depending on the nature of the scene conditions.

ADDITIONAL HEALTH HAZARDS

Asbestos

Asbestos is a naturally occurring mineral that, prior to a 1980 Environmental Protection Agency (EPA) ban for new construction, was widely used in residential and commercial buildings.

Materials such as soundproofing, floor and ceiling tiles and pipe insulation were manufactured from or with asbestos and can be a source of exposure unless proper protective measures are taken (e.g., monitoring, personal protective ensemble and proper abatement procedures).

Investigators should always be aware of the potential for asbestos exposure and contamination.

Once buildings are damaged by fires or explosions, asbestos contamination becomes a significant concern for the fire service and investigators.

Asbestos fibers must be airborne to cause a health risk through inhalation, so the first step is not to disturb the material, which would release more fibers into the air. If you remove or disturb the insulation, it is probable that you may inhale some asbestos fibers.

The degree of health risk depends on how much and how often this occurred. Mesothelioma is a rare form of cancer that usually develops from exposure to asbestos. People who develop mesothelioma have worked in jobs where they inhaled asbestos or were exposed to asbestos dust and fibers. This can be a potential problem for investigators who may be chronically exposed to asbestos when conducting fire scene examinations during their careers.

Vermiculite

Vermiculite is another naturally occurring mineral composed of shiny flakes, resembling mica.

Vermiculite insulation is a pebble-like, pour-in product and is usually gray-brown or silver-gold in color.

When heated to a high temperature, flakes of vermiculite expand as much as 8-30 times their original size. The expanded vermiculite is a light-weight, fire-resistant, and odorless material and has been used in numerous products, including insulation for attics and walls.

A mine near Libby, Montana, was the source of over 70 percent of all vermiculite sold in the United States from 1919 to 1990. There was also a deposit of asbestos at that mine, so the vermiculite from Libby was contaminated with asbestos. Vermiculite from Libby was used in the majority of vermiculite insulation in the United States and was often sold under the brand name Zonolite®.

Additional information can be found at http://www.epa.gov/asbestos/vermiculite.html

Clandestine Drug Labs

Clandestine drug labs are examples of hazards that may be encountered at any fire scene requiring investigators to take appropriate preventive measures to avoid potential injury or exposure.

Clandestine drug laboratories have been discovered in houses, apartments, hotel rooms, trailers, vans, storage units, buried cargo containers, and a variety of other structures. They are often found in rural or remote areas, where greater privacy is afforded to the drug producer.

Health risks in clandestine labs include exposure to poisonous and flammable and reactive chemicals such as anhydrous ammonia and phosphine.

Corrosives include hydrochloric acid, hydriodic acid (hydrogen iodide), sulfuric acid, and sodium hydroxide. Solvents include ethyl and diethyl ether, acetone, toluene, xylene, benzene, chloroform, denatured alcohol, Freon®, hexane, isopropanol, methanol, petroleum ether, and, more recently, Coleman® fuel.

Adverse health effects have been reported for law enforcement personnel involved in the investigation of laboratories and subsequent inhabitants of the buildings when adequate clean-up was not performed.

A recent development with recreational marijuana use is the potential for fires and explosions when making hash oil (a.k.a. Honey oil, Butane Hash Oil [BHO]). The process involves soaking cannabis leaves in butane.

Investigators should treat these scenes and hazardous waste sites and take the appropriate precautions to avoid exposure or serious physical injury. All activities should be closely coordinated with hazardous materials response teams and law enforcement personnel.

Other Locations

Many locations such as Home Depot, Lowe's, and Walmart contain a wide variety of chemicals, including paints, pesticides, fertilizer, pool chemicals and solvents that can contaminate large areas as well as produce contaminated runoff from suppression water.

IV. MEDICAL SURVEILLANCE PROGRAMS

The primary purpose of the medical surveillance program is the early identification of conditions, if any, that could present an increased risk of adverse health effects related to the task being performed or could lead to an occupational disease.

The secondary objective is to ensure compliance with federal and state regulations that require medical monitoring when employees are engaged in certain activities (e.g., hazardous materials response or working at hazardous waste sites).

Fire investigators may work at scenes that contain a variety of potentially harmful substances that may pose adverse health effects unless proper precautions are taken, including participating in a medical surveillance program.

Annual physical examinations to document baseline medical data and for the early identification of potential health issues are invaluable for the long term health and well-being of personnel. It also proves invaluable in those situations where investigators suffer an exposure and go to a physician for a follow-up medical examination.

Additional research is needed to establish a link between fire scene exposures and bladder cancer, which is one of the types of cancers with increased incidence rates in the fire service.

Some agencies, including the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), have implemented screening of fire investigators using a NMP-22 test for early identification of bladder cancer.

The ATF hazardous exposure protection program was implemented in 2002, making medical surveillance, personal protection and respiratory protection mandatory for all personnel who respond to fire and explosion scenes.

V. STANDARD OPERATING PROCEDURES AND GUIDELINES

Fire departments, police department and investigative agencies should adopt their own standard operating procedures and guidelines to limit the likelihood of inadvertent contamination and exposure caused by contact with the contaminants present at fire scenes.

Investigators need to bear in mind that many locations contain large quantities of hazardous materials that may pose increased risk in the event of a fire or explosion.

Pre-planning information and information from on-scene personnel familiar with the facility and materials stored or used should be consulted to help identify specific hazards so that proper precautions can be taken.

Basic washing of hands, face, and adherence to strict decontamination procedures can go a long way to avoid problems such as cross contaminating vehicles, workplaces, and investigators' homes.

Don't pull your gloves off with your teeth – investigators that inadvertently pull their gloves off with their teeth may subject themselves to an exposure via ingestion of contaminants present on their gloves.

Don't eat or drink anything at the "scene" – drinking or eating while working at the scene where the potential for contamination and exposure is high should be avoided. Proper washing of the hands and face needs to occur away from the scene to reduce the likelihood of exposure.

Don't leave the scene without going through decontamination – all clothing, tools, and equipment should be decontaminated prior to leaving the scene.

Don't wear your dirty scene gear in the office – no contaminated gear or equipment should be worn away from the scene.

Don't wash your dirty clothing at home – dirty or contaminated clothing should be professionally laundered.

Additional recommendations included not to use personal washing machines; however, if used, contaminated clothing should not be laundered with non-contaminated clothing.

Boots and equipment should be decontaminated at the scene using soap and water (preferably dishwashing liquid with high grease-cutting performance. This type of solution was shown in previous testing by ATF to be extremely effective in removing hydrocarbon-based residue from tools and equipment used by investigators at fire scenes.

Use disposable uniforms when supplied. If disposable uniforms are not supplied, a professional laundry service should be used. Coveralls or BDU (Battle Dress Unit)-type clothing should be thoroughly decontaminated prior to leaving the scene. Investigators should not take uniforms home for laundering.

Protective Clothing/Personal Protective Ensembles (PPE)

Organizations should ensure that all personnel are properly trained, equipped, and certified on all PPE issued to them and are expected to wear as part of their duties and responsibilities. An investigator's first and last means of defense against many of the hazards present at fire scenes.

Fire investigators wear a variety of protective clothing and respiratory protection based on what is issued to them by their agency and required to be worn while performing their duties. Many investigators fail to wear any type of PPE and therefore place themselves at an increased risk of injury and exposure.

Investigators should wear a complete personal protective clothing ensemble consisting of a helmet/hard hat, eye protection, gloves, steel toe/steel shank shoes or boots, and the appropriate level of respiratory protection, which, at a minimum, should be an air-purifying respirator for all activities associated with fire origin and cause determination, including documentation of the scene.

Investigators need to ensure that they wear appropriate respiratory protection at all scenes regardless of arrival time to conduct their fire scene examination.

Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) fire investigators now wear a protective ensemble consisting of Tyvek® disposable outer garments, helmets, gloves, and half-face air purifying respirators while working at a structure fire scene in accordance with agency policy.

Chemical protective clothing comes in a wide variety and ranges in cost from approximately $40 to $1,000 depending on the specific ensemble, materials of construction, and available options.

Transportation

Remove uniforms before entering personal or official vehicles.

Don't ride around in your car with dirty turnout gear — no contaminated gear or equipment should be worn in any personal or government-issued vehicles to avoid the potential for contamination and repeated, prolonged exposure to potentially toxic substances while driving.

Contaminated gear and equipment should not be stored in the passenger compartment of a vehicle due to the potential for "off-gassing." If not properly decontaminated, they can produce potentially harmful vapors that investigators repeatedly breathe while driving to and from the scene, to the office or home on a daily basis.

Investigators should not store contaminated gear and equipment in the passenger compartment unless it is properly isolated. Lockable plastic containers lined with plastic are a low cost alternative that can be adapted for use in any vehicle.

The size of the container is limited by the size of the vehicle compartments and can assist in temporary storage of gear and equipment until it can be transported to a location where decontamination and/or disposal can take place.

Many agencies have opted for pick-up truck type vehicles or vans for personnel that allow investigators to store their gear and equipment outside of the passenger compartment to avoid potential exposures caused by “off-gassing.”

It is important to remember that each scene presents its own set of unique hazards, and therefore a hazard and risk assessment should be conducted to confirm the proper level of PPE before making the assumption that this equipment will provide an adequate level of protection in all situations.

VI. RESPIRATORY PROTECTION PROGRAM

Fire service personnel typically wear self-contained breathing apparatus (SCBA) and structural firefighter protective clothing for both suppression and overhaul activities. Fire investigators should evaluate the level of respiratory protection based on the assessed risk.

A respiratory protection program is one of the most important components of an organization’s occupational health and safety program. Whether the wearing of respiratory protection is mandatory or is implemented voluntarily, the same requirements of OSHA’s Respiratory Protection Standard (29 CFR 1910.134) apply.

OSHA’s Respiratory Protection Standard (29 CFR 1910.134) requires these eight components for agencies to be in compliance with the regulation:

1. The first and most important step is to conduct a hazard and risk assessment of the workplace to identify the primary or most common hazards.

2. Once this information is obtained, the selection of the most effective means of respiratory protection can be made.

3. Each individual must undergo a medical evaluation to determine if they can safely wear a negative pressure device (such as a half-face or full-face air purifying respirator). If the individual has a medical condition such as asthma or emphysema, they would be required to wear a positive-pressure device such as SCBA.

4. Each person issued a respiratory protective device must be fit tested at least annually or when new equipment is purchased and issued.

5. The program must be in writing.

6. Each person participating in the program must receive training.

7. Records must be maintained by the employer (e.g., training and fit tests).

8. The program must be kept up-to-date and reflect current equipment, policies, and procedures.

The fit test ensures that the selected make, model and size adequately accommodates an individual's facial characteristics, and that this provides assurance that the wearer can don the device properly and can achieve the anticipated protection during use.

Fit Testing

The fit of a device can be determined by qualitative or quantitative methods.

Qualitative methods (QLFT) rely on the wearer's subjective response to a test agent, usually irritant smoke, banana oil, or other sweet or bitter tasting substance.

Quantitative methods (QNFT) provide an objective measure of the fit, generating a number referred to as a fit factor.

A fit factor is the ratio of the concentration of a substance outside the device to the concentration inside the device.

These fit test procedures are outlined in 29 CFR 1910.134 Appendix A.

Additional information can be found at
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=standards

Respiratory Protection Equipment

There are several types of respiratory protection devices available to be worn by investigators.

Investigators should consult with fire service personnel prior to making purchases. It might be good practice to purchase similar/compatible equipment being used by department personnel to make training, fit testing, maintenance, and purchase of supplies easier and more cost-effective. Figure A-9 illustrates eight common types of respiratory protective equipment.

Figure A-9
Sample Respiratory Protection Equipment

Figure A-9.1
Air-Purifying Respirator (Dust Mask)
Applied Protection Factor (APF): 10

Figure A-9.2
Half-Face Air-Purifying Respirator
Applied Protection Factor (APF): 10

Figure A-9.3
Full-Face Air-Purifying Respirator
Applied Protection Factor (APF): 50

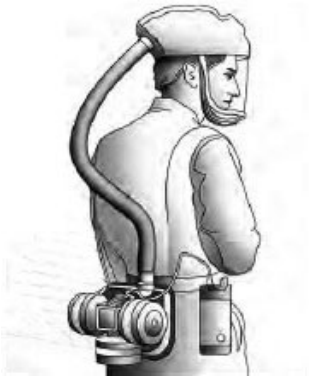

Figure A-9.4
Powered Air-Purifying Respirator
Applied Protection Factor (APF): 25

Figure A-9.5
Powered Air-Purifying Respirator
Applied Protection Factor (APF): 25

Figure A-9.6
Supplied Air Respirator
Applied Protection Factor (APF): 1,000

Figure A-9
Sample Respiratory Protection Equipment (cont'd)

Figure A-9.7
Auxiliary Escape Respirator
Applied Protection Factor (APF): 1,000

Figure A-9.8
Self-contained Breathing Apparatus
Applied Protection Factor (APF): 10,000
Source: http://www.remm.nlm.gov/respiratory_ppe.htm

Each respiratory protection device has its own inherent level of effectiveness and limitations. For example, negative-pressure devices such as half-face, full-face, and powered air purifying respirators cannot be worn in Immediately Dangerous to Life and Health (IDLH) environments.

Note: Only positive-pressure SCBA can be worn in IDLH environments per OSHA regulations.

Agencies should conduct research to identify the most practical and effective solution that will provide an adequate level of protection against the most common toxicological hazards encountered at fire scenes. It should be noted that in some situations, this may mean donning SCBA (if properly trained and fit tested).

Dust Masks

Dust masks (sometimes referred to as particulate respirators) are a cheaper, lighter, and possibly more comfortable alternative to respirators, but may not provide as much protection, and may be more susceptible to misuse or poor fit.

Although dust masks are a low cost alternative for respiratory protection, they are not designed to protect against the chemical hazards present at most fire scenes.

Dust masks with a N95 rating means that they are 95% efficient against non-oil based aerosol particulates.

These masks are typically used in hospital settings for infection control and by welders to protect against fumes and other airborne particulates.

Dust masks have an Assigned Protection Factor (APF)* of 10 and must be fit tested.

Half-Face Air-Purifying Respirator

Half-face air purifying respirators are the device of choice of most fire investigators.

In many instances, these devices (equipped with the proper cartridge) may provide protection against many atmospheric fire scene contaminants.

Half-face air purifying respirators do not provide eye protection, which may be a route of exposure if not protected.

These devices must be fit tested prior to use and cannot be worn in IDLH environments.

These devices have an Assigned Protection Factor (APF) of 10.

Full-Face Air-Purifying Respirator

Full-face air purifying respirators are also used by many fire investigators. Figure A-9.3 illustrates a full-face air purifying respirator.

Not only may these devices provide protection against many atmospheric fire scene contaminants, they also provide eye protection.

These devices must be fit tested prior to use and cannot be worn in IDLH environments.

With certain units and manufacturers, these face pieces can support both APR use as well as supplied air/SCBA use.

These devices have an Assigned Protection Factor (APF) of 50.

Powered Air-Purifying Respirator

Powered air purifying respirators (PAPR) are used by some fire investigators. (See Figure A-9.) These devices provide eye protection for the wearer.

As an air purifying respirator, a PAPR relies on filters and cartridges just like the more familiar negative pressure air purifying respirators. What makes the PAPR different from other negative pressure respirators is the inclusion of a motor blower, which pulls the air through the filter and blows it into the wearer's breathing zone.

Because the motor blower pulls the air through the filter, breathing resistance virtually is eliminated. This can help reduce the wearer's overall physiological stress and depending

* Assigned Protection Factor (APF) means the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program as specified by this section.

on the air temperature, the mechanical movement of air over the wearer's head and face may provide a feeling of cooling in hot or strenuous work environments.

These devices must be fit tested prior to use and cannot be worn in IDLH environments.

These devices have an Assigned Protection Factor (APF) of 1,000.

Filtering Cartridges

The cartridge used with any air purifying respirator is the most important component since that is what provides protection against airborne contaminants. Investigators should contact the manufacturer of the specific respiratory protection device being used and review specification sheets for the cartridge being recommended or considered to ensure that it will adequately protect against the most common fire scene hazards.

Most agencies are currently using some variation of a P100 multi-purpose organic vapor cartridge. P100 means 99.97% filter efficiency for protection particulates, including those that contain oil-based aerosols.

When properly fitted, these cartridges protect against organic vapors, sulfur dioxide, chlorine, hydrogen chloride, chlorine dioxide, hydrogen sulfide (escape only), hydrogen fluoride, ammonia, methylamine, formaldehyde, pesticides, paints, dusts, mists, fumes and asbestos.

According to a 2009 University of Arizona study, 12 laboratory tests of four CBRN (chemical, biologicial, radiological and nuclear) canisters showed CBRN canisters are more effective at filtering irritant gases (acrolein, acetaldehyde, formaldehyde, glutaraldehyde and respirable dust) than non-CBRN cannisters. They contain approximately twice the amount of sorbent material (activated charcoal) as non-CBRN cannisters and no chemicals or particulates penetrated canisters – except carbon monoxide.

Self-Contained Breathing Apparatus (SCBA)

There is little argument that SCBA provides the highest level of protection for fire suppression, overhaul, and investigative operations. However, there is little research to support when SCBA should specifically be used or not used by fire investigators.

There are certain situations based on scene conditions that will dictate SCBA use in lieu of other respratory protection devices.

Investigators using SCBA need to consider issues such as operating time, physiological stress, and use of the buddy system (per OSHA requirements) when wearing these devices.

These devices must be fit tested prior to use and can be worn in IDLH environments.

These devices have an Assigned Protection Factor (APF) of 10,000.

VII. HEALTH MONITORING CASE STUDIES

Phoenix Post-Fire Atmospheric Testing (1998)

In 1998, a report was published based on a comprehensive air monitoring study conducted by the National Institute of Occupational Safety and Health (NIOSH) and the Phoenix, Arizona Fire Department to characterize firefighter exposures during the overhaul phase of 25 structure fires.

Personal samples were collected for aldehydes, benzene, toluene, ethyl benzene, xylene, hydrochloric acid, polynuclear aromatic hydrocarbons (PNA), respirable dust and hydrogen cyanide (HCN).

Gas analyzers were employed to continuously monitor carbon monoxide (CO), HCN, nitrogen dioxide, and sulfur dioxide. Area samples were collected for asbestos, metals, and total dust. During overhaul, the following exceeded published ceiling values: acrolein, CO, formaldehyde (at 22 of the 25 fires); and glutaraldehyde. In addition, other substances exceeded acceptable short term exposure limits.

The results indicate that firefighters should use respiratory protection during overhaul. In addition, these findings suggest that carbon monoxide should not be used as an indicator gas for other contaminants found in this atmosphere.

Additional information can be obtained at
http://www.cfitrainer.net/images/pdf/PhoenixStudy.pdf

NIOSH-ATF Respiratory Study (1996)

The National Institute of Occupational Safety and Health (NIOSH) and the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) have partnered to conduct several health hazard evaluations concerning fire investigator health and safety issues.

These studies were conducted in conjunction with ATF's Certified Fire Investigator (CFI) Training Program.

The investigators studied five fire scenes (two actual and three staged) in the Washington, DC area. The focus of the research was to characterize exposures that fire investigators may encounter at typical fire scenes. Sampling indicates that the potential for exposure existed, including the potential for exposure to carcinogens.

This indicates that both acute and chronic exposures to fire investigators are of concern.

A copy of the complete report can be downloaded at
http://www.cdc.gov/niosh/hhe/reports/pdfs/1996-0171-2692.pdf

NIOSH/ATF — Health Hazard Evaluation involving CCA Wood Exposure (2001)

This study focused on the exposure potential to investigators from chromated copper arsenate (CCA) treated lumber.

Tests conducted in Kinston, NC revealed that trace amounts of arsenic were observed as one of the combustion by-products.

NIOSH/ATF — Health Hazard Evaluation of Decontamination of PPE (2005)

The study monitored results of 25 fire scenes in Austin, Texas.

Uniforms worn during fire investigations were analyzed to see if they contained chemical contaminants and if laundering removed the chemicals.

Results determined that many of the chemicals were removed during the laundry process. However, some chemicals remained after washing and drying. The washer and dryer had no chemicals remaining after laundering soiled uniforms.

Additional information can be found at
http://www.cdc.gov/niosh/hhe/reports/pdfs/2004-0368-3030.pdf

VIII. ADDITIONAL RESOURCES

1. www.firescenesafety.com — a portal dedicated to occupational health and safety information for fire and explosion investigators. Has web links to approximately 100 health and safety-related web sites, document downloads and articles related to fire investigator health and safety issues.

2. www.ul.com/fireservice — Underwriter's Laboratories' web site dedicated to fire service operations, including firefighter safety, research and technology.

3. www.lrc.fema.gov/efop.html — The Learning Resource Center (LRC) at the U.S. Fire Administration maintains an on-line searchable database of research papers published by graduates of the Executive Fire Officer (EFO) Program. Several of these papers address fire investigator health and safety issues.

4. www.firesmoke.org — a web site maintained by the Fire Smoke Coalition (FSC). The mission of FSC is to focus the required attention and resources on the deadly consequences of breathing fire smoke by teaching first responders how to prevent, protect, detect, diagnose, and appropriately treat the exposure if it occurs. FSC is comprised of firefighters and the medical community.

5. www.CFItrainer.net — CFI Trainer is a distance learning platform hosted by the International Association of Arson Investigators (IAAI) that provides free on-line training to fire investigators and others. One of the available training modules is Fire Investigator Scene Safety.

6. www.osha.gov — Federal OSHA's web site provides access to information and resources for all OSHA standards including compliance guides for most significant regulations such as the Respiratory Protection Standard.

UNIT 10: BUILDING CONSTRUCTION AND FIRE PROTECTION SYSTEMS

TERMINAL OBJECTIVE

The students will be able to:

10.1 Recognize various types of building construction and fire protection systems and explain their relevance to fire investigation.

ENABLING OBJECTIVES

The students will be able to:

10.1 Identify common building construction types.

10.2 Describe the investigative considerations associated with each type of building construction.

10.3 Identify building compartmentation features.

10.4 Describe common methods used to defeat a fire protection system's functionality.

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UNIT 10: BUILDING CONSTRUCTION AND FIRE PROTECTION SYSTEMS

Slide 10-1

ENABLING OBJECTIVES

- Identify common building construction types.
- Describe the investigative considerations associated with each type of building construction.
- Identify building compartmentation features.
- Describe common methods used to defeat a fire protection system's functionality.

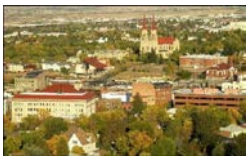
Slide 10-2

I. BUILDING CODE CONSTRUCTION TYPES

BUILDING CODE CONSTRUCTION TYPES

Establish requirements for:

- Use and occupancy.
- Fire resistance.
- Construction materials.
- Structural loads.
- Fire protection systems.



Slide 10-3

A. Building construction generally is regulated by a local building code.

B. Building code addresses requirements for:

1. Use and occupancy.

2. Fire resistance.

   In the building code context, "protected" means the structural elements have been provided some fire-resistive covering.

3. Construction materials.

4. Structural loads.

5. Fire protection systems.

BUILDING CODE CONSTRUCTION TYPES (cont'd)

- International Building Code (IBC).
- National Fire Protection Association (NFPA).
  - Referenced in NFPA 921, *Guide for Fire and Explosion Investigations*.

Slide 10-4

C. Building codes categorize construction types based on their structural elements (materials such as steel, concrete or wood) and fire resistance.

D. There are five types of construction categories recognized in the model building codes.

ARCHITECTURAL FEATURES AND FIRE SPREAD

- Understanding building construction and design features will help in explaining fire growth and spread.
- Fire development, spread and control often depend on:
  - Construction type.
  - Openings (doors, windows and penetrations).
  - Fire protection systems.
  - Structural elements' ability to remain intact.

Slide 10-5

E. Understanding building construction features will help in determining fire growth and spread.

1. 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.

2. Fire development, spread and control are affected by:

   a. Type of construction (fire resistive, noncombustible or combustible).

   b. Openings (windows, doors, penetrations through fire barriers).

   c. Fire protection systems (sprinklers, fire detection and alarm, standpipes and specialty systems).

   d. Structural ability to survive effects of heat and flame.

FIRE RESISTIVE

- IBC Type IA or IB.
- NFPA.
  - I (422) or I (332).
  - Numbers are fire resistance in hours.
    - -- Four-hour rated exterior bearing walls.
    - -- Two-hour rated interior bearing walls.
    - -- Two-hour rated column protection.

Slide 10-6

3. Fire resistive (IBC: Type IA or IB) (NFPA I (422) or I (332)).

a. Noncombustible structural members, walls, floors and roof are typically made of concrete and steel.

b. Members protected from fire effects with:

- Spray-on fibers.
- Concrete encasement.
- Thickness of spray-on fiber or concrete determines fire-resistance rating.
- Gypsum wallboard wrapping.
  - -- One or more layers are added to increase fire-resistance rating.
  - -- Fire-resistance rating increase with more layers.

c. Roof most likely will be concrete.

d. Investigative considerations.

- Primary fuel load is building contents, structural materials add no fuel.
- Damage to protected structural members will weaken structural integrity of exposed to heat.

- Penetrations in floor/ceiling assemblies for building services should be tightly sealed.

- Spaces and/or voids between floors (exterior wall systems and ceiling assemblies) may allow heat and smoke to spread.

NONCOMBUSTIBLE CONSTRUCTION (TYPE II)

- IBC Type IIA or IIB.
- NFPA.
  - II (111) or II (000).

Slide 10-8

4. Noncombustible (IBC Type IIA or IIB) (NFPA II (111) or II (000)).

   a. Structural components of noncombustible steel or concrete.

   b. May be exposed steel or protected by spray-on, concrete or gypsum wallboard.

      - Steel framework may be bolted, riveted or welded together.

      - Steel members are susceptible to expansion, distortion or relaxation from heat resulting in early failure of sagging or collapse.

   c. Roof deck or covering may be combustible: Weather-proofing membrane may consist of asphalt, felt paper, rubberized products or foam insulation.

NONCOMBUSTIBLE CONSTRUCTION (TYPE II) (cont'd)

Slide 10-9

NONCOMBUSTIBLE CONSTRUCTION (TYPE II) (cont'd)

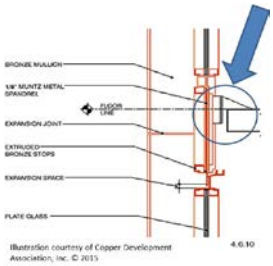
Slide 10-10

d. Investigative considerations.

- Primary fuel load is the contents.
- Penetrations in floor/ceiling assemblies for building services.
- Spaces and/or voids between floors (exterior wall systems (curtain walls)) and ceiling assemblies).
- IBC IIB/NFPA II (000) will have unprotected structural members; subject to early failure.
- Steel will begin to lose strength around 1,100 F (357 C).

CURTAIN WALL

Type I or II construction.



Slide 10-11

e. Curtain wall: nonstructural attachment on exterior. Typically glazing or cosmetic treatment.

f. Generally only on Type I or II buildings.

g. Fire can spread between the curtain wall and edge of floor slab if not fire-stopped.

ORDINARY CONSTRUCTION (TYPE III)

- IBC IIIA or IIIB.
- NFPA.
  - III (211) or III (200).

Slide 10-12

5. Ordinary: IBC Type IIIA or IIIB (NFPA III (211) or III (200)).

   a. Noncombustible exterior walls.

      - Typically load-bearing concrete, concrete masonry units (concrete masonry units (CMUs) or “cinder blocks”) or brick.

- May or may not be reinforced depending upon age and location. Unreinforced masonry (URM) is susceptible to early catastrophic collapse.

- Interior structural members unprotected or have limited protection from fire effects.

- Some states and localities (especially in high seismic zones) require retrofit with reinforcing materials.

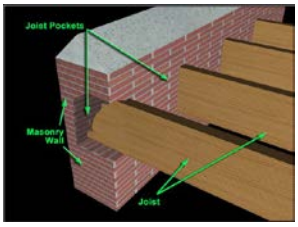
b. May have many void spaces for fire spread.

c. Sagging floors of older buildings reinforced with steel rods.

- Tie rods may strengthen floors, but wall failure is feasible.

d. Floor beams, typically “gravity” fit, may fail quickly when floors sag.

FIRE-CUT JOIST



Slide 10-13

e. Fire-cut joist.

- Floors, roofs, interior partitions made of any material, but typically wood.

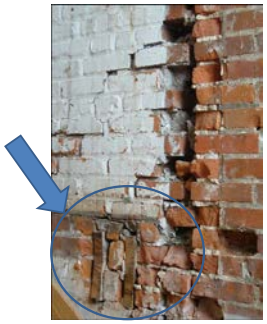
- Investigative considerations.

  -- Interior structural members are fuel.

  -- Combustible concealed spaces between floors, ceilings and partition walls (may be balloon frame interior or may be fire stops).

-- Safety — floor, wall and roof integrity before and after fire.

FIRE-CUT OR EMBEDDED JOIST



Slide 10-14

HEAVY TIMBER CONSTRUCTION (TYPE IV)

- IBC IVHT.
- NFPA IV (2HH).
- Also known as "mill" construction.
- Fire resistance obtained by material mass.

Slide 10-15

6. Heavy timber: IBC Type IVHT (NFPA IV (2HH)).

   a. Type IV is sometimes referred to as "mill construction."

      - Term derived from textile mill construction prevalent in New England and Eastern Seaboard.

   b. Noncombustible exterior walls. Often exposed concrete or brick.

      - Exterior combustible walls with fire retardant treated (FRT) lumber are permitted if they have a two-hour fire-resistive rating.

c. Structural members are unprotected wood with large cross sectional areas (minimum 6 inches).

- Floors 3 inches nominal in thickness covered with 1-inch nominal dimension tongue-and-groove flooring or similar.

d. Fire resistance is based on material thickness (mass) and the long burn times required to destroy the lumber's structural integrity.

HEAVY TIMBER CONSTRUCTION (TYPE IV) (cont'd)

Slide 10-16

e. Investigative considerations.

- Interior structural members are fuel.

- Floor, wall and roof integrity before and after. (Greatest strength is dimension of wood, but that can fail catastrophically.)

WOOD FRAME CONSTRUCTION (TYPE V)

- IBC VA or VB.
- NFPA V.
  - (111) or (000).

Slide 10-17

7. Wood frame: IBC Type VA or VB (NFPA V (111) or NFPA V (000)).

a. Combustible walls and structural framing.

b. Structural members of any type material.

c. Typically wood although steel framing may be used.

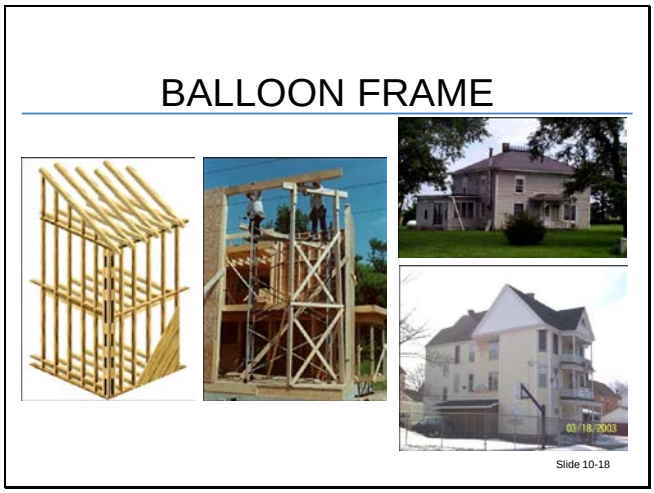
d. Floors and roofs are typically wood.

e. Members unprotected or limited protection from fire effects.

f. Includes balloon frame and platform construction.

g. Investigative considerations.

- Extensive combustible concealed voids and channels.
- Nonfire-stopped spaces in framing members — especially balloon frame construction.
- Heavy fuel load (entire structure can be combustible).
- Safety: Structural integrity must be assessed.
- Possible lightweight construction.



F. Balloon frame.

1. Usually built prior to 1940.

2. Studs run from foundation wall to roofline. Creates a cavity or “flue” for fire gases.

3. Floors are attached with a ribbon board attached to the room side of the studs.

4. If fire is in attic of a balloon frame building, check the basement for fire's origin.

5. Be conscious of drop down within the walls, which may give the appearance of multiple origin areas. Follow the wall stud openings as well as the joist systems. Once fire breaches the wall cavity, it can drop down to the floor below and burn back up.

VIEW LOOKING DOWN INTO WALL "STUD CAVITY"

Slide 10-19

6. Stud cavity provides a means for fire, heat and smoke to be carried throughout a structure.

PLATFORM FRAME

Slide 10-20

G. Platform frame (also known as "Western platform").

1. Required by current codes. Industry practice since late 1940s.

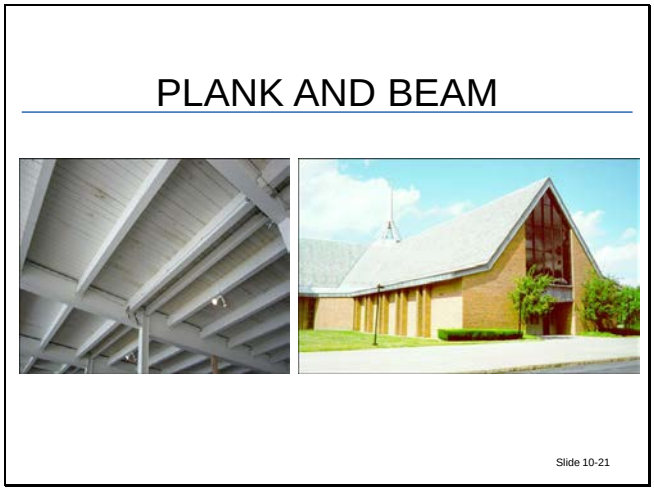
2. Separate floors or platforms are built upon one another.

3. Joists are placed on foundation wall.

4. Subfloor laid on joists.

5. Walls are constructed on subfloor (bottom two-by-four or two-by-six known as the “sill plate”).

6. Ceiling joists constructed on top of walls. Top plate of the framing acts as a fire block to prevent fire from spreading to upper levels.



H. Plank and beam.

1. Large members replace several small dimensional lumber.

2. Roof and floor decking is thick wood.

3. Beams supported by posts.

4. Skeleton of large timbers or steel columns/beams.

5. Most planks are tongue and groove.

POST AND BEAM

Slide 10-22

I. Post and beam.

1. Most barnlike structures and some open floor plans.
2. Like plank and beam, it uses large structural members.
3. Frame is attached to the exterior.
4. Outside wall coverings has no load-carrying responsibility.
5. Roof construction can use purlins and boards, or thick planks.

LIGHTWEIGHT CONSTRUCTION

Slide 10-23

J. Lightweight construction.

Generic term for one of the most widely used types of building construction; however, it poses the greatest building construction (collapse) hazards.

1. Commonly found in new homes, apartments, commercial buildings, and warehouses.

2. Uses lightweight assemblies of small components.

K. Engineered wood products.

1. Modern lightweight construction uses materials and components that are engineered in factories and transported to the construction site.

2. Trusses are commonly assembled with several components and connected by “nailer plates” or “gusset plates.”

   Plates usually penetrate wood only about three-eighths if an inch.

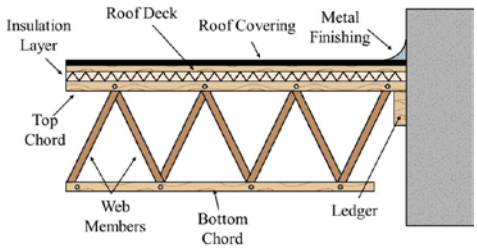
METAL CONNECTORS

Slide 10-24

3. Punched metal connectors are typically made of galvanized lightweight metal with lower melting temperatures, causing failure much sooner during the event.

LIGHTWEIGHT TRUSS CONSTRUCTION

Lightweight metal and wood trusses will fail after five to 10 minutes of fire exposure.



Slide 10-25

L. Lightweight truss construction.

1. Less mass means quicker failure rates.

2. This is important through all phases of the event.

3. Whether entering a structure as a firefighter or entering after the event, all safety measures should be taken.

4. Interviews serve two purposes: safety and fire cause. Check with fire suppression.

JOIST HANGERS

Slide 10-26

M. Joist hangers.

1. Used to connect floor joists to cross beams.

2. Lightweight metal and nailed attachments.

FINGER JOINT CONNECTIONS

No plates or nails — thermoset glue.

Slide 10-27

N. Glued finger joints.

1. Joints are interlaced between truss elements and glued in place using a thermoset adhesive (Phenol — Resorcinol Formaldehyde).

2. Thermosets strengthen when heated but cannot be reshaped.

   Laboratory fire tests show glue outlasts the wooden components. Glues have a char rate that is equal to or better than that of the wood they are bonding. Generally, these adhesives do not ignite at the bond line but do pyrolyze (Source: National Engineered Lightweight Construction Fire Research Project, Technical Report: Literature Search & Technical Analysis, National Fire Protection Research Foundation, October 1992, p. 201).

DANGERS OF ENGINEERED WOOD I-BEAM FLOORS

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

Slide 10-28

O. Structural components made 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 in nearly 50 percent of today's residential construction. Rising cost of lumber makes the wood I-beam affordable.

2. Ease of installation reduces labor cost.

3. Investigative considerations.

   a. High surface-to-mass ratio allows faster heating.

   b. Susceptible to rapid fire spread.

   c. Most lack fire retardant treatments.

d. If unprotected, fail after five to 10 minutes of exposure to fire.

e. Improper installation (upside down, field cut (length), field cut (depth)) or other modifications weaken structural integrity.

f. Can fail from exposure to heat alone.

II. FIRE, SMOKE AND HEAT TRAVEL

A. Fire, smoke and heat travel are determined by:

1. Building construction.
2. Building layout.
3. Fuel load.
4. Built-in fire protection.
5. Air-handling systems.
6. Vent openings.
7. Fire department ventilation efforts.

COMPARTMENTATION

Slide 10-30

8. Compartmentation.

a. Compartmentation is a design concept that employs passive fire-resistive elements (fire barriers, fire walls, fire doors, dampers, etc.) intended to confine an incipient fire to as small a space as possible.

COMPARTMENTATION (cont'd)

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

Slide 10-31

b. Depending upon code requirements, buildings may be constructed so they are divided into smaller spaces or compartments to limit fire and smoke spread. The compartments are created by fire walls, fire barriers, fire-resistive ceilings and floors, and fire doors.

c. Compartment barriers may have fire-resistance ratings of one through four hours, depending upon what uses and occupancies they separate.

9. The fire resistance is a function of the combined materials that are employed in the construction: e.g., wood, steel, gypsum wallboard, spray-on fire-resistance materials, concrete.

   Often, one or more layers of gypsum wallboard, spray-on fire-resistance materials, or concrete are applied to the framing to achieve fire resistance. In practice, more layers mean greater fire resistance.

10. Partitions tend to contain fire and prevent fire spread. Fire-resistive and fire wall construction are only useful if constructed properly and for the rated time as required by the building code.

    a. Openings (doors, windows, air handling ducts) and penetrations (holes for plumbing, electrical, telecoms, etc.) create passages for fire gases.

       - Penetrations of the assemblies are only allowed if properly protected.

    b. Openings between compartments may be allowed if they are protected by proper fire-rated doors and windows.

       - Fire-resistance ratings of “opening protectives” (fire doors, shutters, dampers, windows, etc.) can be identified on labels.

       - New codes require labeling walls with fire rating.

COMBUSTIBLE FURNISHINGS AND FINISHES

- Can comprise a significant fuel load.
- Major factor in fire growth, development and spread.
- Contribute to smoke production and survivability.

Slide 10-32

B. Combustible furnishings and finishes can comprise a significant fuel load.

   1. They are a major factor in fire growth, development and spread.

2. They contribute to smoke production and survivability.

COMBUSTIBLE FURNISHINGS AND FINISHES (cont'd)

- Be careful since this may also leave characteristics of multiple fires.

Slide 10-33

3. One must be careful since combustible furnishings and finishes may also leave characteristics of multiple fires.

4. Investigators need to consider the following:

   a. Combustible finishes have historically been the cause of high numbers of lives lost.

   b. Different finishes have different heat release rates (HRRs) and flame spread.

   c. Geometry of the compartment and flame spread can alter the finish.

LARGE, OPEN SPACES

Slide 10-34

C. Large, open spaces are common in warehouses, churches, large atriums, common attics, and theaters.

1. These open spaces contribute to fire spread throughout the building.

2. Vertical openings and fuel packages are a key factor in onset of flashover.

D. Open plans create large open areas that can result in rapid fire spread.

1. It can sustain tremendous damage as seen in the lower picture.

2. Contents can represent a substantial fuel load.

E. Fire loading is the measurement of the maximum heat that would be produced if all combustibles in the fire area were consumed.

1. Fire loading is common in commercial and storage facilities.

2. It may override sprinkler capabilities and provide access problems for firefighters.

3. Proper inspection and code enforcement is the best defense.

COMPROMISED FIRE BARRIERS

Holes in fire-rated barriers.

- Electrical, plumbing, heating, ventilating, and air conditioning (HVAC).
- Open fire doors.

Slide 10-37

F. Fire barriers are effective at confining fire gases only if their integrity is maintained.

1. Proper inspection and code enforcement is the best defense.

2. Barriers must be repaired to the equivalent level of fire resistance.

PENETRATIONS

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G. Floor, ceiling and wall penetrations provide a means for fire, heat and smoke to travel throughout a structure.

1. Investigators need to keep this in mind when evaluating fire spread relative to their origin determination.

2. Local building codes may require fire-stopping to address this issue.

WOOD SHAKE SHINGLES

Roof **Siding**

Wood shake shingles, even when treated with fire retardant, significantly contribute to fire spread.

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H. Construction materials should be considered and the effects of fire spread as well as it pertains to fire suppression efforts.

III. STRUCTURAL LOADS

STRUCTURAL LOADS

- Knowledge of **loads** can explain fire and collapse behavior.
  - Investigator's safety.
- Dead load.
- Live load.
- Impact load.

Slide 10-40

A. Aside from the danger of an investigator being subject to catastrophic structural collapse, the investigator may have to explain how different loads affected the fire outcome.

B. Loads are the weight of materials that are part of a building and/or its contents.

1. Examples include structural components, roof coverings, mechanical equipment, etc.

2. Three common types of loads may be imposed on a building.

LOADS

- Dead load: combined weight of construction materials.
  - Walls, floors, roofs.
  - Ceilings, stairways.
  - Built-in partitions.
  - Permanent equipment.

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a. Dead loads are the weight of the construction material (e.g., walls, floors, roofs, ceilings, stairways, built-in partitions).

LOADS (cont'd)

- Live load: combined weight produced by the use and occupancy of the building.
  - Movable objects, such as equipment, furniture and people.
  - Snow, rain.

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b. Live loads are the weight of temporary loads that need to be designed into the weight-carrying capacity of the structure (e.g., furniture, equipment, machinery, snow, rainwater).

LOADS (cont'd)

- Impact load: load resulting from kinetic forces and loads.
  - Combined with influence of dead and live loads.

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c. Impact loads are the load resulting from forces and kinetic loads, pressure and possible surcharge from fixed or moving loads.

IV. INVESTIGATION RESOURCES

INVESTIGATION RESOURCES

For building construction information:

- Building and permitting department.
- Fire marshal's office.
- Public works department.
- Electrical utility.
- Insurance carrier.
- Project architect.

Slide 10-44

A. Investigators may need additional help evaluating building or fire protection system performance.

B. Investigators cannot be expected to be experts in all elements of building construction and fire protection systems.

C. There are many resources that can provide support.

1. Public resources.

a. Building and permitting department.

- Plans and inspection records.
- Building code training and explanations.

b. Fire marshal's office.

- Plans and inspection records.
- Fire protection system test records.
- Hazardous materials permitting and inspection records.
- Fire event histories in the property. (Is the current event under investigation the first, or one of many?)

c. Public works department.

- Water supply and utility records.
- Utility termination records, unpaid bills.

2. Private resources.

a. Electrical utility.

- Power consumption records, unpaid bills, shut-off notices.

b. Insurance carrier.

- Fire protection engineers.
- Risk/Loss control inspectors.

c. Project architect.

- Plans and material specifications.

V. SUMMARY

SUMMARY

- Building code construction types.
- Building materials and fire spread.
- Compartmentation features.
- Structural loads.
- Investigation resources for building construction and fire protection systems.

Slide 10-45

SUMMARY (cont'd)

The required reading will reinforce the materials, and information from the reading is included in the exam:

- Fire protection systems.

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APPENDIX

BUILDING CONSTRUCTION AND FIRE PROTECTION SYSTEMS

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CONTENTS

The Appendix contains the following reading materials:

1. Building code construction type comparison
2. Fire protection systems summary

Table A-10
Building Code Construction Type Comparison

CONSTRUCTION TYPE										
IBC*		IA	IB	IIA	IIB	IIIA	IIIB	IVHT††	VA	VB
NFPA** 921/ NFPA 220/ NFPA 5000	I (422)†	I (332)	II (222)	II (111)	II (000)	III (211)	III (200)	IV (2HH)	V (111)	V (000)

**International Building Code*
*** National Fire Protection Association*
† The numbers in parentheses indicate the required fire resistance (in hours) of the exterior bearing walls, interior bearing walls and structural columns, respectively. Thus, under the NFPA system, a Type I (332) structure would have three-hour rated exterior bearing walls, three-hour rated interior bearing walls, and two-hour rated structural column protection.
†† HT and H = Heavy Timber: finished lumber having minimum thicknesses as required by the building code.

FIRE PROTECTION SYSTEMS SUMMARY

Fire protection systems include automatic sprinkler systems, automatic and manual detection and alarm systems, single- and multiple-station smoke detectors, standpipe systems and fire extinguishing systems such as those used in commercial cooking operations. Special fire suppression systems may be designed and engineered where unique fire hazards exist, such as spray booths, aircraft hangers, computer rooms, or hazardous chemical storage. These systems may use foam, chemical agents, or inert gases to control or suppress fires.

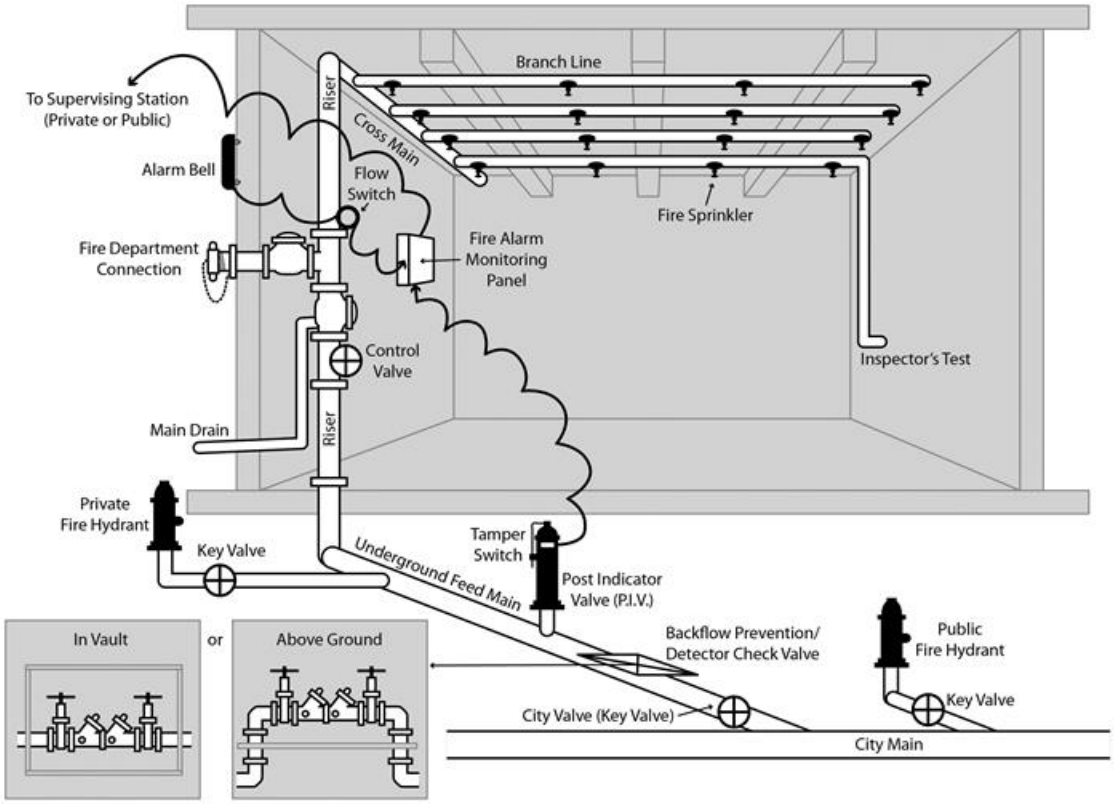
The information contained in this section is very elementary and is presented to familiarize the fire investigator with these types of systems. In order to conduct a thorough analysis of a fire that occurs in a building containing one or more of these types of systems – especially if the systems' performance is questioned – the investigator must use individuals who have in-depth fire protection system knowledge. Independent fire protection contractors, fire protection engineers, fire inspectors or product manufacturers may be able and willing to provide detailed explanations. Additional information on the operating principles of automatic sprinkler or fire alarm systems can be found in books published by the National Fire Protection Association (NFPA) *Automatic Sprinkler and Standpipe Systems* (Bryan, John L.) and *Fire Alarm Signaling Systems* (Bukowski, Richard W. and O'Laughlin, Robert J.).

Automatic Sprinkler Systems

An **automatic sprinkler system** is a network of pipes and valves suspended throughout a building and ready to deliver water through regularly spaced nozzles (sprinklers) shortly after a fire starts.

The sprinkler system should be connected to an adequate water supply that delivers water through an **underground main**. The **system riser** is the vertical pipe that connects the underground main to **feed** and **cross mains**. These mains are connected to the **branch lines** on which the sprinklers are located. Figure 10-1 provides a schematic representation of a simple automatic fire sprinkler system.

Figure 10-1
Typical Automatic Fire Sprinkler System Layout



Water is released from the sprinklers automatically when a sprinkler's operating element is heated to or above its temperature rating. Operating elements may be **fusible links**, **frangible glass bulbs** or **rods**, or **chemical pellets**. The style of operating element is selected by the manufacturer to match the sprinkler's engineered design. When the operating element responds to heat, the sprinkler opens and water under pressure is expelled. The water hits the sprinkler **deflector** and discharges in an umbrella-shaped pattern over the fire. Each sprinkler operates individually. (In **deluge** systems for high hazard properties, all sprinklers operate simultaneously, but this is a rare arrangement.)

Automatic sprinkler systems are the most commonly installed fire suppression systems. The main purposes of sprinkler systems are to:

- Detect fire by the operation of one or more sprinklers,
- Confine and control the fire until the fire department arrives,
- Report the fire via a fire alarm reporting system, and,
- Potentially extinguish the fire by adequate water application.

These activities result in increased life safety and property protection. Sprinkler systems installed in residential properties are designed specifically to prevent flashover in the room where the fire starts, thereby enhancing life safety.

Automatic fire sprinkler systems must be installed in accordance with national recognized standards. Refer to NFPA Standard No. 13 *Installation of Automatic Sprinkler Systems* for detailed installation guidance. Additional standards exist for residential and special hazard sprinkler systems.

System Types

Of the two basic types of automatic sprinkler systems, **wet pipe sprinkler systems** are the most common. They generally are used unless there is a danger of freezing or where special conditions require one of the other system types to be installed. NFPA 13 requires the spaces where wet pipe sprinkler are installed to be heated not less than 40 F (4.4 C). Wet pipe systems use closed automatic sprinklers attached to piping containing water under pressure at all times. When individually fused sprinklers operate, the water immediately discharges and continues to flow until the system is shut off or the water supply dries up. Figure 10-1 represents a wet pipe system.

Dry pipe sprinkler systems are used in unheated areas where having water in the piping would be susceptible to freezing. Instead of water, the piping contains pressurized air. The air holds back the water behind a **dry pipe valve** that must be located in a heated area. Dry pipe systems employ the same basic components as a wet pipe sprinkler system, but may have a connected air compressor or compressed air tank to maintain the air supply on the system. When a sprinkler operates, the drop in air pressure causes the dry pipe valve to open, letting water flow into the pipes. The water then is discharged through the individually fused sprinklers like a wet pipe system. The water will continue to flow until the system is shut off or the water supply is lost.

A dry pipe system usually is slightly slower to apply water than a wet pipe system because it takes more time to purge the air and deliver the water to the sprinklers. This decreases system efficiency and makes dry systems less desirable when immediate water application is important.

Deluge, **pre-action** and **anti-freeze systems** are special types of sprinkler systems similar to dry pipe systems.

Basic System Components

Automatic sprinkler systems should be connected to a ready and reliable **water supply**. This may be an elevated, at-grade or underground tank, a reservoir, lake or pond, or a private or municipal water system. The quality (pressure and volume) and reliability of the water supply often is a controversial matter in a post-incident investigation, especially if the sprinkler system does not perform as expected.

The water supply is connected to the system inside the building through an underground water main. Indoors, the system consists of a network of **pipe** or **tube**. "Pipe" describes ferrous-based materials, and "tube" is used to identify copper or plastic materials. NFPA 13 prescribes where different materials may be employed.

All sprinkler systems are outfitted with a **riser**, the section of pipe or tube that carries water vertically in the building. Most of the sprinkler system's main control features (valves, drains, gauges, etc.) are connected to the riser. The riser supplies water to other pipes known as **feed** or **cross mains**, and these pipes supply water to the **branch lines** to which the sprinklers are connected.

Valves

Water supplies to a sprinkler system are controlled by a series of manually operated valves. NFPA 13 requires that all valves (except one critical valve, noted below) controlling water supplies must be **indicating valves**. An indicating valve is one that the investigator can look at and instantly identify whether it is open or closed.

Indicating valves may be installed solely at the system riser to control the entire sprinkler system, or they may include **sectional control valves** used to isolate portions of a sprinkler system such as individual floors in a multiple story building.

Indicating valves include:

Outside stem and yoke (also known as **outside screw and yoke** or **OS&Y**) consists of a valve assembly with an exposed threaded stem controlled by a hand wheel. The valve stem's relative position indicates its open or closed condition. When the valve stem is extended fully above the valve wheel, the valve is fully open.

Figure 10-2
Outside Stem and Yoke Valve
(Fully open)

Post-indicator valve (PIV). This valve assembly usually is located outside of a building in a yard, parking lot or similar area. It is equipped with a small window or opening that identifies that valve condition. When the valve is closed, the window type has the word "Shut" showing in the window. The opening type simply has a round hole through which the investigator can look. If the hole is partially obstructed, the valve is partially closed.

Figure 10-3
Post-indicator Valve
(Fully open)

Wall-indicator valve (WIV). The operating principle of the WIV is similar to the PIV, but it is installed on the side of a building. These usually are employed where a building sits right on a property line and there is not space for a post-indicator valve.

Figure 10-4
Wall-indicator Valves

Remote-indicator valve. These valves have a manual operating handle that is connected to a small arrow or paddle. When the arrow/paddle is in line with (parallel to) the pipe or tube, the valve is fully open. If the arrow is perpendicular to the pipe, the valve is fully closed.

Figure 10-5
Remote-indicator Valve
(Fully open)

Quarter-turn valve. A simple quarter-turn valve also is an indicating valve. When the valve handle is in line with the pipe, the valve is fully open. Any other position is partially or fully closed.

Figure 10-6
Quarter-turn Valve
(Fully closed)

The position of water supply controlling valves should be documented (photographed) and included in the investigator's report.

The essential valve that is <u>not</u> required to be an indicating valve is the **roadway gate, key valve** or **box valve**. This valve normally is installed at the connection between the water purveyor's pipe, and the underground water main that supplies the sprinkler system. The purpose of this

valve is to isolate the sprinkler system from the water purveyor's system. Since this valve does not have to be indicating – nor does it have to be secured – it is the weak link in the fire sprinkler system. The valve might be closed intentionally for water line maintenance (or failure to pay a water bill) and its status might remain undetected for many months. An arsonist could close this valve to disconnect the sprinkler water supply. If automatic sprinkler system performance is an issue in a fire, the investigator always should check and document the condition of this valve.

Other manually operated valves that exist on sprinkler systems might include **drain** or **test** valves. These are known as **auxiliary valves**. Since they do not control water supplies to the sprinkler system, auxiliary valves are not required to be indicating valves. **Check valves** are automatic operating valves that enable water to flow only in one direction, normally from the supply to the discharge. Check valves are embossed on the outside of their housing with a small arrow that indicates the direction of flow. If automatic sprinkler system performance is an issue, the investigator should confirm that check valves were installed properly.

Alarms

Sprinkler systems normally are outfitted with several types of alarms. The first is a **waterflow alarm**. This may be an electric or a mechanical device that is used to report when a sprinkler or sprinklers have opened – or a pipe breaks – and water has begun to flow through the system. Waterflow alarms often are found near the system riser, and usually consist of a bell, horn, klaxon or similar device. At least one waterflow alarm is located on the exterior wall of a building to notify passersby they should notify the fire department.

Electric waterflow alarms respond to a **flow switch** or **pressure switch**. The flow switch employs a small vane that is inserted into the water stream of the sprinkler pipe. When water flows because a sprinkler has opened, the vane moves and closes an electrical contact that signals an alarm. A pressure switch uses a small diaphragm that responds to water pressure against it, thereby closing the electrical contacts.

Figure 10-7
Electric Flow Switch Assembly
(Mounted on sprinkler riser)

Mechanical alarms are known as **water motor gongs**. The water motor gong has a small-diameter pipe that runs from the wet- or dry-pipe valve to the gong located on the outside of the building. When water flows into the sprinkler system, a small portion of the water is diverted through the pipe to a paddle wheel that drives a small hammer against the side of the gong.

Figure 10-8
Water Motor Gong Assembly

External-mounted alarms (electric bells or water motor gongs) should be examined to determine their operating condition. They may be dismantled or otherwise rendered inoperable. Birds will build nests behind the bell housing that will prevent that hammer from operating when water flows.

Tamper switches are employed to inform the property owner that someone is trying to close a main water supply control valve. This function is known as **valve supervision**. Tamper switches are attached to PIV, WIV or other indicating valves. The underground roadway gate, key or box valve does <u>not</u> have to be supervised, so it may be closed and remain undetected.

Figure 10-9
Tamper Switch Assembly
(Mounted on OS&Y valve)

Low or **high air pressure alarms** are installed on dry pipe sprinkler systems. If the air pressure inside the dry pipe system starts to drop, the dry pipe valve may open inadvertently and fill the sprinkler system with water. While this is not a problem in a fire, if the pipe is filled accidentally in an unheated space it may freeze and result in a maintenance problem. Conversely, unusually high air pressure may prevent the dry pipe valve from readily opening during a fire. The high air pressure alarm will notify a maintenance person that steps must be taken to relieve excess air pressure. Air pressure alarms also may be used on pressurized water tanks that are used to supply a sprinkler system, although this is a water supply method usually found only in rural or remote areas.

Low water or **temperature alarms** are used to identify water leaks or report low temperatures in water tanks.

Fire Department Connection

Nearly all sprinkler systems are equipped with a **fire department connection**. This is a fitting installed on the sprinkler system that enables the fire pumper hose lines to boost the water pressure and volume in the sprinkler system during a fire.

It also may be the sole water source for a dry standpipe system.

Figure 10-10
Fire Department Connection Assembly

If the sprinkler system does not control the fire in its early stages, and the fire continues to grow, more and more sprinklers may open as they are heated. If too many sprinklers open, the desired umbrella-shaped discharge may dwindle to a trickle and reduce the sprinkler system's effectiveness. By supporting the sprinkler system at the fire department connection, the fire pumper sustains an adequate flow and pressure on the system to control the fire.

Fire department connections (called FDCs) may have one or more threaded or "quick connect" inlets. The arrangement and location of the FDC may vary depending upon the local jurisdiction. If the fire department connection has more than one inlet, it probably has some sort of internal check valve. This arrangement allows the fire department to connect only one hose to the FDC while keeping water from flowing out the other inlet.

Fire department connections often are installed in highly public locations along sidewalks, roads or other high traffic area. As a result, they often are easy targets for vandals. The investigator always should check the condition of the FDC if the sprinkler system performance is questioned. The fire department connection may be full of obstructions like trash, soda pop cans, tennis balls, paper or gravel. Hose connection threads may be stripped or out-of-round. The internal check valve may be damaged or corroded. While some of these impairments may be inadvertent, an arsonist easily can block these inlets to prevent effective use of the FDC.

Fire Pumps

In those circumstances where there may be low water pressure or unusually tall buildings, stationary fire pumps are installed to boost water pressure for fire sprinkler or **standpipe** systems. (Standpipe systems are discussed in the next section.) The stationary fire pump is not intended to take the place of the fire department apparatus, but to supplement its effective use.

Usually, fire pump assemblies are designed to operate when a mercury switch senses a drop in the sprinkler or standpipe water pressure. The pump "interprets" this pressure drop as a sprinkler opening, and the pump will start automatically. Some pump installations, though, require someone to report to the pump room to start the fire pump.

Fire pump assemblies consist of three major components:

The **fire pump**. Just like the pump on a fire engine, this device takes water on its inlet side and boosts the pressure to its discharge side. Fire pumps come in a variety of shapes and sizes, and are custom installed to match the building or facility's unique needs.

This is an electrically driven **horizontal split case** fire pump. The cone-shaped device on top is designed to remove trapped air.

Figure 10-11
Horizontal Split Case Fire Pump (Electric drive)

The **driver**. This device provides the method to cause the pump to operate. In past years, fire pump assemblies were "driven" by steam engines. Today, most are either diesel- or electric-drive. This is a high-voltage electric driver.

Figure 10-12
High-Voltage Electric Fire Pump Driver

The **controller**. The controller is the "brain" of the system. It causes the pump to start and stop running, monitors its status and reports any problems with its conditions.

Here, the controller is the tall box at the left of the photograph. It controls a diesel engine that drives the fire pump.

WARNING: Controller boxes may contain very high voltage connections. Do not open the controller door without de-energizing the controller.

Figure 10-13
Controller (left) for Diesel-driven Fire Pump

Fire pump installations can be very complicated. The investigator should refer to someone with professional expertise if he or she has questions. NFPA Standard No. 20 *Fire Pumps* is the nationally recognized standard for fire pump installations.

If fire pump performance is suspect during a fire, the investigator should check the condition of valves, water supplies, pump intakes, wiring methods, fuel supplies and condition, and controller performance.

How Sprinkler Systems Are Disabled

When designed, installed and maintained properly, automatic sprinkler systems are highly reliable. Sprinkler systems have a success rate at fire control or suppression that exceeds 90 percent.

Sprinkler system failures generally can be traced to one of three major causes:

1. **Design deficiencies in the system**. Each automatic sprinkler system is designed to protect a specific occupancy or structure. Based on the national standards, the designer must correctly match the sprinkler system to the use and occupancy of the building and the available water supply.

   For example, if a building owner tells the sprinkler designer that storage never will exceed eight feet high in his stockroom, the designer will select a sprinkler spacing and pipe size arrangement based on that information. If the storage height changes – or more combustible stock is introduced – the sprinkler system may not be adequately designed to protect the risk.

Likewise, if the designer receives inaccurate water supply information (such as an incorrect or out-of-date hydrant flow test report), he or she may not design an adequate safety margin into the system. If the water pressure or volume is not adequate, the sprinkler system will fail to perform as designed.

Sprinkler systems generally are designed and installed to protect against one fire in a structure at a time. Investigators should not expect the system to protect against multiple sets or unanticipated fuel loads (such as accelerants) when none was factored in the original design.

2. **Impairments to the sprinkler system before a fire**. The potential sources of pre-incident impairments are numerous. The leading cause of sprinkler system failures is having water supply **valves** accidentally or intentionally **closed**. It is not uncommon for a maintenance worker to shut off all or a portion of a sprinkler system to perform routine inspections or repairs, and forget to restore the system to full operational status. Likewise, a person intent on setting fire to the building may close a controlling valve to shut off the water supply. Tamper switches often are installed to prevent this from occurring. The tamper alarm will notify a responsible person when the system is not functional, and the person should investigate to ensure the problem is corrected. Even a partially closed valve can severely impede the water flow needed to control a fire.

   A second major problem is **improper component installation**. Numerous cases have been identified where contractors failed to connect water supplies to the sprinkler system, or failed to adequately flush incoming water supply pipes. Rocks, sticks, mud and other debris in the water supply will clog sprinklers and prevent their operation. Occasionally, check valves (which allow water to flow in one direction only) are installed backwards, preventing water to get to the sprinklers on the branch lines.

   Freezing in pipes or individual sprinklers is a problem that occurs primarily in cold climates, but may occur in individual spaces such as cold storage rooms. Wet pipe sprinkler systems are installed where the temperature is expected to never be less than 40°F (4,4 C), but occasionally cold weather causes sprinkler systems to freeze. The result can be devastating. Ice plugs that remain in a system may prevent water from flowing to a fire, or, when the pipes thaw, breaks caused by water expanding into ice may result in serious water damage or cause the system being shut down indefinitely for repairs. The building remains vulnerable to a fire during this period.

   Changes made to the **building** or **contents** may have a major effect on the fire sprinkler system. Often, new tenants will move into a building and make what they perceive are convenient or cosmetic changes by installing walls, partitions, drop ceilings or other semi-permanent barriers that affect sprinkler response and discharge. It is common to find new offices, closets or similar spaces that have been constructed in such a way that the new space has no sprinklers in it.

   A similar problem occurs when new construction results in the sprinklers too close to a wall. NFPA Standard No. 13 requires that sprinklers be located at least four inches from a wall – heat from a fire may not reach sprinklers that are close to a wall or partition because this often is a “dead air” space.

In any case, the most frequent system impairment before a fire is the change in occupancy contents. A sprinkler system designed to protect a "light hazard" occupancy, such as a classroom, office or similar space, will not have the water flow capacity and sprinkler spacing to protect "high hazard" spaces like those where flammable liquids, aerosols or other highly combustible products are used or stored. Tenants often occupy "sprinklered buildings" on the assumption the fire sprinkler system is adequate for their use. This may not be the case. The local fire inspector or an insurance inspector should be consulted if there is any doubt about the sprinkler system's adequacy to protect specific contents or operations.

Similarly, putting **storage too close to sprinklers** may impair their operation. The most effective discharge from a sprinkler is an umbrella-shaped water spray pattern. If this pattern is interrupted by boxes, curtains, blinds or other obstructions, water may not get to the base of the fire or onto nearby combustibles. In most circumstances, storage must be at least 18 inches below sprinkler deflectors.

Another potential system impairment before a fire is the **lack of proper maintenance** on the system and its components. Like any mechanical equipment, sprinkler systems and their attachments should be inspected and tested regularly. NFPA Standard No. 25 *Standard for the Inspection, Maintenance and Testing of Water-Based Fire Protection Systems* establishes the required frequency of inspections and tests. While the list of inspections, testing and maintenance items is lengthy, it is incumbent on the property owner to make certain the work is done in a timely fashion. These tests cover a broad range of items from on-going **water supply adequacy** (pressure and volume), through functional tests to periodic internal pipe inspections to identify corrosion or other obstructions.

In occupancies where the nature of the operation is dirty or dusty, a condition called **"loading"** can occur on one or more sprinklers that affects their performance. Loading is the accumulation of paint, grease, dust, dirt or similar conditions that delay operation of the thermal element, or may cause the sprinkler not to operate at all. Painters often cover sprinklers with masking tape when they paint a ceiling, and forget to remove the tape when they are done.

System sabotage may occur when a vandal or arsonist intentional damages one or more components to the system. Simple techniques, like partially closing a valve or blocking the operating mechanism of an alarm bell, may affect water flow and delay fire department response to a fire.

As mentioned in the previous section, fire sprinkler systems are designed primarily to control one fire at a time in an occupancy. **Multiple sets**, **flammable liquids** or **other accelerants** may cause too many sprinklers to open, thus reducing the available water pressure and volume to any one or two sprinklers nearest the initial fire.

3. **System impairments during a fire**. When a fire occurs in a properly sprinklered building, the system should be capable of controlling the fire until the fire department or brigade arrives to suppress it. Occasionally, however, command decisions made on the fire ground become system impairments.

The most noted problem occurs when **valves are closed too soon**. The incident commander needs to assure the fire is out before the controlling valves are closed. There have been numerous disastrous fires where the fire department was concerned about water damage from the sprinklers – or there was hidden fire in a concealed space – and ordered the control valves closed, only to have the fire grow and overpower the sprinkler system. NFPA 13A *Fighting Fire in Sprinklered Buildings* recommends a fire fighter with a portable radio be stationed at the main controlling valve, and not shut the valve until fire fighters are certain the fire is extinguished.

A second problem occurs when the fire suppression forces **fail to supplement the sprinkler system** through the fire department connection. Modern sprinkler systems are designed to operate with about no more than 20 sprinklers flowing. When more sprinklers open than are considered in the design, the water pressure will drop and the spray pattern from individual sprinklers becomes ineffective. The fire department connection is used to take water from a fire pumper – usually connected to a water main or other reliable source – and boost the pressure and flow in the sprinkler system before the maximum number of design sprinklers is exceeded. Failure to supplement the system is inviting disaster.

Occasionally, an **explosion** will occur that renders the sprinkler system out of service. The force of the explosion may break sprinklers or pipes, or cause sufficient structural damage that the sprinkler system collapses.

A fourth, less common, problem exists when command officers order control valves closed because they fear the sprinkler system is **robbing water from their crews' hose streams**. Fortunately, as command officers have become better educated about sprinkler system performance, this is a rare occurrence. Sprinkler system designs include an adequate amount of water for fire suppression forces in addition to the water for the sprinkler system. It is only in those circumstances where the fire sprinkler system has been overpowered by the fire or is damaged by an explosion should the main control valves be closed so the water is not wasted.

Standpipe Systems

Standpipe and hose systems are installed in large or tall buildings to assist in manual fire suppression activities by building occupants and/or fire personnel. Standpipe systems are an arrangement of piping, valves, hose connections, and related equipment installed within or on the exterior of a building. The systems may or may not have hoses permanently attached, and may or may not be connected to a water supply.

Standpipe systems are used primarily by fire department personnel or trained fire brigades in industrial applications. The fixed piping of the system allows the fire service to connect its hose lines into a pressurized water source near the fire, and avoid the challenge of extending long stretches of hose up multiple flights of stairs or though large buildings. Generally, standpipes are installed in buildings four or more stories tall.

Standpipe systems must be installed in accordance with nationally recognized standards. Refer to NFPA No. 14 *Standpipe and Hose Systems* for guidance, and NFPA No. 25 *Standard for the Inspection, Maintenance and Testing of Water-Based Fire Protection Systems* for on-going care.

There are three types of standpipe systems:

Class I systems have 2½-inch outlets (hose connections) and are designed to be used by the fire department, and fire brigades train in the use of "heavy hose streams." They are designed to flow 500 gallons of water per minute (gpm) at 100 pounds per square inch residual pressure (psi) at the topmost outlet.

Figure 10-14
Class I (One) Standpipe Hose Outlet

The vertically running pipe that supplies the hose station outlets is called a **riser**. The riser is outfitted with hose stations that are threaded hose outlets, usually provided with a brass cap to protect the threads.

Class I systems may be "wet" or "dry." Wet systems are connected to a permanent water supply such as a municipal water main, an elevated tank or a pressure tank. They may have a fire pump assembly to boost the water pressure. Dry systems have no water supply connected to them. The fire department must connect to the water supply and the standpipe inlet to fill the pipe with water and provide volume and pressure with their pumpers.

Class II systems have 1½-inch outlets and are designed to be used primarily by trained building occupants. A hose and nozzles are provided, and the system is designed to flow 100 gpm at 65 psi at the topmost outlet.

Figure 10-15
Class II (Two) Standpipe Hose Outlet and Occupant-use Hose

Class III systems have both 2½-inch and 1½-inch outlets, and combine the features of both Class I and II systems.

Figure 10-16
Class III (Three) Standpipe Hose Outlet
(2 ½-inch and 1 ½-inch adapters included)

Like other fire protection equipment, standpipe systems should be subjected to regular inspection, maintenance and testing. Some of the potential impairments to standpipe systems include:

- **Closed valves**. Those standpipe systems connected to permanent water supplies will have controlling valves on the system supply. They may be inadvertently or intentionally closed before a fire.

- **Impaired or inadequate water supplies**. If the municipal water supply in a neighborhood deteriorates over time, it may affect the performance of the standpipe system, preventing adequate volume or pressure from reaching the standpipe outlets.
- **Absent or ill-maintained hose station outlets, hoses and nozzles.** Hose station outlets that are not exercised regularly can become corroded shut, hose can rot or decay over time, and nozzles (especially valuable brass ones) often are missing.
- **Vandalism**. Since hose station outlets often are located in public areas like stairway enclosures, they are highly susceptible to vandalism. Caps frequently are stolen or damaged, threads are stripped and obstructions are jammed into valve outlets.

A favorite vandal trick is to open all of the hose station valves in a standpipe riser. This may result in one of two problems during a fire:

- If the standpipe system is a wet system, it forces water pressure against the thread cap, preventing a fire fighter from removing the cap until he or she closes the valve and relieves the pressure.
- If the standpipe system is a dry system, a fire fighter must be detailed to check <u>all</u> of the outlets on the same riser to assure valves are closed and caps are in place. If the system is pressurized and there are open valves, water may pour from those hose stations and never reach the intended outlets.

In either case, this seemingly insignificant vandalism may result in a delay in applying water to a fire. (Fire investigators and inspectors can help fire fighters by quickly checking the status of hose outlet valves whenever they pass one. If it is open, take a moment to close it. You'll be amazed how many you find in the "open" position!)

Automatic/Manual Alarm and Detection Systems

A **fire alarm system** is intended primarily to detect, indicate and warn occupants of abnormal conditions, summon appropriate aid, and control building facilities and equipment to enhance life safety and property protection. The system may detect fires automatically or require manual notification of the occupants and the fire department.
A properly designed, installed, operated and maintained fire alarm system can reduce the losses associated with fires in any building. These losses may include human lives and/or property. The primary motivation for including fire detection and alarm systems in buildings is to provide early occupant notification, and eventually notify the fire service so it can respond to the problem.

The design and applications of fire alarm systems can range from very simple to highly complex depending upon their intended use. Investigators having questions about the design or performance of a fire alarm and detection system should consult a qualified fire protection professional, designer/installer/electrician or electrical engineer. Fire alarm and detection systems can be quite sophisticated in their design and operation. NFPA Standard No. 72, the *National Fire Alarm Code®*, is the recognized standard by which systems are installed, tested and maintained. Fire alarm system wiring must be installed in accordance with NFPA 70, the *National Electrical Code®*.

Basic Fire Alarm System Components

A basic fire alarm system consists of several key components, including the fire alarm control panel, initiating devices and indicating appliances, and the wiring that connects all of them.[1]

- The **fire alarm control panel** contains the electronics that supervise and monitor the fire alarm system. It acts as the system's "brain," receiving signals from initiating devices, processing those signals and creating outputs.

- **Initiating devices** are those items that automatically detect or manually report fires or other dangerous conditions. Initiating devices include smoke detectors, heat detectors, flame detectors, gas detectors, pull stations, water flow and tamper switches. They can be easily remembered as any device that "initiates" an alarm.

- **Indicating appliances** are those items that announce an alarm condition: bells, horns, strobes, sirens, klaxons, text printers or other equipment that causes an audible, visual, textual, tactile (touch, using vibrating devices) or olfactory (smell) signals.

[1] There are marketable "wireless" fire alarm systems that employ radio frequencies to transmit signals. They are outside the scope of this text.

Fire Alarm Control Panels

Fire alarm control panels (called "FACPs") contain the electronics that supervise and monitor the fire alarm system. Panels can be very simple, using modular components, or highly sophisticated using computer operated controls. All panels and their related equipment must be listed by Underwriters Laboratories or some other, independent third-party analysis.

Fire alarm control panels normally receive their primary power from the building wiring service, usually 120-volt at 60 MHz. The *National Fire Alarm Code* requires that the fire alarm control panel be powered from a dedicated branch circuit that cannot serve other items such as lights, outlets or direct-wired appliances. The circuit must be provided with overcurrent protection (fuse or circuit breaker), and the fuse or circuit breaker must be arranged so it is tamper resistant to prevent inadvertent or intentional disconnection.

The fire alarm control panel employs a transformer to reduce voltage on the initiating device and indicating appliance circuits to 12 or 24 volts. These circuits – for detection devices and signaling systems – may be wired legally in a huge number of configurations, so the investigator should have a qualified person assess the system wiring.

All fire alarm systems are required to have a secondary power supply in the event the primary (building) power is lost. Generally, this is accomplished with one or more storage batteries located in or near the fire alarm control panel, but my be done using batteries, generators, uninterruptible power supplies (UPS), or a combination among them. The secondary power should activate automatically within 30 seconds of primary power loss. The secondary power supply must be capable of powering the fire alarm system for at least 24 hours, and have enough reserve energy to sound all signaling devices in the building for at least five minutes after that.

FACP Signals

Fire alarm control panels produce a variety of visual and audible signals. The investigator should be able to identify them to interpret what is happening at the FACP when it goes into alarm.

- **Alarm signal**. When an automatic or manual initiating device operates to detect an emergency condition, the fire alarm control panel will respond with an alarm signal. This normally consists of a red light-emitting diode (LED) or other visual signal at the panel, accompanied by some shrill or annoying attention-getting noise at the FACP. When an alarm occurs, the building's fire alarm notification appliances (horns, strobes, bells, etc.) also should operate simultaneously.

- **Trouble signal**. A trouble signal indicates an electrical fault in the FACP, on a circuit or with one or more devices. This fault may be a ground fault, a broken wire or a disconnected device. Generally, a yellow or amber LED will be

illuminated at the panel, and there will be a shrill attention-getting noise. A trouble signal is intended to alert the building owner or management to address the error and get it fixed.

- **Supervisory signal**. The supervisory signal indicates that a non-emergency incident is occurring somewhere in a fire protection or life safety system. For example, if a contractor closes a fire sprinkler control valve equipped with a tamper switch, the FACP will receive a signal to cause someone to investigate the condition. Generally, a yellow or amber LED will be illuminated at the panel, and there will be a shrill attention-getting noise. The noise or the light must be distinctly different from the trouble signal described above.

  Supervisory functions include tamper switches, cold weather alarms, high and low air pressure conditions, high and low water supply conditions, fire pump status indicators and a variety of other equipment controls.

Initiating Devices

Initiating devices are those pieces of equipment installed throughout a building to automatically or manually detect and report a fire, dangerous, or abnormal condition to the FACP. Initiating devices include heat detectors, smoke detectors, infrared and ultraviolet energy (spark and flame) detectors, manual pull stations, water flow switches, supervisory switches and gas detectors. The variety of equipment and devices is huge; there are hundreds of these devices and their manufacturers worldwide.

Heat detectors are used for fire detection where the use of smoke detectors is unsuitable, such as dusty, dirty or humid atmospheres. Heat detectors are not so prone to false alarms as smoke detectors, and are less expensive to install and maintain. Heat detectors are slower to respond to fires than smoke detectors because they do not react to the initial particulate components of combustion. Due to their slower response times, they are not considered suitable as life safety devices.

There are numerous types of heat detectors: fixed temperature, rate-of-rise, and combination fixed temperature and rate-of-rise. Heat detectors may be “spot” type meaning they are located in a single spot on the ceiling or wall, or “line” type that consist of a continuous wire loop throughout a space.

Fixed temperature detectors respond when their operating elements reach a preset temperature established by the manufacturer and selected by the installer based on the anticipated ambient temperature. Generally, the temperature rating of the selected heat detector is about 20 F (6.6 C) above the anticipated ambient ceiling temperature. Thus, if the installer expects the normal ceiling temperature to be 135 F (57.2 C), he or she will install a 155 F (68.3 C) or 160 F (71.1 C) detector.

Rate-of-rise detectors respond to temperature changes within a space, generally 15 F (-9.4 C) per minute. If a fire's temperature equals or exceeds that rate of growth, the detector will send an alarm signal to the FACP, regardless of the overall temperature in the room or space.

Combination fixed temperature and rate-of-rise detectors employ the features of both. A rapid temperature increase will cause a signal to go to the FACP, or – if it is a slow-building fire – when the space reaches the rated temperature of the fixed temperature device, it will cause an alarm to occur.

Line-type heat detectors operate by the installation of a single, continuous heat sensitive cable placed throughout the protected space. The cables operate on the fixed temperature principle. In the first, the "dual conductor," when the fire burns through the temperature-sensitive outer sheathing, the two internal wires will short circuit, thus causing an alarm at the FACP.

The second, "ceramic core," is a little more complicated. As the temperature rises in the space, the ceramic cable around the conductor expands, causing a reduction in electrical current flow through the cable. The FACP interprets this reduced current flow as an alarm condition.

Any of these equipment applications is effective; their choice simply is a matter of cost and design consideration based on the space in which they are installed.

Smoke detectors are used where life safety concerns or early detection is important. They work by sensing the small particles in the atmosphere that exist in the early phases of a fire. Smoke detectors are not usable in all environments (extreme cold, high humidity, dust, dirt, high elevations) and their effectiveness varies on the fire incident and occupant capability.

Smoke detectors employ three basic operating principles: ionization, photoelectric, and combination photoelectric/ionization. Ionization detectors use a small amount of a radioactive material located within the detector that "ionizes" the air existing in the detection chamber.

Once ionized, the air is electrically conductive and allows current to flow through the detector circuits. Small particles entering the ionization chamber reduce the current flow that the detector's electronics interpret as smoke, thereby causing an alarm. This operation explains why dust, moisture, mists, insects and other acutely small items that enter the ionization chamber regularly cause false alarms. Ionization detectors generally are considered a superior choice where hot, fast-burning fires may be expected.

Photoelectric operating principles include light-scattering and light obscuration. Photoelectric smoke detectors tend to be less susceptible to false alarm conditions because they are not so sensitive to small particles in the atmosphere. Light scattering detectors employ a beam of "pulsed light" that occurs in a sensing chamber. When enough smoke enters the chamber to refract the light toward a photosensitive target, the electronic circuitry closes and an alarm occurs.

Light obscuration smoke detectors employ a similar light beam-photosensitive target, but when smoke obscures the beam the broken beam results in an alarm. This principle is employed in both spot-type detectors and beam detectors. This latter type often is found in large, open areas such as warehouses, atria, churches, concert halls and other spaces with high ceilings.

Other Initiating Devices

There are a variety of other initiating devices marketed for special fire protection applications. The investigator should consult other fire protection professionals for guidance on their selection and operation.

- **Infrared and ultraviolet** detectors are used to detect sparks and flames by sensing electro magnetic energy that exists before flaming combustion occurs.

- **Gas-sensing** detectors can be calibrated to sense any number of industrial or fire gases such as carbon monoxide, sulfur dioxide, ammonia, or hydrogen chloride, among others.

- **Pressure-sensing** detectors are used to sense pressure increases in a space due to the expansion of heated air.

- **Very Early Smoke Detection Apparatus (VESDA)** and **cloud chamber** detection systems exist where ambient air velocities are high (such as clean rooms or subways) or product or operational value is significant (computer rooms, museums, telecommunications facilities, or medical equipment rooms).

- **Manual pull stations** are employed on fire alarm systems to enable human intervention. Once a person detects a fire, he or she can notify other building occupants – and occasionally the fire services – by pulling the alarm handle.

- **Flow switches** are connected to water-based fire protection systems to sense water movement. When a sprinkler opens, a fire hydrant is exercised or a fire pump begins operation, the flow switch will report the change.

Combination Burglary/Fire Detection Systems

Many business owners having burglar alarms will ask that one or more fire detection devices be included to provide them a “fire alarm system.” The investigator should be aware of a potential for confusion related to these systems.

Often, these combination systems employ infrared motion sensors to identify the body heat signatures of intruders. This is the same technology infrared fire detectors use to sense electromagnetic energy from the non-flaming stages of a fire.

Some modern and sophisticated infrared devices can identify the different "signature" between a fire and body heat, but older ones were not so discriminating. As a result, these older devices may incorrectly report a fire as an intruder, or vice versa. This information may be misinterpreted as there having been an intruder in the building before the fire occurred: a sequence that suggests the fire may have been set intentionally by a prowler. The investigator should rely on his or her best investigative skills and establish other signs of entry before drawing the conclusion that the fire was subsequent to the intrusion.

Fire Alarm System Monitoring

Many jurisdictions insist that required fire alarm systems are **monitored**, generally that means someone in addition to the building occupants is notified of the alarm, and is expected to take responsible action.

The *National Fire Alarm Code* describes several methods of alarm monitoring, but the most common is alarm reporting to a **central station**. A central station is a privately run business that receives alarms and retransmits them to the local fire department so they can respond to the incident. The central station may not be in the same city, state or country as the building where the fire alarm is located.

The investigator should establish if and how the fire alarm system is monitored, and obtain from the monitoring service detailed records of all alarm activity.

Fire Alarm System Impairments

Fire alarm systems can be disabled easily, and often are because of repeated false alarms or maintenance problems. If fire alarm system performance is identified as an issue in a fire investigation, the investigator should obtain professional help and detailed documentation to help in his or her diagnosis of the problem.

Some common impairments are:

- **Improperly sized fuses**. The fire alarm control panel includes one or more internal fuses to protect it from excess current. The manufacturer's literature should be checked to establish the correct size and type of fuse.

- **Disconnected or damaged devices**. Many people have experienced the frustration of their home smoke alarms sounding from burned toast or cooking vapors. Their solution? Yank it off the wall or ceiling until the problem goes away.

  This condition occurs in non-residential occupancies as well. However, in a fire alarm system, removing or seriously damaging a device should provide a **trouble signal** at the fire alarm control panel if the system is operating properly.

- **Incompatible devices**. All of the devices connected to a fire alarm system must be electrically compatible with one another. Normally, this means the investigator should not find more than one brand of smoke detector or similar device incorporated into a system. However, different brands of equipment *may be* permissible and may function as long as they are compatible, and the manufacturers provide documentation to that effect.

- **Disconnected primary power and exhausted secondary power**. The 120-volt primary power to a fire alarm system may be disconnected inadvertently or intentionally (a trouble signal should result). If the problem is not corrected, and the system remains on secondary power more than the secondary power capacity allows (at least 24 hours), the fire alarm system will not function at all until 120-volt power is restored. This occurs from time-to-time when maintenance work is performed on a system.

- **Systems disconnected because of excessive false alarms**. Improper fire alarm system design, installation, or maintenance usually results in frequent false alarms. Occupants, owners, visitors and the fire services quickly get tired and frustrated by these problems. Unless the faulty conditions are remedied, some owners simply want to "pull the plug" on the system. This is especially true in those communities where excessive false alarms are subject to fines.

- **Changes in room or ceiling design**. Like sprinklers, detection devices must be installed in accordance with strict placement rules to ensure their effective response. If ceiling heights are changed, walls created or removed, or other architectural or mechanical (heating, ventilation or air conditioning system) features are altered, fire alarm system functions may be affected.

- **Circuits bypassed to silence trouble signals**. When an electrical problem occurs, the fire alarm system should report a trouble signal. If the service technician cannot find or repair the fault, he or she may bypass electronically or otherwise disable the circuit to cause the trouble signal to disappear although the fault has not been corrected.

- **Change in building contents**. Significant changes in fuels and storage arrays (methods of storage: racks, shelves, bin boxes, pallets, etc.) may affect how thermal currents are carried throughout a building. This change may affect a fire detection system's response time.

- **Delayed alarm processing**. National standards require that monitoring services call the local fire department "without unreasonable delay" as soon as they receive a fire alarm. Although this is generally interpreted to be 90 seconds, there is no specified time in which the central station must notify the fire department. If the alarm company does not notify the fire department in a timely fashion, the fire will continue to grow because no one responds to control it.

Additional alarm problems occur when the monitoring service is located in another jurisdiction or state. The operator receiving the alarm inadvertently may call the wrong fire department, or may be confused by the jurisdiction's name, thus resulting in another delay.

Single Station Smoke Alarms

Smoke alarms found within dwelling units normally are "single station" devices. This means they are not connected to part of a fire alarm system, and generally sound only in the room where they are located or they may be connected to other detectors within the same dwelling unit.

Single station smoke alarms are used predominantly in one- and two-family dwellings, hotel and motel rooms, apartment dwelling units, condominiums and small group homes. Current building codes require that they be installed inside and outside of the sleeping areas, and there must be at least one smoke alarm on each living level of a multiple-story dwelling. They must be interconnected so if one sounds, they all sound.

Newly constructed buildings must have their smoke alarms powered by 120-volt current with a 9-volt battery back-up for secondary power. Most building and fire codes require smoke alarms in all single family dwellings, and allow existing dwellings to use only battery powered smoke alarms.

Impairments to single station fire alarms include:

- Missing, dead or disconnected batteries.
- Dirty or poorly maintained devices.
- Smoke alarms disconnected due to excessive false alarms.

In any residential fire investigation, the investigator should check and document the condition of the smoke alarm equipment.

Commercial Cooking and Fire Suppression Equipment

Commercial cooking equipment requires special attention. The biggest problem with commercial cooking equipment is the result of poor housekeeping: accumulations of grease (animal fats or vegetable solids) in the duct, hood, and fan housing. Burning grease can reach temperatures of 2,000 F (1093 C), potentially igniting nearby combustible construction or fixtures.

Cooking equipment includes ranges, deep fryers, portable ovens, convection ovens, steamers, warmers, microwave ovens, woks, chain broilers, griddles and tilting skillets. Some of this equipment releases smoke- or grease-laden vapors into the surrounding kitchen space. In that case, the cooking equipment must be provided with a complete hood and duct system that collects those combustible vapors and exhausts them outdoors.

Hood and duct installation must be constructed in accordance with strict standards. These requirements are found either in NFPA Standard No. 96 *Commercial Kitchen Ventilation Systems* or the jurisdiction's mechanical code. The hood and duct installation must be constructed of substantial metal, and all joints and seams must be welded so they are liquid-tight. This prevents grease from escaping the hood or duct by any path other than the intended exhaust outlet.

The hood and duct equipment must be installed at least 18 inches from combustible construction so if it does ignite, the radiant heat is less likely to ignite structural elements.

Automatic and manual fire suppression equipment must be provided to protect the cooking appliances, the hood and duct system. The most common types of automatic systems are dry chemical (typically sodium bicarbonate-based) or wet chemical (employing a potassium-based solution), although some cooking systems are protected by special automatic sprinklers or carbon dioxide systems.

Recent studies have revealed that dry chemical fire suppression systems are ineffective on vegetable-based cooking oils, or on equipment that retains heat for a long time such as a well-insulated deep fryer. Many restaurants have converted from animal fats (lard) to vegetable oils (corn, peanut, or safflower) without changing their fire protection system. In the event of a fire, the dry chemical system probably will discharge, but not control the fire.

The answer to this challenge is the installation of "wet chemical" systems. All newly installed commercial kitchen fire suppression systems must meet UL Standard No. 300 *Fire Testing of Fire Protection Systems for Restaurant Cooking Areas*. This standard requires that the fire suppression agent provide some sort of cooling effect to minimize the likelihood that the cooking grease will re-ignite after the suppression system operates.

The fire suppression system must be capable of automatic and manual operation. Automatic operation usually occurs with the installation of fusible links above the cooking equipment, in the plenum (the space behind the grease collection filters) and in the exhaust duct. The links generally are connected in series on what is called the **detection line**. The detection line is stretched under tension, and when a link releases, the cable slackens and releases the fire suppression agent.

Portable fire extinguishers must be provided to supplement the fire suppression system, and their chemical agent must be compatible with the fixed system.

The fire suppression system must be integrated with electrical and fuel gas (propane or natural gas) service to the kitchen area so that when the fire system operates, all heat-producing appliances under the hood are disconnected and fuel is shut off. These shut off devices must be arranged so they can be set only manually.

Fire suppression systems over commercial cooking equipment are required to be serviced every six months by a qualified technician. Except for sprinkler systems using glass bulbs, all fusible links must be replaced annually.

Commercial cooking systems can suffer the following impairments:

- **Out-of-date or overloaded fusible links**. Fusible links must be changed annually for two reasons: excess grease accumulation could delay its operation, or, because the link is always subject to heated air from the cook top, it may operate inadvertently when there is no fire. Grease accumulation can harden on fusible links or clog sprinkler discharge.

- **Nozzles or distribution pipes blocked by grease**. The fire suppression agents are discharged from their storage tanks through a network of pipe and special nozzles. If the equipment – especially nozzles over the cook top – fills with grease, the agent may not be able to be expelled from the pipe.

- **Inadequate amount, wrong selection or lack of suppression agent**. Chemical fire suppression systems – since they are a "one-shot" operation with no back-up – must be sized to protect the risk. If there is not enough chemical agent supplied, a fire may overpower the system.

  If a dry chemical system is installed to protect vegetable oils or cooking equipment that includes solid fuels (like wood), it will not provide adequate cooling to suppress the Class A fire.

  Occasionally, a commercial kitchen system "dumps" and may not get serviced and refilled in a timely fashion. In that case, the lack of fire suppression agent will allow the fire to grow.

- **Fusible link placement**. The specific placement of the fusible link(s) on the detection line can result in a successful fire outcome or severe failure. The links are located in mounting brackets. If they are not centered in the bracket, the link may release, but parts of it may hang up on the mounting bracket and prevent the detection line from slackening. If the detection line remains taut, the fire suppression agent will not discharge.

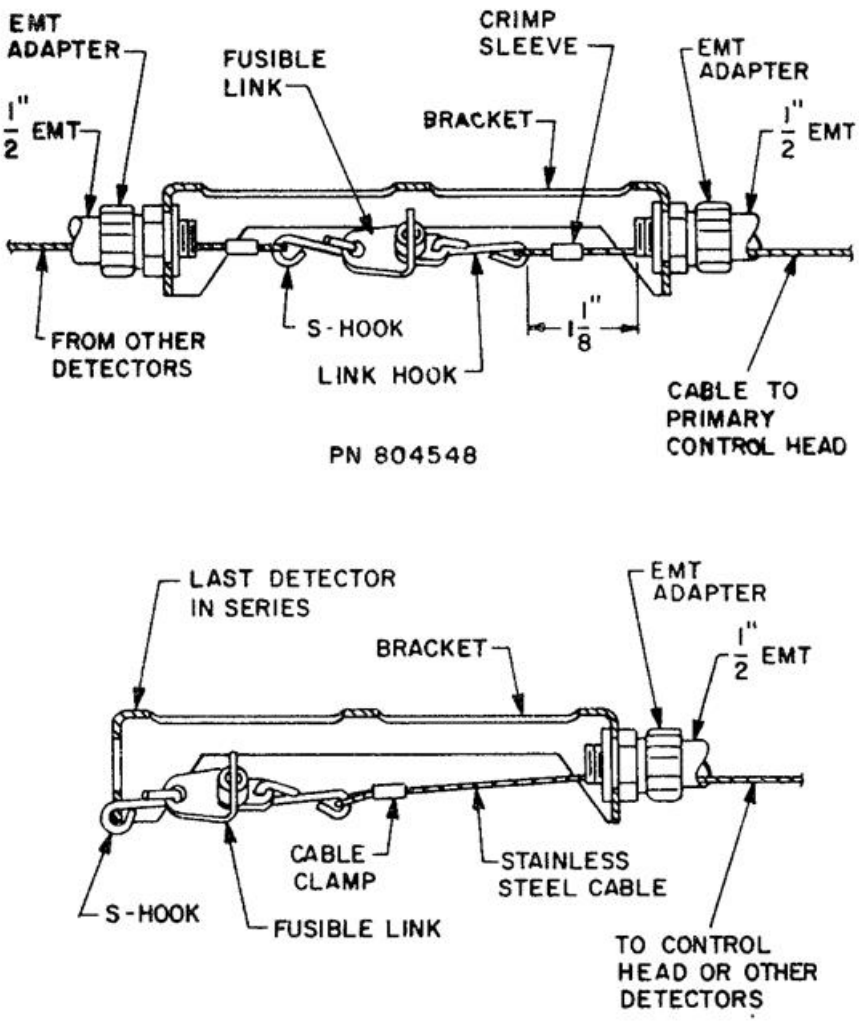


Figure 10-18
Example of Fusible Link Placement Within a Mounting Brackets

The fusible link must be free to travel and release the stainless steel detection line cable. The EMT (electromechanical tube, commonly called conduit) is used to protect the detection line from grease accumulations and allow free travel inside the tube.

If the performance of the fire suppression system in a commercial kitchen is suspect, the investigator should closely examine the mounting brackets to see if any of the fusible link parts are stuck in it.

- **Change in the number, type or location of cooking appliances or fire suppression nozzles**. The fire suppression systems must be installed specifically to match the configuration of the commercial cooking equipment. For example, if a cooking line (from left to right) consists of a deep fryer, griddle, chain griddle and wok, the fire suppression system is customized to protect those appliances. If a new chef rearranges the appliances – say, takes out the wok and installs another deep fryer – the fire suppression system is not designed to protect that configuration.

- **Nozzles moved because they are inconvenient**. The nozzles and distribution piping are matched to the fire suppression system design and cooking line. Sometimes the nozzle placement gets in the way of the chef, and he or she will move the pipe out of the way. If the nozzle is not aimed precisely at the risk, the fire suppression agent is wasted.

- **Excess grease accumulations**. The fire suppression system is designed to protect "normal" grease accumulations. Excess build-up, if ignited, may overpower the system.

- **Failure to disconnect heat or fuel sources**. If the fire suppression system does not shut down heat or fuel sources upon activation, there is an ongoing risk that the heated grease will re-ignite, or that leaking fuel gas will create a dangerously explosive fuel:air mixture.

Maintenance, Inspection and Testing

All fire protection systems and equipment must be inspected, tested and maintained on a regular basis on schedules established in the national fire protection standards or by insurance underwriters.

The test and inspection frequencies are spelled out in:

- Locally adopted fire codes
- NFPA Standard No. 25 *Standard for the Inspection, Maintenance and Testing of Water-Based Fire Protection Systems*
- NFPA Standard No. 72 *National Fire Alarm Code®*
- NFPA Standard No. 17 *Standard for Dry Chemical Extinguishing Systems*
- NFPA Standard No. 17A *Standard for Wet Chemical Extinguishing Systems*
- NFPA Standard No. 12 *Standard on Carbon Dioxide Extinguishing Systems*

The investigator always should obtain copies of inspection and test records on the fire protection systems as part of his or her case file. These records can be obtained from:

- The building or facility owner,
- The building or facility occupants,
- The local fire department, fire marshal, or fire inspection bureau,
- The property owner or occupants' insurance underwriter, or,
- The service company that performed the work.

Documentation

The fire investigator is in an important position to improve life safety and fire protection codes and standards. The well-documented results of his or her investigation can influence changes in practices, codes and standards to enhance fire safety. The information the investigator collects helps fire protection specialists recreate and assess

system performance. It may also help in post-incident litigation to help explain equipment, design, operating or maintenance failures.

The following information should be documented to aid the investigation as well as post-incident analysis:

- **General**.
  - Was the fire protection system required by code, or was it installed at the owner or occupant's choice?
  - Have there been any ongoing maintenance or repair problems with the system? If so, what were they, and were they corrected in a timely fashion?
  - Try to obtain service and maintenance records on all fire protection systems.
  - Identify any obvious building or fire code deficiencies. Obtain a fire department inspection history on the property.

- **Fire sprinkler systems**.
  - Identify the number of sprinklers that opened in the fire, and their location. A small sketch of the area of operation is helpful.
  - Determine the post-incident water pressure coming into the system.
    - Perform, or arrange to have, a "main drain" test to assess the water supply.
  - Describe the fire department's operation related to the sprinkler system.
    - Did they supplement the system at one or more fire department connections? Was the result of this effort effective?
    - Did they close any main controlling valves during the fire? If so, why? What was the result?
  - Include fire fighter and officer assessments of the effectiveness of the sprinkler system on holding the fire in check, or suppressing it altogether.
  - Document any problems that were identified with the sprinkler system, fire pump assemblies or water supplies.
  - Photograph key components:
    - The main sprinkler riser showing valve handle positions and gauge pressures.
    - Sectional control valves and their handle positions.
    - Obstructions to sprinkler discharge.
    - Fire pump assemblies, including the controller, driver and associated equipment.

- **Fire alarm systems**.
  - When were alarms received at the monitoring service?
    - Compare this to the time the fire department received notification at its own dispatch center.
    - What type of alarms were received and in what sequence?
      - Fire? Tamper? Trouble?

- Did automatic detectors operate and notify occupants?
  - Did any occupant complain of inability to hear or see the alarm notification?
- Did fire fighters describe any problems with the fire alarm system during their suppression operations? If so, what were they?

UNIT 11: MOTIVES, INTERVIEWING AND INTERROGATION

TERMINAL OBJECTIVE

The students will be able to:

11.1 Understand the various motives frequently associated with the act of incendiarism and develop a strategy to effectively interview and interrogate potential witnesses/suspects.

ENABLING OBJECTIVES

The students will be able to:

11.1 Describe common arson motives.

11.2 Identify the relationships that may exist between certain motives and certain types of fires.

*11.3 List the steps of the **I**ntroduction, **R**apport building, **O**pening statement, **N**arrative, **I**nquiry and **C**onclusion (IRONIC) interviewing method.*

11.4 Identify the appropriate steps for preparing and conducting an effective interview.

11.5 Identify available resources to assist in conducting interviews and interrogations.

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UNIT 11: MOTIVES, INTERVIEWING AND INTERROGATION

Slide 11-1

ENABLING OBJECTIVES

- Describe common arson motives.
- Identify the relationships that may exist between certain motives and certain types of fires.
- List the steps of the **I**ntroduction, **R**apport building, **O**pening statement, **N**arrative, **I**nquiry and **C**onclusion (IRONIC) interviewing method.

Slide 11-2

ENABLING OBJECTIVES (cont'd)

- Identify the appropriate steps for preparing and conducting an effective interview.
- Identify available resources to assist in conducting interviews and interrogations.

Slide 11-3

I. MOTIVES

MOTIVES

The reason for setting the fire.

Slide 11-4

A. Motive is the reason why someone sets a fire.

INTENT

The deliberateness of the act.

Slide 11-5

B. Intent is the deliberateness of the act of setting a fire.

II. BASIC MOTIVES

BASIC MOTIVES

- Spite/Revenge.
- Crime concealment.
- Profit/Fraud.
- Vandalism.
- Extremism.
- Excitement.
- Juveniles.
  - Separate category in itself.

Slide 11-6

A. Basic motives.

1. Spite/Revenge.
2. Crime concealment.
3. Profit/Fraud.
4. Vandalism.
5. Extremism.
6. Excitement.
7. Juveniles.

SPITE/REVENGE

- Frequently used weapon of someone who wants to be removed from physical act of violence.
  - Can result in extensive loss of life.
  - Responsible for large property losses.

Slide 11-7

B. Frequently used weapon of someone who wants to be removed from physical act of violence.

1. Can result in extensive loss of life.

2. Responsible for large property losses.

SPITE/REVENGE (cont'd)

- Initiated because of jealousy or uncontrolled emotion.
  - Usually occurs at night.
  - May involve available combustibles.
  - Often set using liquid accelerants.
  - Relationships often a major factor.

Slide 11-8

C. Spite/Revenge can be initiated because of jealousy or uncontrolled emotion.

1. Usually occurs at night.

2. May involve available combustibles.

3. Often set using liquid accelerants.

4. Relationships often a major factor.

SPITE/REVENGE (cont'd)

- Work or job relations.
  - Labor disputes.
  - Bar fight.
  - Racial confrontations.
  - Religious/Ethnic antagonism.
  - Almost any age group.

Slide 11-9

D. In some instances, work or job relations can be the motivation for spite-/revenge-related fires.

1. Labor disputes.

2. Bar fight.

3. Racial confrontations.

4. Religious/Ethnic antagonism.

5. Almost any age group.

SPITE/REVENGE (cont'd)

- Fire location may identify motive.
  - Vindictive person may target valued possessions.
  - Vehicle, tools, jewelry, clothes.
  - Articles of clothing often placed in piles on bed or in closet.

Slide 11-10

E. The fire's location may assist investigators in identifying a possible motive.

1. Vindictive person may target valued possessions.

2. Vehicle, tools, jewelry, clothes.

3. Articles of clothing often placed in piles on bed or in closet.

CRIME CONCEALMENT

- Destruction of books/records.
- Destruction of evidence.
- Distraction.
- Escape.
- To conceal murder.
- To conceal suicide.
- Drug-related.
- Gang-related.

Slide 11-11

F. Crime concealment.

1. Destruction of books/records.
2. Destruction of evidence.
3. Distraction.
4. Escape.
5. To conceal murder.
6. To conceal suicide.
7. Drug-related.
8. Gang-related.

VALUABLE CARDS MISSING

Slide 11-12

G. Investigators should look for missing valuable items, such as card or stamp collection, jewelry, firearms, money, etc.

ARSON FOR PROFIT

Fraud is defined as a deception deliberately practiced in order to secure unfair or unlawful gain.

- Direct gain.
- Indirect gain.

Slide 11-13

H. Fraud is defined as a deception deliberately practiced in order to secure unfair or unlawful gain.

1. Direct gain.

2. Indirect gain.

DIRECT FRAUD FIRES

- Economic conditions.
- Foreclosure properties.
- Business problems.
- Vehicle fires.
- Natural disasters.

Slide 11-14

I. Direct fraud fires.

1. Economic conditions.

2. Foreclosure properties.

3. Business problems.

4. Vehicle fires.

5. Natural disasters.

DIRECT FRAUD FIRES (cont'd)

- Completion of business season/contract.
- Cancelled orders.
- Merchandise outdated/obsolete.
- Large inventory.
- Increasing business, occupancy too small.
- Desire to redecorate.

Slide 11-15

6. Completion of business season/contract.

7. Cancelled orders.

8. Merchandise outdated/obsolete.

9. Large inventory.

10. Increasing business, occupancy too small.

11. Desire to redecorate.

DIRECT FRAUD FIRES (cont'd)

- Lack of stock, as well as financial issues.
  - Partner disagreement.
  - Dissatisfaction with location.
  - Changes in traffic patterns.
  - Outstanding accounts.
  - Breaking of a lease.

Slide 11-16

J. Business-related fires can be attributed to issues such as lack of stock, as well as financial issues.

1. Partner disagreement.

2. Dissatisfaction with location.

3. Changes in traffic patterns.

4. Outstanding accounts.

5. Breaking of a lease.

VEHICLE FRAUD FIRES

Vehicle is a “lemon.”

- Expensive mechanical repairs.
- Insurance value higher than trade or sell value.
- Fire offers the only way.

Slide 11-17

K. Vehicle is a “lemon.”

1. Expensive mechanical repairs.

2. Insurance value higher than trade or sell value.

3. Fire offers the only way.

INDIRECT FRAUD FIRES

- Contractual motives.
- Business motives.

Slide 11-18

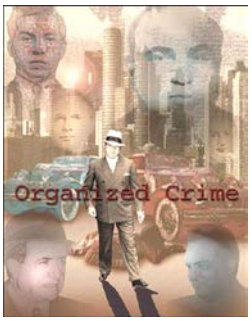
L. Indirect fraud fires may include contractual and business-related motives.

1. In these instances, investigators may need to seek assistance from forensic auditors to identify financial motives.

2. These resources are available from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) and other public and private sector agencies.

OTHER FRAUD-RELATED FIRES

- Organized crime.
- Welfare.
- Insurance.



Slide 11-19

M. Organized crime may engage in welfare fraud to illegally obtain funds to support various types of criminal activity.

1. Organized crime uses arson fires in lieu of mortgage payments from people who are unable to repay loans obtained from the syndicate. Organized crime will also hire professional arsonists to set fires to obtain the plumbing pipes, wires, fixtures, etc., from burned-out buildings to sell.

2. Organized crime further uses arson for extortion, business takeovers, terror, and as a cover-up for other crimes.

3. Arson used for insurance and housing fraud schemes, which include obtaining fire insurance on overvalued buildings, clearing land for a new building, renovating deteriorating buildings, and obtaining housing at low cost.

EXTREMISM

Civil disorder, revolution and political activities.

Slide 11-20

N. Extremism may include criminal activity by environmental and animal rights groups. Many of these incidents are often associated with groups such as The Earth Liberation Front (ELF) and The Animal Liberation Front (ALF). Other related activities, such as civil disorder, revolution and political activities, are also forms of extremism that may involve firesetting.

FIRE USED AS WEAPON PROVIDES TWO RESULTS

- Destruction of property.
- Impression that group activity involves many people.

Slide 11-21

O. Fire may be used to destroy property to give the impression that group activity may be involved when in fact it may only involve one or two individuals.

FIRE USED TO SHOW POWER OF GROUP OVER OTHERS

- Anti-abortion protesters.
- Terrorism.
- Militias.
- Labor disputes.
- Intimidation of the public and opponents.
- "Credit" may not be responsible party.

Slide 11-22

P. Fire used to show power of group over others.

1. Anti-abortion protesters.
2. Terrorism.
3. Militias.
4. Labor disputes.
5. Intimidation of the public and opponents.
6. "Credit" may not be responsible party.

GANGS

Slide 11-23

Q. Investigators should work cooperatively with law enforcement anti-gang units to obtain intelligence related to possible gang-related firesetting activity within their communities.

GRAFFITI/GANG ACTIVITIES

Slide 11-24

R. Gang graffiti may provide clues as to the identity of the responsible individuals and possible locations.

CULTS/SATANIC CRIMES

Slide 11-25

S. Investigators should conduct a thorough examination of the scene to identify any signs of satanic symbols or other identifiers of cult-related activities.

EXCITEMENT

Profit vanity and hero vanity (forms of indirect fraud).

Slide 11-26

T. Profit vanity and hero vanity.

Forms of indirect fraud.

PROFIT VANITY

- Security guard desires pay raise or promotion.
- Firefighters desire extra pay.
- Firefighters “needing” something to do.
- Individual wants to convince businesses that they should hire him or her.

Slide 11-27

U. Profit vanity.

1. Security guard desires pay raise or promotion.
2. Firefighters desire extra pay.
3. Firefighters “needing” something to do.
4. Individual wants to convince businesses that they should hire him or her.

HERO VANITY

- Individual wishing to be a hero.
- Citizen attempting to gain attention.

Slide 11-28

V. Hero vanity.

1. Individual wishing to be a hero.

2. Citizen attempting to gain attention.

JUVENILE FIRESETTERS

- Both genders will exhibit behavior.
- Most common between ages of 4 and 12.
- Usually, curiosity has no criminal intent.

Slide 11-29

W. Juvenile firesetters.

1. Both genders will usually exhibit behavior.

2. Most common between ages of 4 and 12.

3. Usually, curiosity has no criminal intent.

JUVENILE FIRESETTERS (cont'd)

- If child's intent was not to set fire to the building, and/or if the act was intended as playing or experimenting with fire, then the incident should be listed as accidental, not incendiary.

Slide 11-30

4. If child's intent was not to set fire to the building, and/or if the act was intended as playing or experimenting with fire, then the incident should be listed as accidental, not incendiary.

AGE ACCOUNTABILITY

- Age is 7 years for federal law. State statutes will vary.
- Under 7, child usually not accountable.

Slide 11-31

X. Age accountability.

1. Age is 7 years for federal law. State statutes will vary.
2. Under 7, child usually not accountable.
3. Age of reason varies from state to state.

AGE GROUP OF 4 TO 12 YEARS

Most common:

- Curiosity.
- Revenge.
- Crime concealment.
  - Influenced by television.
  - Vandalism may be practiced by 8- to 12-year-olds — usually involves schools.

Slide 11-32

4. Most common:

   a. Curiosity.

   b. Revenge.

   c. Crime concealment.

      - Influenced by television.

      - Vandalism may be practiced by 8- to 12-year-olds — usually involves schools.

JUVENILE SPITE/REVENGE

Slide 11-33

5. Common targets for these offenders include schools, playgrounds, brush fires and within their rooms at home.

16 TO 18 YEARS OLD

Slide 11-34

6. These offenders tend to target structures, vehicles, outbuildings, schools, places of employment and houses of worship. The fires may also involve gang initiation where individuals are targeted.

7. Depending on the individual and the seriousness of the offense, they may be charged as adults.

TYPICAL SERIAL ARSONIST

- Single, white male.
- Ages 20 to 27 years old.
- Raised in an unstable family environment.

Slide 11-35

8. Single, white male.

9. Ages 20 to 27 years old.

10. Raised in an unstable family environment.

TYPICAL SERIAL ARSONIST (cont'd)

- High school education.
- Underachiever.
- Sloppy and unkempt.
- Poorly adjusted socially and sexually.

Slide 11-36

11. High school education.

12. Underachiever.

13. Sloppy and unkempt.

14. Poorly adjusted socially and sexually.

TYPICAL SERIAL ARSONIST (cont'd)

- If married, periods of separation.
- Infantile behavior and fits of rage.
- Sense of satisfaction after the fire.
- When arrested, shows no remorse.

Slide 11-37

15. If married, periods of separation.

16. Infantile behavior and fits of rage.

17. Sense of satisfaction after the fire.

18. When arrested, shows no remorse.

FACTORS IN ARSON PROFILING

- A detailed study of the crime scene.
- Area demographics.
- Review of maps.
- Aerial photography.
- Review of the fire and police reports.
- An analysis of the time, day and week of the fires set.

Slide 11-38

Y. Factors in arson profiling.

1. A detailed study of the crime scene.
2. Area demographics.
3. Review of maps.
4. Aerial photography.
5. Review of the fire and police reports.
6. An analysis of the time, day and week of the fires set.

FACTORS IN ARSON PROFILING (cont'd)

- Possible motives.
- Experience of the investigation staff.

Slide 11-39

7. Possible motives.
8. Experience of the investigation staff.

INVESTIGATIVE ASSISTANCE FROM THE BUREAU OF ALCOHOL, TOBACCO, FIREARMS AND EXPLOSIVES AND FBI

- Interview strategies.
- Case consultation.
- Criminal investigative analysis.
- Profiling.
- Prosecutorial assistance.
- Courtroom testimony.

Slide 11-40

Z. Criminal profiling assistance for state and local investigators is available from the FBI National Center for the Analysis of Violent Crime (NCAVC). Investigators should contact their local ATF or FBI field office to request assistance.

III. INTERVIEW AND INTERROGATION

INTERVIEW AND INTERROGATION

Slide 11-41

A. Physical evidence may have only limited value in court without interpersonal communications between the investigator and those involved in the incident.

B. The successful investigator needs to develop effective techniques for conducting interviews.

C. Approximately 85 percent of information gathered during an investigation comes from interviews.

D. The investigator must be familiar with the basic methods and techniques used by skilled, ethical and successful interviewers.

E. The manner in which an interview is conducted will determine judicial acceptance or rejection.

INTERVIEWING

- Goal: to gather useful and accurate information that will establish the existence of previously unknown facts.
- Definition: a systematic conversation with a person believed to have information who is willing to cooperate.

Slide 11-42

F. Goal: to gather useful and accurate information that will establish the existence of previously unknown facts.

G. Definition: a systematic conversation with a person believed to have information who is willing to cooperate.

INTERVIEWS

Majority of investigative information comes from interviews.

Slide 11-43

H. Definition: An interview involves asking questions of individuals who have knowledge pertaining to the investigation; it is not an interrogation. An interrogation is a formal line of questioning used to obtain information from reluctant individuals or suspects. The principles of interrogation and appropriate techniques are beyond the scope of this course.

1. Be familiar with basic interview methods and techniques.

2. Improve interpersonal communication skills.

3. Develop correct interview techniques.

4. Acceptance of interview legality.

HOW DO I BECOME A GREAT INTERVIEWER?

- Previous life experience.
- Ability to relate to people/families.
- Communication skills.
- Desire to get better.
- Practice.

Slide 11-44

I. Everyone has the ability to become a great interviewer. There are five keys to realizing your interviewing potential.

1. Previous life experience: We all have different life experiences that shape who we are. The interviewer needs to embrace them (don't try to be someone you are not) and draw on them (hobbies, other life experiences, good and bad) when interviewing.

2. Ability to relate to juveniles/families: If you like people and enjoy talking to teenagers and families, you will be successful.

3. Communication skills: Do you really like to talk to people? If you do then you should also be a good listener. Do you pay attention to verbal and nonverbal cues? Do you know how to keep a conversation moving? Does your body language suggest that you want to hear what the other person is saying? You should be answering yes to all these questions.

4. Desire to get better. Your mindset must be: I want to get better.

5. You need to start practicing. Last night’s homework was your first practice session.

INTERVIEWING TIPS

- Learn to relax.
- Exude confidence.
- Credibility is crucial.
- Find your voice.

Slide 11-45

6. Learn to relax.

7. Exude confidence.

8. Credibility is crucial.

9. Find your voice.

INTERVIEWING TIPS (cont'd)

- You're only limited by your own imagination!

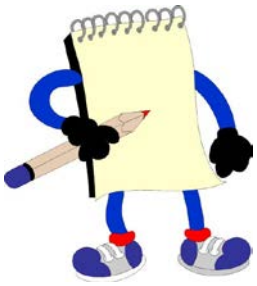
Slide 11-46

10. You're only limited by your own imagination!

IV. FIVE STEPS OF EFFECTIVE INTERVIEWING

FIVE STEPS OF EFFECTIVE INTERVIEWING

1. Planning.
2. Knowledge of case.
3. Timeliness.
4. Setting.
5. Documentation.



Slide 11-47

A. Five steps:

1. Planning.
2. Knowledge of case.
3. Timeliness.
4. Setting.
5. Documentation.

PLANNING

- Identify:
  - Gaps in information.
  - Questions that remain unanswered.
- Establish the goals of the interview.
- Prepare questions.

Slide 11-48

B. Planning.

1. Identify:

   a. Gaps in information.

b. Questions that remain unanswered.

2. Establish the goals of the interview.

3. Prepare questions.

PLANNING (cont'd)

- Determine a rapport building strategy.
- Determine documentation method.
- Decide if you need to consult with anyone before the interview:
  - Prosecutor.
  - Insurance investigator.
  - Other experts.

Slide 11-49

4. Determine a rapport building strategy.

5. Determine documentation method.

6. Decide if you need to consult with anyone before the interview:

   a. Prosecutor.

   b. Insurance investigator.

   c. Other experts.

KNOWLEDGE OF CASE

Review entire case file and all information gathered during preparation.

Slide 11-50

C. Knowledge of case: Review entire case file and all information gathered during preparation.

TIMELINESS

- Conduct the interview as close in time to the most recent fire as possible.
- When you are ready!
- Other considerations?

Slide 11-51

D. Timeliness.

1. Conduct the interview as close in time to the most recent fire as possible.

2. When you are ready!

3. Other considerations?

SETTING

- Options.
  - In the family home.
  - In an office environment.
- Other options?

Slide 11-52

E. Setting.

1. Options.

   a. In the family home.

   b. In an office environment.

2. Other options?

3. The location of the interview may be affected by:

   a. Department policy.

   b. Safety concerns.

   c. Transportation issues.

4. Family home: An interview in the family home allows the interviewer to learn about the family dynamics firsthand. When you interview in the family home, you are putting the family in their comfort zone. You also will be dealing with distractions that surround the family — neighbors, siblings, extended family, pets, etc.

5. Office: An interview in the office allows the interviewer to be in his or her comfort zone and take control of the interview. In this setting, you control distractions; however, you lose the ability to see family dynamics firsthand.

SETTING (cont'd)

- Consider an environment that is not unnecessarily distracting and allows you to collect the information that you are after.
- Other considerations?

Slide 11-53

F. Consider an environment that is not unnecessarily distracting and allows you to collect the information that you are after.

G. Other considerations?

DOCUMENTATION

Good documentation.

- Prevent later denials from interviewees.
- Consider legal issues.
- Decide best method of documentation.

Slide 11-54

H. Good documentation.

1. The key to preventing denial on the part of the interviewee is proper documentation.

2. All interviews should be properly documented.

3. All interviews must stay within legal guidelines.

4. Proper documentation demonstrates professionalism and proper procedures by the investigator.

5. Proper documentation includes:

   a. Taking notes.

   b. Tape recording interviews.

   c. Obtaining statements.

   d. Identifying pictures or diagrams with statements.

PREINTERVIEW PREPARATION

- Gather facts about the incident.
- Gather facts about the witness.

Slide 11-55

I. Gather facts about the incident.

J. Gather facts about the witness.

FACTS ABOUT THE INCIDENT

- Review all the case reports (police and fire reports).
- Review insurance information.
- Review earlier statements (witnesses and victim reports).
- Review the evidence.
- Establish how the fire was set (modus operandi).

Slide 11-56

K. Facts about the incident.

1. Review all the case reports (police and fire reports).
2. Review insurance information.
3. Review earlier statements (witnesses and victim reports).
4. Review the evidence.
5. Establish how the fire was set (modus operandi).

FACTS ABOUT THE WITNESS

- Learn as much as possible about the witness's background before the interview.
- Assists in rapport building with the witness.
- May change attitude of an uncooperative person.

Slide 11-57

L. Facts about the witness.

1. Learn as much as possible about the witness's background before the interview.

2. Assists in rapport building with the witness.

3. May change attitude of an uncooperative person.

FACTS ABOUT THE WITNESS (cont'd)

- Thoroughness may depend upon:
  - The seriousness of the incident.
  - The type of information desired.
  - The attitude of the witness.

Slide 11-58

M. Thoroughness may depend upon:

1. The seriousness of the incident.

2. The type of information desired.

3. The attitude of the witness.

WHOM DO YOU INTERVIEW?

Slide 11-59

N. Whom do you interview?

1. Firefighters.

   a. Fire personnel interviews are mandatory.

   b. Interviews can be conducted back at the station, but don't wait until the following day, since pertinent information may be lost or forgotten.

   c. Actions of first-arriving companies and actions of first-responding firefighters are considered critical information.

   d. Information needed.

2. Any suspicious activity noted while en route.

3. Problems with hydrant — blocked hydrant?

4. Hydrant threads tampered with, accessibility to scene — entry blocked.

5. Location and extent of fire: Was there forcible entry? Who did it? What method did they use? Which doors, windows, etc.?

6. Color of smoke and flames?

7. Spectators on-scene? Manner of dress, familiar faces, any spectators with signs of being involved in the fire?

8. Any vehicles leaving the scene?

   a. Note vehicles with fire damage.

b. Obtain license plate numbers.

9. Any equipment or possessions removed?

10. Unnatural odors?

11. Unusual fire load?

12. Location of fire upon entry?

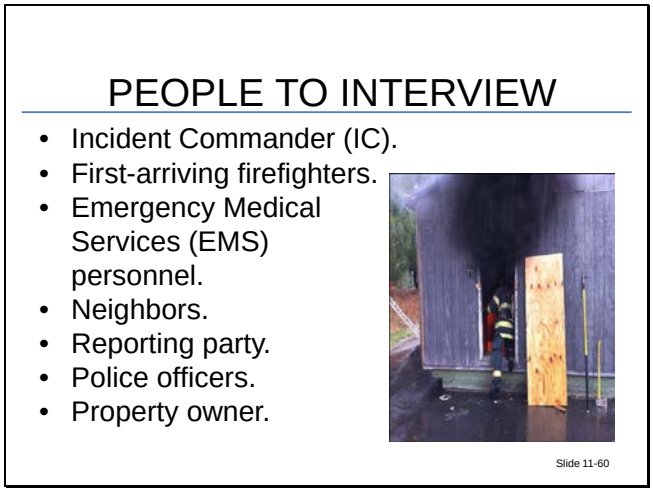
13. Reaction of fire when water was applied: Was the fire difficult to extinguish?

14. Was the structure prepared for burning?

a. Holes in ceilings, walls, floors?

b. Accelerants?

c. Devices found?



O. People to interview:

1. Incident Commander (IC).

2. First-arriving firefighters.

3. Emergency Medical Services (EMS) personnel.

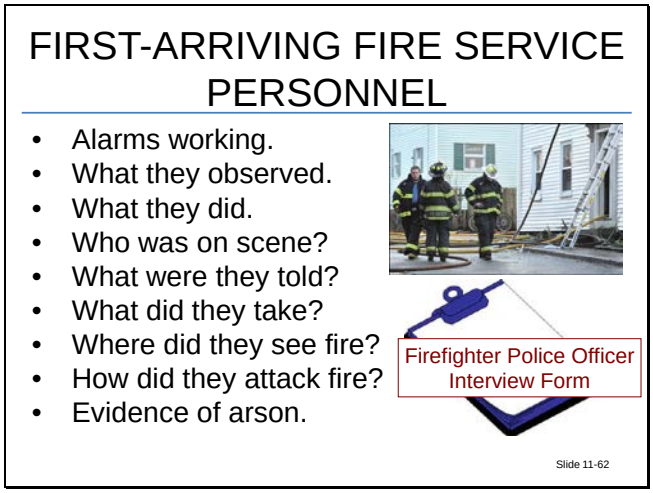
4. Neighbors.

5. Reporting party.

6. Police officers.

7. Property owner.

P. Start with the IC if the trucks are still on-scene.



Q. First-arriving fire service personnel.

1. Was the alarm system functioning?

   a. Type of system?

   b. Condition of system?

2. Were the owners/occupants on-scene?

   a. Attitude?

b. Opinions/Statements?

c. Dress?

d. If not on-scene, how soon did they arrive, and how far were they from the scene when notified?

3. Names of all people allowed into the fire scene.

4. Any physical evidence removed?

5. Have overhaul operations commenced?

6. Conditions of utilities? Who turned them off? What was turned off? Did they mark the circuit breakers they turned off or the ones that were already off?

7. Note construction or work crews in area.

a. Any crews in area before or during the fire.

b. Any crews there during the investigation.

8. Was there any evidence of incendiarism?

a. Flash fires?

b. Devices?

c. More than one fire?

d. Low burning?

e. Fires in unnatural locations?

f. Fires that were hard to extinguish?

9. Any civilian injuries or burns?

10. Any other information they may have?

EMERGENCY MEDICAL SERVICES PERSONNEL

- What did they observe?
- What did people tell them?
- Did the victim make any statements en route or at the hospital?

Slide 11-63

R. EMS personnel.

1. What did they observe?

2. What did people tell them?

3. Did the victim make any statements en route or at the hospital?

NEIGHBORS

Remember to conduct a neighborhood canvass.

Slide 11-64

S. Investigators need to remember to conduct a thorough neighborhood canvass to identify potential sources of information.

REPORTING PARTY

- The 911 caller.
- Person who discovered the fire.

Slide 11-65

T. Reporting party.

1. The 911 caller.

2. Person who discovered the fire.

REPORTING PARTY (cont'd)

Slide 11-66

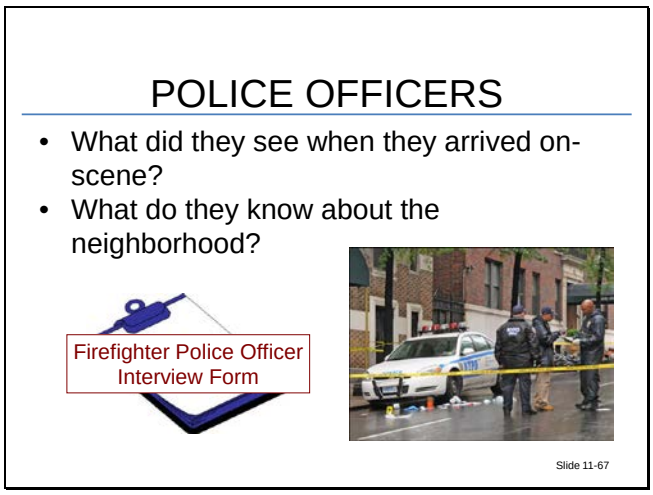
3. Ask yourself: Did the reporting party belong at the scene?

4. Could this be the arsonist?

5. Don't forget the five W's and the H (who, what, where, when, why and how).

6. Ask about observations regarding the fire (smoke, flames, etc.).

7. Ask about incidents prior to the fire (fights, etc.).



U. Police officers.

1. May be the first people on the scene.

2. Trained to notice peculiarities.

3. May have “street information” regarding incident.

4. Information needed:

   a. Extent of fire?

   b. Time on-scene?

   c. Color of flames/smoke?

   d. Vehicles observed leaving?

   e. Suspicious actions?

      - Owners/Occupants.

      - Spectators.

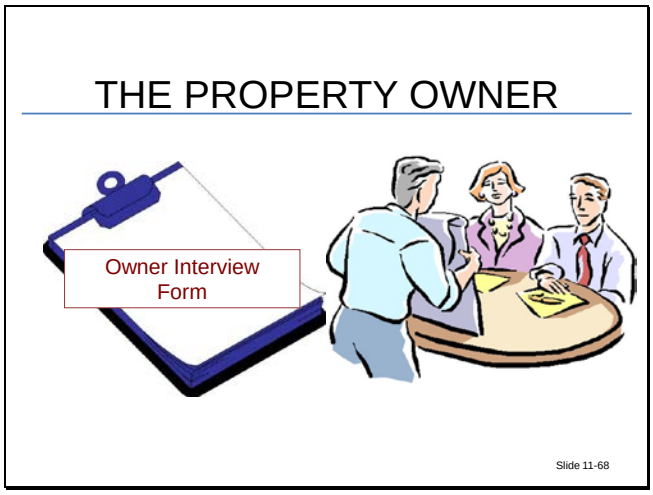
      - Crimes prior to accident.

      - Dress of spectators.

   f. Were owners/occupants on-scene?

      - Did you notify them?

- Their actions regarding the fire.
- Their opinions/statements.



V. The owners/occupants can usually provide facts about the incident.

1. This interview often takes place away from the scene, especially if there is any fear of retaliation, emotional trauma, etc.

2. Information needed:

   a. How was he or she notified of the fire?

   b. Who was the last person in the occupancy?

   c. How many keys are available? Who has a key?

   d. Was the building/business for sale?

   e. How has business been?

THE FOUR MECHANICS OF INTERVIEWING

- Document biographical information.
- Use the IRONIC method.
- Begin with the 24-hour alibi.
- Ask open-ended questions.

Slide 11-69

3. Document biographical information.

4. Use the **I**ntroduction, **R**apport building, **O**pening statement, **N**arrative, **I**nquiry and **C**onclusion (IRONIC) method.

5. Begin with the 24-hour alibi.

6. Ask open-ended questions.

EXPANDED BIOGRAPHICAL INFORMATION, NATIONAL FIRE PROTECTION ASSOCIATION 921, 14.4.2.4

- Full name.
- Date of birth.
- Social Security number.
- Driver's license number.

Slide 11-70

W. Expanded biographical information.

The statement must include:

1. Full name.

2. Date of birth.

3. Social Security number.

4. Driver's license number.

EXPANDED BIOGRAPHICAL INFORMATION, NATIONAL FIRE PROTECTION ASSOCIATION 921, 14.4.2.4 (cont'd)

- Physical description.
- Home address and telephone number.
- Place of employment.
- Business address and telephone number.

Slide 11-71

5. Physical description.

6. Home address and telephone number.

7. Place of employment.

8. Business address and telephone number.

V. "IRONIC" INTERVIEWING METHOD

"IRONIC" INTERVIEWING METHOD

- **I**ntroduction.
- **R**apport building.
- **O**pening statement.
- **N**arrative.
- **I**nquiry.
- **C**onclusion.

Slide 11-72

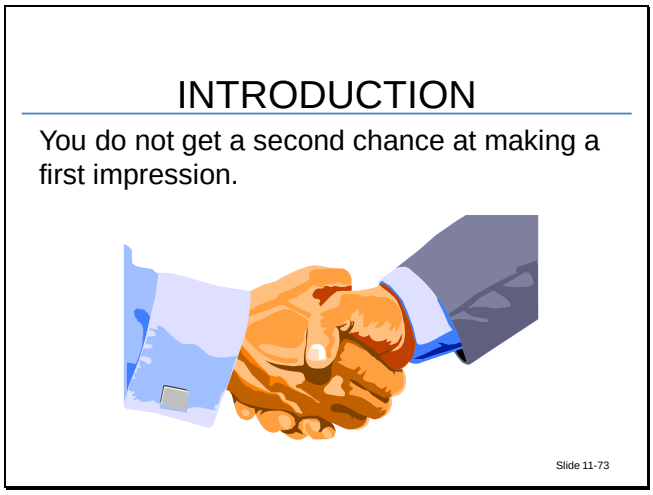
A. One officer does the interview; one takes notes and shows interest.

1. Use the 20/80 rule.

2. No interruptions.

3. Stay with the youth in the story.

4. Verify understanding.



B. Introduction.

1. Introductions usually are verbal.

2. First, the investigator should introduce and identify himself or herself.

3. The investigator needs to confirm the interviewee's identity.

4. Driver's license can speed up the confirmation process.

   a. Picture.

   b. Date of birth.

   c. Address.

   d. Driver's license number.

5. Styles of introduction:

   a. Businesslike: Present a business card.

   b. Nonchalant: Casually introduce yourself, with no pressure.

   c. Authority: Use your title, and exhibit an "I'm in charge" attitude.

   d. Friendly: Offer a handshake, pat on the back, "How are you doing?" approach.

RAPPORT BUILDING

The key to the IRONIC method!

Slide 11-74

C. Rapport building: Investigator's attitude can be a deciding factor in the interview.

1. Investigator must be professional and positive.
2. Investigator is there in an objective role, not a subjective one. The purpose is to get the facts, not to decide innocence or guilt.
3. Attempt to get the interviewee in a talkative mood.
4. Guide the interview.
5. Subject should be allowed to complete his or her answers without interruptions.
6. Make mental notes of inconsistencies.
7. Be prepared for spontaneous statements.
8. Interviewee may stop if the investigator appears to be shocked or caught off guard.
9. Questions need to be phrased to maintain a free flow of information.
10. Be prepared to vary the line of questioning.
11. Interviewee may provide more information than the investigator expected.

D. Opening statement.

1. Advise the interviewee that you will be recording the interview.

   a. Recording can be in the form of note-taking, tape recorder, video recorder, etc.

   b. Advise of consent to record form.

2. Begin by noting date, location, people present and time interview began.

3. Make a few general statements about the incident in question.

   a. Do not disclose any specific facts regarding the case.

   b. This provides a starting point for questioning and allows the investigator to size up the interviewee.

4. Proceed with the interview.

NARRATIVE

- Take the statement in a narrative form.
- Have the interviewee tell you his or her story.

Slide 11-76

E. Narrative.

1. Indirect approach often is used when the interviewee is aware of the reasons for the interview.

2. Interviewee should be allowed to relate the information in narrative form.

   a. Specific questions may not be necessary until interviewee has finished his or her story.

   b. If questions are interjected, interviewee may not finish the story.

3. Direct questioning may be necessary when the interviewee shows:

   a. Dislike or distrust of the investigator.

   b. Fear.

   c. Retaliation.

   d. Desire to protect family, relative or friend.

   e. Reluctance to talk.

4. Interviewing specific individuals:

   a. Complainant.

      - Here investigator must be receptive.

      - Let complainant know the importance of the situation and that actions will be taken.

- Use caution in rendering a decision due to the fact that complainant may be acting on a grudge.

- Listen to both sides.

b. Witnesses.

- Examine relationships between witness and those connected with the incident.

- Convince the witness that his or her information is important.

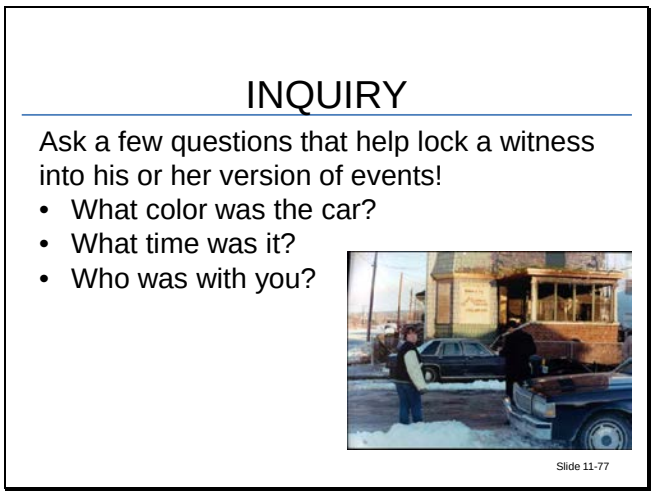
c. Owners/Occupants.

- Investigator must be sympathetic.

- May be emotional trauma.

- May be shock.

5. Investigator needs to be objective when comparing physical evidence to statements obtained.



F. Inquiry: Ask a few questions that help lock a witness into his or her version of events!

1. What color was the car?

2. What time was it?

3. Who was with you?

CONCLUSION

Close the interview:

- Thank them.
- Give them your contact information.
- Tell them to call when they remember something.

Slide 11-78

G. Close the interview.

1. Thank them.

2. Give them your contact information.

3. Tell them to call when they remember something.

THE 24-HOUR ALIBI

12 hours **before**

12 hours **after**

Slide 11-79

H. Investigators should establish the events around an incident 12 hours before and 12 hours afterward and lock in witness/suspect statements to corroborate their exact whereabouts during this 24-hour time frame.

OPEN-ENDED QUESTIONS

- Who?
- What?
- Where?
- When?
- Why?
- How?

Slide 11-80

I. The six basic investigative questions to be answered in all incidents are who, what, where, when, why and how.

DOCUMENTING THE INTERVIEW, NATIONAL FIRE PROTECTION ASSOCIATION, 14.4.3

- Oral:
  - Investigator takes notes.
  - Audio recording.
- Written by:
  - Interviewee.
  - Suspect.
  - Investigator.
- Obtain signed, written statements from as many witnesses as possible.

Slide 11-81

J. Documenting the interview.

1. Oral:

   a. Investigator takes notes.

   b. Audio recording.

2. Written by:

   a. Interviewee.

   b. Suspect.

   c. Investigator.

3. Obtain signed, written statements from as many witnesses as possible.

DOCUMENTING THE INTERVIEW, NATIONAL FIRE PROTECTION ASSOCIATION, 14.4.3 (cont'd)

- Electronic recording.
  - Video recording.
    - -- Comply with state laws and regulations.

Slide 11-82

K. All taping must be done in accordance with applicable laws and regulations.

VI. INTERVIEW VERSUS INTERROGATION

INTERVIEW VERSUS INTERROGATION

- What are the differences?
- When does an interview turn into an interrogation?

Slide 11-83

INTERVIEW VERSUS INTERROGATION (cont'd)

- Goals of an interview.
  - Fact-gathering.
  - Elicit information.
  - Investigate information.
- Goals of interrogation.
  - Confession.
  - Admission.
  - Detailed lie.

Slide 11-84

A. An interview and an interrogation have very different goals. What is a goal?

1. Goal-setting ideally involves establishing **S**pecific, **M**easurable, **A**ttainable, **R**ealistic and **T**ime-targeted (SMART) objectives. Work on the goal-setting theory suggests that it can serve as an effective tool for making progress by ensuring that participants have a clear awareness of what they must do to achieve or help achieve an objective.

2. An **interview** is a conversation between two people (the interviewer and the interviewee) where questions are asked by the interviewer to obtain information from the interviewee. This is a dialogue between the interviewer and interviewee.

   a. Fact-finding.

   b. Elicit information.

   c. Investigate information.

3. **Interrogation** (also called questioning or interpellation) is interviewing as commonly employed by officers of the police, military and intelligence agencies with the goal of extracting a confession or obtaining information. Subjects of interrogation are often the suspects, victims or witnesses of a crime. Interrogation may involve a diverse array of techniques, ranging from developing a rapport with the subject to outright torture. An interrogation involves a monologue. Other goals of an interrogation are documenting an admission or taking a detailed lie.

Differences Between Interview and Interrogation	
Interview	**Interrogation**
Fact-gathering	Accusatory
Dialogue	Monologue
Cordial	Sympathetic and compassionate
Does not have to be in a private setting	Conducted in a private setting
Interview is documented, notes are taken	Notes are not taken during the interrogation

Slide 11-85

THE SIX DEADLY SINS OF INTERVIEWING

- Interrupting.
- Interrogating.
- Arguing.
- Judging.
- Advising.
- Doing all the talking.

Slide 11-86

B. If any of the six deadly sins make their way into an interview, they will have disastrous results. Remember, the goal of an interview is to gather information. The six deadly sins inhibit that process.

SPECIAL CONSIDERATIONS

- How many interviewers?
- How do I interview in teams?
- Who else needs to be present?

Slide 11-87

C. Special considerations.

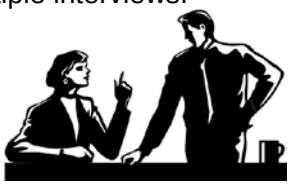
1. How many interviewers?

2. How do I interview in teams?

3. Who else needs to be present?

NUMBER OF INTERVIEWERS

- Local customs/requirements may dictate.
- Single person: rapport building/sensitive issues.
- Team: covers more ground/reduced need for multiple interviews.



Slide 11-88

D. Number of interviewers.

1. Local customs/requirements may dictate.

2. Single person: rapport building/sensitive issues.

3. Team: covers more ground/reduced need for multiple interviews.

INTERVIEWING IN TEAMS

- Duties of a lead interviewer:
  - Build rapport.
  - Develop and exhaust question list.
  - Defer to second interviewer when done.
  - Determine method of documentation.

Slide 11-89

E. It is highly recommended that interviews take place in teams when possible. This will allow for a more rich and complete interview. As previously stated, two interviewers is ideal. Each interviewer has duties and a set of responsibilities.

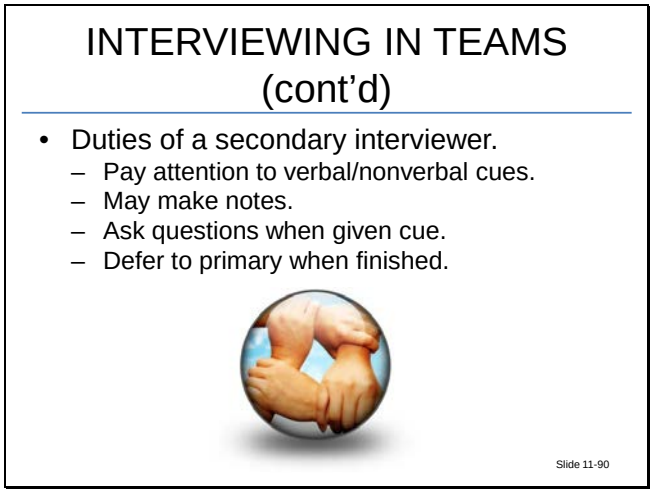
1. Build rapport with juvenile and caregiver.

2. Develop and exhaust question list. Once the questions are developed, make sure they are all asked.

3. Defer to second interviewer when done. When you have asked all your questions, defer to your partner.

4. Determine method of documentation. You are responsible for documenting the interview; you decide how to document it.

F. Law enforcement officers typically have interview training and experience, as well as an understanding of legal issues and police powers.



G. As the second interviewer, you are responsible for:

1. Paying attention to verbal/nonverbal cues from the juvenile.

2. Taking notes. Write down observations or thoughts while the first interviewer is asking questions.

3. Asking questions when given cue. Ask any questions you have when the first interviewer defers to you.

4. Defering to primary when finished. When you have finished all your questions, defer back to the primary interviewer.

WITNESSES PRESENT

Slide 11-91

H. Follow all department policies when determining who should be present during an interview.

1. Make sure witnesses will not be detrimental to the interview. (Too many witnesses may cause the interviewee to be reluctant to talk.)

2. Consider having another person present when interviewing:

   a. Juveniles.

   b. People of the opposite sex.

   c. Interpreters.

INTERVIEWING (cont'd)

- Purpose: to gather information that will establish the existence of previously unknown facts.
- A systematic conversation with a person believed to have information who is willing to cooperate.

Slide 11-92

I. Interviewing.

1. Purpose: to gather information that will establish the existence of previously unknown facts.

2. A systematic conversation with a person believed to have information who is willing to cooperate.

GOALS OF A GOOD INTERVIEW

- Obtain useful information.
- Confirm or contradict the investigator's findings.
- Develop a timeline or sequence of events.
- Establish investigative leads.
- Establish possible motives or reasons for the fire.

Slide 11-93

J. Goals of a good interview.

1. Obtain useful information.
2. Confirm or contradict the investigator's findings.
3. Develop a timeline or sequence of events.
4. Establish investigative leads.
5. Establish possible motives or reasons for the fire.

GOALS OF INTERROGATION

The goal of an interrogation is to obtain:

- A legal confession to a crime.
- Admission to the crime.
- Detailed lie.

Slide 11-94

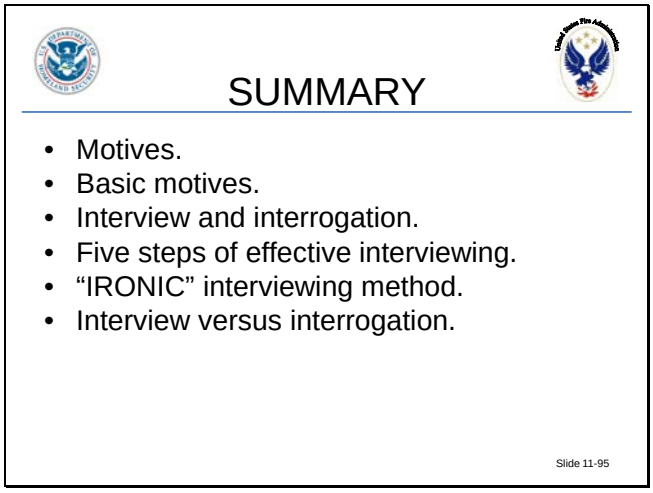
K. The goal of an interrogation is to obtain:

1. A legal confession to a crime.

2. Admission to the crime.

3. Detailed lie.

VII. SUMMARY



UNIT 12: INJURY AND FATAL FIRE INVESTIGATION

TERMINAL OBJECTIVE

The students will be able to:

12.1 Employ the proper procedures for the investigation of an injury or fire fatality.

ENABLING OBJECTIVES

The students will be able to:

12.1 Identify the relationship between an origin-and-cause investigation and an injury or death investigation.

12.2 Identify the specific roles of the coroner, medical examiner, law enforcement, fire investigator and other involved agencies.

12.3 Explain the importance of the fire victim's location, condition, physiology, toxicology and position.

12.4 Identify the protocol for a line-of-duty death (LODD).

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UNIT 12: INJURY AND FATAL FIRE INVESTIGATION

Slide 12-1

ENABLING OBJECTIVES

- Identify the relationship between an origin-and-cause investigation and an injury or death investigation.
- Identify the specific roles of the coroner, medical examiner, law enforcement, fire investigator and other involved agencies.

Slide 12-2

ENABLING OBJECTIVES (cont'd)

- Explain the importance of the fire victim's location, condition, physiology, toxicology and position.
- Identify the protocol for a line-of-duty death (LODD).

Slide 12-3

I. FATAL FIRE STATISTICS

FIRE AND EXPLOSION DEATHS AND INJURIES

According to National Fire Protection Association (NFPA), Chapter 23:

- Mechanism of death — toxic gases, hyperthermia, skin burns, smoke and soot, hypoxia, blast pressure.
- Consumption of the body by fire — skin, muscle, bone, fat damage.
- Post-mortem changes — rigor mortis, lividity.

Slide 12-4

According to National Fire Protection Association (NFPA), Chapter 23, certain statistics are prevalent in fire and explosion deaths and injuries.

A. In fatal situations:

1. The mechanism of death is usually toxic gases, hyperthermia, skin burns, smoke and soot, hypoxia, or blast pressure.

2. Consumption of the body by fire includes skin, muscle, bone and fat damage.

3. Post-mortem changes include rigor mortis and lividity.

FIRE AND EXPLOSION DEATHS AND INJURIES (cont'd)

- Investigating fire scenes with fatalities — fire department's role, team concept, safety, documentation, body and evidence recovery.
- Investigating fire scene with injuries.
  - Explosion deaths and injuries.

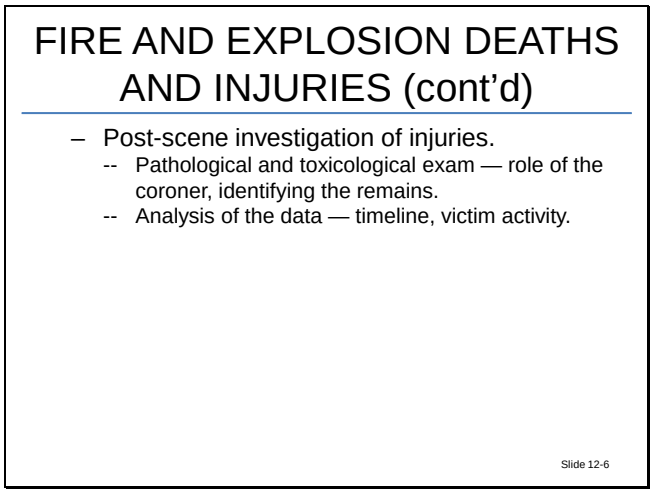
Slide 12-5

B. The fire departments have their own roles that deal with team concept, safety, documentation, and body and evidence recovery.

C. In situations involving injury:

1. Fire scenes are investigated.

2. Explosion scenes are investigated.

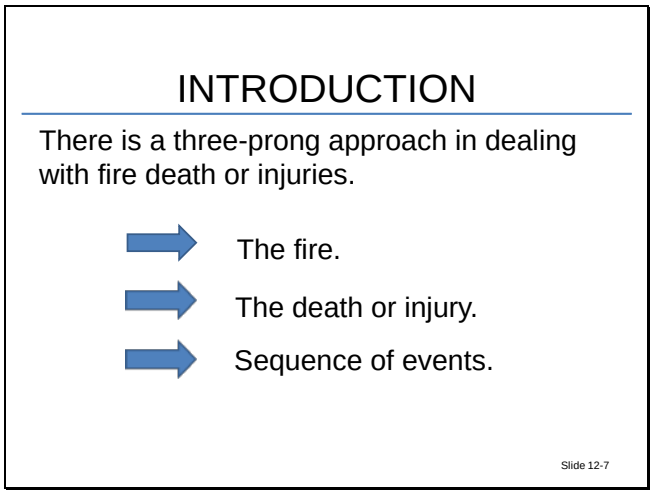


3. Further investigation continues post-scene, including:

   a. Pathological and toxicological exam performed by the coroner who is responsible for identifying the remains.

   b. Analysis of the data, including the timeline and victim activity.

II. DEATH SCENE CONSIDERATIONS



A. There are three distinctive investigations — the origin-and-cause investigation; the injury or death investigation; and the third prong that often encompasses both, bringing the entire case together.

1. The fire.

2. The death or injury.

3. Sequence of events.

WHAT IS YOUR ROLE?

Slide 12-8

4. Understanding your role during a fatal fire investigation is critical to a successful outcome. Before any fatality or injury investigation, the investigator needs to understand his or her specific role.

   a. Often, the assigned fire investigator may “wear several hats” and will be responsible for all aspects of the investigation.

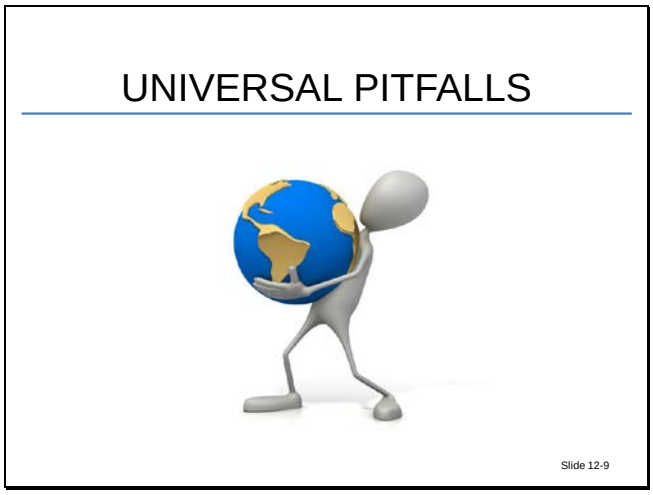
   b. Some jurisdictions separate duties, wherein the fire department will be responsible for the fire scene and the police department will handle the death or injury investigation.

5. In many locations, the fire investigator is required to determine if other agencies should be notified concerning a fire fatality or injury.

   a. Many fire injuries or deaths are connected to other crimes (or crime concealment) and must be investigated jointly by the fire investigator and other agencies.

   b. Frequently, fire investigators are required to testify in civil lawsuit actions concerning fire injuries and deaths, as they relate to product defects and/or equipment failures.

B. The investigation of fatal fires may be subject to very detailed examination (or review) by government administrators, news media and court officials, even years after the incident.



1. Investigators can create several problems during the preliminary scene examination. These can include:

   a. Slow or delayed response to the scene.

   b. Lack of proper scene security to prevent unnecessary damage to the body or contamination of the scene and evidence.

   c. Extensive fire department overhaul.

   d. Poor documentation of the body and surrounding circumstances.

   e. Failing to work with other agencies as required, such as the police department and coroner's/ medical examiner's office.

   f. Making assumptions too early in the investigation, before all information has been obtained and thoroughly reviewed.

   g. Not properly preparing for interviews.

RESPONSIBILITIES IN THE INVESTIGATION OF FATAL FIRES

- Timely arrival of the investigator.
- Security of incident scene.
- Provide investigative assistance.
- Notification of appropriate agencies.

Slide 12-10

2. Investigators need to be mindful of four basic responsibilities.

   a. They must arrive in a timely manner.

   b. They must maintain security of the incident scene.

   c. They must provide investigative assistance.

   d. They must notify appropriate agencies.

C. The four basic responsibilities are extremely important.

TIMELY ARRIVAL OF THE INVESTIGATOR

Slide 12-11

1. Timely arrival of the investigator:

   a. Reduces anxiety.

   b. Helps preservation of the scene.

c. Allows for identification and interviews of witnesses who are still present.

d. Helps to locate injured people who may still be at the scene.

SCENE SECURITY

Slide 12-12

2. Scene security, control and preservation are paramount in a fatal fire investigation.

   a. Many fire scenes attract spectators who can contaminate the scene. Use sign-in sheets to record who entered the scene and for what purpose.

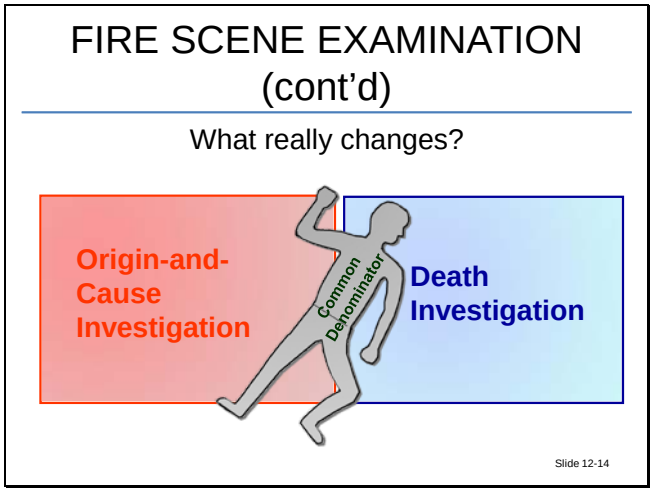
   b. Overhaul should be managed to limit the potential for loss, alteration or destruction of evidence (not to mention the body).

   c. All building systems should be left in their original conditions (i.e., electrical switches, heating and air conditioning units, natural gas appliances, etc.).

FIRE SCENE EXAMINATION

Slide 12-13

3. The fire scene examination must be carefully conducted, taking into consideration that the location may be a potential crime scene and requires meticulous processing to identify the circumstances surrounding the fire and the death.



a. It becomes two individual investigations.

- Fire origin and cause.
- Fire death investigation.

b. Any contradiction of facts that develops must be reconciled.

- This may involve notification and/or response from other agencies.
- This may involve line-of-duty deaths (LODDs).

c. Understand and know your responsibility.

DEVELOP A TEAM CONCEPT

Slide 12-15

4. The practice of notifying appropriate agencies is best served by developing a team approach before a fatality occurs. This team should include, but is not limited to:

   a. Legal.

   b. Fire investigator.

   c. Police homicide investigator.

   d. Medical examiner (coroner).

   e. Private sector investigator.

   f. Additional experts who may, at times, be needed.

      - Electrical engineers.
      - Mechanical engineers.
      - Fire protection engineers.
      - Accelerant detection professionals.
      - K-9 teams.

ROLE OF THE CORONER

- Fire investigator's determination can be preliminary, but be careful! Final reports should not be completed until the coroner's final report is reviewed.
- Forensic pathologist is needed to perform forensic autopsies.

Slide 12-16

D. The coroner plays a key role in the death scene investigation.

1. The fire investigator's determination can be preliminary, but final reports should not be completed until the coroner's final report is reviewed.

2. A forensic pathologist is needed to perform forensic autopsies.

OBJECTIVES OF A FORENSIC AUTOPSY

- Identification of victim.
- Establish:
  - The time of death.
  - The cause of death.
  - The manner of death.

Slide 12-17

a. Identification of victim.

b. Establish:

- The time of death.
- The cause of death.
- The manner of death.

FORENSIC AUTOPSY PROCEDURES

- Supervise the removal of the victim.
- Conduct a post-mortem examination of the body.
- Through external, internal and microscopic exams.
- Perform a radiological examination.
- Conduct toxicology tests.

Slide 12-18

3. Special considerations are taken in regard to firefighter deaths.

   a. Consider the impact that a fire death delivers when there is a firefighter fatality or young children are involved.

   b. Despite these issues and any potential political pressure, step back and take the time needed to ensure that a comprehensive inquiry is conducted.

SEARCHING MAY BE DIFFICULT

Slide 12-19

E. Searching a fatal fire scene may be difficult.

   1. Special equipment/resources may be required:

      a. Front end loader.

      b. Hazardous materials site.

      c. Crane.

2. Be sure not to contaminate the scene during the origin-and-cause investigation and recovery of remains.

Slide 12-20

III. FIRE SUPPRESSION CONSIDERATIONS

FIRE SUPPRESSION CONSIDERATIONS

Fire suppression efforts or delay in response can play a large part in determining cause of death.

Slide 12-21

A. Fire suppression efforts or delay in response can play a large part in determining the cause of death as well as the cause of the fire.

THREE BRIDGES

- Moving the body.
- Embalming the body.
- Disposing of the body.
- Once crossed, you cannot go back.

Slide 12-22

B. There are specific actions that once done cannot be reversed.

1. The investigator should leave the body where found, if possible, to avoid further loss, damage or alteration of the body and the scene.

MOVING THE BODY

- Most states do not forbid moving the body prior to the coroner's arrival.
- Factors involved in deciding to move the body.

Slide 12-23

a. It benefits the entire investigation by leaving the body in place.

b. There are times when the body may be removed before the investigator arrives:

- Rescue or resuscitation.
- Imminent danger of building collapse.
- Uncontrollable fire in vicinity of the body.

2. Document, if at all possible, the exact area/location where the body was recovered.

   Statements from the firefighters or individuals who located and removed the body are going to be crucial in understanding where the body was located, how it was discovered, how it was positioned, etc.

IV. DOCUMENTATION

DOCUMENTATION

Slide 12-24

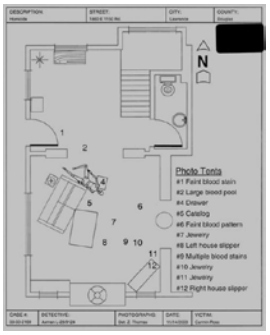
A. As soon as conditions permit, photograph the scene.

   1. Even if the body is going to be moved, a series of photographs is important to document the original location and condition of the body.

   2. Don't disturb debris.

DOCUMENTATION (cont'd)

- Diagrams — not to scale.
- Photography.
  - Scene photos.
  - Body photos.
- Information regarding the fire and the victim.



Slide 12-25

   3. Photograph or videotape the body movement.

a. Document the area where the body was removed from.

b. Photograph the body when placed in the body bag.

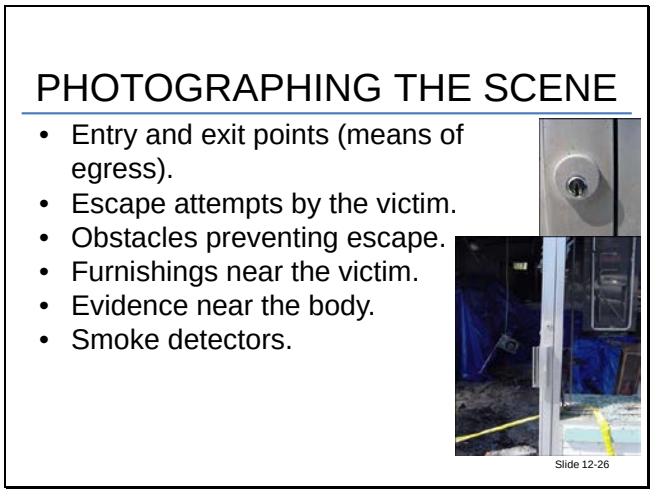
c. Photograph the body before the clothing is removed.

4. Photograph burns, from a distance and close-up. Close-ups should be taken with a scale in the photo.

5. Document measurements and distances. You need to be able to “place” the body back in the diagram.

6. Consider total station system or forensic mapping if these resources are available.

7. Doors, windows, exits, and other unique features or obstructions need to be documented.



B. Photos of the scene are taken with respect to the victim. These are over and above those taken for origin and cause.

SMOKE DETECTORS

- Identify location.
- Were they operational?
- Hard-wired or battery.
- Monitored.
- Witness statements to support activation.

Slide 12-27

C. Look for smoke detectors on the floor in the debris or in the pile of overhaul debris.

1. Did anyone hear the alarm sounding?

2. Determine if soot is attached to the external audible horn.

3. Sound activation causes vibrations, which result in remarkable patterns around the sound cone. Recent research suggests that these soot accumulations around the horn are an indication that the smoke detector was sounding.

PHOTOGRAPHING THE BODY

- Items that assist in identification.
- Position of the body.
- Extent of burning to the body.
- Removal of the body.
- Body location in relation to the origin of the fire.

Slide 12-28

D. Photograph everything in and around the body.

1. Items that assist in identification.

2. Position of the body.

3. Extent of burning to the body.

4. Removal of the body.

5. Body location in relation to the origin of the fire.

Slide 12-29

6. Note position of the body relative to the surrounding items. Does it make sense?

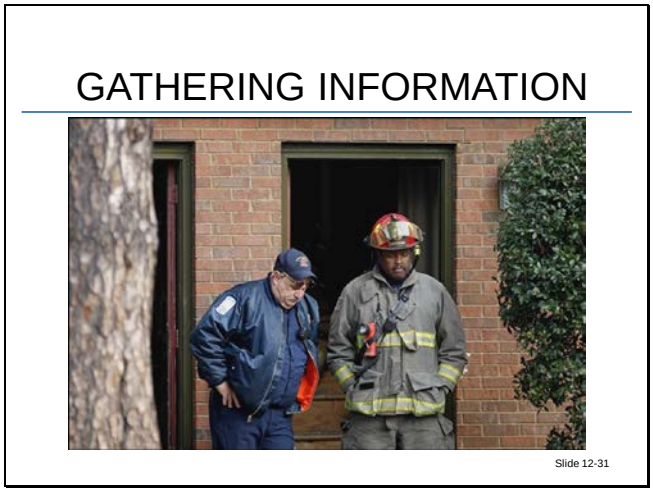
Slide 12-30

7. Identifying the fire cause is the first priority.

   a. In this case, spent matches were located near the deceased's body.

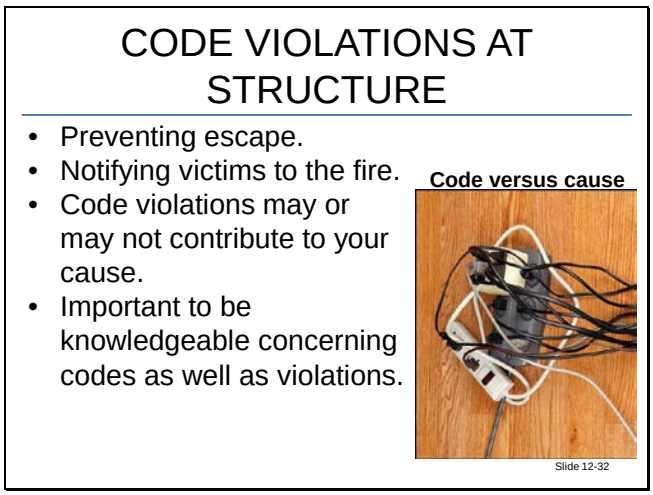
   b. These could be a clue as to the cause of the fire and could help support hypotheses concerning the cause of death.

V. GATHERING INFORMATION



A. Information gained through interviews and evidence at the scene must be carefully analyzed, based on the totality of the circumstances.

1. Who is likely to be at the scene?
2. Who was seen entering the structure?
3. Who is missing?
4. What is missing?
5. Who has access?



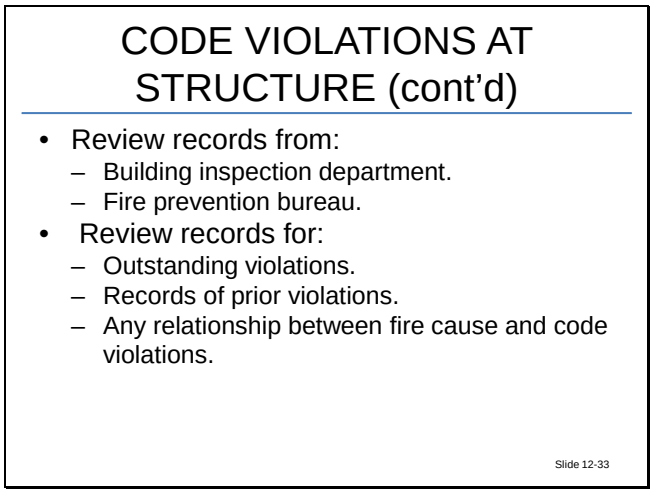
B. Code violations at structure.

1. Preventing escape.

2. Notifying victims to the fire.

3. Code violations may or may not contribute to your cause.

4. Important to be knowledgeable concerning codes as well as violations.



C. There are a variety of resources for researching code violations, including fire department records and building inspection department records.

1. Review records from:

   a. Building inspection department.

   b. Fire prevention bureau.

2. Review records for:

   a. Outstanding violations.

   b. Records of prior violations.

   c. Any relationship between fire cause and code violations.

MEANS OF EGRESS

Slide 12-34

D. Interior door lock without the key or security grates on windows and doors may have prevented escape.

IF TENTATIVE ID MADE, ASK:

- Was the victim a smoker or drug user?
- What was the mental state of the victim?
- What was the victim's medical history?
- When did you last see the victim? Establish a timeline.

Slide 12-35

E. Gather facts about the victim.

1. Could these have contributed to the death? If so, they need to be followed up on and documented as part of the final investigative report.

Slide 12-36

2. Documenting the lifestyle of the deceased can help paint a picture that may provide an indication of why the victim was unable to escape the fire.

GATHER ADDITIONAL INFORMATION

Sources:

- Last person to see victim.
- Discoverer of the fire.
- Discoverer of the victim.
- Last person at the point of origin.
  - Remember to maintain custody!

Slide 12-37

a. The last person to see the victim alive can help provide clues as to his or her mental state or physical condition prior to the fire.

b. The person who discovered the fire may be able to help identify the area/room of origin.

c. The person who discovered the victim may be able to provide detailed information regarding the location, position and condition of the body.

d. The last person at the point of origin can help establish prefire conditions, specific location(s) of building contents, and prefire layout of the structure.

DETAILS OF INSURANCE COVERAGE

- Fire insurance.
- Life insurance.

Slide 12-38

F. Investigators should determine the existence of any fire or life insurance policies to document coverage, beneficiaries, etc.

VI. DOCUMENT BODY AT SCENE

DOCUMENT BODY AT SCENE

Slide 12-39

A. Careful examination of the body must be completed at all scenes to help locate any evidence that the death was not the result of accidental causes.

CONSIDERATIONS ABOUT HUMAN BEHAVIOR

- Fear.
- Panic.
- Peer response.
- Training in appropriate fire behavior.
- Lack of training in appropriate fire behavior.

Slide 12-40

B. There are a variety of reasons why some people do not escape fire.

1. Peer response is the primary reason why people were slow to exit the Station Nightclub fire in Warwick, Rhode Island, in 2003 that claimed the lives of 100 people.

   a. Fear.

   b. Panic.

   c. Peer response.

   d. Training in appropriate fire behavior.

   e. Lack of training in appropriate fire behavior.

FIRST REACTION TO FIRE

Slide 12-41

2. Individuals' reactions to fire vary; however, the first thought that most people have is to call the fire department, then evacuate the building.

UNIVERSAL PRECAUTIONS

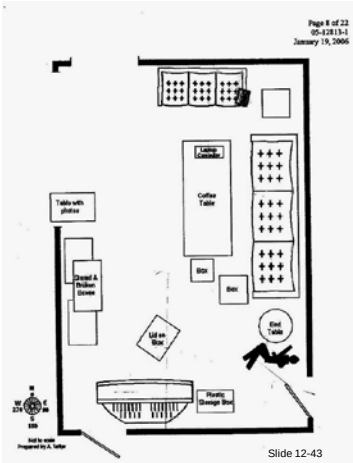
- Disposable gloves.
- Do not use fire work gloves.
- Eye and face protection.
- Disposal of contaminated debris.
- Clean tools after use.

Slide 12-42

C. Universal precautions against contamination from body fluids must be taken at all scenes where a fatality or injury occurs.

1. Disposable gloves.
2. Do not use fire work gloves.
3. Eye and face protection.
4. Disposal of contaminated debris.
5. Clean tools after use.

Location of the Victim



Slide 12-43

D. The location of the victim is important in determining if he or she was mobile or not and whether he or she could have escaped the fire.

Slide 12-44

1. Victim is located in the bathroom, which he may have thought was a safe refuge. Oftentimes, individuals (especially children) are found in places that they feel are safe from the fire, such as in closets or under beds.

VICTIM'S MOVEMENT

- Myth: A victim discovered facedown indicates that the person was moving; a victim lying face up is suspicious.
- Fact:
  - Forward movement and center of gravity may cause victim to fall facedown but not an absolute.
  - Standing straight up, a victim could fall forward or back.

Slide 12-45

Slide 12-46

2. Victim is found facedown. This may be an indicator that the victim was mobile, but it is not an absolute indicator.

VICTIM'S MOVEMENT (cont'd)

- If victim is located at the point of origin, need to ask why.
  - Attempting to locate/suppress the fire.
  - Incapacitated.
  - Ignition witness.
    - -- Person responsible for initiating fire.

Slide 12-47

E. It is important to determine why the victim is found in the area or room of origin.

Slide 12-48

1. This is a victim at the point of origin, as confirmed by the burn patterns on furnishings, walls and body. This was confirmed during reconstruction.

Slide 12-49

Slide 12-50

2. This victim was mobile and found to be in the bathroom with the water running.

Slide 12-51

3. This is a protected area, showing the victim's position after removal.

MANNER OF DRESS

Slide 12-52

F. Manner of dress will affect establishing the time of death.

1. This fire occurred on a spring night. Is the dress appropriate for the time of day and season?

Slide 12-53

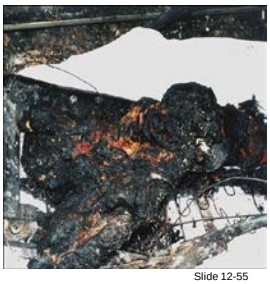
2. Does the clothing have burn patterns, or is the damage consistent with the suspected fire cause? The suspected cause was removing a pot of burning oil from the stove and spilling it, filling a portable heater while it was still in operation. Is the burning to the shoes and feet consistent with this?

Slide 12-54

3. Some clothing is located under the victim. It was protected by the victim's body. The area may contain a wallet or other form of identification or evidence.

QUESTIONS TO CONSIDER

- Are the remains human?
- What was the victim's identity?
- Was the victim alive during the fire?
- What were the cause and manner of death?



Slide 12-55

G. One of the key questions that must be considered is whether the remains found are human or animal.

1. Are the remains human?

2. What was the victim's identity?

3. Was the victim alive during the fire?

4. What were the cause and manner of death?

VII. ROLE OF THE MEDICAL EXAMINER

DETERMINING CAUSE OF DEATH

- Cause and manner of death are the responsibility of the coroner.
- Fire investigator can make observations.
  - Observation of fire effects.
  - Observation of time effects on the body.

Slide 12-56

The coroner or medical examiner is ultimately responsible for determining the cause and manner of death.

A. Cause and manner of death are the responsibility of the coroner.

B. Fire investigator can make observations.

1. Observation of fire effects.

2. Observation of time effects on the body.

VIII. CARBON MONOXIDE, HYDROGEN CYANIDE GAS AND OXYGEN DEFICIENCY

CARBON MONOXIDE POISONING

- Carbon monoxide combines with hemoglobin and displaces oxygen.
  - Carboxyhemoglobin (COHb).
- It has an attraction 230 times greater than oxygen.
- Takes place in the red blood cells.
  - Cells take O_2 to the body.
  - Cells remove carbon monoxide from the body.

Slide 12-57

One possible cause of death is carbon monoxide poisoning.

A. Carbon monoxide is produced in every fire.

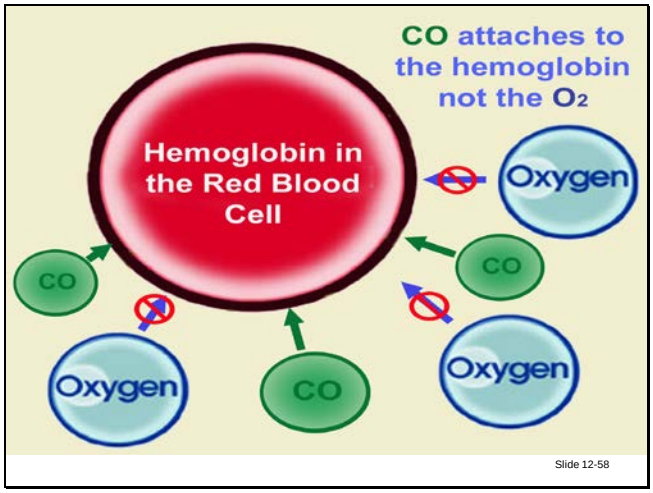
B. Carbon monoxide combines with hemoglobin and displaces oxygen — carboxyhemoglobin (COHb).

C. It has an attraction 230 times greater than oxygen.

D. Takes place in the red blood cells.

1. Cells take O_2 to the body.

2. Cells remove carbon monoxide from the body.



E. This graphic shows that there is a greater attraction between carbon monoxide and hemoglobin than between oxygen and hemoglobin.

CARBON MONOXIDE POISONING (cont'd)

0-10%	Normal, shortness of breath with vigorous exercise
10-20%	Headache, flushed skin, shortness of breath with moderate exercise
20-30%	Headache, throbbing temples, irritability, emotional instability, impaired judgment, memory impairment, rapid fatigue
30-40%	Dizziness, weakness, nausea, vomiting, severe headache, visual disturbances, confusion, incapacitation
40-50%	Intensified symptoms, hallucinations
>50%	Syncope, coma, tachycardia, convulsions, loss of reflexes, respiratory paralysis, death

Slide 12-59

F. Over 50 percent carbon monoxide poisoning is fatal, but death can result from lower levels of carbon monoxide intake.

CARBON MONOXIDE POISONING (cont'd)

- Smokers will naturally have higher levels than nonsmokers.
  - Smokers have between 4 to 10 percent.
  - Nonsmokers have between 0.5 to 1 percent.
- Amount of carbon monoxide is based upon age, activity, weight, and carbon monoxide concentration.
  - Higher levels usually due to lack of activity.

Slide 12-60

G. The post-mortem carbon monoxide level is stable. It cannot be absorbed.

1. O_2 and CO_2 levels cannot be determined post-mortem due to break down of the blood.

2. Carbon monoxide concentration of 1.3 percent in air is fatal in two to three breaths.

3. Burn-off rates of carbon monoxide in fire survivors:

   a. A 50 percent reduction in four to five hours in air.

   b. A 50 percent reduction in approximately one hour with O_2 therapy (Emergency Medical Services (EMS)).

   c. A 50 percent reduction in 1/2 hour in hyperbaric chamber.

CARBON MONOXIDE POISONING (cont'd)

- Evidence of carbon monoxide poisoning is cherry red skin.

Slide 12-61

H. One classic sign of carbon monoxide poisoning is more often seen in the dead, rather than the living. People have been described as looking pink-cheeked and healthy.

1. However, since this “cherry red” appearance is common only in the deceased and is unusual in living people, it is not considered a useful diagnostic sign in clinical medicine.

2. In pathological (autopsy) examination, the ruddy appearance of carbon monoxide poisoning is notable because unembalmed dead people are normally bluish and pale, whereas dead carbon monoxide poisoned people may simply appear unusually lifelike in coloration.

3. The colorant effect of carbon monoxide in such post-mortem circumstances is thus analogous to its use as a red colorant in the commercial meat-packing industry.

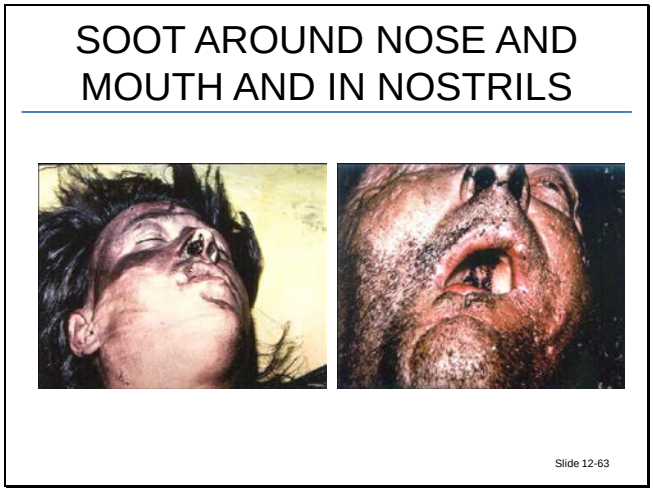
CONSIDER OTHER CONTRIBUTING SOURCES OF CARBON MONOXIDE

- Portable generators.
- Vehicle exhaust.
- Gas appliances.
  - Water heaters.
  - Stoves/Ovens.
  - Furnaces.

Slide 12-62

I. Portable generators, vehicle exhaust and gas appliances are all potential sources of carbon monoxide.

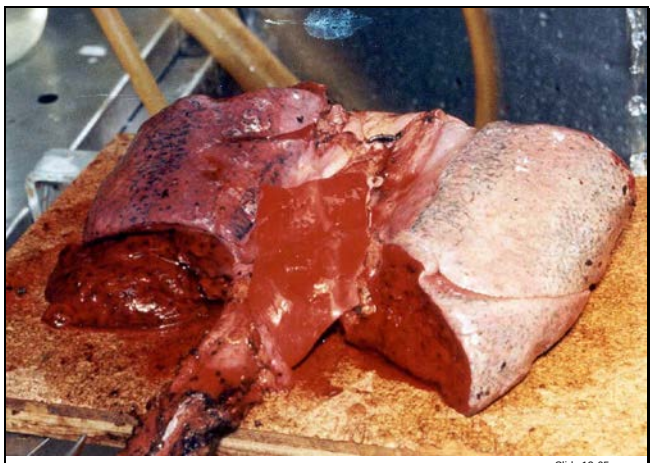
IX. INHALATION OF SOOT



Another possible cause of death is the inhalation of soot.

A. Soot patterns within the nose and mouth cavity indicate that the victims were breathing at the time of the fire.

B. This cross section of trachea displays soot deposits, indicating that the victim was breathing at the time of the fire.



Slide 12-65

C. These lungs show inhalation of soot.

EVIDENCE OF SOOT IN STOMACH

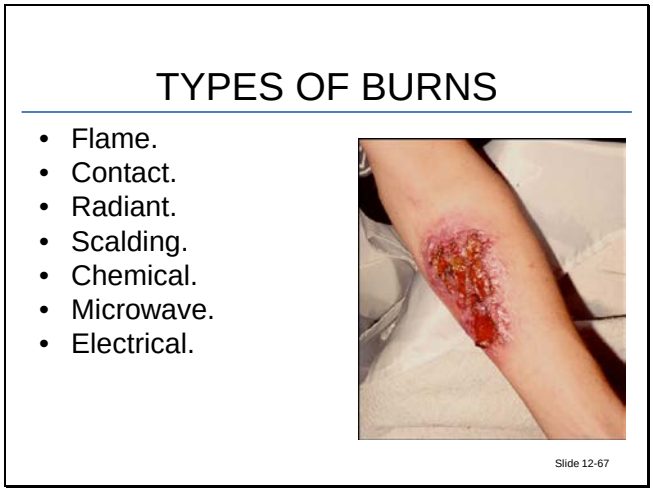
Outside

Inside

Slide 12-66

D. These soot deposits in the stomach were ingested during the fire as a result of breathing, gasping and swallowing.

X. TYPES OF BURNS



A. Burns are a possible cause of injury and/or death during a fire.

1. There are seven types of burns; we will focus on thermal-related burns and injuries.

   a. Acute hyperthermia is the condition of overheating the body to high temperatures over a short time.

   b. First-degree hyperthermia is like sunburn.

   c. Second-degree hyperthermia causes blistering.

   d. Third-degree hyperthermia causes a full thickness of skin damage.

   e. Fourth-degree hyperthermia causes charring.

   f. The “Rule of 9s” is used to establish percentage of burn damage.

CAUSES OF THERMAL BURNS

- Excessive heat from fire.
  - Radiation, conduction and convection.
  - Direct flame contact.
- Hot liquids.
  - Steam.
- Hot objects.

Slide 12-68

2. Pain will result when skin temperature reaches 113 F (45 C).

   a. Radiant heat tolerances:

      - 2-4 kilowatts per square meter (kW/m²) for 30 seconds produces pain.

      - 10 kW/m² for five seconds produces pain and 12 seconds produces blisters.

      - 20 kW/m² will ignite clothing and will result in burns and possibly death.

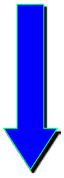
   b. In conducted heat greater than 130 F (54 C), skin cells are damaged.

   c. Convected heat of 248 F (120 C) air temperature will create blisters and is the threshold of pain.

HEAT OR THERMAL EFFECTS

- Color change of the skin.
- Blistering of the skin.
- Peeling of the skin.
- Splitting of the skin.
- Pugilistic attitude.
- Bone damage or fractures.

Minimum exposure



Maximum exposure

Slide 12-69

3. The body is part of the fuel load.

   a. Skin, muscle tissue and bone are not good fuels, but they will burn, get consumed and develop patterns.

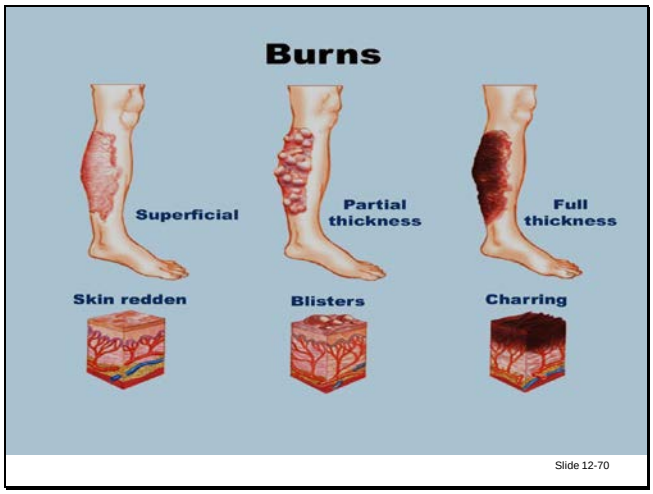
   b. Fat is a good fuel.

   c. The skull can appear exploded/ cracked open and fall apart (thermal artifact).

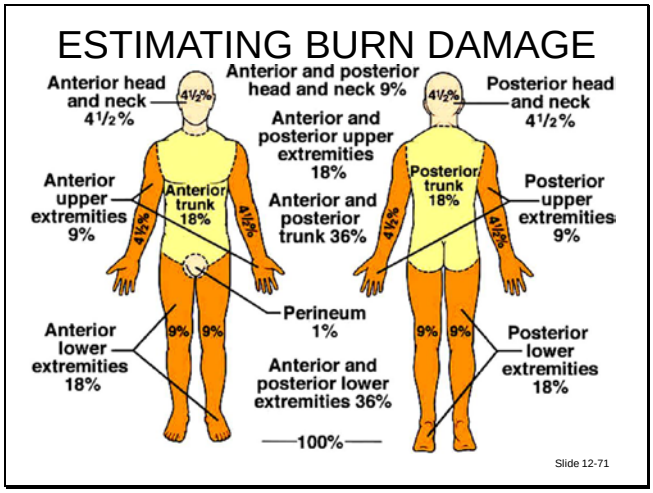
   d. Bodies do not combust spontaneously.

   e. Body fat from a body can produce a persistent fire.

   f. The torso may almost burn away, leaving the legs, head and arms relatively unburned.



- This diagram shows thermal burns of the first, second and third degree.



- This is a burn chart with the “Rule of 9s.”

BLISTERING

Slide 12-72

- This victim has large blisters that may have ruptured.

PEELING OF THE SKIN

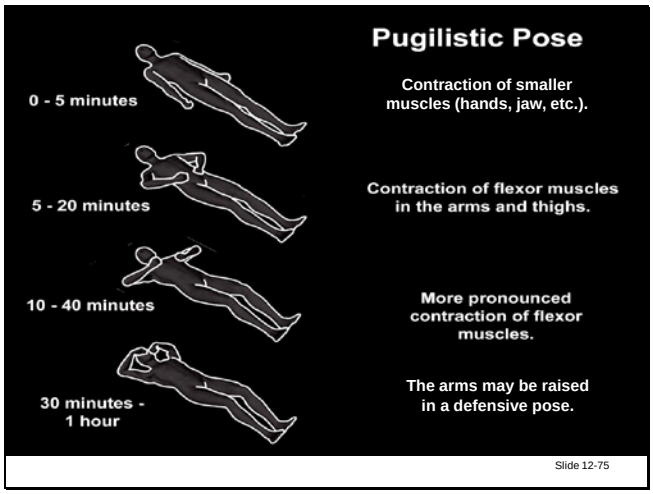
Slide 12-73

- Exposure to heat may cause peeling (sloughing) of skin, which usually occurs after the formation of blisters.

- This shows splitting of the skin due to heat exposure.

  -- The skin then shrinks, splitting and exposing the fat layer. Note the jagged edges of the split.

  -- A medical treatment conducted on burn victims is escharotomy. This procedure relieves the pressure from swelling and helps regain blood flow and nerve sensation.



B. This shows the pugilistic pose, which is caused by the contraction of muscles due to heat. This can help indicate time.

   1. Within zero to five minutes, smaller muscles contract (hands, jaw).

   2. Within five to 20 minutes, flexor muscles in the arms and thighs contract.

3. Within 10 to 40 minutes, there is a more pronounced contraction of flexor muscles.

4. Within 30 minutes to an hour, the arms may raise in a defensive pose.

PUGILISTIC ATTITUDE

Slide 12-76

a. Pugilistic posture ("fighting pose") is caused by the retraction of flexor muscles due to heat. Contraction of the fingers, arms and legs occurs after death.

FLEXING AT THE JOINTS DUE TO HEAT

Slide 12-77

b. Flexing at the muscle joints is a common reaction to heat from the fire.

HEAT EFFECTS ON BONE

Slide 12-78

C. Bones go through color and degradation changes, proportional to the exposure to heat and orientation.

1. Color changes from buff to carbonized black from charring.
2. Calcination changes from white to gray.
3. Bones become brittle and fracture easily.
4. Long bones may shrink.

EXPLODING SKULL

Slide 12-79

LOSS OF PHALANGES

Small bones are generally not consumed but become dislodged and lost in debris.

Slide 12-80

5. Small bones in the hands and feet are thought to be consumed due to the thin skin layer and effects of heat. In most fires, they become dislodged and are often lost in the debris and difficult to recover.

INHALATION INJURIES

Exposure to:

- Toxic gases.
- Extreme heat.

Slide 12-81

D. Inhalation of combustion byproducts can cause injuries and death.

1. Byproducts of combustion can produce hydrogen cyanide and hydrogen sulfide, as well as carbon monoxide.

   a. These create systemic poisoning.

   b. Inhalation poisoning is more frequent than thermal inhalation burns.

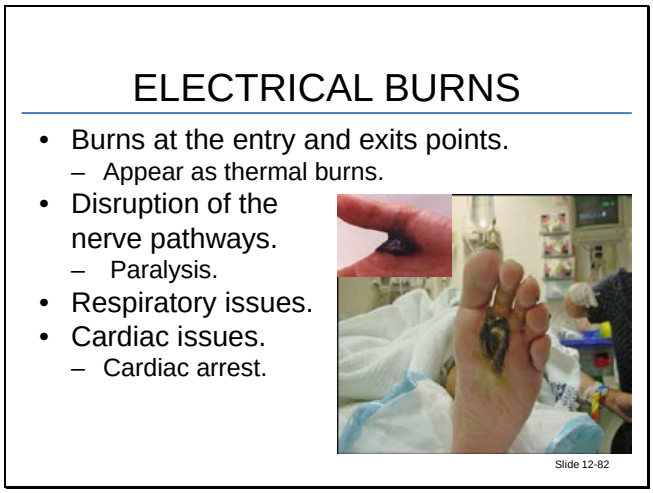
2. Thermal inhalation injury risk factors include:

   a. Standing in a burning environment.

b. Screaming or yelling in a burning environment.

c. Being trapped in a closed, burning environment.

d. Exposure to superheated steam.



E. Electrical burns are another common burn injury. They also have serious side effects, such as:

1. Blood pressure changes.

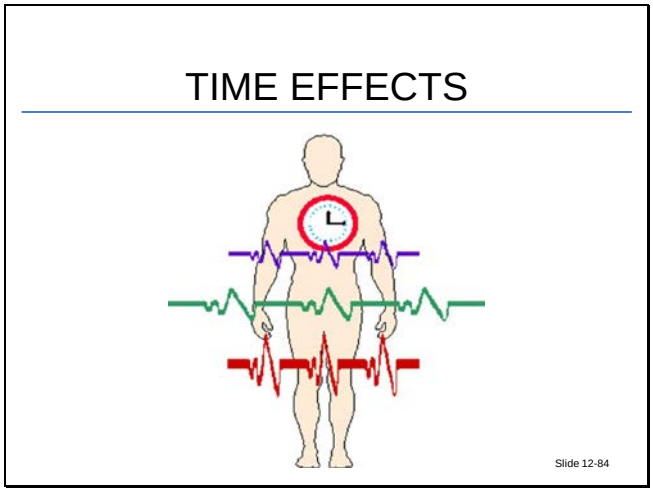
2. Seizures.

3. Visual disturbances.

4. Fractures.

F. Copper thieves were trying to steal an energized 13,000-volt conductor.

XI. POST-MORTEM CHANGES

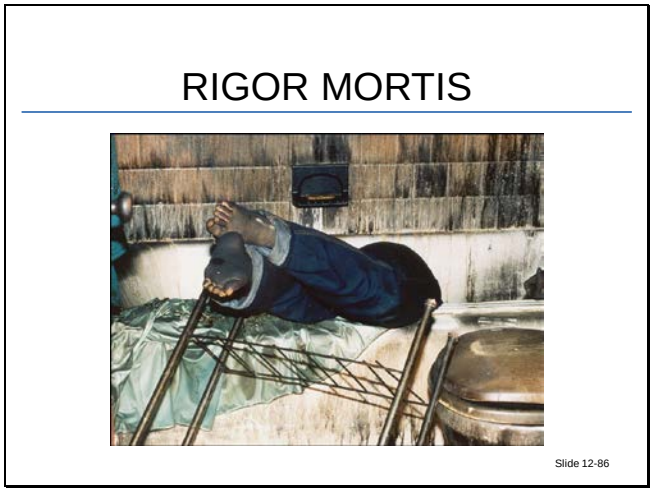


A. Post-mortem effects normally begin with the onset of death, but they might not be observed until later. These include:

1. Loss of body temperature.
2. Rigor mortis.
3. Post-mortem lividity.
4. Decomposition.

B. In general, body temperature decreases by 2 F per minute in the first 10 to 12 minutes after death. Then the heat loss rate becomes 1.5 F per minute until ambient temperature is reached.

XII. RIGOR MORTIS



A. Rigor mortis develops first in the hands and feet, then in the torso, limbs and head.

1. The onset has to do with the temperature of the body, the environment, and the physical activity of the victim just before death.

2. Rigor mortis dissipates after 12 to 24 hours.

3. An experienced forensic pathologist can determine the difference between rigor mortis or rigidity caused by exposure to fire and heat, which helps establish time of death.

B. Lividity (liver mortis) is the pooling of blood.

1. It can change within the first few hours after death, but is fixed in six to nine hours.

2. Severe carbon monoxide discoloration (poisoning) can give a similar appearance.

DECOMPOSITION

Slide 12-88

C. There are noticeable indicators of the decomposition process.

1. Blood remains fluid without post-mortem clotting.

2. With onset of decomposition, colors will change to green and brown.

3. Decomposition does not produce carbon monoxide.

4. It can be detected after embalming and prolonged burial.

XIII. IDENTIFICATION OF THE VICTIM

IDENTIFICATION OF THE VICTIM

Slide 12-89

A. Identification of the victim is made by the coroner or medical examiner in most states.

1. Tentative identification may be accomplished with documentation found at the scene or on the person.

2. Do not reveal the identification of the victim unless you are authorized or confirmation is made by the coroner or medical examiner.

B. If victim is recognizable, you may elect to do a gross tentative identification using photos, ID cards, etc. Remember, this is tentative, as the identification of the victim is not confirmed until positive identification is received from the coroner or medical examiner.

VICTIM IDENTIFIERS

- Fingerprints.
- Medication.
- Prosthetics.
- Scars.
- Jewelry.
- Tattoos.
- X-rays.

Slide 12-90

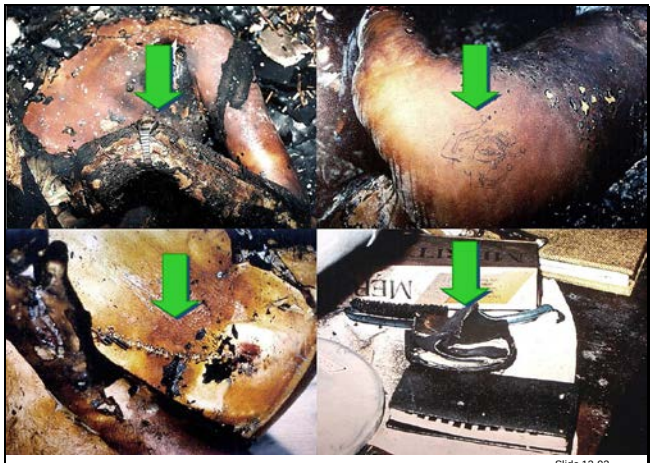
C. Fire victims may be identified by:

Slide 12-91

1. Fingerprints can be retrieved from fingertips if the skin has peeled away. The underlying tissue would have to be rehydrated, which would cause the print to become more legible.

2. Medication may help to establish identification and other information regarding the victim. Any prescription bottle should be collected and given to the medical examiner. The type of prescription may help in the identification of past illness, mental health or recent injury.

3. Prosthetics can also assist in the identification of the victim while on the scene.



Slide 12-92

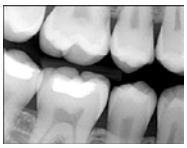
4. Scars, marks, tattoos and engraved jewelry may be used to make tentative scene identification.

X-rays

Slide 12-93

5. Full body X-rays should be part of the autopsy protocol; they can also assist in the identification of the victim.

DENTAL RECORDS



Slide 12-94

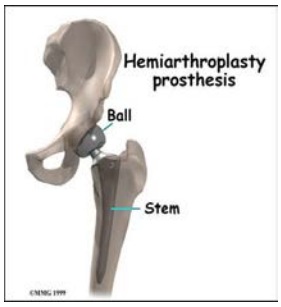
D. Dental records.

1. Dentures may have identification of the “wearer” engraved in the appliance.

2. If dental appliances are recovered at the scene, they should accompany the body to the morgue. Dental X-rays may assist with identification. Molars will normally remain because of their location within the mouth.

3. Dental crowns/caps may explode due to high heat.

PROSTHETICS

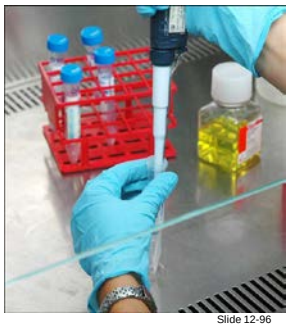


Slide 12-95

4. Many surgical appliances have serial numbers and can be traced back to the person who received the device. Additionally, the appliance/implant may support the tentative identification of the deceased.

OTHER RECOMMENDED TESTS

- Toxicology.
- Blood.
- DNA.



Slide 12-96

5. Other recommended tests include:

   a. Toxicology.

   b. Blood.

   c. DNA.

XIV. CAUSE VERSUS MANNER OF DEATH

CAUSE VERSUS MANNER OF DEATH

Slide 12-97

A. The cause and the manner of death are two of the fundamental inquiries in any fatal fire investigation.

CAUSE VERSUS MANNER OF DEATH (cont'd)

- Cause of death.
  - Examples of the reason or event that caused the person to die.
    - -- Gunshot.
    - -- Stabbing.
    - -- Asphyxiation.
    - -- Heart attacks.
- Manner of death.
  - Examples of how the cause of death occurred (natural or unnatural).
    - -- Accidental.
    - -- Homicide.
    - -- Suicide.
    - -- Natural.
    - -- Undetermined.

Slide 12-98

B. Cause and manner of death are two distinct classifications.

1. Cause of death is the reason or specific event that caused the death. Many not listed.

2. Manner of death is how the death occurred — natural or not natural.

INVESTIGATIVE CONSIDERATIONS

Victim's activity should be determined.

- Location.
- Position.
- Clothing.
- Patterns.
- Items within the body.
- Blast damage.

Slide 12-99

C. The relationship between the death and the fire should be investigated. Not all fire-related deaths are directly caused by heat, flame, smoke and gas. For example, a person smoking in bed may die from a heart attack.

1. Immediate deaths include:

a. Smoke inhalation.

b. Thermal burns.

c. Blunt force trauma.

2. Delayed deaths that take two to three days include:

   a. Shock.

   b. Fluid loss.

   c. Inhalation of toxic gases.

3. Delayed deaths that take greater than three days include:

   a. Sepsis.

   b. Chronic respiratory insufficiency.

HOMICIDES VERSUS SUICIDES

Slide 12-100

HOMICIDE?

Slide 12-101

D. Identify wounds, when possible, prior to moving the body. Official determination of the wound will be done at the autopsy. However, if there is even the slightest suspicion of criminal activity, law enforcement should be notified if they are not already involved.

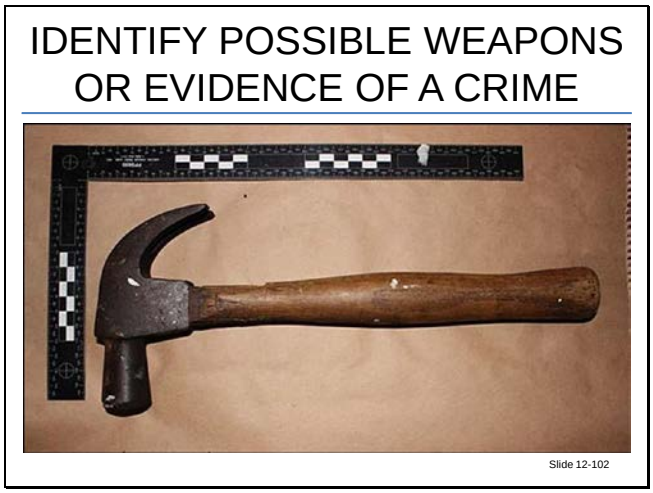
1. Remember your legal requirements. Are you still legally on the property once evidence of a crime has been discovered?

2. What are the protocols for involving other agencies?

3. What are the search and seizure requirements?

   a. Michigan v. Tyler.

   b. Michigan v. Clifford.



- Weapons found at the scene of a fire. The fire is typically secondary to conceal a crime.

- Photos of items should potentially be taken prior to any movement at the scene, whether inside or outside.

- Properly documenting evidence locations at the scene is crucial to a successful prosecution and conviction.

Slide 12-104

Slide 12-105

SUICIDE BY FIRE

Slide 12-106

E. Suicide-by-fire victims are generally alone.

1. The methods they use may include:

   a. Pouring ignitable liquid on self.

   b. Preventing escape.

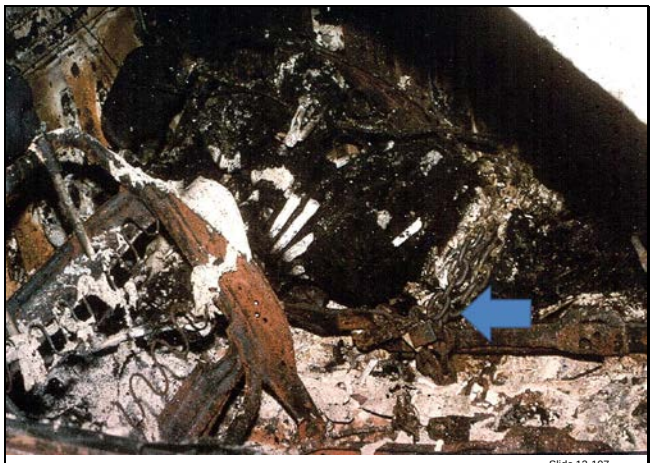
2. Indicators that the death may have been suicide include:

   a. Recent depression.

   b. Notes.

   c. Previous attempts.

   d. Religious beliefs.

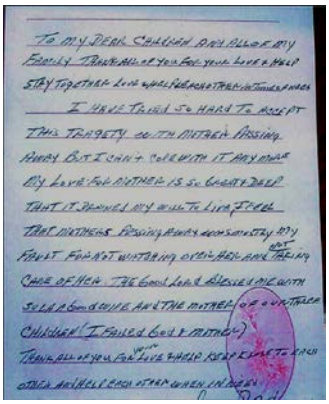


Slide 12-107

   e. All restraints should be identified.

Slide 12-108

Suicide note?



Slide 12-109

SOMETIMES IT IS TOO EASY

Slide 12-110

F. Incendiary devices in the victim's possession are not necessarily the cause of the fire.

XV. LINE-OF-DUTY DEATHS

A. Firefighting claims about 100 lives annually in the United States.

1. Coronary heart disease has consistently been the leading cause of "on-duty" deaths, accounting for about 45 percent of the mortality rate.

2. The vast majority of the remaining deaths are traumatic, with motor vehicle-related deaths, smoke inhalation/burns, and falls/ structure collapse being common causes.

3. To address this continuing national occupational fatality problem, the National Institute for Occupational Safety and Health (NIOSH) conducts independent investigations of firefighter LODDs.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH FIRE FIGHTER FATALITY INVESTIGATION AND PREVENTION PROGRAM (cont'd)

- 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 12-113

a. The NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) conducts investigations of firefighter LODDs to formulate recommendations for preventing future deaths and injuries.

b. NIOSH investigators are not conducting their investigation to enforce compliance with state or federal occupational safety and health standards, and they do not determine fault or place blame on fire departments or individual firefighters. Their reports contain causal factors and recommendations to help prevent reoccurrences.

c. NIOSH does not investigate every firefighter fatality.

d. The program has investigated approximately 40 percent of firefighter LODDs since the program was initiated.

PUBLIC SAFETY OFFICER BENEFITS ACT

- The Public Safety Officer Benefits (PSOB) Law 26, the PSOB Act (42 United States Supreme Court (USSC) 3796, Public Law 94-430), became law on Sept. 29, 1976 .
- On Oct. 26, 2001, as part of the Patriot Act of 2001, the benefit was increased to $250,000 and made retroactive to Jan. 1, 2001.

Slide 12-114

4. As part of the Public Safety Officer Benefits (PSOB) program, an autopsy is recommended on all LODDs, regardless of how they occurred.

U.S. FIRE ADMINISTRATION AUTOPSY PROTOCOL

Slide 12-115

B. The U.S. Fire Administration (USFA) firefighter autopsy protocol has been extensively revised since its original 1994 edition.

1. In the new protocol, a number of additional areas of information have been provided to take into account emerging issues and new technologies as applied to firefighter autopsies.

2. It is recommended that autopsies be performed for all firefighter fatalities where an LODD has occurred.

3. It is further recommended that an autopsy be performed when a non-LODD may be linked to a line-of-duty exposure.

C. Autopsies are now recommended for all firefighter deaths, and the International Association of Fire Fighters (IAFF) and other organizations encourage this practice.

1. NIOSH's FFFIPP uses autopsy results in the analysis of firefighter fatalities and specifically recommends that an autopsy be performed even if the cause of death is presumed to be natural.

2. A copy of the USFA Firefighter Autopsy Protocol can be downloaded at https://apps.usfa.fema.gov/publications.

U.S. FIRE ADMINISTRATION AUTOPSY PROTOCOL (cont'd)

Personal protective equipment (PPE) description:

- Turnout gear.
- Helmet.
- Gloves.
- Boots.
- Self-contained breathing apparatus (SCBA).

Slide 12-116

a. Securing the personal protective equipment (PPE) is crucial since an examination to determine if it failed in some way needs to be performed by qualified personnel.

b. PPE description:

- Turnout gear.
- Helmet.
- Gloves.
- Boots.
- Self-contained breathing apparatus (SCBA).

U.S. FIRE ADMINISTRATION AUTOPSY PROTOCOL (cont'd)

- Personal Alert Safety System (PASS).
- Protective hood.
- Clothing worn under turnouts.

Slide 12-117

- Personal Alert Safety System (PASS).

- Protective hood.
- Clothing worn under turnouts.

CUSTODY OF EQUIPMENT

- Appropriate storage conditions.
- Chain of custody.
- Limitation of handling if clothing and equipment are fragile.

Slide 12-118

D. 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.

XVI. SUMMARY

SUMMARY

- Fatal fire statistics.
- Death scene considerations.
- Fire suppression considerations.
- Documentation.
- Gathering information.
- Document body at scene.
- Role of the medical examiner.
- Carbon monoxide, hydrogen cyanide gas and oxygen deficiency.

Slide 12-119

SUMMARY (cont'd)

- Inhalation of soot.
- Types of burns.
- Post-mortem changes.
- Rigor mortis.
- Identification of the victim.
- Cause versus manner of death.
- LODDs.

Slide 12-120

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UNIT 13: FIRE SCENE EXAMINATION PRACTICAL EXERCISE

TERMINAL OBJECTIVE

The students will be able to:

13.1 Conduct, document and present a complete fire loss investigation.

ENABLING OBJECTIVES

The students will be able to:

13.1 Conduct a safe and systematic scene investigation to determine the point of origin and fire cause.

13.2 Identify pertinent physical evidence and the appropriate laboratory testing to be requested.

13.3 Prepare and present all appropriate reports to document the complete investigation.

13.4 Identify appropriate individuals to be interviewed and questions to be asked.

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UNIT 13:
FIRE SCENE EXAMINATION PRACTICAL EXERCISE

Slide 13-1

ENABLING OBJECTIVES

- Conduct a safe and systematic scene investigation to determine the point of origin and fire cause.
- Identify pertinent physical evidence and the appropriate laboratory testing to be requested.

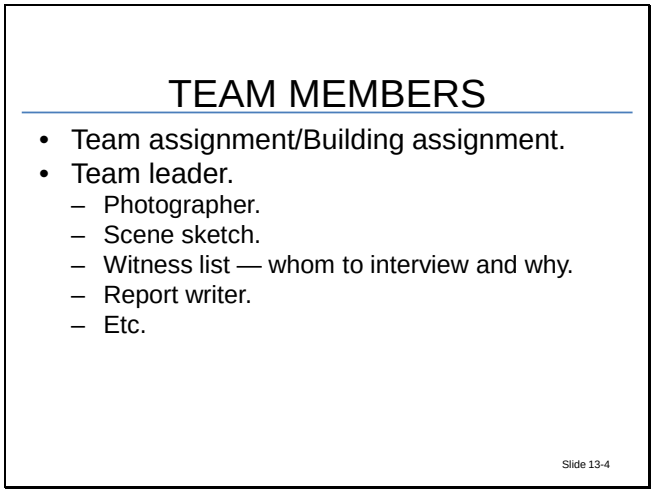
Slide 13-2

ENABLING OBJECTIVES (cont'd)

- Prepare and present all appropriate reports to document the complete investigation.
- Identify appropriate individuals to be interviewed and questions to be asked.

Slide 13-3

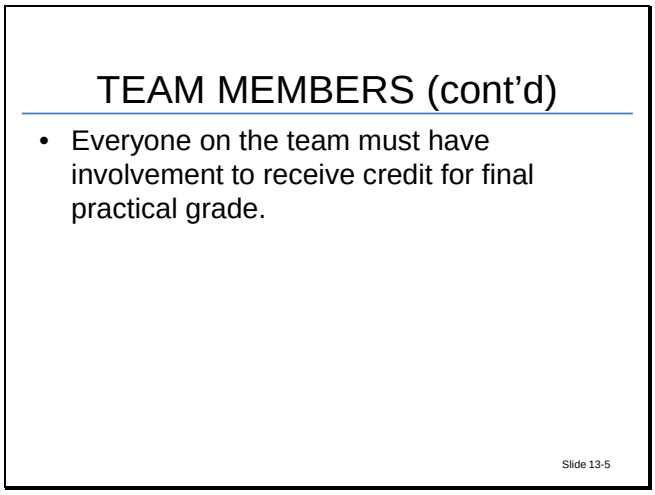
I. BRIEFING



A. Team assignment/Building assignment.

B. Team leader.

1. Photographer.
2. Scene sketch.
3. Witness list — whom to interview and why.
4. Report writer.
5. Etc.



C. Everyone on the team must have involvement to receive credit for final practical grade.

MUST DEFINE AND IDENTIFY THE FOLLOWING:

- Origin of the fire.
  - Heat source.
  - Initial fuel ignited.
  - Event that brought the heat and fuel together.
- Cause of the fire.
  - Accidental, incendiary, natural, undetermined.

Slide 13-6

D. Origin of the fire.

1. Heat source.
2. Initial fuel ignited.
3. Event that brought the heat and fuel together.

E. Cause of the fire — accidental, incendiary, natural, undetermined.

MUST DEFINE AND IDENTIFY THE FOLLOWING: (cont'd)

- Degree of certainty.
- Witness and victim information will be limited; use scenario sheet for information.

Slide 13-7

F. Degree of certainty.

G. Witness and victim information will be limited; use scenario sheet for information.

BURN RANGE

- Large shed for scene processing kit.
  - Kits are numbered and inventoried.
  - Cameras available if a group needs them; get one from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) before going down range.
- Hard hats, dust masks (**must be worn**), shovels and brooms are located in storage cell, next to Unit 1.

Slide 13-8

H. Large shed for scene processing kit.

1. Kits are numbered and inventoried.

2. Cameras available if a group needs them; get one from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) before going down range.

I. Hard hats, dust masks (**must be worn**), shovels and brooms are located in storage cell, next to Unit 1.

BURN RANGE (cont'd)

- All burn cells will be cleaned out at the end of the processing, furniture and debris only.
- Decontamination will be set up near hydrant; clean off all tools, etc., before putting them away.
- Make sure that halogen lights are cool before putting them in scene kits.

Slide 13-9

J. All burn cells will be cleaned out at the end of the processing, furniture and debris only.

K. Decontamination will be set up near hydrant; clean off all tools, etc., before putting them away.

L. Make sure that halogen lights are cool before putting them in scene kits.

BURN CELL DOCUMENTATION

- Sprinklers are out of play, used to assist in suppression.
- North is toward the large metal building.
- Rock and bricks in front of cells are out of play.
- Vent holes on the sides of the cells are also out of play.

Slide 13-10

M. Sprinklers are out of play, used to assist in suppression.

N. North is toward the large metal building.

O. Rocks and bricks in front of cells are out of play.

P. Vent holes on the sides of the cells are also out of play.

BURN CELL DOCUMENTATION (cont'd)

- Ground-fault circuit-interrupter (GFCI) outlets on the rear of the cells are used for halogen lights; they are out of play.
- The panel boxes attached to the side of the cells are in play; all four circuits were energized at the time of the fire.
- The curtilage around the front, Side A, should be considered in play for potential evidence.

Slide 13-11

Q. Ground-fault circuit-interrupter (GFCI) outlets on the rear of the cells are used for halogen lights; they are out of play.

R. The panel boxes attached to the side of the cell are in play; all four circuits were energized at the time of the fire.

S. The curtilage around the front, Side A, should be considered in play for potential evidence.

BURN CELL DOCUMENTATION (cont'd)

- No need to put up scene tape, even though that may be done in "real life."
- Instructors are assigned cells; ask questions if needed.

Slide 13-12

T. No need to put up scene tape, even though that may be done in "real life."

U. Instructors are assigned cells; ask questions if needed.

BURN CELLS

- Evidence.
  - One properly labeled sample if a sample(s) is taken.
  - Ten samples, only physically take one, **but** document all others.
  - Submit lab request at the end of the day identifying what testing you are looking for (e.g., ignitable liquids, electrical evaluation, DNA, etc.).

Slide 13-13

V. Evidence.

1. One properly labeled sample if a sample(s) is taken.
2. Ten samples, only physically take one, **but** document all others.
3. Submit lab request at the end of the day identifying what test you are looking for (e.g., ignitable liquids, electrical evaluation, DNA).

BURN CELLS (cont'd)

- Exemplars of most items are available in large shed; if you want to do a test on something, explain to the instructor assigned to the cell what you want to do.

Slide 13-14

W. Exemplars of most items are available in large shed; if you want to do a test on something, explain to the instructor assigned to the cell what you want to do.

COMPLETED GROUPS

- Once you are completed as a group, remain down range until all groups are completed.
- Classroom and breakout rooms will be opened to work on projects when we get back to J-Building.
- You will have 15 to 20 minutes maximum for presentation.

Slide 13-15

X. Once you are completed as a group, remain down range until all groups are completed.

Y. Classroom and breakout rooms will be opened to work on projects when we get back to J-Building.

Z. You will have 15 to 20 minutes maximum for presentation.

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ACTIVITY 13.1

Fire Scene Examination Practical Exercise

Purpose

Conduct a safe and systematic scene investigation to determine the point of origin and fire cause. Identify pertinent physical evidence and the appropriate laboratory testing to be requested. Prepare and present all appropriate reports to document the complete investigation.

Materials

- Fire scene scenario.
- Fire scene documentation packages.
- Camera.
- Scene processing kit.
- Safety equipment.
- Appropriate footwear and clothing.

Safety Precautions

1. You will be required to wear a hard hat, safety glasses, gloves and a dust mask while processing the fire scene.

2. You should take appropriate measures to avoid physical hazards such as protruding nails, broken glass, and falling debris. Any injury must be immediately reported to an instructor.

Directions (burn range)

1. Each team will have approximately 2 1/2 hours to process its assigned burn cell scenario to determine origin and cause.

2. Identify any items of evidence and properly document them. Any evidence to be submitted to the laboratory for analysis must be accompanied by a laboratory submission form (which is included in the documentation package). “Submit” your evidence and form(s) to the instructor to receive results related to your scenario.

3. Identify the origin of the fire, heat source, initial fuel ignited, event that brought the heat and fuel together, and cause of the fire (accidental, incendiary, undetermined).

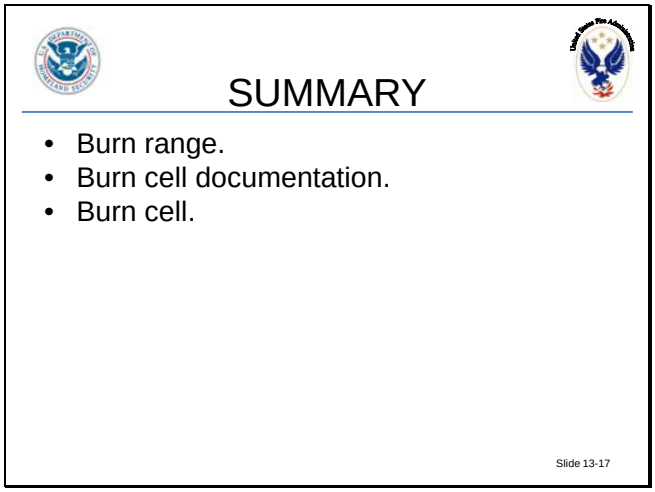
4. All burn cells will be cleaned out at the end of the processing, furniture and debris only. Decontamination will be set up near hydrant; clean off all tools, etc., before putting them away. Make sure that halogen lights are cool before putting them in scene kits.

Directions (in classroom)

1. Each team will prepare and deliver a 15- to 20-minute presentation of its assigned scenario and findings.

2. The instructor(s) will give your team feedback.

II. SUMMARY


SUMMARY
• Burn range.
• Burn cell documentation.
• Burn cell.
Slide 13-17

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UNIT 14: VEHICLE FIRE INVESTIGATION

TERMINAL OBJECTIVE

The students will be able to:

14.1 Process and analyze a vehicle fire to determine the origin and cause.

ENABLING OBJECTIVES

The students will be able to:

14.1 Identify basic vehicle components and mechanical and electrical systems.

14.2 Recognize and document potential ignition sources, and identify materials capable of supporting combustion.

14.3 List the most common motives associated with incendiary vehicle fires.

14.4 Describe the proper procedures to document the vehicle identification and history/ownership.

14.5 Identify safety considerations when investigating a vehicle fire.

14.6 Explain the basic construction and safety features of a hybrid vehicle.

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UNIT 14: VEHICLE FIRE INVESTIGATION

Slide 14-1

ENABLING OBJECTIVES

- Identify basic vehicle components and mechanical and electrical systems.
- Recognize and document potential ignition sources, and identify materials capable of supporting combustion.
- List the most common motives associated with incendiary vehicle fires.

Slide 14-2

ENABLING OBJECTIVES (cont'd)

- Describe the proper procedures to document the vehicle identification and history/ownership.
- Identify safety considerations when investigating a vehicle fire.
- Explain the basic construction and safety features of a hybrid vehicle.

Slide 14-3

I. NEED FOR VEHICLE FIRE INVESTIGATIONS

A. The need for vehicle fire investigations is increasing.

1. Higher court costs.
2. Insurance costs on the rise.
3. Loss of jobs, income and services.
4. Arsonists may “graduate” to larger fires.
5. Recall data.
6. Potential hazards.
7. Small compartment size in vehicles may result in more rapid fire growth.
8. Fire dynamic is the same in a vehicle as is in any other type of compartment.

COMMON VEHICLE ARSON MOTIVES

- Revenge/Spite.
- Vandalism.
- Crime concealment.
- Profit.

Slide 14-5

B. The following are some of the most common vehicle arson motives.

1. Revenge/Spite.
2. Vandalism.
3. Crime concealment.
4. Profit.

INVESTIGATOR'S RESPONSIBILITY

- Identify the heat source.
- First fuel.
- Sequence of events. How did the fuel and heat source come together?

Slide 14-6

C. Investigator's responsibility.

1. Determine the point of origin first; the cause comes later.
2. National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations*, Section 27.4.5, Smoking Materials.

a. Modern vehicle upholstery fabrics and materials are generally difficult to ignite with a lighted cigarette.

b. Ignition may occur if a lighted cigarette is buried in paper, tissue and/or other combustible debris, or if the seat material comes into contact with an open flame.

c. Urethane foam, typical seat cushion material, burns readily once ignited with a flame and adds substantially to the intensity of a vehicle fire.

INVESTIGATOR'S PROBLEMS

Slide 14-7

D. Common problems faced by an investigator.

1. Traditional burn patterns may not occur.

2. Packaging large amount of combustibles in small container.

3. Variety of fuels and ignition sources.

4. Design of vehicles changes annually.

5. Mobility of vehicle.

6. The numerous accidental ignition sources that must be eliminated.

7. Lack of witnesses at the scene.

8. Contamination of the scene.

INVESTIGATOR'S PROBLEMS (cont'd)

The destruction of the vehicle and thus the point of origin and possible evidence.

Slide 14-8

INVESTIGATOR'S PROBLEMS (cont'd)

Slide 14-9

INVESTIGATOR'S PROBLEMS (cont'd)

Slide 14-10

INVESTIGATOR'S PROBLEMS (cont'd)

Slide 14-11

SCENE CONTAMINATION IS A PROBLEM

Slide 14-12

E. Contamination occurs at most scenes.

1. Normally done by public safety personnel in the course of their duties.

2. Caused by:

   a. Fire department and Emergency Medical Services (EMS).

   b. Police department.

   c. Helpful bystanders.

WHAT IS IN A CAR?

Potential fuels:

- Engine fuels, transmission fluid.
- Power steering and brake fluids.
- Coolants, lubricants.
- Contents or cargo.

Slide 14-13

F. Various types of fuels are present in a vehicle that could be the primary or secondary fuel source.

1. All affect the rate of fire spread.

2. Combustible material such as plastic and metal.

FUELS FOUND IN VEHICLES

- Solids.
  - Plastics, metals, rubber.
- Liquids.
  - Gasoline, oil, transmission and power steering fluid, brake fluid, antifreeze.
- Gases.
  - Hydrogen, natural gas, liquefied petroleum gas (LPG), OZ_{12}, N_3O.

Slide 14-14

3. There are different types of fuels in various states of matter that are in vehicles.

   a. Some are more volatile than others.

   b. All can be secondary fuels that can cause more destruction than initial fuel ignited.

SOLID FUELS

- Plastics can burn with a heat release rate (HRR) similar to ignitable hydrocarbon liquids.
  - Do not be confused by the patterns.
- Most metals need to be melted or in a powdered form to burn.

Slide 14-15

4. Solid fuels.

   a. Solid fuels are less common than liquids as the first materials ignited.

   b. They can be encountered in overloaded wiring, as an exposure, or in careless smoking fires.

   c. Plastics can burn with a heat release rate (HRR) similar to ignitable hydrocarbon liquids. Do not be confused by the patterns.

   d. Most metals need to be melted or in a powdered form to burn.

   e. A large amount of movement in the belts, pulleys, bearing and tires can produce a lot of heat due to friction.

LIQUID FUELS

- Often associated with vehicle fires because they are always there.
- What state were they in, and how are they being introduced?

Slide 14-16

5. Liquid fuels.

a. They are often associated with vehicle fires because they are always there.

b. You need to consider what state they were in and how they are being introduced.

DVD PRESENTATION

"AMERICAN HEAT/FETN VEHICLE FIRES"

Slide 14-17

II. HEALTH AND SAFETY ISSUES

HEALTH AND SAFETY ISSUES

- Cold scenes can be just as dangerous as "hot" ones.
- Getting under an object that may weigh several thousand pounds may be dangerous.
- May need a qualified mechanic to check if the mechanical, hydraulic or electrical systems are still active and capable of deploying.

Slide 14-18

A. Cold scenes can be just as dangerous as "hot" ones.

B. Getting under an object that may weigh several thousand pounds may be dangerous.

C. May need to consult with a qualified mechanic to check if the mechanical, hydraulic or electrical systems are still active and capable of deploying.

D. NFPA 921, Section 25.2, Vehicle Investigation Safety.

1. The completion of a thorough investigation of a burned vehicle may pose a variety of safety-related concerns that are different from those that may normally be found in a structure fire.

HEALTH AND SAFETY ISSUES (cont'd)

- Wear appropriate respiratory protection.
- Wear gloves and heavy clothing.

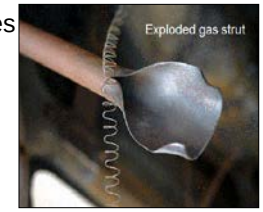
Slide 14-19

2. Wear appropriate respiratory protection.

3. Wear gloves and heavy clothing.

HEALTH AND SAFETY ISSUES (cont'd)

- Airborne hazards.
  - Gases and fumes.
  - Solid particles.
- Mechanical hazards.
  - Sharp and ragged edges of metals.
  - Air bags and energy absorbing bumpers.



Slide 14-20

E. There are various types of hazards.

1. Airborne hazards.

   a. Gases and fumes.

   b. Solid particles.

2. Mechanical hazards.

a. Sharp and ragged edges of metals.

b. Air bags and energy absorbing bumpers.

HEALTH AND SAFETY ISSUES (cont'd)

- Gas struts.
  - Struts under high pressure and during extreme heat are potentially a ballistic missile waiting to go off.
  - Struts can project themselves hundreds of feet with great velocity once they explode.

Slide 14-21

3. Examples of gas hazards.

a. Gas struts can explode during extinguishment and can be observed by suppression personnel. Interviews would reveal information.

- Under high pressure and during extreme heat, struts are potentially a ballistic missile waiting to go off.

- They can project themselves hundreds of feet with great velocity once they explode.

HEALTH AND SAFETY ISSUES (cont'd)

- Air bags — escaping gas measured at 800 F.
- Hot propellant grains, sodium azide.
  - Can exit onto driver or passenger.
  - May cause burns to occupants.
  - Depending on material, some clothing may ignite.
- Newer seatbelt retractors may also be gas operated.

Slide 14-22

b. Air bags may have delayed deployment. They should be rendered safe.

- They have escaping gas measured at 800 F.
- Hot propellant grains, sodium azide can exit onto the driver or passenger.
  - -- They may cause burns to occupants.
  - -- Depending on the material, some clothing may ignite.

c. Newer seatbelt retractors may also be gas operated.

III. CONDUCTING AN EXAMINATION OF A VEHICLE

CONDUCTING AN INVESTIGATION

Slide 14-23

APPLY A SYSTEMATIC EVALUATION

- Secure the scene.
- Conduct a preliminary scene exam.
  - Get an overall view of scene and vehicle.
  - Safety considerations.
  - Additional resources may be required.
  - Identify areas of concern.
  - Develop preliminary scenario.

Slide 14-24

A. The following are steps a fire investigator should be considering prior to conducting a vehicle examination.

1. Get an overall view of scene and vehicle.
2. Safety considerations.
3. Additional resources may be required.
4. Identify areas of concern.
5. Develop preliminary scenario.

APPLY A SYSTEMATIC EVALUATION (cont'd)

- Apply a comprehensive examination.
  - Identify the vehicle and owner.
  - Conduct an exterior and interior examination.
  - Identify the point of origin.
  - Identify the fuel and ignition source.
  - Establish the event.
  - Develop a plausible theory.

Slide 14-25

6. Identify the vehicle and owner.
7. Conduct an exterior and interior examination.
8. Identify the point of origin.
9. Identify the fuel and ignition source.
10. Establish the event.
11. Develop a plausible theory.

SECURE THE SCENE

- Limit firefighter overzealous overhaul.

Slide 14-26

B. Secure the scene.

1. Limit firefighter overzealous overhaul.

SECURE THE SCENE (cont'd)

- If the vehicle is removed from the scene, then two separate examinations may be required.

Slide 14-27

2. If the vehicle is removed from the scene, then two separate examinations may be required.

   a. Stress reasons to keep vehicle at the scene.

   b. The vehicle may need to be removed from the scene to conduct a more extensive examination.

DOCUMENTATION

- Record vehicle identification information.
  - Year, make, model, vehicle identification number (VIN), license number.
- Diagram scene and vehicle, noting:
  - Burn patterns, damage, missing parts.

Slide 14-28

C. Documentation.

1. Record the vehicle identification information such as the year, make, model, vehicle identification number (VIN), and license number.

2. Diagram the scene and vehicles while noting the following: the burn patterns, damage and missing parts.

DOCUMENTATION (cont'd)

- Photograph:
  - Interior, exterior and undercarriage.
  - Burn patterns that show fire spread.
  - Removal of vehicle (debris field).
  - Evidence of arson or accidental cause.
  - Bird's-eye view.

Slide 14-29

3. Photograph.

   a. The interior, exterior and undercarriage.

   b. Burn patterns that show fire spread.

   c. Removal of vehicle (debris field).

   d. Evidence of arson or accidental cause.

e. Bird's-eye view.

f. Photograph from the eight points (video).

HISTORIES

- Every person, place, building, vehicle, etc., that an investigator comes in contact with, needs to have its history checked.
- Vehicle title history/search.
  - Carfax is an example.
- Identify victim(s)/owner(s).
- Conduct witness interviews.

Slide 14-30

D. Histories.

1. Every person, place, building, vehicle, etc., that an investigator comes in contact with, needs to have its history checked.

2. Vehicle title history/search (e.g., Carfax).

3. Identify victim(s)/owner(s).

4. Conduct witness interviews.

OWNER/OPERATOR QUESTIONS

- Engine fires.
  - Where was smoke visible?
  - How was the vehicle running?
  - Did flames appear before or after the vehicle stopped?

Slide 14-31

E. Questions to ask the owner/operator.

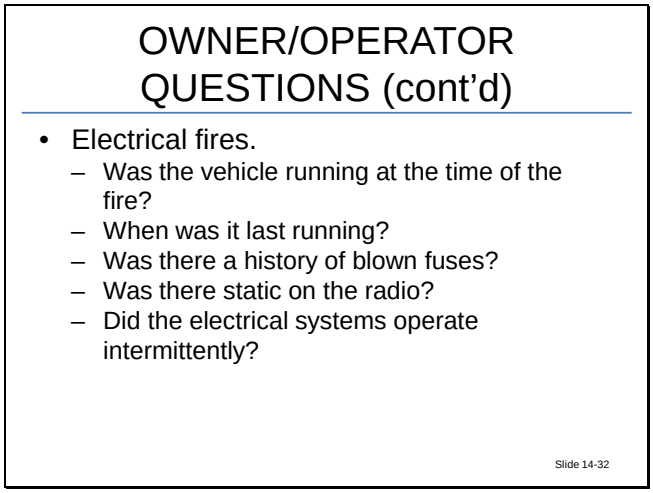
1. Establish the sequence of events.

2. Engine fires.

   a. Where was smoke visible?

   b. How was the vehicle running?

   c. Did flames appear before or after the vehicle stopped?



3. Electrical fires.

   a. The owner/operator should report some problems prior to seeing fire (e.g., odor, smoke, flame).

   b. Was the vehicle running at the time of the fire?

   c. When was it last running?

   d. Was there a history of blown fuses?

   e. Was there static on the radio?

   f. Did the electrical systems operate intermittently?

OWNER/OPERATOR QUESTIONS (cont'd)

- How much time between first indicator and fire?
- Has any equipment been added, altered or worked on?
- Who did the work and when?

Slide 14-33

g. How much time between first indicator and fire?

h. Has any equipment been added, altered or worked on?

i. Who did the work and when?

OWNER QUESTIONS

- Who was last to drive the vehicle?
- Is the vehicle in good running condition?
- How many keys exist for the vehicle?
  - Do you have them?
- Do you know who might have taken the vehicle?

Slide 14-34

F. Owner questions. Establish an alibi as soon as possible. Lock him or her into a story.

1. Who was last to drive the vehicle?

2. Is the vehicle in good running condition?

3. How many keys exist for the vehicle? Does he or she have them?

4. Does he or she know who might have taken the vehicle?

OWNER QUESTIONS (cont'd)

- Are your payments up-to-date?
  - Was the vehicle repossessed?
- Have you been looking to sell the vehicle?
- Are there any valuables in the vehicle?

Slide 14-35

5. Are his or her payments up-to-date? Was the vehicle repossessed?

6. Has he or she been looking to sell the vehicle?

7. Are there any valuables in the vehicle?

WITNESS QUESTIONS

- Where was smoke or flame visible?
- Were doors open or closed? Windows up or down?
- How fast did the fire spread?
- What were the reactions of the operator?

Slide 14-36

G. Ask witnesses questions about what they saw and consider whether it agrees with the operator.

1. Where was the smoke or flame visible?

2. Were doors open or closed? Windows up or down?

3. How fast did the fire spread?

4. What were the reactions of the operator?

PUBLIC VEHICLE IDENTIFICATION NUMBER

- The plate is normally in front of the driver on the dash.
- If it survives the fire, it should be recorded and photographed.
- The rosette rivets that hold it in place should be closely examined for authenticity.

Slide 14-37

H. Investigators need to establish the identity of the vehicle using public VIN. The VIN and coded information can be altered and reused.

1. The plate is normally in front of the driver on the dash.

2. If it survives the fire, it should be recorded and photographed.

3. The rosette rivets that hold it in place should be closely examined for authenticity.

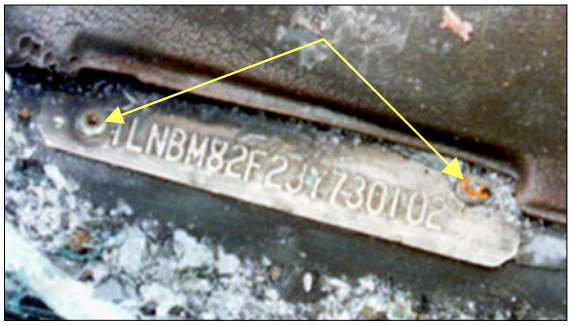
4. Investigators need to properly identify the vehicle in question.

PUBLIC VEHICLE IDENTIFICATION NUMBER (cont'd)

Slide 14-38

5. The photograph shows the VIN number on the driver's side dash.

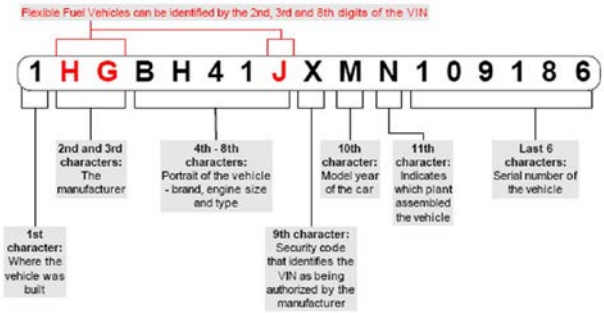
PUBLIC VEHICLE IDENTIFICATION NUMBER (cont'd)



Slide 14-39

6. Check the fastener (rosette rivets) to see if it is altered.

VEHICLE IDENTIFICATION NUMBER DECODER



Slide 14-40

I. The VIN decoder shows the breakdown of the VIN.

OTHER VEHICLE IDENTIFICATION NUMBER LOCATIONS

- Federal Standards Compliance Label (FSCL) sticker.
- Transmission.
- Engine.
- Confidential VIN.

Slide 14-41

J. Other VIN locations.

1. Federal Standards Compliance Label (FSCL) sticker.

2. Transmission.

3. Engine.

CONFIDENTIAL VEHICLE IDENTIFICATION NUMBER

Slide 14-42

4. Confidential VIN.

VEHICLE IDENTIFICATION NUMBER RESOURCES

- National Insurance Crime Bureau (NICB).
- Police.
  - Auto theft units.
- Insurance companies.
- National Crime Information Center (NCIC).

Slide 14-43

K. List of resources for VINs.

1. National Insurance Crime Bureau (NICB).

2. Police (e.g., auto theft units).

3. Insurance companies.

4. National Crime Information Center (NCIC).

SCENE FACTORS TO NOTE

- The time of the incident.
- The location.
- The orientation of vehicle.
- Weather conditions.
- Video surveillance.

Slide 14-44

L. Factors that affect the patterns. These may be confusing if the vehicle was moved prior to the examination.

1. Take note whether it is appropriate for the location of the vehicle? Remote?

2. Is the location reasonable for the time of day?

3. Note the orientation of the vehicle (e.g., facing uphill or down, tilted to one side).

4. Weather conditions.

5. Video surveillance.

LOCATION

Slide 14-45

M. Remote location may ensure a total burn of the vehicle due to delayed discovery.

ORIENTATION

Slide 14-46

N. Orientation may affect burn patterns or the vehicle and mislead the investigator when the vehicle is on level ground.

SEARCH THE AREA FOR EVIDENCE

- Evidence needed to support theory as to cause.
  - Evidence to establish the arson.
  - Evidence to establish another crime.
- Evidence sometimes found:
  - Tires and footprints.
  - Tools.
  - Accessories.
  - Cans, bottles and containers.
  - Tags.

Slide 14-47

O. Search the area for evidence.

1. Evidence is needed to support theory as to cause.

   a. Search for evidence to establish the arson.

   b. Look for evidence to establish another crime.

2. Evidence is sometimes found in:

   a. Tires and footprints.

   b. Tools.

   c. Accessories.

d. Cans, bottles and containers.

e. Tags.

EVIDENCE OF TRACKS

Slide 14-48

3. To find tracks, you need to move away from the immediate area of the vehicle. Activity by the fire department around the vehicle will destroy tracks.

SCENE EXAMINATION

Slide 14-49

4. Examine the scene for additional evidence. Note trailer patterns on the grass. A sample would be required to confirm this at the scene after the vehicle was removed.

TRAILERS

Slide 14-50

OBTAIN SOIL SAMPLES

Slide 14-51

5. Obtain soil samples if accelerant is suspected. Dirt is a good absorbent.

TOTAL BURNS

- **Myth or fact:** Total burns are the result of arson.

Slide 14-52

P. Total burns.

1. The longer the fire goes undiscovered, the longer the burn time, and the time of first response are all potential indicators when more destruction is identified.

2. Total burns are the result of arson. Is this a myth or a factor?

TOTAL BURNS (cont'd)

- **Myth:** Total destruction can be the result of arson or an accidental cause.
  - Time is the most critical factor.

Slide 14-53

a. Myth.

b. Total burns of vehicles may occur from accidental means and are influenced by several factors:

- Delayed fire suppression.
- Remote location.
- Weather conditions.
- Delayed discovery.

TOTAL BURNS (cont'd)

- Total burns do not give much to work with.
  - Generally an undetermined fire (not necessarily)!
  - Evidence of the cause could be destroyed.
    - -- Remember, this could occur in any fire.
- Attempt to establish prefire condition.
  - Refer to an exemplar.
  - Any items missing or added should be noted.

Slide 14-54

3. Total burns do not give much to work with.

   a. It is generally an undetermined fire, but not necessarily.

   b. Evidence of the cause could be destroyed; however, this could occur in any fire.

4. Attempt to establish the prefire condition.

   a. Refer to an exemplar.

   b. Note any items missing or added.

TOTAL BURNS (cont'd)

- Check vehicle fluids for mechanical problems (may need to discuss with an auto expert for this type of evidence collection).
- Check area for ignitable liquid residue where not normally found.
  - Interior (passenger area) floor pans.
  - Soil away from the vehicle (trailer).
- Photograph of the scene after removal.

Slide 14-55

5. Check vehicle fluids for mechanical problems. If necessary, discuss with an auto expert for this type of evidence collection.

6. Check the area for ignitable liquid residue where not normally found.

   a. Interior (passenger area) floor pans.

   b. Soil away from the vehicle (trailer).

7. Photograph of the scene after removal.

EXAMINE THE EXTERIOR OF THE VEHICLE

Slide 14-56

Q. Examine the exterior of the vehicle.

PATTERNS

- Metal components that are exposed to the most intense or prolonged heating will begin to oxidize (rust) soon after extinguishment.
- Soft metals and plastics can be a guide to direction of fire travel.

Slide 14-57

1. Burn patterns become more obvious over time with metal parts. Plastic will melt.

   a. Metal components that are exposed to the most intense of prolonged heating will begin to oxidize (rust) soon after extinguishment.

   b. Soft metals and plastics can be a guide to direction of fire travel.

ENCLOSURES CAUSE FIRE PATTERNS

Slide 14-58

2. Enclosures like garages cause fire patterns.

Slide 14-59

3. The photograph shows the fiberglass hood of a Corvette. The fire originated in the wiring harness between the bulkhead and the wheel.

EVALUATING EXTERIOR PATTERNS

- Work from the top down.
- Compare burned areas to less burned areas.
- Evaluate horizontal surfaces.
  - Roof, hood and trunk.
- Evaluate vertical surfaces.
  - Fenders and door panels.

Slide 14-60

4. Employ a systematic approach to exterior evaluation.

   a. Work from the top down.

   b. Compare burned areas to less burned areas.

   c. Evaluate horizontal surfaces (e.g., roof, hood and trunk).

   d. Evaluate vertical surfaces (e.g., fenders and door panels).

VIEW FROM ABOVE

Slide 14-61

5. View of roof area of vehicle.

   a. The spot burns show the location of roof supports.

   b. The fire originated in the passenger compartment of the vehicle.

ROOF DEFORMITY

Myth: The heat from combustibles within the vehicle along with the use of thinner or lightweight metal will cause roof deformity.

Slide 14-62

   c. The deformity of the roof is due to heat only. The deformity is due to thinner metal used in construction of vehicle.

HOOD PATTERNS

Slide 14-63

6. The photographs show burn patterns on hood. The top two are compartment fires; the bottom is extension from passenger compartment.

MELTING OF METALS

- Do not assume the presence of melted metals as an indicator of accelerants.
- Metals melt at different temperatures, especially alloyed metals, which will show varying degrees of damage when exposed to heat.

Slide 14-64

7. Melting of metals.

   a. Plastics, fiberglass and aluminum will melt at various lower temperatures than metals.

   b. Do not assume the presence of melted metals as an indicator of accelerants.

   c. Metals melt at different temperatures, especially alloyed metals, which will show varying degrees of damage when exposed to heat.

MELTING OF METALS (cont'd)

- Remember, no one indicator makes a case.
- Common combustibles and ignitable liquids can produce the same flame temperatures.

Slide 14-65

d. Remember that no one indicator makes a case.

e. Common combustibles and ignitable liquids can produce the same flame temperatures.

MELTING OF METALS (cont'd)

Slide 14-66

f. Plastic or lightweight metals can be consumed by the fire. Plastic and lightweight metals are used to lighten the vehicle and increase gas mileage.

COMPARING EXTERIOR DAMAGE

More damage on the door

Less damage on the door

Slide 14-67

g. Comparing exterior damage may indicate the more severe damage to the exterior. It may indicate an area of origin, and it may indicate a ventilation issue.

WEATHER REPORT

Slide 14-68

8. The exterior may be affected by wind direction.

PLASTIC PANELS MELT

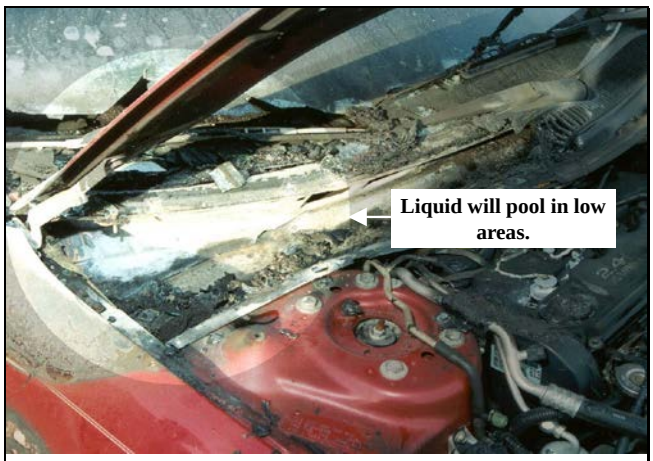
Slide 14-69

9. Plastic panels may melt with heat impingement. Note that the gas cap is still intact.

POUR PATTERNS

Slide 14-70

10. Ignitable liquid pour patterns with high HRR will only scorch due to short exposure time.



Slide 14-71

11. Areas from which to retrieve samples include engine cowl, window rubber seal, and rain channels.

TIRES AND WHEELS

Slide 14-72

12. Examine the tires and wheels.

    a. A tire pad can be found under the wheel for examination. When it is not found, it could indicate that the vehicle has been moved.

TIRES AND WHEELS (cont'd)

Is the tire wear even?

Slide 14-73

b. Uneven or excessive wear or mismatched tread patterns may indicate mechanical or financial problems, or that newer, more expensive tires have been removed and replaced with older ones.

TIRES AND WHEELS (cont'd)

Slide 14-74

c. Check for missing or loose lug nuts, which may indicate a wheel switch at the location.

EXAMINE DOOR POSITIONS

- Determine the door position.
- Door position can affect fire growth and patterns.

Slide 14-75

13. Examine door positions.

    a. Confirm door position by examining the debris on the ground.

    b. Debris should be located beneath the door.

    c. Examine burn patterns to also confirm door position.

EXAMINE THE WINDOW GLASS

- Delamination of the windshield glass due to heat.
- Plastic between glass begins to burn.

Slide 14-76

14. Examine the window glass.

    a. Windshield will burn due to combustible plastic between glass layers.

    b. Delamination of the windshield glass due to heat.

    c. Plastic between the glass begins to burn.

Slide 14-77

d. Window arms show the position of the window. Beware of nylon bushings that can melt and drop window arms.

PASSENGER COMPARTMENT FIRE
VERSUS ENGINE COMPARTMENT FIRE

Engine compartment

Passenger compartment

Slide 14-78

R. In engine compartment fires, the fire damage is low due to the fire penetration of bulkhead. Meanwhile, fire in passenger compartment rises, spreads laterally, and exits high.

EXAMINATION OF FUEL CAP

- Tank fill cap and spout.
  - Often removed to allow fuel siphoning.
  - Cap may be discarded.
  - Owner may claim fuel tank explosion blew cap off.
  - Check for damage to cap flanges (older).
  - Check for damage to filler spout.
- Some late models do not have removable caps, only a fill door.

Slide 14-79

S. Examine the fuel cap.

1. It is important to know what type of fuel cap was in place if there was one present.

2. Tank fill cap and spout.

   a. Often removed to allow fuel siphoning.

   b. Cap may be discarded.

   c. The owner may claim that a fuel tank explosion blew the cap off.

   d. Check for damage to the cap flanges (older).

   e. Check for damage to filler spout.

3. Some late models do not have removable caps, only a fill door.

EXAMINATION OF FUEL CAP (cont'd)

Slide 14-80

4. Fuel vapors venting from fill pressurized type system(s).

EXAMINATION OF FUEL CAP (cont'd)

Slide 14-81

5. These are the remains of the fuel cap in fill tube.

6. The investigator should document any foreign objects located around the cap or that dropped down.

7. Delayed or incendiary device remains may be located.

MISSING PARTS OR EQUIPMENT

Slide 14-82

T. Investigators should conduct a thorough examination of the interior and exterior of the vehicle to document whether any parts or equipment are missing that may have been removed prior to the fire.

MECHANICAL CONDITION OF THE VEHICLE

- The mechanical condition of the vehicle prior to the fire should be established.
- Visual observations and owner statements should be documented for investigators.

Slide 14-83

U. Poor mechanical condition could be reason for accidental fire or arson.

1. The owner could be trying to sell the vehicle to the insurance company. Beware of deceptive interviews.

2. Establish the mechanical condition of the vehicle prior to the fire.

3. Visual observations and owner statements should be documented for investigators.

Slide 14-84

4. Investigators should identify if maintenance work was being performed on the vehicle at the time and location of the loss.

EXAMINE THE VEHICLE'S UNDERCARRIAGE

Slide 14-85

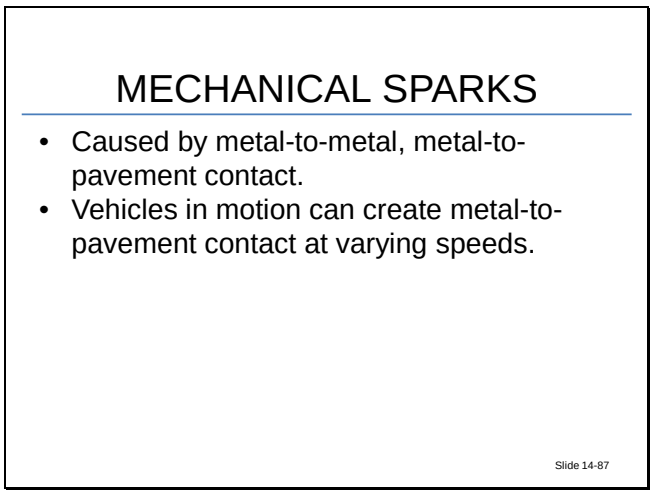
V. Examine the vehicle's undercarriage.

1. It may provide investigators with clues as to potential heat sources and modes of failure.

EXHAUST SYSTEM

Slide 14-86

2. Heat shields may become loose or fall off exposing floor pans to heat.



3. Dragging metal parts can create sparks (as high as 2,000 F) sufficient to cause ignition.

4. NFPA 921, Section 27.4.4, Mechanical Sparks.

   a. Metal-to-metal contact (steel, iron or magnesium) or metal-to-pavement contact can create frictional contact sparks, with enough energy to ignite gases, vapors and/or liquids that are in an atomized state.

   b. Metal-to-metal contact may occur at drive pulleys, drive shafts or bearings, for example.

   c. Metal-to-pavement contact typically involves a broken component, such as a drive shaft, exhaust system or wheel rim after the loss of a tire or in a crash.

   d. All metal-to-metal or metal-to-pavement sparking requires that the vehicle be running and/or in motion.

   e. Sparks generated at speeds as low as 5 mph (8 kilometers (km) per hour) have been determined to reach temperatures of 1,470 F (800 C) (orange sparks).

   f. Higher speeds have produced white sparks in the 2,190 F (1,200 C) range.

   g. Aluminum-to-pavement sparks are not a competent ignition source for most materials because of the relatively low melting temperature of aluminum.

   h. The small particle size (mass) of sparks limits the quantity of energy available from them to ignite materials that they contact.

i. Sparks cool rapidly, especially when moving through air, which further limits the rate of heat transfer to materials that they contact. For these reasons, it is difficult for sparks to ignite solid materials.

CATALYTIC CONVERTERS

- Catalytic converters have very high external temperatures — 600 to 1,000 F (especially if malfunctioning).
- They can ignite combustible liquids (brake/transmission).
- They can also ignite ordinary combustibles on contact.

Slide 14-88

5. Catalytic converters have very high external temperatures ranging from 600 to 1,000 F (especially if malfunctioning).

   a. They can ignite combustible liquids (e.g., brake or transmission fluids).

   b. They can ignite ordinary combustibles on contact.

   c. Catalytic converter temperature may increase when engine shuts off. It takes approximately 45 to 90 minutes to reduce temperature by 80 percent.

EVIDENCE OF FLUID LEAKS

Slide 14-89

6. Transmission lines under pressure 250 pounds per square inch (psi) can leak and spray combustible fluid mist onto hot exhaust. Fluid ignites at approximately 650 F.

FUEL TANKS

Fuel tanks are reservoirs that contain ignitable liquid fuels.

- Most modern vehicles have plastic gas tanks that fail when exposed to an external fire.

Slide 14-90

7. Fuel tanks are reservoirs that contain ignitable liquid fuels.

   a. Most modern vehicles have plastic gas tanks that fail when exposed to an external fire.

   b. Plastic fuel tanks can melt when exposed to 400 to 600 F.

FUEL TANKS (cont'd)

- When exposed to fire, the soldered seams of a metal tank may fail and separate, releasing the fuel.
- Many fuel tanks are plastic and are totally consumed by the fire.
- Fuel tanks do not explode. Vapors burn at vents and fillers where air is available.

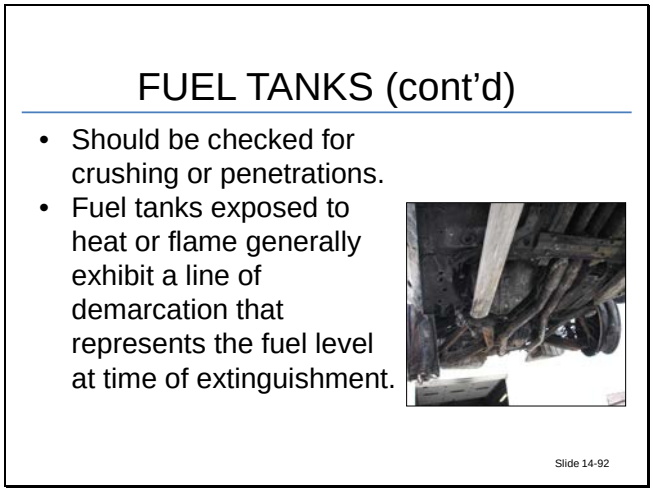
Slide 14-91

   c. When fuel tanks are exposed to fire, the soldered seams of a metal tank may fail and separate, releasing the fuel.

   d. Examinations should be conducted with the vehicle on a secured lift. Do not crawl under the vehicle to examine until it is properly secured.

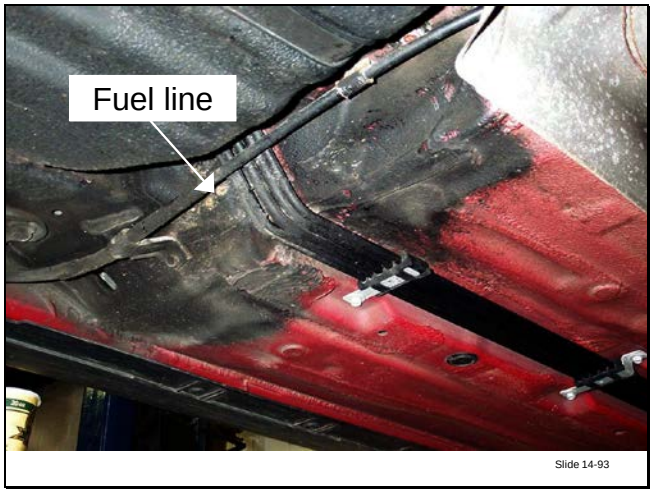
e. Many fuel tanks are plastic and are totally consumed by the fire.

f. Fuel tanks do not explode. Vapors burn at vents and fillers where air is available.



g. Fuel tanks should be checked for crushing or penetrations.

h. When they are exposed to heat or flame, they generally exhibit a line of demarcation that represents the fuel level at the time of extinguishment.



8. Some fuel lines are made of nylon and can melt at approximately 400 to 500 F.

IV. COMPARTMENTS AND SYSTEMS

COMPARTMENTS AND SYSTEMS

- Compartments.
  - Passenger.
  - Engine.
  - Cargo.
- Systems.
  - Fuel.
  - Electrical.
  - Exhaust.

Slide 14-94

A. Compartments consist of the passenger, engine and cargo area.

1. There is no solid compartment separation.

2. There will be voids and breaches between compartments.

B. Systems consist of fuel, electrical, exhaust, etc.

1. Examine the vehicle, and work from areas of least amount of damage to areas of most amount of damage.

2. Most fires, both incendiary and accidental, occur in the passenger compartment. Human involvement plays a part.

SWITCHES, HANDLES AND LEVERS

- Determine “on or off” if possible.
- Window positions.
  - Window rails within the door.
- Position of gear shift.
- Position of ignition switch.
- Any indication of tampering can be helpful.

Slide 14-95

C. Positions of switches, handles and levers may have contributed to the fire. It may confirm or contradict statements of the owner.

1. Determine the state of the switches, whether they were “on or off.”
2. Identify the window positions. Look at the window rails within the door.
3. Note the position of the gear shift.
4. Note the position of the ignition switch.
5. Any indication of tampering can be helpful.

Slide 14-96

6. Examples.

   a. Ignition appears to be defeated by only the metal ring that has been removed.

Slide 14-97

   b. This is the screwdriver used to defeat the ignition.

Slide 14-98

c. The key is in the ignition, but it is odd to have one key with an extra ring attached.

TRANSPONDERS

- Approximately 75 percent of vehicles sold in the United States have transponder technology.
- It's difficult to clone transponder type keys, and the equipment to do so is very expensive.
  - Keyless ignition (key fob).
- There are over one trillion transponder codes.

Slide 14-99

D. Transponders are a new technology that makes stealing vehicles without the key very difficult.

1. Approximately 75 percent of vehicles sold in the United States have transponder technology.

2. It is difficult to clone transponder type keys, and the equipment to do so is very expensive (e.g., keyless ignition, key fob).

3. There are over one trillion transponder codes.

4. During any interview, both keys should be produced by the owner and documented. Note the following:

   a. How many?

b. How many came with the vehicle?

c. Where are they?

d. Who had access to them?

e. What type (key versus keyless)?

Slide 14-100

f. Note if the vehicle is in gear.

g. Automatic transmissions in park, not defeated, may indicate movement that is required by a key.

h. This may confirm or contradict the owner's statement.

Slide 14-101

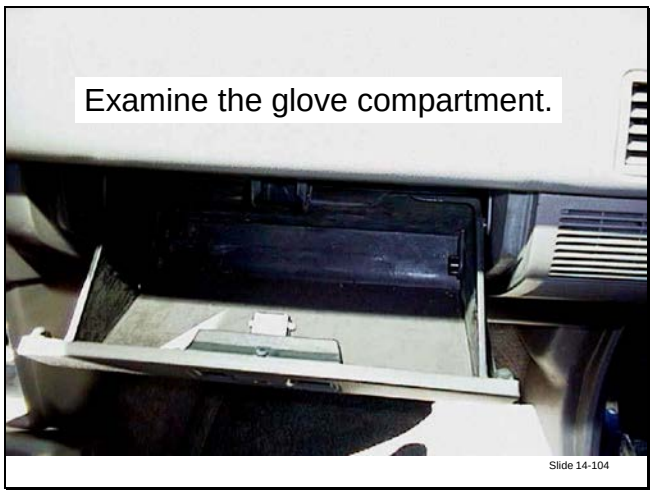
E. Examine the dash area for damage.

Slide 14-102

F. Examine wiring harnesses located in the dash area for evidence of electrical activity.

Slide 14-103

G. Look for cut wires near the accessories. They may indicate that the vehicle was stolen and then burned.



H. Examine the glove compartment.

1. They are not usually empty.

2. Look for maintenance receipts.

3. Does the glove box appear to be in the same condition as the debris in the car?

I. Myth or fact? Discarded smoking material can ignite the seat material.

1. Myth.

2. Cigarettes do not provide sufficient ignition energy to ignite seat material, which often contains fire inhibitors. The fire may progress if secondary fuel sources are large enough to sustain a fire (e.g., paper, trash, etc.); then combustion to the seat can be sustained.

EXAMINE THE FLOOR AREA

Slide 14-106

J. Examine floor area for any remains of potential evidence (e.g., flare).

1. If located, collect and secure as evidence.

2. A floor sample may be necessary to submit to the laboratory for analysis.

EXAMINATION OF THE TRUNK

- Most new vehicles are equipped with a spare tire.
  - Have tires been replaced?
- Trunks are usually not empty.
  - Personal effects may be present throughout the vehicle.

Slide 14-107

K. Examine the trunk.

1. Most new vehicles are equipped with a spare tire.

2. Trunks are usually not empty. Personal effects may be present throughout the vehicle.

3. Fire may have easy extension to cargo area through fold down rear seats.

BULKHEAD PENETRATION

- Fires originating in the engine compartment typically penetrate the interior on the passenger side.
- Fire can spread through the bulkhead, rubber grommets, plastic heater ducts, etc.

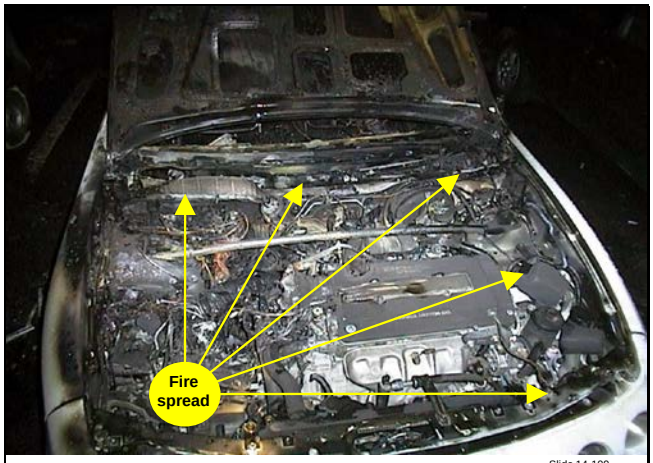
Slide 14-108

L. Bulkhead penetration.

1. Fires originating in the engine compartment typically penetrate the interior on the passenger side.

2. Fire can spread through the bulkhead, rubber grommets, plastic heater ducts, etc.

3. Many voids and openings allow extension to and from engine compartment.



Slide 14-109

4. Fire spread laterally due to closed hood casting surface damage to hoses and belts. Most destruction is at origin, vehicle front passenger side.

FUEL SYSTEMS

Slide 14-110

M. Fuel systems.

1. Carburetor system operates at a lower psi.

2. What is missing in this photo (carburetor, air filter)?

FUEL SYSTEMS (cont'd)

Slide 14-111

3. In fuel injector systems, the fuel rail has an injector at each cylinder.

FUEL SYSTEMS (cont'd)

- Operate approximately between 30 to 90 pounds per square inch (psi).
- A pinhole leak would cause the fuel to atomize.
- Increases the risk of ignition.

Slide 14-112

4. Fuel systems operate approximately between 30 to 90 psi.

5. A pinhole leak would cause the fuel to atomize.

6. Atomized fuel under pressure could be ignited by a spark or hot surface.

FUEL SYSTEMS (cont'd)

- Pressure regulator can be another area where fuel can leak into the compartment.

Slide 14-113

7. Pressure regulator can be another area where fuel can leak into the compartment.

FUEL SYSTEMS (cont'd)

- Fuel system line breakdowns will occur at their weakest point.
- Fuel lines can be steel, flexible nylon or synthetic rubber.

Slide 14-114

8. Fuel system line breakdowns will occur at their weakest point.

9. Fuel lines can be steel, flexible nylon or synthetic rubber.

ELECTRICAL SYSTEMS

- Battery location and condition.
- Engine components and accessories.
- Fuse box.

Slide 14-115

N. Electrical systems.

1. Battery location and condition.

2. Engine components and accessories.

3. Fuse box.

4. Investigators should research the vehicle, if possible, prior to the investigation to determine what systems are energized when the vehicle is off, running, parked, etc.

5. The research will help the investigator to eliminate potential ignition scenarios.

ELECTRICAL SYSTEMS (cont'd)

Slide 14-116

6. Battery.

   a. Battery in place next to combustible fluid (oil) will produce hydrogen gas.

ELECTRICAL SYSTEMS (cont'd)

Slide 14-117

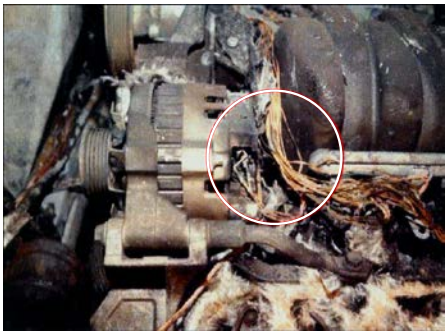
   b. A fire-damaged battery may release hydrogen gas, which ignites between 900 F and 1,000 F.

ELECTRICAL SYSTEMS (cont'd)

Slide 14-118

7. The alternator produces electrical energy for the vehicle, which needs to be regulated through a voltage regulator.

ELECTRICAL SYSTEMS (cont'd)



Slide 14-119

8. Voltage regulator failure at the rear of the alternator.

ELECTRICAL SYSTEMS (cont'd)

- Lamps and bulbs can possibly be an ignition source; think about what possible fuels could be receptive to the ignition source.
- However, the temperature (2,500 F) generated by a short circuit is normally short lived and in open air.

Slide 14-120

9. Lamps and bulbs.

   a. They can possibly be an ignition source; think about what possible fuels could be receptive to the ignition source.

   b. The temperature (2,500 F) generated by a short circuit is normally short lived and in open air.

SHORTS AND ARCS

Arcs can result from worn insulation going to ground.

- Attempt to determine if the vehicle has ever been wrecked, salvaged or recalled. Owner may not know, especially on a recently purchased vehicle.

Slide 14-121

10. Shorts and arcs can result from worn insulation going to ground.

    a. Attempt to determine if the vehicle has ever been wrecked, salvaged or recalled. The owner may not know, especially on a recently purchased vehicle.

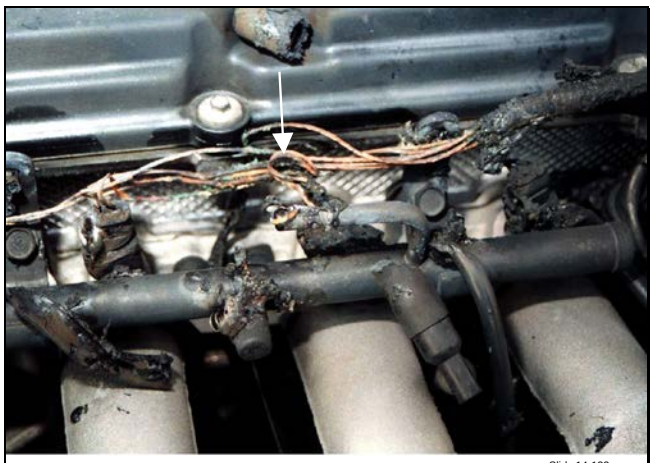
SHORTS AND ARCS (cont'd)

- Do not forget that batteries can hold large amounts of energy and deliver excessive amperage.

Slide 14-122

    b. Do not forget batteries can hold large amounts of energy and deliver excessive amperage.

    c. Shorts and arcs may indicate electrical malfunction.



Slide 14-123

d. Investigators should carefully inspect wiring in the engine compartment for evidence of localized damage.

FUSE BOXES SHOULD BE LOCATED

Slide 14-124

11. By determining which fuses are tripped, the investigator can use this data to trace the tripped circuit in an attempt to locate where the wire failed or was attacked by fire. This will also assist the investigator in confirming the origin location of the fire as well as fire progression.

FUSES

- Normally located on the driver's side or under the dashboard; however, depending on the manufacturer, the fuse block may be located anywhere in the vehicle.
- Consult vehicle manufacturer.

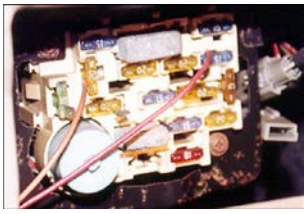
Slide 14-125

a. Fuses are one-time safety devices that protect various functions.

- They are normally located on the driver's side or under the dashboard; however, depending on the manufacturer, the fuse block may be located anywhere in the vehicle.

- Consult the vehicle manufacturer.

EXAMINE PROTECTION DEVICES



Slide 14-126

b. Examine the protection devices that are used to protect the wires.

FAILURE OF FUSE DUE TO MOISTURE

Slide 14-127

c. Fuse block failure due to exposure to moisture. Fuse protects a bilge pump on a vessel.

CIRCUIT BREAKERS

For circuits that are used intermittently: wipers, turn signals, cruise control units, etc.

Slide 14-128

12. Circuit breakers.

    a. They are used for circuits that are used intermittently (e.g., wipers, turn signals, cruise control units, etc.).

    b. Circuit breakers are resettable.

FUSIBLE LINKS

Located in the wiring harness and often not visible without destruction or removal of the harness covering.

Slide 14-129

13. Fusible links are located in the wiring harness and are often not visible without destruction or removal of the harness covering.

ADDITIONAL ELECTRICAL COMPONENTS

- Present special problems mainly because of alternating current (AC)/direct current (DC) circuits, pressurized fuels and appliances.
  - AC/DC converters/inverters.
  - Generators.

Slide 14-130

14. Additional electrical components present special problems mainly because of alternating current (AC)/direct current (DC) circuits, pressurized fuels and appliances.

    a. AC/DC converters/inverters.

    b. Generators.

ADDITIONAL ELECTRICAL COMPONENTS (cont'd)

- Collecting power from outside sources, undersized extension cords, shore lines, loose connections.
- Excessive length of cords, voltage differences.

Slide 14-131

c. Collecting power from outside sources, undersized extension cords, shore lines, loose connections.

d. Excessive length of cords, voltage differences.

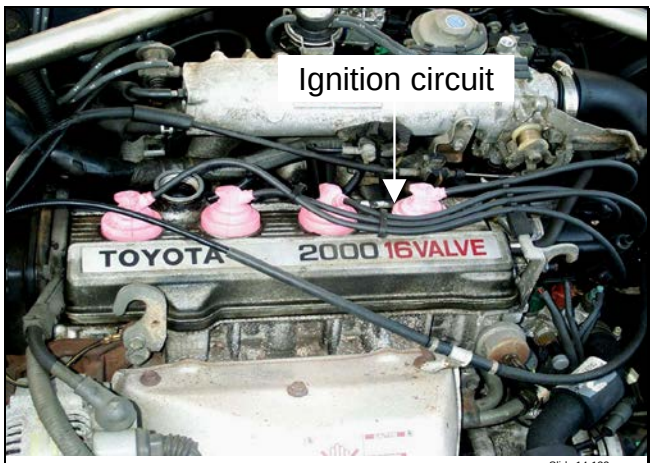
e. After market additions may cause problems if not installed or fused properly.

ADDITIONAL ELECTRICAL COMPONENTS (cont'd)

- Added accessories.

Slide 14-132

15. Examine added accessory installation for proper installation. These locations are usually suspect of high resistance connections (HRCs). HRC could potentially reach temperatures of over 2,500 F depending on the circuit and load. These sustained temperatures can ignite nearby combustibles.



Slide 14-133

16. Cracked insulation on spark plug can arc and cause ignition.

ARC MAPPING

Slide 14-134

17. Investigators should attempt to locate circuits that may potentially produce electrical activity.

HOT SURFACES

- Manifolds are extremely hot and can ignite fluid spray.
  - When engine and fan stop, it takes approximately 30 minutes to reduce temperature by 80 percent.
  - Temperature of surface must be above the auto ignition temperature (AIT) of the suspected fuel.
  - If fuel is atomized, the AIT is lowered.
  - Ignition will occur within 10 minutes of turning motor off.

Slide 14-135

O. Hot surfaces.

1. Manifolds are extremely hot and can ignite fluid spray.

   a. When the engine is off and airflow ceases, it takes 30 minutes to reduce the temperature by 80 percent. This is why the fan continues to run to continue airflow over motor.

   b. Temperature of the surfaces must be above the auto ignition temperature (AIT) of the suspected fuel.

   c. Ignition will occur within 10 minutes of turning the motor off.

HOT SURFACES (cont'd)

- Gasoline vapors can ignite by arc, spark or open flame.
- Automatic transmission fluid, engine oil, and brake fluid can all ignite, even when the engine is off.

Slide 14-136

2. Gasoline vapors can ignite by arc, spark or open flame.

3. Automatic transmission fluid, engine oil, and brake fluid can all ignite, even when the engine is off.

HOT SURFACES (cont'd)

- Testing the hypothesis of a hot surface ignition may be difficult.
  - Dependent upon type of fuel and surface material.

Slide 14-137

4. Testing the hypothesis of a hot surface ignition may be difficult, depending upon type of fuel and surface material.

5. NFPA 921, Chapter 27, Section 27.4.3.2.

   a. Typically, gasoline will not be ignited by a hot surface, but requires an arc, spark or open flame for ignition.

   b. While ignition of gasoline vapor by a hot surface is difficult to reproduce, such ignitions should not be dismissed out of hand.

   c. As reported in LaPointe, et al., ignition of liquids by hot surface in the open air was not observed until the surface temperature was several hundred degrees above the published ignition temperature.

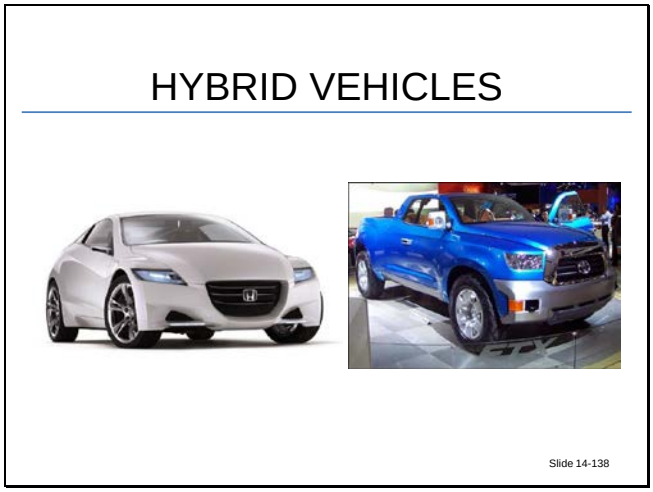
   d. The ignition of liquids by hot surfaces is influenced and determined by many factors, not just ignition temperature.

      - These factors include ventilation and environmental conditions, such as humidity, air temperature, and airflow.

      - Fluids' physical properties, such as autoignition point, liquid flash point, liquid boiling point, liquid vapor pressure, liquid vaporization rate, and misting of liquid.

      - Other factors include hot surface roughness, material type, and residence time of the liquid on the hot surface.

V. HYBRID VEHICLES



HYBRID VEHICLES (cont'd)

What is a hybrid? (Any vehicle is a hybrid when it combines two or more sources of power.)

Slide 14-139

A. A hybrid is any vehicle that combines two or more sources of power.

PREINVESTIGATION OF VEHICLE

Ascertain from Officer in Charge (OIC) if:

- Identified as a hybrid.
- Vehicle chocked.
- Ignition off/Keys removed.
- 12-volt battery disengaged.
- Air bag deployed.
- High voltage system rendered safe.

Slide 14-140

B. Before investigation of vehicle, ascertain from the Officer in Charge (OIC) if:

1. The vehicle is identified as a hybrid.
2. Vehicle is chocked.
3. Ignition is off or keys removed.
4. The 12-volt battery is disengaged.
5. Air bag deployed.
6. High voltage system is rendered safe.

INVESTIGATION OF VEHICLE

- Investigate as recommended with added precautions.
  - If fire originated within battery pack or high volt system.
    - -- Orange cables are high voltage (300 plus volts).
  - If battery pack damaged by radiant heat.

Slide 14-141

C. Investigation of the vehicle.

1. Investigate as recommended with added precautions:

a. If the fire originated within the battery pack or high volt system. Orange cables are high voltage (300 volts or higher).

HIGH VOLTAGE CABLES

Slide 14-142

b. If the battery pack was damaged by radiant heat.

INVESTIGATION OF VEHICLE (cont'd)

- Do not remove cover of high voltage battery case.
- Put special attention to the nickel metal hydride (Ni-MH) battery.

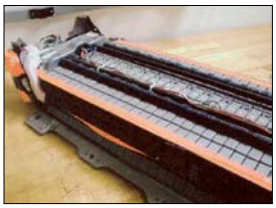
Slide 14-143

2. Do not remove the cover of the high voltage battery case.

3. Pay special attention to the nickel metal hydride (Ni-MH) battery.

HYBRID BATTERIES

Toyota Prius



Honda Insight

Slide 14-144

D. Hybrid batteries have various types and configurations.

1. They are not common in appearance.

HYBRID BATTERIES (cont'd)

Slide 14-145

2. Burned battery from vehicle.

VI. SUMMARY

SUMMARY

- Need for vehicle fire investigations.
- Health and safety issues.
- Conducting an examination of a vehicle.
- Compartments and systems.
- Hybrid vehicles.

Slide 14-146

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ACTIVITY 14.1

Instructor-Led Practical Demonstration

Purpose

Observe a live vehicle fire presented by the instructor. This demonstration will reinforce the key principles of conducting a systematic vehicle fire examination.

Materials

Equipment set up at burn range by ATF/NFA staff.

Safety Precautions

Instructor will wear required PPE during demonstrations.

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UNIT 15: LEGAL CONSIDERATIONS

TERMINAL OBJECTIVE

The students will be able to:

15.1 Recognize legal concepts related to fire scene investigation, evidence collection, report writing, depositions and courtroom testimony.

ENABLING OBJECTIVES

The students will be able to:

15.1 Recognize the elements of arson.

15.2 Apply search-and-seizure laws.

15.3 Describe four methods for lawful access at a fire scene.

15.4 Apply the law of confessions.

15.5 Discuss preparation pointers for polishing lay and expert testimony.

15.6 Prepare for providing testimony in legal proceedings.

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UNIT 15:
LEGAL CONSIDERATIONS

Slide 15-1

ENABLING OBJECTIVES

- Recognize the elements of arson.
- Apply search-and-seizure laws.
- Describe four methods for lawful access at a fire scene.
- Apply the law of confessions.
- Discuss preparation pointers for polishing lay and expert testimony.
- Prepare for providing testimony in legal proceedings.

Slide 15-2

I. ARSON LAWS

ARSON LAWS

Slide 15-3

The definition of arson is actually specific to one type of structure.

A. We commonly refer to many different fire crimes as arson.

B. Here we will be defining arson and then referring to many fire-related crimes.

C. The investigator must know what the elements are for each different fire crime in his or her jurisdiction in order to correctly charge crimes.

D. Search-and-seizure laws must be complied with because a violation can result in dismissal of charges that the investigator knows occurred.

E. Fire investigators can obtain lawful entry into crime scenes and collect evidence under certain situations, but a violation can lead to dismissal of a case that could and should have been won.

II. COMMON LAW

COMMON LAW ARSON

- Common law.
  - "Found" by judges.
  - Individual case decisions.
- Statutory law.
  - Made by the legislature.
- Willful and malicious burning of a dwelling of another.

Slide 15-4

A. Criminal law is derived from two sources, common law and statutory law.

1. Common law crimes are acts that have been considered criminal as passed down by tradition and interpreted by judges.

   a. Common law crimes are basically acts that people consider inherently wrong and unacceptable behavior, such as murder, theft and arson.

   b. Many common law crimes have been defined by the legislature in statutes and now are statutory crimes.

   c. The legislature compiles and defines prohibited acts and assigns a numerical code to them.

2. Statutory crimes include unlawful acts such as driving while impaired, insurance fraud, and many of our fire crimes, which are now defined by statute.

B. Even crimes that are still "common law crimes" often have their corresponding sentencing requirements defined by statute.

1. So we have two sets of crimes:

a. Common law or traditional crimes defined by judges in case law.

b. Statutory crimes defined by the legislature.

2. All crimes may require some interpretation by judges as the cases are tried and appealed.

C. Arson is generally defined as the **willful** and **malicious burning** of a **dwelling of another**.

1. Each of the words in the definition of arson has a specific meaning that must be proven in order to prove arson has been committed.

a. Willful — intentional and without excuse or justification.

b. Malicious — with ill will, hatred, spite or resentment.

c. Burning — charring, not just mere discoloration or scorching (must be a change in the composition).

d. Dwelling — structure regularly used for sleeping.

e. "Of another" — some person other than or in addition to the defendant.

STATUTORY ARSON

- Passed by state legislatures.
  - Covers more than dwellings.
  - Degrees and types vary by state (know your state's law).

Slide 15-5

2. Legislature passes laws prohibiting certain acts defined as crimes.

   a. Fire crimes involve different types of fire damage: to buildings, personal property, vehicles, real property (land).

      - Because state legislatures create statutory law, these crimes vary by state.

STATUTORY ARSON (cont'd)

- Federal arson requires interstate commerce effect.
- Title 18 United States Code (USC), Section 844.

Slide 15-6

   b. Federal arson laws involve interstate commerce.

   c. Interstate commerce is much more easily affected presently than it was in the past because so many items cross state lines.

   d. Federal prosecution for fire crimes may or may not be accepted by a federal prosecutor, and state prosecution should be in cooperation with federal agents.

e. The Federal Arson Statutes are codified in Title 18 United States Code (USC) — Crimes and Criminal Procedure. Section 844 includes the interstate commerce clause, which makes it a federal crime to use fire or explosive materials and devices to destroy any building, vehicle, or other personal or real property in whole or in part owned or possessed by, or leased to, the United States, or any department or agency thereof, or any institution or organization receiving federal financial assistance or otherwise affecting interstate commerce (i.e., across state lines).

JUDICIAL INTERPRETATION

- Courts apply the plain meaning rule.
- Ambiguous language in statute leads to judicial interpretation of legislative intent.

Slide 15-7

D. All laws, common and statutory, are subject to judicial interpretation once a case is prosecuted and appealed.

1. Judges generally cannot change a statutory law; however, they are oftentimes called upon to interpret exactly what the legislature prohibited.

PLAIN MEANING RULE

- If there is ambiguity in the language of a statute, court applies the “plain meaning” of the word or phrase.
- Not necessarily what was meant by the legislature at the time it was enacted, but what it plainly means without considering the intent behind it.

Slide 15-8

2. If the meaning of a word or phrase is not clear, the courts will need to clarify what it means.

3. The plain meaning rule means that the judges will interpret the meaning of the word or phrase to be the ordinary (or literal) definition rather than attempting to discern what the legislature intended the word or phrase to mean.

4. The plain meaning rule allows judges to avoid taking sides in legislative or political aspects of a crime (judges are prohibited from taking sides).

ATTEMPT CRIMES

- Requires specific intent to commit the crime.
- State must prove substantial step toward completion of the intended crime.

Slide 15-9

E. Specific intent will be distinguished from general intent in a few moments.

1. An attempt crime means the defendant did not accomplish committing the crime, but he or she wanted to and tried to.

2. In order to prove a defendant attempted to commit a particular crime, there must be proof that:

   a. The defendant specifically intended (wanted) to commit the crime.

   b. The defendant did accomplish some substantial part of the crime and would have completed it but was stopped.

CONSPIRACY

- Connects two or more people to a specific crime.
- Requires an agreement and at least one overt act in furtherance of the planned crime.
  - Co-conspirators' statements are exceptions to the hearsay rule.

Slide 15-10

F. A conspiracy is an agreement between two or more people to commit an act that is a crime and at least one act toward completing the crime.

1. A conspiracy can be charged if the crime was completed or if it was attempted (some states even without an attempt).

   a. When there is proof that defendants got together to plan a crime ahead of time, the punishment can be increased.

   b. When defendants are charged with a conspiracy, each defendant's statement made during the conspiracy can be used against the other defendants. (This is an exception to the hearsay rules.)

2. There must actually be at least two defendants who agreed to commit a crime. (If one of only two was an undercover law enforcement officer, there is no conspiracy.)

ATTEMPT AND CONSPIRACY

- Conspiracy requires two or more people; attempt requires only one.
- Proof is circumstantial for both.

Slide 15-11

3. Because an attempt is an incomplete crime, and a conspiracy may also be an incomplete crime, the proof will be mostly circumstantial.

   a. Direct evidence directly proves a fact.

      - Example of direct evidence — witness who saw defendant pour gas on the victim's porch and light a match that ignited the gas vapors.

   b. Circumstantial evidence provides an inference to assist in proving a fact (chain of events that, when put together, provides evidence of a crime).

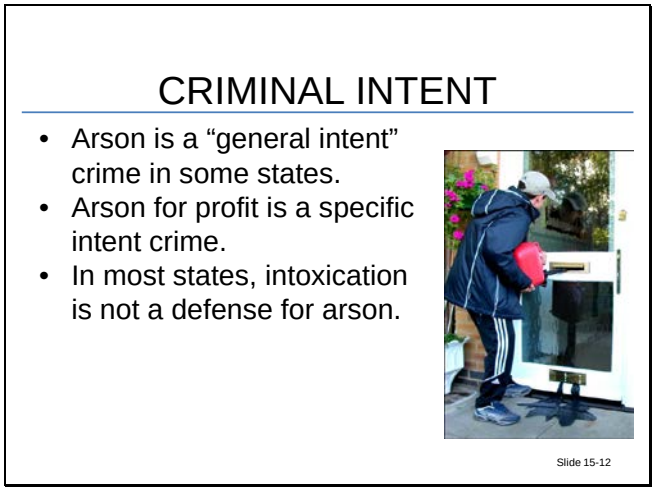
      - Example of circumstantial evidence — defendant's fingerprints located on the gas can found on the victim's porch.

4. There is no distinction between the weight to be given to direct or circumstantial evidence.

   a. An attempt may involve only one defendant who tries to commit a crime.

   b. A conspiracy requires at least two people who agree to commit a crime.

III. INTENT



A. Generally, arson crimes require some sort of intent.

1. It is the intent that distinguishes crimes from generally civil torts such as negligence and accidents.

2. Many crimes are general intent crimes, and that basically means the defendant acted purposely.

   a. Example of a general intent crime: Defendant swings at the victim. Whether he or she actually intends to harm the victim, seriously injure the victim, or even if he or she hits the wrong person, he or she intentionally acted by swinging, and whatever is the result of that crime is his or her responsibility.

   b. Example of arson: Defendant lights a match and puts the match on a sofa in a residence. Whether only the sofa burns, the residence is destroyed, or in some jurisdictions if a person is injured or killed, the defendant is criminally responsible, regardless of whether he or she only intended to burn the sofa.

   c. Another example of arson: Defendant lights a building on fire. There is no requirement that he or she knew the building was a residence or that it was occupied at the time of the fire.

3. Specific intent means the defendant acted with a specific purpose.

   a. An example is arson for profit. In order to prove the defendant committed the crime, there must be proof that he or she intended to make a profit.

   b. Specific intent crimes are more difficult to prove because the government must prove beyond a reasonable doubt that the defendant wanted to commit that particular crime.

4. There are defenses to specific intent crimes, such as diminished capacity (twinkie defense), voluntary intoxication, etc.

5. Basically, the defenses to specific intent crimes mean that the defendant was mentally unable to do something on purpose.

6. As long as a fire crime is not classified as a specific intent crime, defenses such as intoxication are not available to a defendant.

B. Trend toward a legal duty on law enforcement officers to collect evidence favorable to defense.

   1. General rule is no duty. New Mexico, Nevada and California recognize a limited duty.

2. If defense can show materiality (i.e., that evidence may have changed the verdict and can show that the police acted in bad faith in failing to collect the evidence), then court can dismiss the case or set aside a verdict.

C. Daniel's case — homicide during a robbery. Defendant claims that he was intoxicated at the time and police should have given him a breath alcohol test.

1. Arson is an area where this defense is possible, "spoliation of evidence." Private investigators who are second in line at fire scenes may also want to see more complete documentation of scenes. O.J. Simpson case had impact in many ways.

JUVENILE/CIVIL INTENT

- State statutes set age limits for the capacity to form criminal intent.
- Civil liability applies to the foreseeable consequences of voluntary acts.

Slide 15-13

2. Most laws concerning juveniles, and even what the definition of a juvenile is, are determined by the legislature in each state.

a. There are often specific state laws requiring strict compliance regarding juveniles in the areas of interviewing, fingerprinting and photographing.

b. In some cases, juveniles who would normally be required to handle their cases in juvenile court can be bound over and treated as an adult.

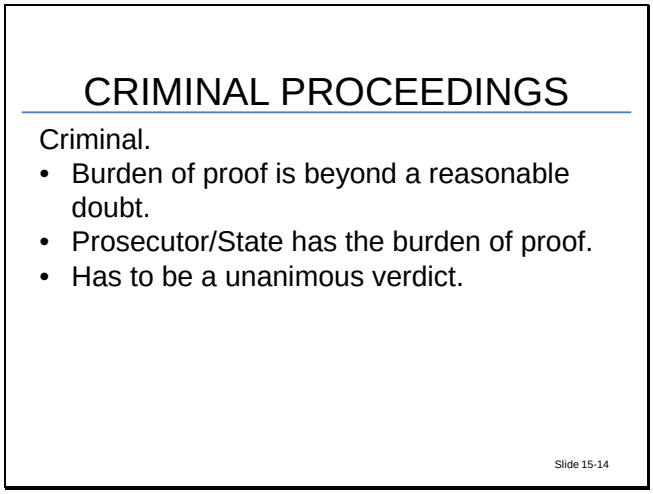
D. The United States Supreme Court (USSC) has set some federal guidelines regarding juveniles.

1. Defendants who were under the age of 18 when they committed murder cannot be sentenced to death.

2. Defendants who were under the age of 18 when they committed murder cannot now be automatically sentenced to life.

a. When juveniles are interrogated, their age is a consideration in determining whether their statement was voluntary.

b. There are often limits on the financial recovery for victims of juvenile crime; however, their parents or guardians may be civilly liable.



E. The burden of proof in a criminal case is the highest legal standard in our system of justice: It requires proof beyond a reasonable doubt.

1. The government (prosecutor, either federal or state) has the burden of proof, and the defendant has nothing to prove.

2. A defendant does not have to present any evidence at all and he or she cannot be called to testify (unless he or she wants to testify).

3. A criminal conviction requires each and every juror to agree that the government has proven the defendant's guilt beyond a reasonable doubt.

4. Guilt beyond a reasonable doubt is not proof beyond any doubt or beyond the shadow of a doubt, but it is proof based on reason and common sense that fully satisfies and entirely convinces the jury of the defendant's guilt.

CIVIL PROCEEDINGS

Civil.

- Burden of proof is preponderance of the evidence or clear and convincing.
- Plaintiff has the burden of proof.
- Does not have to be a unanimous verdict.

Slide 15-15

F. The burden of proof in civil court is the preponderance of the evidence, which means more likely than not (greater than 50 percent).

1. The burden of proof in some civil actions is clear and convincing evidence, which means highly and substantially more probably true than not.

2. The plaintiff, which is the person who brought the suit or action, has the burden.

3. The plaintiff can call the defendant to testify (no Fifth Amendment right to silence).

4. The jury may not have to be absolutely unanimous. (Some states do require unanimity.)

LEGAL DEFINITION OF PROBABLE CAUSE TO SEARCH

Look at the totality of the facts and circumstances and make a common sense, practical decision whether there is a **fair probability** that contraband or evidence of crime will be found in a particular place.

— *"IL v. Gates, 462 U.S. 213 (1983)."*

Slide 15-16

G. Probable cause is the standard required to search a person or a place or to arrest a person.

1. Probable cause is a fluid concept that depends on an assessment of probabilities in each particular situation.

2. Basically, probable cause is a fair probability that evidence of a crime may be in a certain place.

3. The information is time-sensitive because there must be an expectation that the items believed to be there will still be there.

PROBABLE CAUSE

- Measured by totality of the circumstances test.
- Facts must support a reasonable likelihood that the described evidence of a crime will be present at a particular place to be searched.

Slide 15-17

H. Probable cause is a totality of the circumstances test in determining whether there is a fair probability that specific evidence of a crime is located in a specific place at a specific time.

PROBABLE CAUSE (cont'd)

- May or may not need a search warrant, depending on situation.
- Golden rule: When in doubt, investigators should obtain a warrant.

Slide 15-18

1. There are times when a search warrant is not required; however, the only disadvantage to a search warrant is the time it takes to obtain it.

2. There are very good reasons to obtain a search warrant even when one is not required.

a. In a situation where evidence of probable cause is marginal, the fact that a search warrant was obtained may tilt the scales in favor of the validity of the search.

b. In a case where probable cause is lacking, a judge may decline to sign a search warrant, thus preventing an unlawful search that would lead to evidence that must be excluded. Instead, the investigator may obtain more information supporting probable cause prior to the search, resulting in a case where all evidence located is admissible against the defendant with a more suitable search warrant.

3. In some states and in the federal system, the good faith exception protects evidence obtained with the use of a search warrant even if the probable cause supporting the search is later determined to be lacking.

4. In some cases, defendants or others may attempt to sue an investigator due to a search, and judicial approval by granting the search warrant will support the lawfulness of the investigator's search. (If an investigator does not want to spend time obtaining a search warrant, the case may not be altogether that important to him or her.)

FOURTH AMENDMENT

"The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched and the persons or things to be seized."

Slide 15-19

5. Incorporation doctrine.

6. Mapp v. Ohio made federal law supreme via due process clause of the 14th Amendment.

7. Criminal law is the Fourth, Fifth and Sixth.

8. Key provision of the Fourth is the "warrants clause."

9. Purpose of the Fourth is to limit investigatory authority:

   a. Search with warrant presumptively constitutional.

   b. Without warrant presumptively unconstitutional.

10. Fourth constitutional means for gaining access to fire scene: continuous presence, consent, administrative search warrant and criminal search warrant.

11. Fourth Amendment violations cannot be fixed later.

12. Violations of the Fourth are significant: exclusionary rule and 1983.

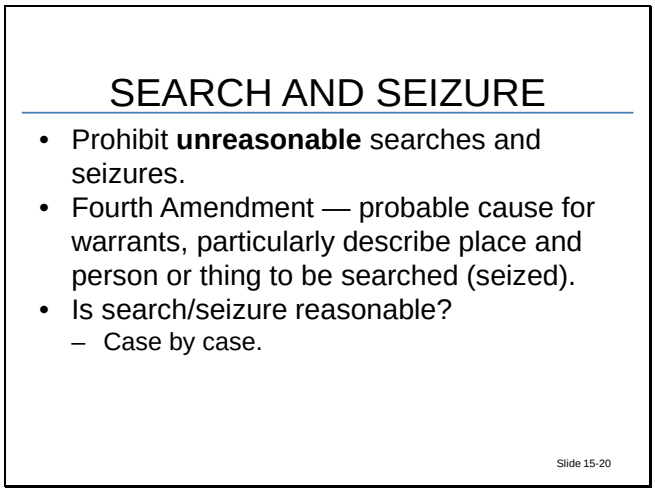
13. Exclusionary rule is court-created and bars evidence and "fruits" or derivative evidence.

14. Exclusionary rule is intended to punish police for overzealous investigation.

15. Warrants clause has four requirements: probable cause, oath, particularity of places and things, and neutral and detached magistrate.

16. Probable cause determined by "totality of circumstances" test.

17. Particularity is important. Avoid general language in affidavits.



   a. The Fourth Amendment protects citizens from unreasonable searches and seizures by the government.

b. The Fourth Amendment requires that searches and seizures by the government be supported by probable cause, particular descriptions of the evidence to be seized, and the place and time of the taking.

FOURTH AMENDMENT PURPOSE

Prohibit general searches and seizures by law enforcement officers.

Slide 15-21

18. The Fourth Amendment means government officials cannot generally and randomly enter, look around, and take property from citizens.

I. Describe the place or person specifically so that another officer would know where or whom to search.

SEARCH AND SEIZURE (cont'd)

- Make sure you have probable cause for what you are affirming you want to search for.
- Be cognizant of the constitutional issues with your search and protecting the "defendant's" rights.
- Reasonable expectation of privacy in place — car, home, motel, purse, etc.

Slide 15-22

1. Photographs may be attached to a search warrant and can be easily obtained off the Internet, from residences, etc.

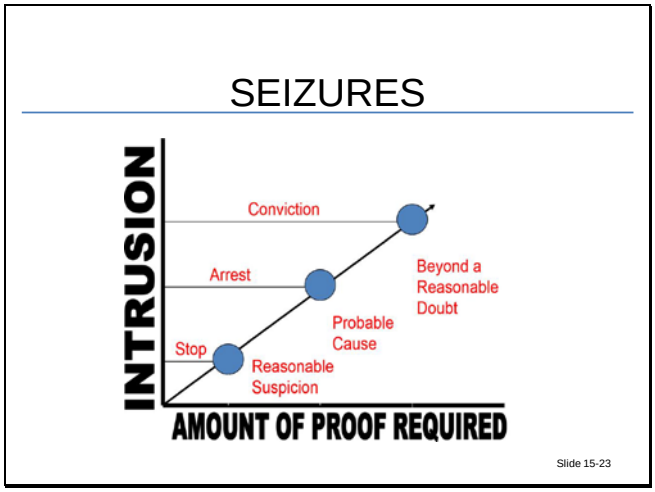
2. In addition to an address, a building should be particularly described, including such information as single-family, one-story brick residence with black shutters, address: 178 Fort Mill Road, Emmitsburg, Maryland.

3. Include all the information that supports your reasonable expectation that evidence of a crime is located there.

J. The investigator may desire to keep some information from the public until the investigation is complete. However, sufficient information to support a finding of probable cause must be included.

1. In places where someone has a reasonable expectation of privacy, you will need a search warrant or an exception such as consent.

2. Even if there is consent to search, and even if the consent is in writing, many defendants later claim the investigator did not have valid consent.



K. In order to stop a person, an officer must have reasonable suspicion that a crime is, has been or is about to be committed. Reasonable suspicion is a particularized and objective basis for suspecting the particular person of criminal activity based on the totality of the circumstances.

L. In order to arrest a person, an officer must have probable cause to arrest.

1. Probable cause to arrest is facts and circumstances at the moment of arrest within the officer's knowledge and of which the officer had reasonably trustworthy information that was sufficient to warrant a prudent person believing the defendant had committed or was committing an offense.

2. Basically, that means the defendant probably committed a crime.

M. In order to convict a person of a crime, the government must prove his or her guilt beyond a reasonable doubt.

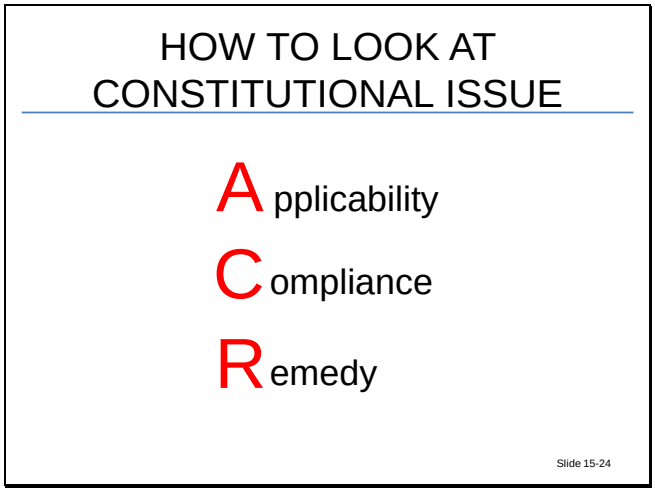
1. If all an investigator cares about is the arrest, stop at probable cause; that is enough to get an arrest.

2. If an investigator actually wants a conviction, do not stop until the investigation is complete and there is sufficient admissible evidence to prove guilt beyond a reasonable doubt.

3. Your cases will not turn into convictions unless you work long and hard with your prosecutor.

   a. Regardless of how hard you work on a case, your prosecutor must be invested in your case.

   b. Regardless of how hard your prosecutor works, you must be invested in your case.



4. The investigator must understand what constitutional and other laws apply to each step in an investigation and prosecution.

5. The investigator must understand what must be done in order to comply with each of the applicable legal requirements.

6. The investigator must understand what the remedy is for any alleged or actual violation of the legal requirements.

APPLICABILITY

Government action.

- Reasonable expectation of privacy in place to be searched?
- Home, car, person, bags, motel room, etc.
  - Plain view and abandoned property.
  - Physical characteristics.

Slide 15-25

N. When the government acts, civilians may have varying degrees of privacy interests.

1. There is a privacy interest in a residence, motel room (often used as a residence), or maybe even in a guest room in another person's home.

2. There is a privacy interest in personal property, such as bags, purses, luggage, etc.

   a. There is often a privacy interest in a vehicle; however, a vehicle in a public place has a lessened privacy interest.

   b. There may be a protected interest in items that can be seen by investigators in plain view (to seize it there must be a legal right to access).

3. What is or is not abandoned personal or real property must be determined before the right to a privacy interest can be determined.

COMPLIANCE

- Is the search or seizure reasonable?
- Reasonable depends on the individual circumstances.
- If search is under warrant, are the warrant's limits being followed?

Slide 15-26

O. A search with or without a warrant must be reasonable.

1. A search of a residence typically includes the building and area within the curtilage of the home.

2. Curtilage is the area immediately surrounding the home and areas that are regularly used as part of the home.

3. A search of a vehicle typically includes inside the glove compartment, console and trunk, but it does not normally include inside door panels.

   a. If there is a warrant, areas to be searched should be included, such as additional structures or vehicles on the property.

   b. A search of a residence may or may not include searching electronic devices, and additional warrants may be necessary to search those items.

REMEDY

- Exclusion of evidence obtained in violation of constitutional safeguards.
- Exclusionary rule.

Slide 15-27

4. Evidence obtained in violation of the Fourth Amendment cannot be used against the defendant. (That evidence will be excluded.)

5. The purpose of the exclusionary rule is to deter officers from committing Fourth Amendment violations.

   a. There is no benefit to an officer in obtaining evidence that will be excluded as the result of a violation.

   b. Oftentimes, defendants will claim a Fourth Amendment violation and a suppression hearing will be required.

- At the hearing, the investigator must explain under oath the details of the search and justify, if applicable, this and other government actions.

VIOLATION OF FOURTH AMENDMENT EXCLUSIONARY RULE

- United States Supreme Court (USSC) perception that law enforcement abuse search and seizure principles.
- Bars the use of the seized evidence for all purposes.

Slide 15-28

6. Not only is all evidence obtained in violation of the Fourth Amendment excluded, but all evidence obtained as a result is excluded.

VIOLATION OF FOURTH AMENDMENT EXCLUSIONARY RULE (cont'd)

- Bars the use of all derivative evidence ("fruit of the poisonous tree").

Slide 15-29

a. The "fruit of the poisonous tree" rule means that potentially all evidence located after the violation may be excluded.

b. For example, if a search is conducted in violation of a defendant's Fourth Amendment privacy interests, and as a result of the search the investigator finds incriminating evidence that influences the defendant to confess to the crime, both the illegally obtained evidence and the confession are excluded, and, in effect, all evidence necessary to obtain a conviction may be excluded.

GOOD FAITH EXCEPTION TO EXCLUSION

Magistrate's mistakes do not exclude **warrant** items unless:

- Misleading.
- Not neutral and detached.
- Lacks particularity.
- Probable cause belief unreasonable.

Slide 15-30

7. If an officer searches with a search warrant that a court later rules to be invalid, evidence seized with the warrant will still be admissible if a reasonably well-trained officer would not have known the warrant was invalid. (The particular officer involved is not the standard.)

   a. The rule applies because there is no need to deter officers if they would not have realized the warrant was invalid.

   b. For example, the warrant provided insufficient statement of probable cause, but a reasonably trained officer would not have realized it was insufficient.

SEARCH WARRANT OR NO SEARCH WARRANT?

- Consent.
- Search incident.
- Exigent circumstances.
- Limited to original justification for search.
- Reasonable expectation of privacy.
- Based on probable cause.

Slide 15-31

P. Searches can be legal without a warrant. (A warrant can be obtained in addition to these other legal searches.)

   1. Consent to search can be obtained from a person with an apparent privacy interest in the property.

2. Consent searches can be limited in any manner, including scope and duration, and consent can be revoked at any time.

3. It is best to obtain written consent, though it is not necessary. (They will claim you lied later and they did not consent.)

4. Search incident to arrest affords the opportunity to search the person and the area within his or her immediate control to prevent destruction of evidence or the use of weapons.

5. Search incident to arrest for a defendant inside a vehicle is limited now and does not include a search of the vehicle except where there is probable cause to believe evidence of the crime that the defendant is being arrested for is present in the vehicle or the defendant still has access to the vehicle (which he or she should not have).

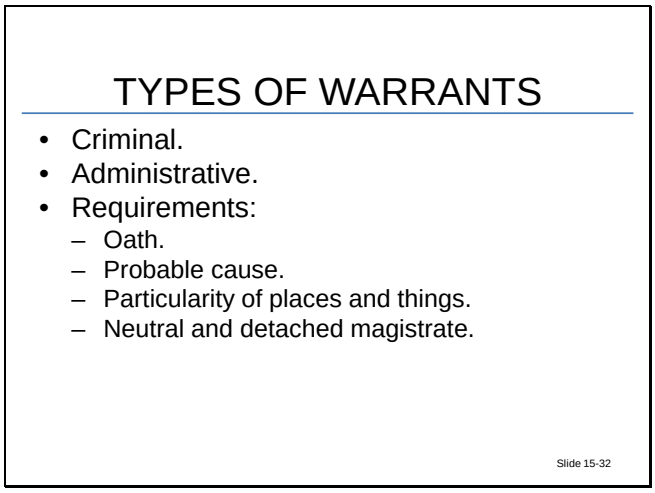
   Arizona v. Gant.

6. Exigent circumstances can provide a legal opportunity to search without a warrant if there is an objectively reasonable belief that evidence will be destroyed or people will be harmed in the time it would take to obtain a search warrant.

   a. If there is no reasonable expectation of privacy, there is no search.

   b. The person/people with the expectation of privacy is/are the only person/people who have standing to contest an illegal search.

IV. WARRANTS/REASONABLENESS



A. Criminal warrants for search and seizure or arrest require probable cause that a crime has been committed.

1. Administrative warrants can be obtained to conduct inspections and to complete a fire scene investigation.

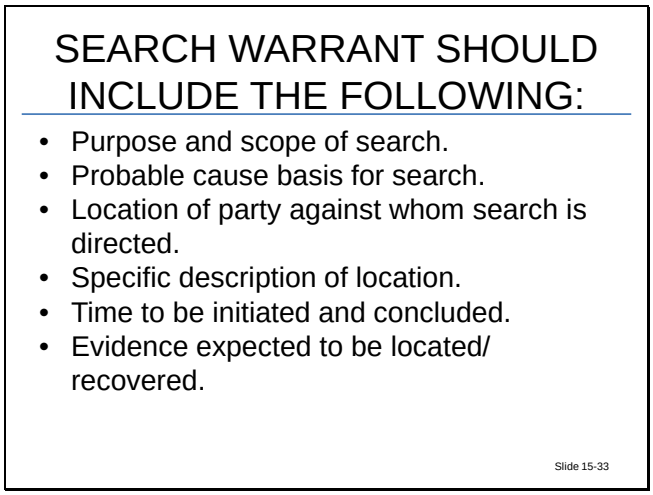
2. If probable cause that a criminal act has been committed exists or develops at a fire scene, once the origin has been determined, a search warrant must be obtained to search further.

3. Warrants require an oath by the applicant that all the information contained within the warrant application is true — and a statement sufficient to support probable cause (of a crime or that a reason exists to inspect).

   a. A particular description of the place to be searched (address and description and/or photograph).

   b. A particular description of the items to be seized (specific enough to justify the seizure but not so specific that it prevents reasonable seizure).

   c. Cannot just say stolen property or even TVs; must include electronics, explain it can include contraband, and get it independently approved by a judge or magistrate.



4. A search warrant should include the following:

   a. Purpose and scope of search.

   b. Statement of probable cause: Include personal observations, hearsay from other officers or civilians, and information from documents.

   c. Location: Address and name of owner or property may be helpful.

d. Specific description of location: Include address, or detailed description of building if no address, and descriptions of particular vehicles and/or additional buildings to be searched on the property.

e. Time to be initiated and concluded: There are time limits. (For example, a search warrant may only be valid if executed within 48 hours.)

f. Items to be seized: Describe specifically enough so an officer unfamiliar with the case can make appropriate seizures.

- Stolen property: be as accurate as possible, serial numbers if possible (to prevent taking property that is not the subject of a crime).

- Documents: Describe the particular items, such as checkbooks, deposit slips, ownership documentation, etc.

- Evidence at crime scene of unknown origin — blood-stained items; weapons such as knives, firearms; fingerprints; fired and unfired bullets and casings; footwear impressions; trace hair and fiber evidence; and any and all evidence that pertains to the arson.

- Computers and electronics: Describe computers, cameras, cellphones; investigator may need an additional search warrant.

- Fire scene evidence — ashes, fuses, fuse trails, adhesive tape, burned furniture, fibers, hairs, accelerants, physical layout of the premises, fire alarms and extinguishers, and other evidence tending to show how the fire started and spread.

PARTICULARITY

- Limits scope of search authority to specific places and things.
- Applies to both the **place** and the **thing**.

Slide 15-34

B. The description of the property or place to be searched should be specific enough to justify what needs to be searched.

1. Do not be so specific that other areas discovered and other buildings within the premises, such as barns, are not included.

2. The description of items to be seized must be specific enough to justify seizure but not so specific that items which need to be seized are excluded.

3. A catchall phrase may be added; however, discovery of other evidence during the search may provide information to support an additional warrant with specific information. (Electronic information assistance from experts in the area can be of benefit.)

SEARCH WARRANT EXCEPTIONS

Slide 15-35

WARRANT EXCEPTION — EXIGENCY

- Hot pursuit.
- Evidence would be lost or destroyed.
- Public safety.
- Irreparable harm to person or property.

Slide 15-36

C. Exigent circumstances — totality of the circumstances test considering among other possible factors.

1. Objectively reasonable belief that destruction of evidence is imminent.

2. Likelihood of violence against officer.

3. Seriousness of offense.

4. How much time it would take to obtain a search warrant.

5. If investigator had opportunity to obtain search warrant previously but did not do so.

WARRANT EXCEPTION — CONSENT

- Must have reasonable expectation of privacy in place or thing to be searched.
- Can be revoked or limited.
- If later find out no capacity to consent, but reasonable belief could, can uphold.

Slide 15-37

D. Only a person with an apparent reasonable expectation of privacy has authority to consent to a search.

1. Only defendant with a reasonable expectation of privacy has standing to challenge a search.

   a. Consent can be revoked at any time.

   b. Consent can be limited in any way.

2. If probable cause did not exist prior to the consent search, it may develop so that if consent is revoked a search warrant may be obtained.

   a. Always better to get consent in writing.

      - Can use a standard form that grants consent for a reasonable period of time.

      - Even if a search warrant has been obtained, consent can provide additional protection for the search.

      - Many defendants consent to searches prior to the existence of probable cause.

   b. Just ask.

WARRANT EXCEPTION — SEARCH INCIDENT

- Lawful arrest.
- Contemporaneous with arrest.
- Immediate control of defendant.
- Arizona v. Gant (2009).
  - Limited since needs to be related to the original arrest.

Slide 15-38

   c. A search of the person and the area immediately surrounding the defendant is proper upon arrest (for officer safety and destruction of evidence).

   d. A search of a vehicle is not authorized except for very limited circumstances now (evidence of the arrest crime or unsecured defendant).

WARRANT EXCEPTION — PLAIN VIEW

- Lawful observation of open and obvious.
- Legal access to seize (i.e., car stop).

Slide 15-39

e. Plain view doctrine requires:

- An object can be seen, smelled, touched, tasted or heard from a place the officer has a legal right to be.

- The object is immediately identified as evidence of a crime.

- The officer has a legal right of access.

f. Vehicle stop provides opportunity to view and opportunity to seize because vehicles are mobile and there is a lower expectation of privacy.

g. Residence opportunity to view from a legal distance does not necessarily provide legal access to seize (may get consent or have exigency).

h. Observation in public place provides legal access to seize.

i. Response to what turns out to be a crime scene often provides legal access.

WARRANT EXCEPTION — TERRY STOP

- Reasonable and articulable suspicion to stop and detain.
- No probable cause or warrant.

Slide 15-40

E. A stop is not necessarily a seizure. (A seizure is detainment such that a reasonable person would feel like they are not free to leave or an arrest.)

1. Regular traffic stops do prevent a person from leaving; however, the duration of time is very limited and not like an arrest.

   Reasonable people do not feel restricted at a traffic stop like they do when under arrest.

2. Terry v. Ohio is a court decision that explained how regular traffic stops are not seizures.

   a. Traffic stops require only reasonable and articulable suspicion that a crime is, has, or is about to be committed.

WARRANT EXCEPTION — TERRY STOP (cont'd)

- Not intended to be a search.
  - "Authorized limited purpose and duration seizure on a reasonable suspicion that crime is planned or in progress."

Slide 15-41

   b. Reasonable suspicion is a particularized and objective basis for suspecting a particular person of criminal activity based on the totality of the circumstances.

- Articulable means the officer must be able to explain the reasonable suspicion.

- A temporary detainment like a traffic stop may develop into a seizure.

WARRANT EXCEPTION — TERRY STOP (cont'd)

- Can convert to arrest.
  - Physical restraint, display of force.

Slide 15-42

c. If the person stopped for a traffic violation is physically restrained, told to get inside a patrol car, etc., consider the totality of the circumstances.

INVENTORY SEARCHES

For purposes of logging what is inside, **not looking for evidence of any crime**.

Slide 15-43

F. Inventory searches can be very helpful in gathering evidence, especially after Arizona v. Gant (search of vehicle incident to arrest considered unlawful).

1. An inventory search protects the rights and property of the defendant by detailing items inside the vehicle when it is seized.

2. An inventory search also protects the officers and the agency by preventing false claims by a defendant of loss of property.

3. A proper inventory search must be pursuant to agency policy, and it must be done with each vehicle seized.

SEARCH AND SEIZURE ISSUES IN ARSON CASES

Slide 15-44

SEARCH AND SEIZURE ISSUES IN ARSON CASES (cont'd)

- Immediate investigation necessary to preserve evidence from intentional or accidental destruction.
- Prompt determination of fire's origin may be necessary to prevent recurrence and continuing dangers (i.e., faulty wiring or defective furnace).

Slide 15-45

G. When fire personnel arrive at the scene of an ongoing fire, access to the property is legal and they can remain for a reasonable time.

1. The purpose for such access is to extinguish the fire and to allow a determination of the fire's origin to be sure no continuing danger exists.

2. Once the property is no longer being actually secured by the fire investigator, re-entry will require some other form of legal access.

a. Leaving the property unattended for a very short amount of time may be later justified; however, someone should remain on the premises.

b. Since the purpose is to make sure there is no further danger, it makes better sense to have someone stay.

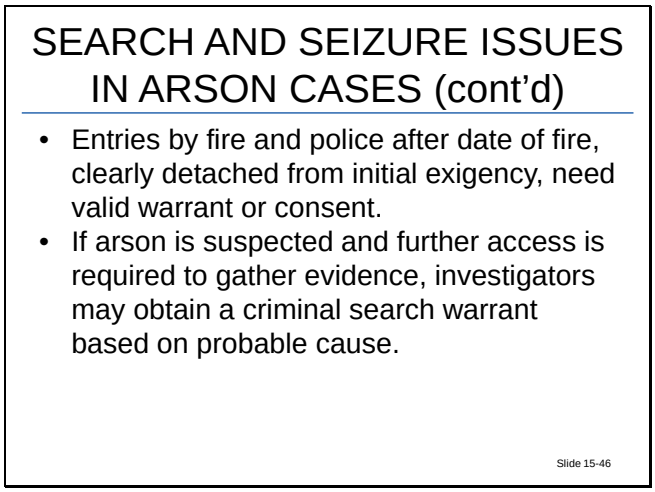
c. An unsecured crime scene creates many obstacles to overcome, as proof that the scene was not altered would in effect be impossible.

d. Once the scene is left unattended, an administrative warrant for an inspection can provide access for additional inspection activities.

H. Once probable cause is developed to believe a crime has been committed, re-entry will require a search warrant.

1. If re-entry is to inspect and probable cause develops during the inspection, a search warrant must be obtained to search the remainder of the property after the origin is determined.

2. Consent or some other exception may provide access; however, a search warrant is always helpful.



3. Entries by fire and police after date of fire, clearly detached from initial exigency, need valid warrant or consent.

4. If arson is suspected and further access is required to gather evidence, investigators may obtain a criminal search warrant based on probable cause.

SEARCH AND SEIZURE ISSUES IN ARSON CASES (cont'd)

- Critical inquiry.
  - Whether a reasonable expectation of privacy exists in fire-damaged premises at a particular time and, if so, whether exigencies justify the re-entries.

Slide 15-47

5. These are the reasons for warrant exceptions for initial entry. Basically, the fire scene exception is an exigent circumstance and a public safety exception.

SEARCH AND SEIZURE ISSUES IN ARSON CASES (cont'd)

- Because origin and cause serves a compelling public interest, the warrant requirement doesn't apply when aftermath of fire presents exigencies that will not tolerate delay necessary to obtain warrant or secure owner's consent to enter.

Slide 15-48

SEARCH AND SEIZURE ISSUES IN ARSON CASES (cont'd)

- Immediate threat of rekindling presents exigency that would justify warrantless and nonconsensual post-fire investigation into the cause of fire.

Slide 15-49

RIGHT OF ENTRY ONTO PREMISES — FOUR OPTIONS

- Exigent circumstances.
  - That is, to extinguish a fire; emergency.
  - Michigan v. Tyler, 436 U.S. 499 (1978).
- Consent.
  - That is, owner allows you to remain on the premises.
  - Only person with privacy interest has authority to grant consent, which can be revoked at any time.

Slide 15-50

6. Upon initial arrival at the fire scene while the fire is being extinguished, entry is allowed due to an exigent circumstance.

7. Any lawful re-entry must be justified by consent, inspection warrant or search warrant.

   Once the fire investigator leaves, the owner's expectation of privacy returns (in many cases).

RIGHT OF ENTRY ONTO PREMISES — FOUR OPTIONS (cont'd)

- Administrative search warrants.
  - Provide for investigation of origin and cause.
- Criminal search warrants.
  - Probable cause to believe you will find evidence of a crime.

Slide 15-51

8. Administrative search warrants.

   Provide for investigation of origin and cause.

9. Criminal search warrants.

   Probable cause to believe you will find evidence of a crime.

MICHIGAN V. TYLER (1978)

- Furniture store.
- No effort to secure.
- Origin and cause interrupted due to darkness and smoke.
- Search resumed at daybreak — evidence of arson collected — **admissible**.
- Returned on several other occasions to collect more evidence — **inadmissible**.

Slide 15-52

I. Michigan v. Tyler (1978).

1. Jan. 21, 1970, 12 a.m. Fire department responds to fire at Tyler's Auction furniture store, discovers containers of flammable liquid, and calls law enforcement.

2. Officer arrives and takes pictures, but further investigation is hampered by smoke and steam. Fire is out by 4 a.m. Fire chief and law enforcement officer take containers and leave.

3. 8 a.m. Fire chief returns. Another examination of scene is made by fire and law enforcement officers, and carpet with burn marks and tape is collected.

4. Feb. 16, 1970. A different law enforcement officer takes additional photographs. Several other visits follow, and more evidence is collected.

5. Loren Tyler and Robert Tompkins were convicted of conspiracy to burn real property. Tyler was also convicted of burning insured property with intent to defraud.

MICHIGAN V. TYLER (1978) (cont'd)

- **Decision**:
  - No warrant needed for entry to fight fire (fire = exigent circumstance).
  - Once inside building, officials may remain for a **reasonable** time to investigate the cause of a fire.
  - Secondary search after smoke cleared and daybreak was deemed reasonable under the circumstances.

Slide 15-53

J. The USSC finds that fire is an exigency that allows lawful access by fire officials, and evidence of a crime in plain view may be seized.

1. Fire officials must extinguish fires and promptly determine cause and origin to prevent recurrence, such as faulty wiring or defective furnace, and to preserve evidence from intentional or accidental destruction.

2. Re-entry four hours later was a continuation of the earlier search that was hampered by the fire itself, no purpose in requiring a warrant.

3. Evidence of a crime discovered during this time is admissible in a criminal prosecution.

MICHIGAN V. TYLER (1978) (cont'd)

- Evidence of arson discovered in course of fire suppression efforts is admissible (plain view).
- Thereafter, additional inquires to investigate cause need to follow warrant procedures governing administrative searches.

Slide 15-54

4. Later entries require a criminal search warrant if there is probable cause that a crime has been committed because the exigency no longer exists.

a. Later entries and seizures of evidence that occur in violation of the Fourth Amendment are unlawful, and the evidence collected must be suppressed.

b. New trial.

MICHIGAN V. CLIFFORD (1984)

- Private residence.
- Fire department left scene.
- Neighbor contacted owner.
- Owner contacted insurance company to board up windows.
- Investigators arrive six hours later.
- Water being pumped out when investigator arrives: Investigators seize evidence of arson.

Slide 15-55

K. Michigan v. Clifford (1984).

1. Nov. 18, 1980. Raymond and Emma Jean Clifford's residence was the scene of an early morning fire while they were camping out of town.

2. The fire was extinguished. All officials left at 7 a.m.; at 8 a.m. fire investigator is notified, but he does not respond until 1 p.m. due to other assignments.

3. Neighbors had spoken to the Cliffords, who requested the house be boarded up. The work crew was doing that already and pumping water out.

4. Investigator located a Coleman fuel can in the driveway and waited 30 minutes until the water was pumped out before entering.

5. Upon entering, the investigators quickly confirmed the origin was under the stairs in the basement with more fuel cans, a crock pot and a timer.

6. Further search revealed closets and furniture full of old clothes, only nails in the walls but no pictures, and only the wires for a video machine.

7. Pretrial motion to suppress.

L. The exigency had passed prior to the investigator's arrival; in fact, the investigation did not appear to be an emergency when he went hours later.

1. There probably was not sufficient evidence to obtain a criminal search warrant at this time, based only on the can in the driveway.

MICHIGAN V. CLIFFORD (1984) (cont'd)

- Administrative warrant will suffice if primary object is to determine origin and cause.
- Need to show:
  - Fire of undetermined origin has occurred.
  - Time and scope of proposed search are reasonable and will not intrude unnecessarily on victim's privacy.
  - Entry has been denied or the person with standing cannot be found.

Slide 15-56

2. An administrative warrant would have provided access to determine the origin and cause of the fire.

MICHIGAN V. CLIFFORD (1984) (cont'd)

- Reasonable expectation of privacy when owners make arrangements for house to be secured in their absence.
- Criminal warrant required when primary objective is to gather evidence of criminal activity (**probable cause required**).

Slide 15-57

3. An expectation of privacy exists in fire-damaged property.

   a. Residential property has a higher expectation of privacy than business property, and especially here where the owners were having it secured.

   b. Re-entry for an inspection to determine origin and cause requires a warrant because there is an expectation of privacy that must be protected.

4. An administrative warrant would have provided lawful access to the home until the origin and cause was determined.

a. Once the additional cans and the crock pot were located and determined to be the origin and cause of the fire, any further search required probable cause.

b. All the evidence, including testimony about the search inside the home itself, was illegally obtained and was excluded.

c. The can located in the driveway in plain view is admissible.

d. Remember, this probably was not sufficient to provide probable cause. Without other untainted evidence, a conviction is not possible.

MICHIGAN V. CLIFFORD (1984) (cont'd)

- Once cause of fire was determined, additional search of home could only have been for purpose of finding evidence of arson. Thus, a criminal warrant was required.
- Only evidence discovered in plain view is admissible.

Slide 15-58

e. Once cause of fire was determined, additional search of home could only have been for purpose of finding evidence of arson; thus, a criminal warrant was required.

f. Only evidence discovered in plain view is admissible.

MICHIGAN V. CLIFFORD (1984) (cont'd)

- If evidence of criminal activity is discovered during the course of a valid administrative search directed at cause, it may be seized under plain view doctrine and may be used to establish probable cause for a criminal search warrant.

Slide 15-59

5. An administrative search warrant is limited in scope in that once the origin and cause has been determined, the search is complete.

   a. Any further search would only be to locate evidence of a crime, and at that point a search warrant must be applied for.

MICHIGAN V. CLIFFORD (1984) (cont'd)

- In searching solely to ascertain cause, firefighters customarily remove debris or search other areas where cause is likely to be found. Things that come into view during such a search may be preserved without a warrant.

Slide 15-60

   b. In searching solely to ascertain cause, firefighters customarily remove debris or search other areas where cause is likely to be found. Things that come into view during such a search may be preserved without a warrant.

FIFTH AMENDMENT

"No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the Militia, when in actual service in time of War or public danger; nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation."

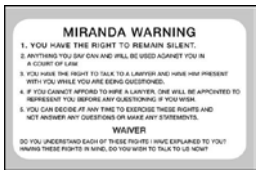
Slide 15-61

6. Fifth Amendment — right not to incriminate self.

   Defendants can remain silent and refuse to give a statement, and that refusal cannot be used against them.

FIFTH AMENDMENT (cont'd)

- "No person … shall be compelled in any criminal case to be a witness against himself …"
- Miranda — intended to overcome custodial interrogation coercion.



Slide 15-62

M. The Fifth Amendment to the Constitution provides, among other things, the right that a defendant cannot be called as a witness in his or her own case.

1. As a logical interpretation, a defendant also cannot be required to make a statement to the government concerning his or her guilt.

2. Miranda v. Arizona (1966).

   Five cases involving confessions that led to the Miranda warning requirement to prevent coerced custodial confessions.

FIFTH AMENDMENT (cont'd)

- Two independent considerations:
  - Miranda warnings.
  - Voluntariness of confession.

Slide 15-63

3. Miranda warnings include:

   a. Right to remain silent.

   b. What they say will be used against them.

   c. Can have lawyer for interrogation.

d. Can be appointed.

4. A waiver does not specifically need to be obtained because the act of being silent does **not** invoke the right to silence.

5. A defendant may be silent for the duration of questioning. As long as he or she does not unequivocally request an attorney or specifically say he or she wishes to remain silent, questioning can continue.

N. Recent case where defendant was completely silent until officer asked defendant if he asked God for forgiveness, and he replied yes.

MIRANDA AND VOLUNTARINESS

- Before **Miranda**, test was voluntariness of confession.
- Voluntariness tested by "totality of the circumstances."

Slide 15-64

O. Any statement made by a defendant must be voluntary and understood using a totality of the circumstances test.

1. Understanding does not require a particular intelligence level or IQ.

2. In fact, many defendants who are classified as mentally disabled provide admissible confessions.

3. Factors to consider regarding "understanding" include:

a. A defendant's prior experience in the criminal justice system.

b. Whether a defendant's responses were responsive to the officer's questions.

c. Whether a defendant acknowledged that he or she understood his or her Miranda rights.

4. Factors to consider regarding "voluntariness" include:

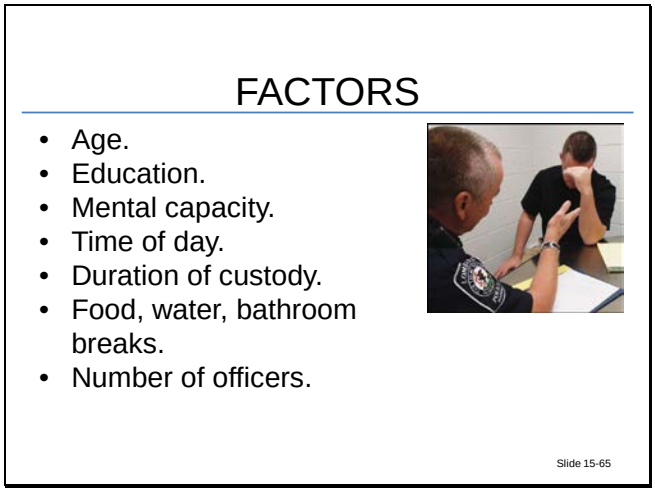
   a. Officer's conduct before and during the interrogation.

   b. Defendant's physical and mental condition before and during the interrogation.

   c. Defendant's prior criminal justice experience.

   d. Place where the interrogation took place.

   e. Promises or threats made by the officer(s).



P. Age in juvenile interrogations is a new factor that must be considered. Also must consider education, mental capacity, time of day, duration of custody (food, water, bathroom breaks), number of officers.

   1. A promise to tell the judge that a defendant was cooperative may make a confession inadmissible.

   2. Telling a defendant it would be best to tell the truth is okay (but do not elaborate).

FACTORS (cont'd)

- Perceived ability to voluntarily leave.
- Threats, lies or coercion.

Slide 15-66

3. Promises regarding charge and/or sentence reductions are at the prosecutor's discretion anyway — blame them (us).

WHEN DOES MIRANDA APPLY?

- Custody.
  - Arrest or mere questioning.
- Interrogation.
  - Questioning or spontaneous utterance — "blurting out."
- Exception: identity details.
  - Not required for questions such as name, date of birth, etc.

Slide 15-67

Q. These warnings are only required when a defendant is in custody and being interrogated.

1. Custody means arrested or seized such that a reasonable person in the defendant's position would not feel free to leave.

   a. What the particular defendant or the particular officer thinks about whether the defendant is in custody is not the test.

   b. Look at it as though the definition of the reasonable person standard, the judge who will determine whether he or she was in custody.

2. Interrogation means statements or actions by a law enforcement officer designed to elicit an incrimination response.

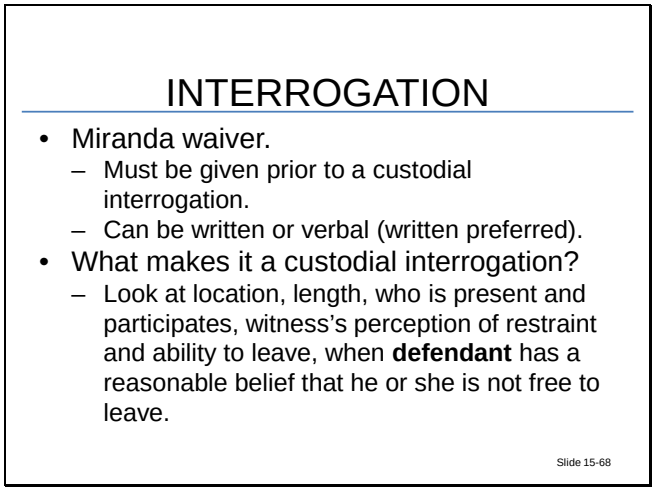
a. Questions asked by a law enforcement officer (other than booking questions) of a defendant who is in custody is interrogation.

b. Statements between officers designed to elicit an incriminating response from the defendant is also interrogation.

3. Christian burial case — child was abducted, officers transporting defendant discussed between each other the fact that they wanted to find the child's body because she should have a Christian burial. Defendant responded with her location — inadmissible.

   Even some booking questions may be inadmissible if they provide evidence of an element of a crime.

4. Example: Crimes that require a particular age of a defendant prevent use of defendant's statement of his or her age during the booking process.



5. Miranda warnings must be given prior to custodial interrogation.

   Waiver is not necessary, but it is very helpful. (Remaining silent is not an actual invocation of the right to silence.)

6. The proper test for custody is whether a reasonable person in the defendant's position would feel that he or she was not free to leave.

   The test is objective; therefore, the subjective beliefs of the officer and the defendant are not dispositive.

INTERROGATION (cont'd)

- Confessions.
  - Before a defendant's confession can be admitted into evidence, the state must prove that a crime occurred (corpus delicti).
  - Independent scientific evidence of incendiary fire required.

Slide 15-69

7. A confession alone is not enough.

   a. Not only must the government prove a crime occurred, it must prove the defendant's confession was trustworthy.

   b. There must be some evidence to support that the fire was incendiary rather than accidental.

INTERROGATION (cont'd)

- Confession is inadmissible unless investigator can prove that the fire was intentionally set absent the confession.

Slide 15-70

   c. There must be some evidence to support who intentionally started the fire. (Remember, specific intent is not necessarily required.)

      - Did the defendant have the opportunity? Was he or she in the vicinity? Did he or she have materials to start the fire? Did he or she have a motive?

      - None of these are specifically required, but there must be some reliable linkage of the defendant to an intentional fire.

JUVENILE INTERROGATION

- Advisement of rights generally follow same guidelines as adults.
- Courts will consider the juvenile's age, education, and background to determine whether the juvenile was capable of a proper waiver.

Slide 15-71

8. Juvenile confessions are requiring more and more of those who investigate fires and other juvenile crimes.

   a. Some jurisdictions require additional Miranda warnings, such as a right to have a parent or guardian present.

JUVENILE INTERROGATION (cont'd)

- Check with local prosecutor for specific state-by-state laws and procedures.

Slide 15-72

   b. Such requirements must be followed specifically or the confession is inadmissible.

   c. Right to have parent, guardian, custodian, caretaker or lawyer present — told right to have anyone he or she chooses present.

      - Chose adult brother — inadmissible.

9. Some jurisdictions require video and/or audio of all juvenile custodial interrogations or the statement is inadmissible.

10. Even when all requirements are carefully complied with, a motion will be made that it was unknowing or involuntary.

11. As with all interrogations, document all conditions so that when called upon to testify, it will be possible to answer.

    a. How many officers were present?

    b. Whether one, both or no parent was present.

    c. Whether any officers had firearms in their possession during the interrogation.

    d. Whether the defendant was offered food, water, bathroom break, etc.

DOUBLE JEOPARDY

- According to the Fifth Amendment.
  - "… Nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb. …"

Slide 15-73

R. Double jeopardy means we get one shot at a conviction: We have to do it right the first time.

DOUBLE JEOPARDY (cont'd)

- Double jeopardy is generally accepted as protecting against:
  - Twice being tried for the same offense.
  - Twice being punished for the same offense.
- Reprosecution after a judgment of acquittal is prohibited, even if the acquittal is in error.

Slide 15-74

1. At trial:

   a. If it is discovered the offense date or some other technicality is incorrect in the charging document, there may be no opportunity to recharge.

   b. If a witness fails to show for any reason and the element of the crime they had knowledge of is not presented in evidence, there is no opportunity to recharge.

   c. If the trial judge dismisses the charges based on a finding of insufficient evidence because he or she does not understand fire crimes, there is no opportunity to recharge.

   d. If we lose, there is no opportunity to recharge.

   e. If we win, he or she will appeal every aspect of the trial or plea, attempting to reverse the conviction or obtain a new trial.

DOUBLE JEOPARDY (cont'd)

- Double jeopardy does not apply to:
  - Civil sanctions.
  - Administrative sanctions.
  - Civil forfeitures.
- Where the civil action is intended as punishment, the supreme court has held in a couple of cases that double jeopardy will apply. Use caution!

Slide 15-75

2. Criminal responsibility is separate and apart from civil liability.

   The standard is higher in criminal court, so if a jury is unable to unanimously agree on guilt beyond a reasonable doubt, he or she can still be sued. For example, think of O.J. Simpson. The criminal trial had many problems. The burden of proof is higher, and the defendant has more protections.

3. In civil court, a defendant is responsible if the jury believes the plaintiff more than it believes the defendant.

4. A victim cannot get "double recovery."

a. If a defendant is ordered to pay restitution in criminal court for the full loss, a civil judgment is precluded.

b. If a civil sanction is viewed as punitive, it may bar criminal prosecution.

- For example, DWI defendant has license revoked for a year; a criminal court may decide it was punishment and bar the DWI prosecution.

DOUBLE JEOPARDY (cont'd)

- Each sovereign who has an interest that has been offended by the crime may exact punishment without violating the prohibition against double jeopardy.
- In other words, both the federal government and the states may punish the same act and in some cases two states may punish the same act.

Slide 15-76

5. If a crime can be charged by the federal government, the military and a state, multiple prosecutions are possible.

6. Generally if a defendant can be charged by the federal government and it wants the case, the affected state will dismiss state charges.

7. There is a great deal more paperwork involved to have a double prosecution.

a. In some situations, more than one government may have the option to prosecute, but only one prosecution is allowable.

b. In such a situation, the first prosecution bars subsequent prosecutions.

- For example, fraud charges can be sought where the defendant commits the act, where the victim is, or where any part of the transaction occurred.

- It is important to know these limitations because one jurisdiction may care a whole lot more about the case and the other may plead it down.

EVIDENCE

Slide 15-77

TYPES OF EVIDENCE

- Demonstrative.
  - Tangible items, authenticated by witness identification or chain of custody (photos/ illustrative evidence — fair and accurate representation of the event depicted).

Slide 15-78

S. Physical pieces of evidence are very important, and juries love this stuff.

1. Photographs, diagrams and videos of fires demonstrate the danger involved in fire cases, and they keep the jurors interested.

2. Pieces of burned carpet that were collected and other items from the scene make the case real for the jury, which otherwise just hears a story.

TYPES OF EVIDENCE (cont'd)

- Documentary.
  - Written form.
  - Business record, etc., kept in the normal course of business (witness statement — signed, dated and witnessed by a third party).
- Testimonial.
  - Competent live witness under oath.

Slide 15-79

3. Documentary evidence can tie a defendant to a crime.

4. Written witness statements are not admissible in a criminal trial unless and until the witness takes the stand (except for defendant statements).

5. Testimony is the largest piece of evidence for each trial.

6. Testimony allows the jury to assess the reliability and credibility of a witness firsthand by observing and listening, like we do with everyone we meet.

7. Some prosecutors have even brought fire dogs into the courtroom for demonstrations for the jury.

COLLECTION OF EVIDENCE

- Understand the proper way to bag and tag.
- Respect chain of custody!
- Label your found evidence on a diagram.
- Prevent contamination/cross-contamination.
- Document **all** items that are relevant or of evidentiary value.

Slide 15-80

8. Physical evidence collection is critical.

   a. Items of evidence must be collected in such a way that the witness can identify it years later at trial.

b. Fire investigators collect thousands of samples, labs test thousands of samples, and the containers must be marked to be identifiable.

COLLECTION OF EVIDENCE (cont'd)

- Have someone with you to help identify.
- Do not collect evidence of other crimes. Keep them separate.
- Remember legal requirements — search warrant?

Slide 15-81

c. The location within the crime scene where items were located and who actually located each item must be documented for admissibility.

d. The item collected must be collected in such a way that it can be preserved for testing or for general preservation purposes.

- In addition to marking and sealing the item itself, there must be paper documentation of what was collected, when, where and by whom.

PROBLEMS SPECIFIC TO ARSON CASES

- Must prove that a crime occurred and prove who did it.
- Large amount of circumstantial evidence.
- Scene contamination.
- No "victim."

Slide 15-82

T. When dealing with arson cases, there are a couple issues at hand:

1. First issue: Was there a crime? Meaning that all elements of some fire-related offense can be proven beyond a reasonable doubt (no accident).

2. Second issue: Who is criminally responsible for the crime, and can it be proven beyond a reasonable doubt that he or she did it?

   a. In many cases, the fire investigator can determine a fire was intentionally set by human hands, but who set it is difficult to establish.

   b. Prosecutors, judges and jurors tend to be very skeptical about whether there is enough proof in fire cases.

      - Prosecutors have more cases than they can try: Trials are very time consuming, and other cases can be more easily tried and won.

   c. Judges have to decide if there is sufficient evidence to go forward, and they do not like being overturned by an appellate court.

   d. If the government loses at the trial stage, the case is over. If the defendant loses, he or she can appeal, so generally the only time trial judges are at risk of being overturned is if the judge lets the case go forward.

   e. Prosecutors, judges and jurors prefer to have evidence like videos, crime scenes with fingerprints and DNA, and a sympathetic victim.

      - Fire scenes are inherently contaminated and compromised crime scenes due to the fire itself and the fire suppression efforts.

      - Most often the evidence is circumstantial (pieces of evidence that must be linked and pieced together to explain intent and identity).

   f. Oftentimes, the victim is an insurance company, and prosecutors, judges and jurors do not see them as sympathetic victims.

      - Fire cases are difficult to investigate and difficult to prove, but the defendants are dangerous, so hard work and dedication is imperative.

CRIME SCENE INVESTIGATION EFFECT

- Jurors watch a lot of television and expect investigators to always have DNA, fingerprints, videotape and signed confessions in all cases.
- Investigators need to be aware of this expectation and guard against it by properly documenting all evidence.

Slide 15-83

3. Jurors used to trust prosecutors and law enforcement officers. Unfortunately, now they are distrustful, and they expect what they see on TV.

4. Fortunately, public trust in professionals in the fire industry is still high, and fire personnel are viewed as trustworthy and even as heroes.

5. It is probably impossible to have 12 people sit on a jury in which all of them do not watch one or more crime scene investigation shows.

   a. People are fascinated with CSI, and this can be used to keep the jury interested in a fire case; however, the expectations are unrealistic.

      - The equipment and testing procedures on TV are not available or even applicable in many cases, and the laws regarding testimony are changing.

      - Getting CSI evidence admitted into evidence is a difficult hurdle for several reasons, including securing all necessary witnesses for trial.

   b. Judges of the USSC cannot agree among themselves whether evidence is admissible if the testing analyst is unable to appear at trial.

      - The issue is whether a substitute analyst may review the records and testify. The answer appears to be no.

   c. Jurors as well as many judges and prosecutors want lab testing to prove how the fire started and who started it in addition to a confession.

d. When lab testing is done, the results may need to be explained to the prosecutor, judge and jury, even where they initially appear unfavorable.

e. When lab testing is not done, reason for not doing it may need to be explained as well.

f. Documentation of everything done is imperative to show that the investigation was professional, thorough and complete and the results are accurate.

- In some cases, the only defense is that the investigation was incomplete or substandard, and it can be successful (as opposed to he or she did not do it).

SANCTIONS FOR DESTRUCTION OF EVIDENCE

- The evidence must be expected to play a significant role in the suspect's defense. In other words, regardless of whether the evidence was of such significance to create a reasonable likelihood that the outcome of trial would be affected.

Slide 15-84

6. The defense has a right to view and test all evidence, but they cannot do that if it is not collected, preserved properly, and made available.

7. Failing to collect items of evidence may present a defense argument that favorable evidence was destroyed to the defendant's detriment.

8. The entire crime scene cannot be collected, and during the initial investigation it may be impossible to know what items need to be preserved.

SANCTIONS FOR DESTRUCTION OF EVIDENCE (cont'd)

- Defendant must show:
  - State acted in bad faith in destroying the evidence.
  - Exculpatory value of evidence was apparent before it was destroyed (14th Amendment).

Slide 15-85

9. Testing evidence may destroy it or change its character such that additional testing may not be possible or capable of reliable results.

   a. Testing should be done, if possible, in such a manner that the remainder of the evidence can be retested.

   b. After testing, the evidence should be maintained in a condition so that its evidentiary value remains constant.

      - This means keep it sealed, refrigerated if necessary, etc.

SANCTIONS FOR DESTRUCTION OF EVIDENCE (cont'd)

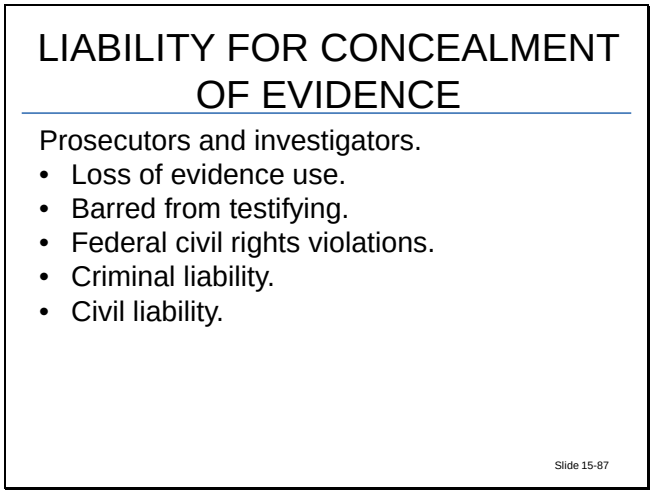
- Absent above.
  - Failure to preserve even potentially useful evidence doesn't constitute denial of due process. However, if state fails to produce material exculpatory evidence, the good or bad faith of the state is irrelevant.

Slide 15-86

10. Common sense and the investigator's experience affect the "apparently exculpatory" prong. (Exculpatory means tends to make guilty less likely.)

11. If common sense and proper training should have alerted the investigator to collect an item or to properly preserve it, a sanction may occur.

12. If the government purposely destroys evidence, a sanction is rather certain to occur.



13. The sanctions for purposeful or negligent (accidental) destruction or concealment of evidence vary from a warning to felony prosecution.

    a. The investigator is responsible for providing the evidence to the prosecutor (and thereby is responsible for providing it to the defendant).

    b. The prosecutor is responsible for providing the evidence to the defendant, and he or she may be held liable for failure to do so by the investigator.

14. The most likely sanction is exclusion of favorable evidence from the case against the defendant in both purposeful and negligent concealment.

15. A judge often has the authority to dismiss a case due to a concealment violation.

16. Many states have recently enacted criminal legislation making it a crime for an investigator and/or a prosecutor to conceal evidence.

17. Defendants may sue the investigator, the prosecutor, and any associated agency if concealment occurs.

18. The preservation of evidence is helpful to the investigator, regardless of the potential favorable aspects to the defendant.

a. Many times, evidence that initially appears to favor a defendant's case is actually neutral or favorable to the government once the investigation is complete and the role that piece of evidence played is understood.

b. In every case, proper presentation and preservation of evidence shows the jury that the investigation and prosecution were fair.

"BAD FAITH"

- Destruction for purpose of depriving defendant of exculpatory evidence.
- Exculpatory value must have been apparent to government official prior to destruction.

Slide 15-88

19. Bad faith concealment will subject both the investigator and the prosecutor to the most severe sanctions.

a. In some jurisdictions, the prosecutor is responsible for failing to provide evidence to the defendant even when the prosecutor was unaware that the investigator concealed it.

b. In North Carolina, an elected district attorney, Mike Nifong, went to prison and an investigator, Dwayne Deaver, had his career ruined.

- In that case, a lab report included only confirmed analysis but did not include some additional results (Duke Lacrosse Case).

- In fact, this case is one of the key reasons why jurors have lost faith in the credibility of law enforcement officers and prosecutors.

SPOLIATION

Slide 15-89

BLACK'S LAW DICTIONARY DEFINITION

Spoliation: destruction, mutilation, alteration or concealment of evidence.

Slide 15-90

U. The idea is that evidence should be maintained in its original state if possible.

1. The purpose is to provide the evidence to the defense and to present it to the jury in a manner consistent with how it was when located.

2. Courts are making this more important as testing and technology continue to advance.

NATIONAL FIRE PROTECTION ASSOCIATION 921 DEFINITION

Spoliation: 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.

Slide 15-91

3. The collecting investigator and agency and the government or party bringing an action must retain and preserve nearly all evidence.

   a. Basically means the same as the legal definition.

   b. Collect and preserve all evidence that is important to the case.

WHEN DOES IT APPLY?

- Intentional or malicious destruction of evidence.
- Negligent destruction of evidence.
  - Mainly concerns civil litigation and subrogation issues.
  - But can occur in criminal cases.

Slide 15-92

4. Purposeful decisions to not collect, document or properly preserve evidence. Reckless, careless or thoughtless decisions or failure to collect, document or preserve evidence.

   a. The term subrogation is usually used in civil court.

   b. The idea is the same in criminal court.

HOW IS IT APPLIED?

- To establish "spoliation," the party alleging must show that the party being grieved had a duty to preserve evidence and that it nonetheless destroyed the evidence.
- Translation: You knew that the widget caused the fire, but you still took it apart and destroyed it without properly notifying all responsible parties.

Slide 15-93

5. First question: Was there a duty to collect and preserve the evidence? The test: Should the investigator have realized that the item should have been collected and preserved?

6. Second question: Was it not collected or destroyed purposefully or negligently rather than by total accident (out of the investigator's control)? For example, the fire was probably caused by a curling iron, but you cannot rule out the coffee pot. They must both be collected and preserved.

7. Just because there will not be a criminal prosecution does not mean there will not be a civil suit.

    a. Remember, the burden of proof is lower in civil court and the potential for financial gain in a civil suit is high, so there are a lot of them.

    b. Once evidence is collected, there needs to be an agency policy for preservation and destruction.

8. If there is a criminal case, the prosecutor should be consulted. If there is not, the prosecutor cannot advise concerning destruction.

    a. For example, victim is burned then wrapped in a tarp and buried. The tarp must be hung to dry, and it smells horrible. Investigator wants to destroy it — sorry but no. (Additionally, there may be a DNA preservation law requiring post-trial preservation.)

    b. For example, fire investigators have collected so many samples and other fire scene evidence that the storage space is at capacity.

c. For example, investigator wants to know what, if anything, can be discarded. (Keep all criminal evidence and all evidence of potential civil cases.)

- That is a difficult call, so there must be an agency determination.

WHAT CAN BE DONE TO REMEDY?

- Exclude evidence.
- Dismiss court action.
- Apply evidentiary inferences or limitations.
- Tort actions for destruction of evidence.
- Prosecution for obstruction of justice.
- These remedies are primarily used in civil cases not involving government entities.

Slide 15-94

9. Like sanctions for other violations, such as:

a. Fourth Amendment violation of an improper search and/or seizure.

b. Fifth Amendment violation of an improper custodial interrogation.

- The sanctions vary between excluding admission of the evidence at trial against the defendant, dismissal of the case, civil suit, and prosecution.

ADDITIONAL SPOLIATION CONCERNS

- Fire investigation team intentionally destroys scene after examination, so as to not allow subsequent investigators to determine a cause.
- This must be “willful and negligent” destruction and not just normal scene processing or normal fire department overhaul activities.

Slide 15-95

c. Intentional destruction of a fire scene to prevent proper examination should never occur, and the most severe sanctions will result.

FINAL THOUGHTS ON SPOLIATION

- Be aware of spoliation issues.
- If you feel that the fire cause was due to a certain piece of equipment, **do not take apart the item unless you are an expert on that item**.
- If you are an expert and you do take it apart, then prepare to defend your actions in court.

Slide 15-96

10. The entire fire scene cannot be preserved in its exact state.

    a. Proper investigation and documentation of the fire scene before and after examination preserves the possibility for other investigators to complete subsequent investigations.

        - There often will be two investigations going on nearly simultaneously, first by law enforcement and then by an insurance investigator.

        - Then later there may be follow-up investigations, and additional experts may be asked to investigate and/or provide opinions and suggestions.

        - Finally, criminal and/or civil defendants may hire defense investigators.

    b. At each step, investigators should be careful to preserve items reasonably related to the fire's cause and documentation of the scene.

11. The original investigator may gain information later in the investigation that causes the need for additional investigation.

12. Proper investigation may require dismantling or partial use of an item of evidence. An expert in that sort of item or test should handle that.

a. If the evidence is dismantled or used for testing by someone who is not an expert in that area, subsequent expert testing may be impossible.

b. When an item is dismantled, partially consumed or altered during testing, the reasoning for such action must be adequately explained.

SUBROGATION

- According to Black's Law Dictionary:
  - The right of a person to assume a legal claim of another; the right of a person who has paid a liability or obligation of another to be indemnified by that person; an insurer's substitution in place of the insured in regard to a claim against a third party for indemnification of a loss paid by the insurer.

Slide 15-97

V. Subrogation. (Yes, it's really that simple.)

SUBROGATION (cont'd)

- Translation: The company that manufactured the "widget" is held responsible for the malfunction.
- The insurance company sues the manufacturer to cover the loss of the insured.

Slide 15-98

1. The purpose of subrogation is to make the person or company who is ultimately responsible pay for the damages. (This is a fairness issue.)

   a. Once an insurance company pays for damages to the insured (victim), the insurance company literally steps into the place of the victim.

b. When the insurance company takes the place of the victim, it is entitled to sue the person or company that caused the loss to occur.

c. The lawsuit is then between an insurance company and often a manufacturer.

- A manufacturer has probably made money by selling this item to many different buyers.

d. An insurance company wants to recover what it paid the insured and does not want to take additional losses.

2. A fire investigator's expert opinion as to the cause of the fire may result in a high financial cost or gain to someone or some company.

PRETRIAL MEETINGS AND CHALLENGES

Slide 15-99

W. Pretrial meetings can be very challenging, for a variety of reasons.

1. Preparing for trial is just as important as the investigation.

a. A professionally and thoroughly investigated case still has to be properly presented to the jury in order to obtain a conviction.

b. The jury and the judge will only be able to see, hear and consider what is properly presented in court.

- The case never gets before the judge and jury until the investigator convinces the prosecutor that the case is sufficient to go forward.

PRETRIAL MEETINGS

- Key element of being an effective witness is to prepare in advance of your testimony with your attorney, as well as on your own.
- In rare circumstances, a defense attorney in criminal cases may call you as a witness.
- There is no limit to the number of meetings you can have with your attorney to prepare.

Slide 15-100

c. Fire investigators who have never testified and/or qualified as an expert before may not realize how difficult it is to be a good witness.

- Fire investigators who have testified before realize that each case is different and a team approach is essential in pretrial preparation.

d. When an investigator charges a case, and oftentimes prior to charging, the investigator should contact the prosecutor regarding resolution.

PRETRIAL MEETINGS (cont'd)

- Need to meet as often as it takes for you to feel comfortable.
- Make sure your attorney knows whether or not you have testified before.
- Make sure you call in advance to know what to bring with you.

Slide 15-101

e. When an investigator receives a subpoena to appear for a case, the investigator should contact the prosecutor to discuss trial preparation.

- The investigator must explain the cause and origin of the fire in terms of how and where the fire started and point out photos that prove it.

- The investigator should also explain any mistakes in the report (like typos) and any mistakes in the investigation (like failing to collect evidence).

- The investigator may be asked to meet with the defense; the prosecutor cannot advise not to do so, and it is the witness's choice.

f. If the witness chooses to meet with the defense, he or she may invite the prosecutor to be present or discuss the meeting afterward.

PRETRIAL MEETINGS (cont'd)

- Always take copies of your most current curriculum vitae (CV), along with all previous versions of your CV.
- Know what the changes are in your CV from one version to the next (i.e., updated classes attended or certificates obtained versus found an error or "misreported" something).

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g. Know what a curriculum vitae (CV) is (similar to resume), and get a copy to the prosecutor or civil attorney whom you are working with.

- Keep your CV updated and accurate; it will be shared by defense attorneys in preparation to attack the investigator's credibility.

h. Review the report and the entire case file prior to the meeting, point out mistakes, and be prepared to explain everything!

PRETRIAL MEETINGS (cont'd)

- Review reports in advance of your meeting, and be ready to point out and address any mistakes found.
- If you were deposed for this case, review your deposition before your meeting.
- Be familiar with reports prepared by other people regarding this incident.

Slide 15-103

i. Depositions are recorded statements made under oath, so be very familiar with the case prior to arrival.

- If you get deposed for a civil case that has related pending criminal charges or potential charges, contact the prosecutor as soon as possible.

j. Testifying in civil court may impair an ongoing criminal investigation or prosecution, and your attendance for civil proceedings may be avoided.

PRETRIAL MEETINGS (cont'd)

- If called in for a civil matter, be familiar with opposing experts — their reports, background, experience and previous testimony.
- If you have "dirt" on opposing experts, bring it with you.
- Do your homework.

Slide 15-104

- Stay informed about the posture of your case. If there have been defense investigators and/or experts, find out who they are and what they reported.

- Be prepared to justify, if appropriate, any problems or potential problems that the defense expert claims exist in the investigation.

- Be prepared to give an opinion and explain why the defense opinion is either correct or incorrect, misleading or otherwise inaccurate.

- Any information known about the defense investigator and/or expert should be discussed with the attorney.

MOTIONS IN LIMINE AND STIPULATIONS

- Find out before trial whether or not any motions in limine were filed.
- If so, what were the rulings?
- Find out if any of your opinions or evidence has been excluded.

Slide 15-105

X. A motion in limine simply means a motion to be heard prior to trial. This often involves potentially excluding evidence.

1. Sometimes both sides may agree to some fact or issue, and this results in a stipulation.

2. Some examples of stipulations in fire cases include stipulating that the investigator is an expert or stipulating to the cause and/or origin of a fire.

MOTIONS IN LIMINE AND STIPULATIONS (cont'd)

- Find out if there have been any stipulations regarding your testimony or any evidence.
- Stipulations mean that both sides agree to certain facts and live testimony is not required.

Slide 15-106

3. Generally, a defendant may want to stipulate to the status of the investigator as an expert. But that prevents the jury from hearing how skilled he or she is, so often the prosecutor or civil attorney working with the investigator will prefer to make you qualify in front of the jury.

4. In some cases, a defense may stipulate to either the cause or origin of a fire; like if the cause was accidental, the defense wants the jury to know.

TESTIMONY

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V. LAY TESTIMONY

LAY TESTIMONY

- Testify to observations, not interpretations or opinions.
- Critical to be familiar with complete investigation.
- Must communicate credibly with jury.
- Often the fire officer and firefighters are called as fact witnesses.

Slide 15-108

A. Lay witnesses are fact witnesses; they describe for the jury what they know because they saw, heard, smelled, felt or tasted something. The facts of a case are essential because they tell the story of when the event occurred, where it happened, what was seen, heard, etc.

B. The jury ultimately must decide whether they believe the witnesses enough to convict or punish a defendant, so credibility is essential. In order for the jury to understand the evidence, a witness must understand it and be able to explain it to 12 eighth-grade minds.

C. All witnesses are fact witnesses except for those few witnesses who are called upon to give an opinion on an ultimate fact.

D. Lay witnesses can give opinions in a few areas that regular life experiences provide information to support, such as:

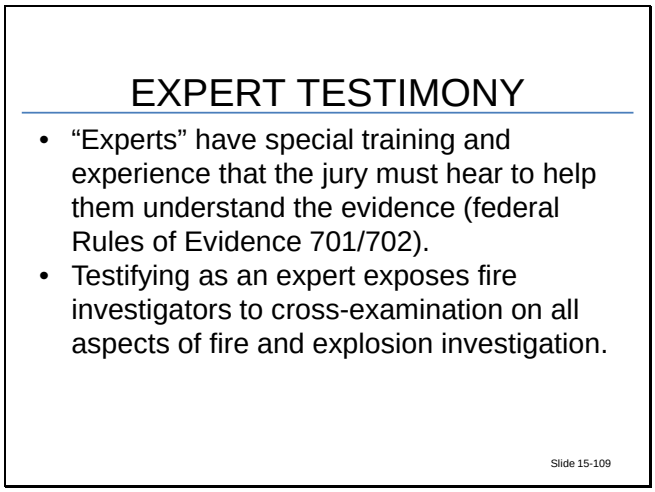
1. The approximate speed a vehicle was traveling.

2. Appearance of intoxication.

3. Appearance of mental impairment.

4. How a person appeared emotionally and/or physically.

VI. EXPERT TESTIMONY



A. Only expert witnesses can provide opinions on ultimate facts, such as if and how something happened that no one actually saw.

1. In order to qualify as an expert, a judge must determine that the witness has experience or training and has relevant information that will assist the jury in determining whether something is more or less likely to have occurred.

2. In many cases involving experts, the entire case is essentially a "battle of the experts."

EXPERT TESTIMONY (cont'd)

- Opinions are judged "within a reasonable degree of scientific certainty."
- Be prepared to explain your decisions in National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations* terms.

Slide 15-110

3. In order to prevail at trial, an expert must be prepared, knowledgeable about the entire case, and able to explain procedures and mistakes.

   a. An expert must be professional when attacked by the opposing attorney regarding procedure, knowledge and ethics.

   b. An expert must present an air of professionalism as well as a likable personality while making the fire investigation and its results crystal clear.

NATIONAL FIRE PROTECTION ASSOCIATION 921 — LEVEL OF CERTAINTY

Chapter 20, Section 19.7.4; 4.5 — opinions.

- 100 percent confident/positive.
- Reasonably certain.
- Likely/Unlikely.
- We think/believe.
- Probable = 60 percent or greater likelihood.
- Possible = 25 percent or greater likelihood.

Slide 15-111

B. National Fire Protection Association (NFPA) 921, *Guide for Fire and Explosion Investigations* — level of certainty.

1. U.S. Navy standard operating guidelines (SOG) levels of certainty:

   a. Highly probable = 90 percent or greater likelihood.

   b. Probable = 60 percent or greater likelihood.

c. Possible = 25 percent or greater likelihood.

NATIONAL FIRE PROTECTION ASSOCIATION 921 — LEVEL OF CERTAINTY (cont'd)

- Could be/Near as we could tell/We figured/ decided.
- Suspicion.
- Guess/Do not know.

Slide 15-112

d. Unlikely/Low possibility = 10 percent or less believes.

- A fire investigator should be very cautious about attaching specific numerical data or percentages to opinions.

- The trial standard should not be confused with the NFPA levels of certainty.

2. Either the investigator has an opinion or he or she does not, and there should be an explanation regarding how the opinion was reached.

3. Whether something else is possible is almost always a reality; the point is how the opinion is justified.

a. "My opinion is based on (review of the fire scene, statements by witnesses, lab testing, etc.) … "

b. "Certainly anything may be possible; however, in this case the evidence shows that did not happen because … "

STANDARDS FOR ADMISSION OF EXPERT TESTIMONY

- Daubert — criteria to measure reliability of the methodology.
  - Relevant.
  - Reliable.
    - Theory or technique tested with appropriate standards and controls?
    - Subject to peer review?
    - What is the known or potential rate of error?
    - What is the level of general acceptance?
  - Judge is gatekeeper.

Slide 15-113

C. There are two standards for determining whether a witness qualifies to testify as an expert (to give an opinion on an ultimate fact).

1. Some states are "Daubert States," some are "Frye States," and some are hybrid states. (Federal courts use the Daubert standard.)

   This is an example of case law. Daubert and Frye were cases that, as the result of court decisions, determined the rules for expert qualification.

2. Both standards require some degree of relevance (to the particular case set for trial) and reliability.

   a. The Daubert test involves a flexible reliability determination wherein the judge considers the four factors listed on the slide before ruling on the reliability.

STANDARDS FOR ADMISSION OF EXPERT TESTIMONY (cont'd)

- Frye — generally accepted in the relevant scientific community.
  - Two components:
    - Relevant.
    - Reliable.

Slide 15-114

   b. The Frye test is also referred to as the general acceptance test.

3. Basically, the witness may only qualify to testify as an expert if the methods used are generally accepted as reliable in the scientific community.

4. Frye was convicted of murder, but at trial his attorneys attempted to introduce expert testimony about a blood pressure deception test.

   USSC held that the test was not reliable because it had not gained general acceptance in the scientific community.

DAUBERT AND/OR FRYE CHALLENGES

- Are your opinions being challenged?
- If so, how are they being challenged?
- Has a hearing been requested regarding your opinions?
- Is your state a Daubert or Frye state?
  - You need to know the rules.
  - Federal court follows Daubert.

Slide 15-115

5. In almost every case, the opinion will be challenged, either by an expert or by opposing counsel.

   a. Whether a witness even qualifies as an expert is the first challenge.

      - If the witness is not able to qualify as an expert, then the witness will only be able to testify to observations, not to any opinions.

      - That means the jury will not hear where the fire started or how it started.

      - Even if the witness qualifies as an expert and testifies on direct to his or her opinion as to origin and cause, cross examination will be ferocious.

   b. If a witness's qualifications and/or opinions are challenged, this must take place outside the presence of the jury. (Basically, testify two times.)

- The witness should prepare prior to trial to answer qualification questions, opinion questions, and potential cross-examination questions.

DAUBERT V. MERRELL DOW PHARMACEUTICALS (1993)

- Birth defects from anti-nausea medication.
- "General acceptance" not necessary precondition to admissibility of scientific evidence.
- Judge ensures expert's testimony is reliable **and** relevant.
- Federal Rules of Evidence supersede Frye.

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D. Daubert v. Merrell Dow Pharmaceuticals (1993):

1. Jason Daubert and Eric Schuller were born with serious birth defects, and their parents claimed Bendectin, a drug, caused the defects.

2. Merrell Dow's expert presented documentation that no published scientific study had shown a link between the drug and defects.

3. Daubert and Schuller's experts had evidence of a linkage that was determined by in vitro and in vivo (animal) studies.

   a. The in vitro and in vivo studies had not yet gained acceptance within the general scientific community.

   b. The Frye test required general scientific acceptance, and this was the common law rule regarding the admissibility of expert testimony.

4. Prior to Daubert, Congress adopted the federal Rules of Evidence in 1975.

   a. Rule 702 of the federal Rules of Evidence states:

      - If scientific, technical, or other specialized knowledge will assist in understanding evidence or determining a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify to their opinion.

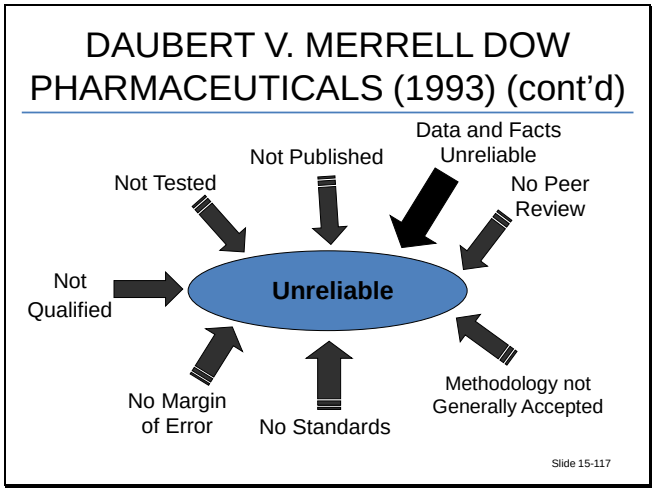
b. The USSC held that this law overruled the common law Frye test that required general acceptance in the scientific community.

- The test is:

  -- Scientific knowledge.

  -- Assists the trier of fact (judge or jury) by having a valid scientific connection to the issue in the case.

- Judge decides if reasoning/methodology is scientifically valid and if it can be applied to the facts of the case.



c. Has the theory or technique been subjected to peer review and publication? (Publication is one aspect of peer review.)

d. Is there a known or potential rate of error, and is there a set of standards regarding the operation? If so, are they maintained?

e. Is there general acceptance in the scientific community? This factor, like the others, is not required but is relevant in the inquiry.

- Focus is on principles and methodology, not on the conclusions, and the test is flexible.

  -- Basically, the expert must provide some element that shows reliability because his or her opinion alone is not enough.

KUMHO TIRE COMPANY V. CARMICHAEL (1999)

- Tire failed on vehicle; one passenger killed, others injured.
- Daubert's "gatekeeping" (relevance and reliability) applies to all expert testimony, not just "scientific" testimony.
- "Technical" and "other specialized" knowledge.

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E. Kumho Tire Company v. Carmichael (1999):

1. Patrick Carmichael was driving his minivan when the right rear tire blew out, causing a crash that killed one passenger and injured three others.

2. Carmichael sued the tire manufacturer, claiming a defect in the tire caused the crash.

3. Carmichael's "tire failure expert" used methods that were not scientific but were based on "skill or experienced based observations."

4. USSC reasoned that Rule 702 applied to "scientific, technical or otherwise" and therefore concluded that Daubert applies to all types of expert testimony.

5. The expert's testimony was simply that his examination of the tire did not provide evidence of any other cause, so he concluded that it was defective.

6. A statement by the expert is not enough to make an opinion admissible and valid (ipse dixit).

MICHIGAN MILLERS MUTUAL INSURANCE V. BENFIELD (1998)

- Residential fire.
- Insurer filed declaratory judgment to determine if liable for damage caused.
- Court ruled that testimony of insurer's origin expert was properly excluded under Daubert.

Slide 15-119

F. Michigan Millers Mutual Insurance v. Benfield (1998):

1. Janelle Benfield and her husband were having marital difficulties, and their home was insured by Michigan Millers.

2. Janelle left the home empty; locked only the regular locks, not the deadbolts; and cracked the windows.

3. She put the deed to the home on the dining room table with bags of clothing for Goodwill and a bottle of lamp oil, all under a light that flickered.

MICHIGAN MILLERS MUTUAL INSURANCE V. BENFIELD (1998) (cont'd)

- Testimony based on scientific principles — scientifically valid and properly applied to facts.
- Expert took no samples, performed no tests, couldn't explain methodology for elimination of source.

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4. Lt. Kehoe responded and found an empty, intact lamp oil bottle but no evidence of accelerant, and he could not determine the cause of the fire. He was allowed to testify that his personal opinion was the fire was "suspicious."

5. William Buckley, Miller's arson investigator, arrived three days later. He concluded that the fire was intentionally set because there was no accidental source of ignition at the origin on the table.

6. Janelle filed a claim to recover her loss of personal belongings in the fire, and Millers denied the claim, holding her responsible for the fire.

MICHIGAN MILLERS MUTUAL INSURANCE V. BENFIELD (1998) (cont'd)

- Came to opinion that fire was incendiary because unable to identify source of ignition.
- Nothing requires admission of opinion evidence connected only by "ipse dixit of the expert" (General Electric v. Joiner (1997)).

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7. Fire investigator's determination that a fire was intentionally set because accident was eliminated is not a rational explanation for the finding.

   a. The investigator could not even describe the chandelier that hung over the fire, much less his methodology: His opinion was not admissible.

   b. The fire investigator believed lamp oil was poured on the clothes, but he did not know if lamp oil was in the bottle prior to the fire.

      - The evidence supported arson, but the expert testimony was not admissible. (He did not present as a reliable expert witness.)

QUALIFYING AS AN EXPERT

So you've passed the Daubert or Frye challenge, now what?

- You will have to be qualified in front of the jury.
- Qualifying is when you build your background and experience based on your CV.
- This is why an up-to-date and thorough CV is so important.
- Boosts your credibility with the jury.

Slide 15-122

G. Expert testimony is a multistep process.

1. The area of fire science is an accepted area of expertise.

2. Expert opinions concerning origin and cause of a fire are relevant to fire cases.

3. The fire investigator must have sufficient knowledge, skill, experience, training or education to be accepted by the court to testify as an expert.

4. If the investigator is unable to personally qualify as an expert, his or her opinions regarding cause and origin will not be admissible.

   a. The defense will often object to the fire investigator's qualification as an expert.

   b. Every expert witness has to go to trial and testify once, admitting that they have not yet been qualified as an expert. (First time is the hardest.)

5. Fire investigation is a very specialized area. The training that an investigator receives at the National Fire Academy (NFA) and the experience that an investigator has are significant.

   a. All prior knowledge, skill, experience, training and education should be included on the CV.

   b. Build it, document it, proofread it!

QUALIFICATIONS OF AN EXPERT

- Current position — length of service.
- Professional work experience.
- Educational background.
- Training.
- Professional certifications.
- Professional affiliations.
- Honors/Awards/Publications.
- Accepted as court expert where and by whom.

Slide 15-123

H. Qualifications of an expert:

1. Some CVs are a single page; some are more than 20 pages.

2. A page or two should be sufficient (unless the investigator has been working in the field forever).

3. Make sure everything that supports experience, skill, training and education regarding fires is included.

4. Working for a fire department responding to fires is experience with fires; include it.

5. Statistics should be kept for approximate number of fires responded to, investigated, investigated as lead, origin and cause called, and testimony.

6. Do not include personal information, such as home address and personal phone numbers or email addresses.

7. Make sure certification information is not confused with training and classes.

   a. Certifications and accreditations are generally approved by an agency after formal training and testing (i.e., Certified Fire Investigator (CFI)).

   b. Training information should be listed, but it should not be the focus. For example, 159 CFI trainer.net classes should not be listed individually.

- Be careful not to include classes that you do not complete. (Some courts are now requiring discovery detailing failing grades.)

8. Do not stretch the truth. (Information online is easily verifiable, and attorneys share expert CVs.)

9. Do not include experience that is not fire-related or otherwise helpful to a determination of your professional expertise.

10. Work as a bartender or stripper is not helpful (not here anyway).

PREPARING FOR COURT

- Subpoena — mark calendar. (Yes, we mean it.)
- Contact the prosecutor to discuss case.
- Know where your evidence is (hopefully not in the back of your car).
- Review case files.
- Dress appropriately.
- May have motions to suppress.

Slide 15-124

I. Subpoena is a court order, not a request.

1. Prepare by reviewing the file and meeting with the prosecutor.

2. Make sure that all evidence has been returned after testing.

3. Wear a suit and tie or uniform. (Agency policy should be followed.)

4. Be prepared to answer difficult, stupid and repeated questions (with a professional attitude).

TESTIMONY — DIRECT VERSUS CROSS-EXAMINATION

- Direct.
  - Questions asked by your lawyer.
  - Calls for a more "narrative" type of answer.
  - Allows you an opportunity to speak more and bond with the jury more.
  - Allows you to dazzle them with your brilliance.

Slide 15-125

J. On direct, the questions must be open-ended, meaning the question should not indicate how you should answer.

1. Basically, the questions are who, what, when, where, why, how and a whole bunch of "what happened next."

2. This is a time to educate the jury while you explain the highly specialized technical skills and knowledge you have as simple facts.

   a. If there were mistakes or errors in the report or investigation, mention and explain them so they are not a big deal.

   b. Just answer the question that is asked. Take time to think about the question, then answer clearly and confidently.

TESTIMONY — DIRECT VERSUS CROSS-EXAMINATION (cont'd)

- Cross.
  - Questions asked by opposing counsel.
  - Try to prevent you from explaining anything.
  - Try to point out errors you didn't see, or trick you into answers.
  - Do not assume counsel knows something you do not just by the question asked.

Slide 15-126

3. On cross-examination, questions will generally be leading, meaning they require yes or no answers. If explanation is needed, do so after the yes or no.

a. Be polite and respectful even as the opposing attorney attempts to discredit you.

- Do not be so polite that you agree with questions that are not correct.

b. Just as on direct, listen carefully to the question. Think about the answer before you begin to answer.

c. If you need to admit something, do it. Making mistakes is human, and admitting it proves your credibility, but explain it if there is an explanation.

TESTIMONY — DIRECT VERSUS CROSS-EXAMINATION (cont'd)

- Redirect.
  - Your counsel's opportunity to do damage control after cross (if needed).
  - If you are cut off from answering/explaining something during cross-examination.
  - Focus jury back on your theory.

Slide 15-127

4. Redirect allows your attorney to ask questions to clear up facts and issues that were distorted on cross.

5. The best witnesses clear up everything themselves by explaining the answers on cross, but this is not always possible.

TESTIMONY — DIRECT VERSUS CROSS-EXAMINATION (cont'd)

- Recross.
  - Chance for opposing counsel to undo anything fixed on redirect.

Slide 15-128

6. Back on cross again, you are getting tired of being questioned. (This goes on for hours or even days, and you feel like you are the one on trial.)

7. Remain calm and professional. Keep the same pleasant, confident demeanor with both sides, showing the jury that you are just there to tell the truth.

OBJECTIONS — WHAT TO DO

- Sustained: You cannot answer.
- Overruled: You can answer.
- As soon as you hear "objection," stop talking.
- Wait for the court to rule before answering.
- If you are not sure whether you can answer or not, ask the judge.

Slide 15-129

8. When you hear the word objection, from anyone, stop talking immediately, right in the middle of your word.

   a. If you answer a question that was objectionable, the judge may declare a mistrial, and a year later you will start this whole thing over.

   b. If you are asked a question that you think is objectionable but the lawyers and the judge do not say objection, pause briefly but you must answer.

   c. Your attorney should be paying attention and protecting you, but sometimes it is a matter of picking which battle to take.

   d. Sometimes the defense opens the door by asking a question that allows you to say something you otherwise could not say.

   e. Sometimes your attorney does not object because your attorney does not want the jury to think you are hiding evidence or information.

      - If you are unsure, turn to the judge and say "Your honor, should I answer that?"

TESTIFYING — BEING A GOOD WITNESS

- Listen to the entire question before answering.
- Answer only the questions asked.
- Do not volunteer information.
- Tell the truth.
- Make good eye contact.
- Keep your voice up.
- Do not make answers into long narratives.

Slide 15-130

f. Above all else — good, bad or ugly — tell the truth.

- For example, arresting officer testifies that he did not believe the defendant was appreciably impaired when he arrested him for driving while impaired.

-- The officer's credibility is impressive and honorable.

TESTIFYING — BEING A GOOD WITNESS (cont'd)

- Do not use scientific, technical or police/ fire jargon.
- Avoid fidgeting.

Slide 15-131

-- The jury unanimously convicts the defendant of driving while impaired.

-- The appellate court upholds the conviction, making new case law. State need not prove a defendant is impaired to prove DWI.

TESTIFYING — BEING A GOOD WITNESS (cont'd)

- Do not guess.
- Watch out for compound questions — "Which question would you like for me to answer first?"
- If you're interrupted, ask if you can finish.
- Know the facts of your case (dates and times) without having to refer to your report.

Slide 15-132

9. Do not say "I believe" or "I think." Testify to what you know, what you did, what you saw, etc.

10. When you get multiple questions at the same time, address them one at a time. If you cannot remember the next part, it is ok to ask.

11. Your attorney should object if you get interrupted; if he or she does not, wait, then ask to finish your previous answer.

12. The court reporter cannot take down what two people say at one time, and the jury cannot hear it all.

TESTIFYING — BEING A GOOD WITNESS (cont'd)

- Remember whom you discussed the case with.
- Know your report, but do not memorize it.
- Show a small amount of personality, you want the jury to like you.
- Be respectful of all counsel.

Slide 15-133

13. Admit that you spoke to the prosecutor in preparation for trial, but the only thing the prosecutor told you to say was the truth (and that better be true).

14. It is ok and often preferable to refer to your report for details, but you should know basics without doing that.

15. What you take to the stand is available to the defense to question you about, which is ok. Do not try to testify to measurements, etc., from memory.

TESTIFYING — BEING A GOOD WITNESS (cont'd)

- Be aware of any personal tics/habits, and work on getting rid of them before testifying.
- Rehearse in front of a mirror until you get comfortable.
- If you testify a lot, do not get so comfortable that you get caught off guard.

Slide 15-134

a. Do not chew gum. If you squint because you need glasses, get them. Do not swivel in your seat or cross your arms on cross.

b. Sounds goofy, but really, rehearse in front of a mirror (and take "Interviewing-Interrogation Techniques and Courtroom Testimony" (IITCT) (R0208) so you can be challenged by friendlies to perfect your testimony).

16. Do not get so comfortable that you become sloppy in appearance or manner of answering questions.

a. Some apprehension is healthy.

b. You are going to be on the stand for what seems like forever. Pay attention, but if you miss something, you are human. Ask to repeat the question.

TESTIFYING — BEING A GOOD WITNESS (cont'd)

- Make sure you understand a question before you answer it.
- If you zone out, simply ask for the question to be repeated.
- If you cannot hear counsel asking questions, let them know.

Slide 15-135

17. Make eye contact with jury members when answering questions; they are the ones who need desperately to understand what you have to say.

VISITING THE COURTROOM

- You should do this **every** time.
- Be familiar with the actual courtroom you are testifying in (doesn't matter if you have testified one or 100 times before).
- Know where the judge sits.
- Know where the witness stand is.
- Know where the court reporter sits.

Slide 15-136

18. You own that courtroom. Do not be cocky, but be confident. Know where to be, who is there, and how the courtroom functions.

VISITING THE COURTROOM (cont'd)

- Know where the bailiff sits (will swear you in).
- Know where the jury box is.
- Know anything that is particular to this courtroom.

Slide 15-137

19. Investigators should visit the courtroom prior to the day of trial to familiarize themselves with the layout of the courtroom to avoid being nervous.

ONLY ONE CHANCE TO MAKE A GOOD FIRST IMPRESSION

- Proper attire.
- Entering the courtroom.
- Posture while testifying.
- Voice.
- Eye contact.
- Manner of speech.
- Confidence while testifying.
- Exiting the courtroom.

Slide 15-138

K. You are the most professional person in that courtroom.

1. The lawyers have a side to take, an argument to make, and they may lose their cool. (Defense attorneys will do just about anything to upset you.)

2. You have an opinion, but it is based on a fair assessment of the facts, and the facts are the facts; you did not get to choose them.

3. Do not get so wrapped up in the case that you lose objectivity and the ability to be fair.

TESTIFYING DO'S

- **Review your case file**!
- Be on time.
- Think before you speak.
- Admit mistakes in your report, especially if inconsequential.
- Be respectful to both sides and the court and jury.
- Answer the question.

Slide 15-139

L. Testifying do's:

Testimony is really a conversation; you just have to speak a little louder than normal because the jurors are a little farther away than normal.

TESTIFYING DO'S (cont'd)

- Make your testimony appear conversational with the jury.
- Keep your hands away from your face.
- Appear to be confident and neutral — even if you are not.
- Maintain formalities.
- Seize opportunities to educate the judge/ jury.

Slide 15-140

1. During breaks and in the restroom, etc., maintain your professionalism. The jury members will see you, and they look up to you; keep it that way.

TESTIFYING DO'S (cont'd)

- Make eye contact with each and every juror at least once.
- Speak clearly for the court reporter.
- Tell the truth.

Slide 15-141

2. Be prepared, be professional, and be truthful.

TESTIFYING DON'TS

- Do not be combative.
- Do not lock in on opposing counsel during cross-examination.
- Do not ignore the jury.
- Do not raise your voice during cross-examination.
- Do not interrupt counsel/speak over one another.

Slide 15-142

M. Testifying don'ts:

1. Do not let the defense control you.

2. The premise of the U.S. court system is that it is adversarial.

3. The purpose of cross-examination is to expose bias and lack of knowledge and to discredit the witness (that means you).

4. Aside from questioning a defendant, cross-examination of an expert witness is so much fun for the attorney.

TESTIFYING DON'TS (cont'd)

- Do not have your testimony too rehearsed.
- Do not testify like a robot.
- Do not speak too quietly or too quickly.
- Do not bring a bunch of documents into the courtroom with you.
- Do not bring your coat or briefcase into the courtroom with you.

Slide 15-143

5. Presenting evidence through a professional, competent, trustworthy witness is extremely gratifying. (Make everyone in the room love you.)

TESTIFYING DON'TS (cont'd)

- If you do not remember/know, say so.
- Do not be too eager to please or fight.
- Do not chew gum or candy.
- Do not be disrespectful outside the courtroom.

Slide 15-144

6. Remembering and knowing are different.

   a. You do not know everything; if you do not know, say so.

   b. If you do not remember, say that too.

   c. If someone else said or documented something differently than you did, you can only speak for what you saw, heard or did.

CURRICULUM VITAE

- Everyone should have one.
- Keep it updated.
- Do not exaggerate your experience.
- Be specific.
- Make sure prosecutor has your most recent version.
- Keep copies of all certificates.

Slide 15-145

TEAM APPROACH

Slide 15-146

N. Working as a team:

1. Fire investigators must work with fire suppression personnel; they can help you preserve your scene.

2. Fire investigators must work with law enforcement officers; they typically bring the charges, perform custodial interviews, etc.

   a. Law enforcement must also work with fire investigators; they know what questions you need to ask because they know how fire behaves.

   b. Fire investigators and law enforcement must work with prosecutors, approach them, and invite them to watch you set something on fire.

- Get your prosecutor invested and motivated. Prosecuting fire crimes is difficult, but it is very rewarding to convict dangerous offenders.

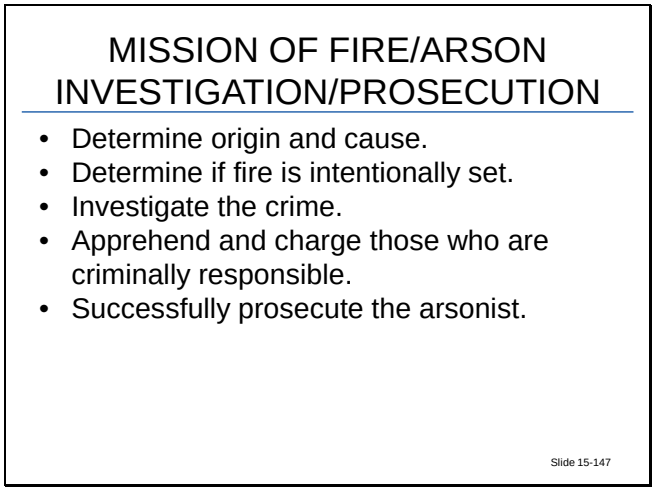
3. Know what resources are available. Fire professionals are unusually willing to work together, to assist, to brainstorm.

4. The Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) has resources available to state agencies, and they love to play with fire cases; they will dig, interview witnesses, and provide expertise.

5. Insurance companies want to help you catch criminals. This saves them money. Even if you cannot prove the arson, you may be able to prove a fraud.

6. K-9 officers from various agencies are invaluable and are often on 24-hour call, willing to assist you.

7. Some state agencies can help you get phone records; find experts in electrical fires, vehicle fires; etc.



8. Successful prosecution of fire crimes requires very specialized knowledge, skills, training, education and team work.

9. It is hard! But those dedicated to working fire crimes do it because they love it, it is important, it saves lives, and it is extremely rewarding.

PROSECUTOR DUTIES

- No charge without probable cause.
- Disclose to defense all exculpatory or mitigating evidence (Brady violation).

Slide 15-148

O. Government always has burden of proof on elements of crime(s). Standard of proof in criminal is beyond a reasonable doubt and civil is preponderance of the evidence.

P. Brady decision and Model Rules of Professional Conduct (MRPC) require disclosure of exculpatory and mitigation evidence by prosecutors to defense.

1. Ignorance is no excuse for prosecutors. If any government agency or investigator has the info, prosecutor must give it up.

2. Prosecutor must review cases that are charged and agree that probable cause exists, or they have a duty to dismiss the charges themselves.

3. Prosecutors have a duty to disclose all evidence favorable to the defendant, and in many jurisdictions, absolutely all evidence that exists.

PROSECUTOR DUTIES (cont'd)

- No extrajudicial statements — criminal record, confession, test results, opinions of guilt or lying, excluded evidence, invoked right to remain silent.
- Outcome of pretrial rulings imparted to witnesses.

Slide 15-149

4. Prosecutors have more ethical obligations than other lawyers, and they can lose their license to practice law or go to jail if they fail to comply.

5. Prosecutors have duties to inform some witnesses — most often, victims of the results of proceedings — when requested to do so.

JURORS' EXPECTATIONS

- They have stereotyping/myths.
- They want to do what is morally fair.
- They look for case consistency.
- Complexity without simplicity = not guilty.
- They expect respect for the process.
- They prefer to be educated/not entertained.
- They are looking for deception.

Slide 15-150

Q. For the most part, jurors want to do what they believe is fair. (That may not be the same as what the law requires.)

1. Jurors take convictions very seriously, and they are afraid to convict unless they are completely and entirely convinced and satisfied.

2. Jurors believe punishments are harsher than they are, so they are hesitant to convict on circumstantial cases or without a sympathetic victim.

3. Jurors must understand the danger that arsonists and firesetters pose to the community.

4. Jurors expect you to have done absolutely everything possible to prove the defendant's guilt and to disprove any other theories.

ARSON REPORTING IMMUNITY STATUTES

- http://www.arsoncontrol.org/legal/laws.htm.

Slide 15-151

R. Insurance agencies, investigators and their investigations are an invaluable source of evidence for criminal fire investigators.

ARSON REPORTING IMMUNITY STATUTES (cont'd)

- All 50 states have arson reporting immunity laws.
- Provides for law enforcement and insurance companies to share information without fear of criminal or civil liability.
- Information from insurance company can be obtained via an immunity letter sent to the insured's insurance carrier.

Slide 15-152

1. This means that you can get the investigative materials collected by the insurance company to use to prove fire crimes.

ARSON REPORTING IMMUNITY STATUTES (cont'd)

- Letter should request copy of insured's master claim file.
- Examination under oath (EUO): Questioning is being done by a civil attorney retained by the insurance company.
- Defendant is technically in "custody" since present via court subpoena.

Slide 15-153

ARSON REPORTING IMMUNITY STATUTES (cont'd)

- Miranda does not apply since defendant is not being questioned by a criminal investigator (government).
- Circumstances change if criminal (fire) investigator suggests questions to the attorney before the EUO.

Slide 15-154

2. Insureds who make a claim under their insurance policy are required by the insurance company in order to be reimbursed for an alleged loss.

   a. This means people who are suspects have to make a statement.

   b. If they are intentional fire starters, their statement will contain information to use in your investigation regarding evidence, witnesses, etc.

      - It will either be a confession, a partial admission, or a detailed lie that you might be able to disprove.

   c. If you are still unable to prove they committed an intentional burning, you may very well be able to prove insurance fraud.

      - Look carefully through the statement of loss. Did they report items lost that were not actually destroyed in the fire? Did they claim false values?

ARSON REPORTING IMMUNITY STATUTES (cont'd)

- If collusion occurs between the fire investigator and insurance company attorney, the attorney can be considered an agent of the government, and the EUO becomes a criminal interrogation where Miranda would apply.

Slide 15-155

S. Multidisciplinary teams and any team approach by a law enforcement officer may implicate constitutional protections such as Miranda.

T. Go, watch, be a passive participant, or just obtain the documents afterwards so suspects do not realize you will be obtaining the statement.

KEYS TO REMEMBER

- Get prosecutor involved early.
  - Good documentation (photos, reports, notes, etc.).
  - Thorough scene processing.
  - Obtain detailed witness statements.
  - Look for motive.
  - Prepare for testimony.

Slide 15-156

U. Communicate with the prosecutor before charging if possible. He or she may have suggestions for evidence to obtain before charging.

1. Take all the photographs you need to recreate the scene after the scene is gone.

2. Take your time, process the scene carefully, make interviews detailed so they can lead to other evidence or support your theory.

3. Motive is not required, but it is important to understanding the crime and convincing the prosecutor, judge and jury.

   a. Common motives in fire crimes are:

   b. Anger, domestic or business, financial gain, concealment of other crimes, juvenile experimentation, and fire fascination.

KEYS TO REMEMBER (cont'd)

- **Ultimate destination of your investigation = the judge and the jury!**
  - Make sure the jury gets the chance to see your evidence.
  - If your evidence gets suppressed by the judge, the jury will never see it.
  - When in doubt, be legally conservative: Do not "stretch" your case to fit the facts.

Slide 15-157

4. If the investigation is complete and professional, a factually weak case may be successfully prosecuted.

5. If the investigation is incomplete and unprofessional, even a factually strong case likely will not be successfully prosecuted.

6. A successful prosecution takes teamwork, but it is on you to make everyone understand why you are right about what happened and who did it.

KEYS TO REMEMBER (cont'd)

- Ultimate standard of proof?
  - **Proof beyond a reasonable doubt!**
  - Focus on your final audience: judge/jury.
    - -- More detail is better than little detail.
    - -- More evidence is better than little evidence.
    - -- Paint a picture for the jury: Think visually.
    - -- Answer the questions.
    - -- Get perspective on your case.
    - -- Motive, means, opportunity.
    - -- Alibi.

Slide 15-158

7. Examine all the evidence and all the possibilities.

8. Understand what caused the fire, how and why. Understand and explain what did not cause the fire and how and why you are sure.

KEYS TO REMEMBER (cont'd)

- Keep the final goal in mind: prosecution.
- Do not get lost in your case: Keep the big picture **and** the details in mind.
- Team effort:
  - Talk to your prosecutor early and often.
  - Develop a team approach.

Slide 15-159

VII. SUMMARY

SUMMARY

- Arson law.
- Common law.
- Intent.
- Warrants/Reasonableness.
- Lay testimony.
- Expert testimony.

Slide 15-160

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UNIT 16: BOMB ARSON TRACKING SYSTEM TRAINING

TERMINAL OBJECTIVE

The students will be able to:

16.1 Describe the basic operation of the Bomb Arson Tracking System (BATS) and its application and use in maintaining fire/arson investigation case information.

ENABLING OBJECTIVES

The students will be able to:

16.1 Explain the basic functionality of BATS as a case management system.

16.2 List the advantages of using an automated case management system for fire and explosion investigations.

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UNIT 16: BOMB ARSON TRACKING SYSTEM TRAINING

Slide 16-1

ENABLING OBJECTIVES

- Explain the basic functionality of the Bomb Arson Tracking System (BATS) as a case management system.
- List the advantages of using an automated case management system for fire and explosion investigations.

Slide 16-2

I. BOMB ARSON TRACKING SYSTEM MISSION

UNITED STATES BOMB DATA CENTER NATIONAL COLLECTION PLAN

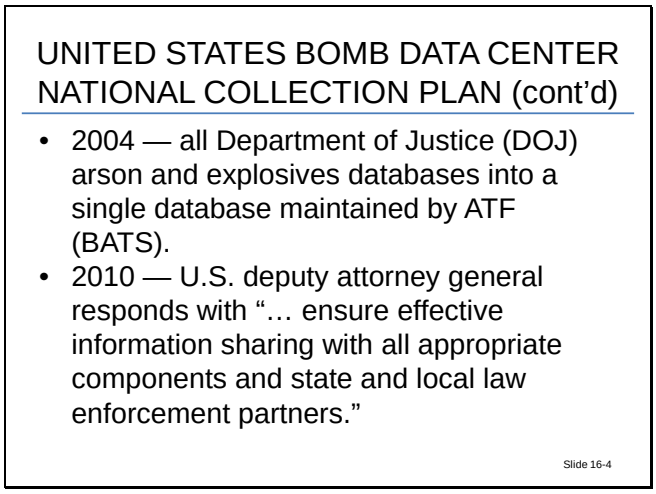
Federal explosives laws:

- Public Law 104-208 (1996) — federal agencies required to report arson and explosives incidents to the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) (amending the Explosives Control Act).

Slide 16-3

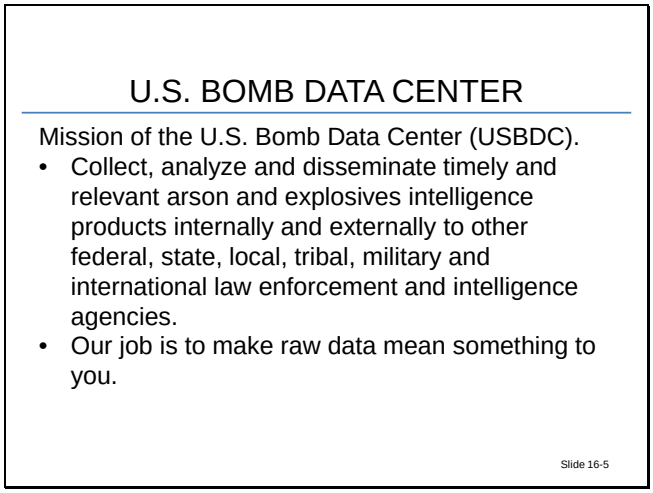
A. Federal explosives laws:

1. Public Law 104-208 (1996) — federal agencies required to report arson and explosives incidents to the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) (amending the Explosives Control Act).



2. 2004 — all Department of Justice (DOJ) arson and explosives databases into a single database maintained by ATF (Bomb Arson Tracking System (BATS)).

3. 2010 — United States deputy attorney general responds with "… ensure effective information sharing with all appropriate components and state and local law enforcement partners."



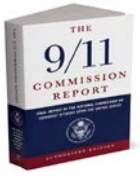
B. Mission of the U.S. Bomb Data Center (USBDC).

1. Collect, analyze and disseminate timely and relevant arson and explosives intelligence products internally and externally to other federal, state, local, tribal, military and international law enforcement and intelligence agencies.

2. Our job is to make raw data mean something to you.

BOMB ARSON TRACKING SYSTEM

- Sharing information electronically.
- "The biggest impediment to ... connecting the dots is the human or systemic resistance to sharing information" ("The 9/11 Commission Report").



Slide 16-6

C. Sharing information electronically.

D. "The biggest impediment to ... connecting the dots is the human or systemic resistance to sharing information" ("The 9/11 Commission Report").

BOMB ARSON TRACKING SYSTEM (cont'd)

- Trusted information sharing.
  - BATS shares information in a **trusted** manner.
  - All users must apply and be public safety personnel.
  - First responders can report information directly into BATS.

Slide 16-7

E. Trusted information sharing.

1. BATS shares information in a **trusted** manner.

2. All users must apply and be public safety personnel.

3. First responders can report information directly into BATS.

BOMB ARSON TRACKING SYSTEM (cont'd)

- Each agency.
  - Administers its BATS account.
  - Assigns an account manager.
  - Determines and controls how information is shared.
  - Uses its own letterhead/seals for BATS reports.

Slide 16-8

F. Each agency.

1. Administers its BATS account.
2. Assigns an account manager.
3. Determines and controls how information is shared.
4. Uses its own letterhead/seals for BATS reports.

BOMB ARSON TRACKING SYSTEM MISSION

State/Local needs.

- BATS is your connection to the national database.
- You can report your incidents to the national database.
- Query over 320,000 incidents in BATS.
- Manage your cases (optional feature).

Slide 16-9

G. State/Local needs.

1. BATS is your connection to the national database.
2. You can report your incidents to the national database.
3. Query over 320,000 incidents in BATS.

4. Manage your cases (optional feature).

BOMB ARSON TRACKING SYSTEM MISSION (cont'd)

- Track statistics and squad activities (optional feature).
- BATS is 100 percent free.

Slide 16-10

5. Track statistics and squad activities (optional feature).

6. BATS is 100 percent free.

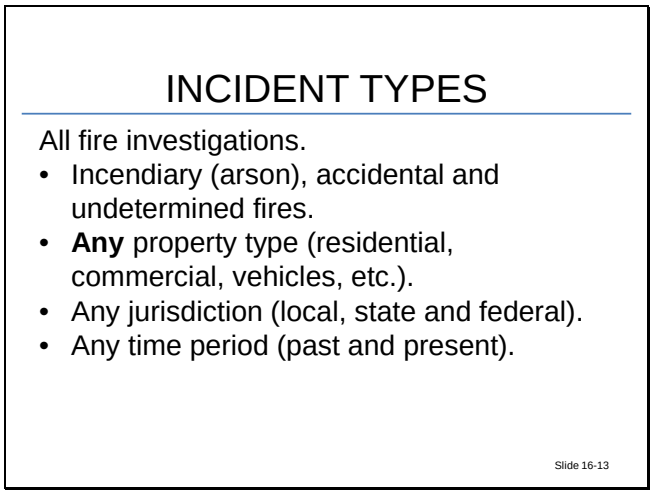
II. BOMB ARSON TRACKING SYSTEM USER CONFERENCES

BOMB ARSON TRACKING SYSTEM USER CONFERENCES

Built by you — built for you

Slide 16-11

III. INCIDENT TYPES



All fire investigations.

A. Incendiary (arson), accidental and undetermined fires.

B. **Any** property type (residential, commercial, vehicles, etc.).

C. Any jurisdiction (local, state and federal).

D. Any time period (past and present).

INCIDENT TYPES (cont'd)

- Inclusive rather than exclusive: A case initially classified as an accident could later become an arson.

Slide 16-14

E. Inclusive rather than exclusive: A case initially classified as an accident could later become an arson.

IV. ADVANTAGES

THE BOMB ARSON TRACKING SYSTEM ADVANTAGE

Why BATS?

- Designed by bomb technicians and fire investigators.
- Easy to use.
- Searchable national database with over **320,000** incidents dating from the 1970s.
- Administered by your agency (more agency control every version).

Slide 16-15

Why BATS?

A. Designed by bomb technicians and fire investigators.

B. Easy to use.

C. Searchable national database with over **320,000** incidents dating from the 1970s.

D. Administered by your agency (more agency control with every version).

THE BOMB ARSON TRACKING SYSTEM ADVANTAGE (cont'd)

- Real time.
- Can be used anywhere you have an Internet connection.
- View national trends and run reports.
- Keep current with advisories.
- Automated reporting for situational awareness.
- No costs to participating agency for maintenance or development.

Slide 16-16

E. Real time.

F. Can be used anywhere you have an Internet connection.

G. View national trends and run reports.

H. Keep current with advisories.

HOW BOMB ARSON TRACKING SYSTEM IS DIFFERENT

- **BATS**
  - Nationwide connections.
  - Can work large fire incidents with other BATS agencies.
  - Can search nationwide for similar cases to identify suspects.
  - ATF pays for all maintenance.
  - Can access database from anywhere you have an Internet connection.
    - -- Mobile workforce.
    - -- Print out reports at the courthouse.
    - -- Access off-duty in an emergency.
- **Local database**
  - Can't share info outside agency.
  - Must print reports to share any information with other agencies.
  - Searches are limited to cases inside your own agency.
  - Who pays for your maintenance?
  - Limited to a connection or software program within the agency.

Slide 16-17

I. Automated reporting for situational awareness.

J. No costs to participating agency for maintenance or development.

V. NATIONAL FIRE INCIDENT REPORTING SYSTEM

WHAT ABOUT NATIONAL FIRE INCIDENT REPORTING SYSTEM?

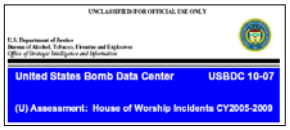
- **National Fire Incident Reporting System (NFIRS)**
  Fire suppression.
  - Operations/Emergency management.
  - Fire suppression.
  - Document response to fire.
  - Limited arson module does not replace case management.
  - Managed by U.S. Fire Administration (USFA).
- **BATS**
  Fire investigation.
  - Fire and explosives investigations.
  - Fire investigations (prosecution).
  - Document the criminal investigation (area of origin).
  - Case management, including property tracking, photos and reports.
  - Managed by USBDC.

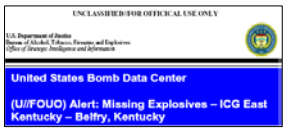
Slide 16-18

VI. ASSESSMENTS AND ALERTS

ASSESSMENTS AND ALERTS

- Current issues.
- Nationwide assessments.
- **Threats.**





Slide 16-19

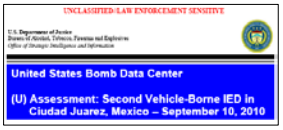
A. Current issues.

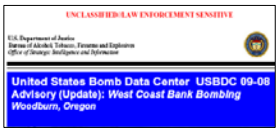
B. Nationwide assessments.

C. Threats.

ASSESSMENTS AND ALERTS (cont'd)

- Nationwide broadcasts.
- Trend analysis.
- **Situational awareness.**





Slide 16-20

D. Nationwide broadcasts.

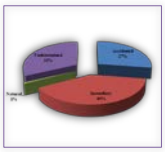
E. Trend analysis.

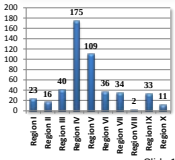
F. **Situational awareness.**

VII. ADVISORIES AND REPORTS

ADVISORIES AND REPORTS

A National View





Slide 16-21

A. A national view.

ARSON SUMMARY REPORT MAP

Trends

Slide 16-22

B. Trends.

INVESTIGATIVE RESOURCE LIBRARY

Accessible in the field on your mobile device.

Slide 16-23

C. Accessible in the field on your mobile device.

BOMB ARSON TRACKING SYSTEM CUSTOM GROUPS/TASK FORCES

All case information goes into BATS and is shared with everyone.

Slide 16-24

D. All case information goes into BATS and is shared with everyone.

VIII. GRAPHICAL USER INTERFACE

BOMB ARSON TRACKING SYSTEM
GRAPHICAL USER INTERFACE

Easier Every Version

Slide 16-25

SIMPLICITY IS THE KEY

- Visually driven.
- Simple interface.
- Easy input = good data.

Slide 16-26

A. Simplicity is the key.

1. Visually driven.
2. Simple interface.
3. Easy input = good data.

DECISION TREES

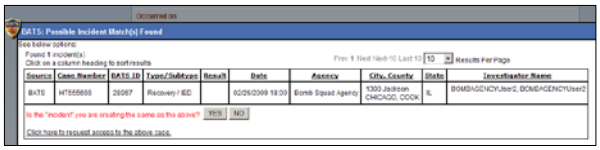
Decision trees guide users to report accurately.

Slide 16-27

B. Decision trees guide users to report accurately.

DECONFLICTION CHECKS

Deconfliction checks ensure accurate national reporting **and** accurate agency statistics.

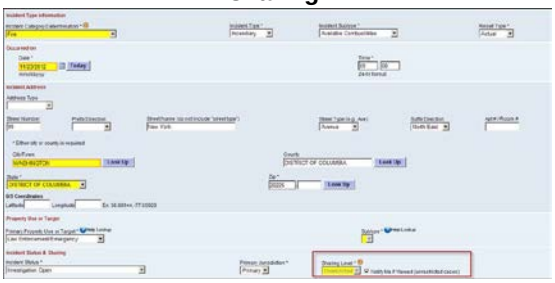


Slide 16-28

C. Deconfliction checks ensure accurate national reporting **and** accurate agency statistics.

SHARING LEVELS

Each agency determines its own level of sharing.

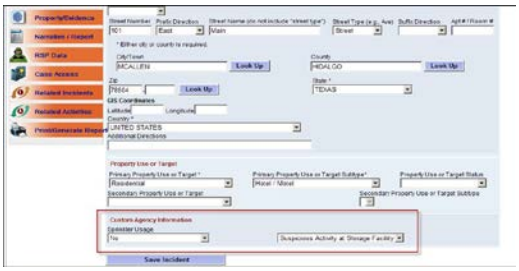


Slide 16-29

D. Sharing levels: Each agency determines its own level of sharing.

CUSTOM FIELDS

Agencies can collect information not already in BATS.

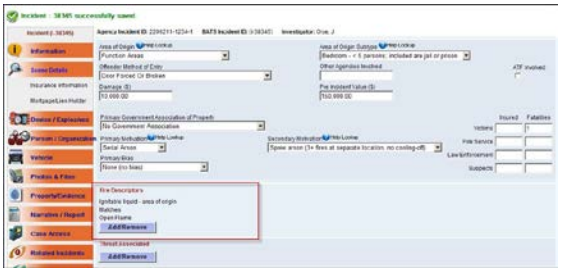


Slide 16-30

E. Custom fields: Agencies can collect information **not** already in BATS.

SIMPLICITY IS THE KEY (cont'd)

Build your case file and document investigation information.



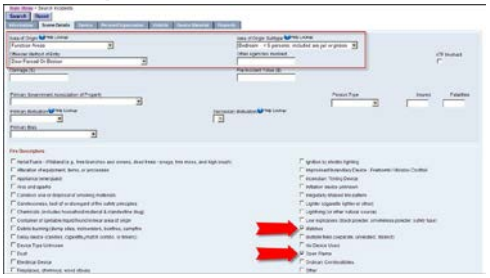
Slide 16-31

F. Build your case file and document investigation information.

IX. SEARCH TOOLS

POWERFUL SEARCH TOOLS

Search for cases nationwide to identify suspects and case similarities.

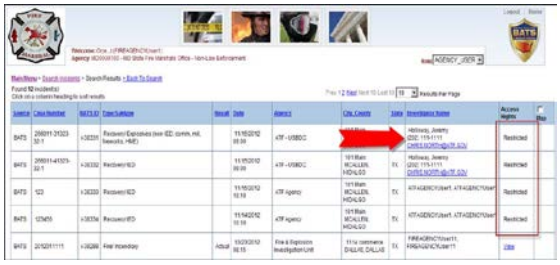


Slide 16-32

A. Search for cases nationwide to identify suspects and case similarities.

SEARCH RESULTS

Restricted cases display investigator's contact information after a search.



Slide 16-33

B. Restricted cases display investigator's contact information after a search.

X. SYSTEM FEATURES

PROPERTY TOOL

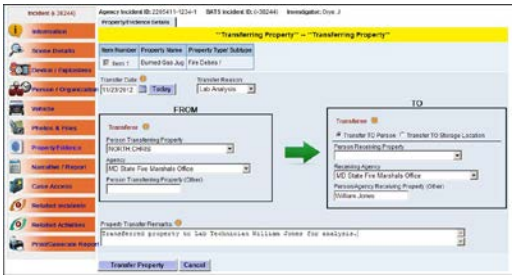
Track property and evidence throughout the life cycle of the case.

Slide 16-34

A. Track property and evidence throughout the life cycle of the case.

PROPERTY TOOL (cont'd)

Property/Evidence transfers are easy and intuitive.



Slide 16-35

B. Property/Evidence transfers are easy and intuitive.

PHOTOS/FILE ATTACHMENTS

- Photos.
- Videos.
- Audio.
- Confessions.
- Statements.
- Affidavits.
- Warrants.
- Mugshots.

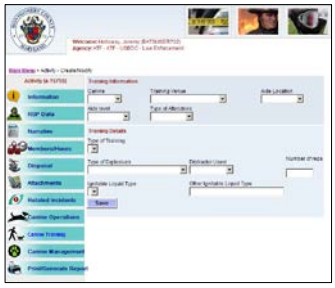
Slide 16-36

C. Photos/File attachments.

1. Photos.
2. Videos.
3. Audio.
4. Confessions.
5. Statements.
6. Affidavits.
7. Warrants.
8. Mugshots.

CANINE SECTION

Canine section to document operations and training.

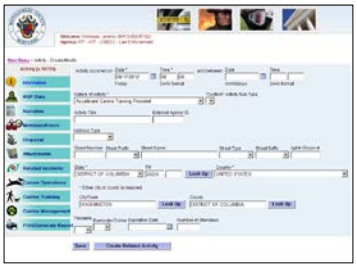


Slide 16-37

D. Canine section to document operations and training.

ACTIVITY FEATURE

Activities track everything in support of your mission.



Slide 16-38

E. Activities track everything in support of your mission.

BATS MANAGEMENT AND ADMINISTRATION FEATURES

Slide 16-39

BOMB ARSON TRACKING SYSTEM USER ACCOUNT TYPES

Agency user — all users.

- Basic user who inputs information.
- No need for reporting or administrative access.
- Account manager — supervisor/senior member/“techie.”

Slide 16-40

F. Agency user — all users.

1. Basic user who inputs information.

2. No need for reporting or administrative access.

3. Account manager — supervisor/senior member/“techie.”

BOMB ARSON TRACKING SYSTEM USER ACCOUNT TYPES (cont’d)

- Approves additional users and reassigns cases.
- Generates management reports and spreadsheets.
- Coordinates and develops BATS policy for agency.

Slide 16-41

a. Approves additional users and reassigns cases.

b. Generates management reports and spreadsheets.

c. Coordinates and develops BATS policy for agency.

XI. INCIDENT REPORTS

INCIDENT REPORTS

- Agencies design their own letterhead.
- Incident reports can be configured to include only the information you want.

Slide 16-42

A. Agencies design their own letterhead.

B. Incident reports can be configured to include only the information you want.

INCIDENT REPORTS (cont'd)

- Your seals and logos make it look professional.
- You can print a hard copy for the case file.

Slide 16-43

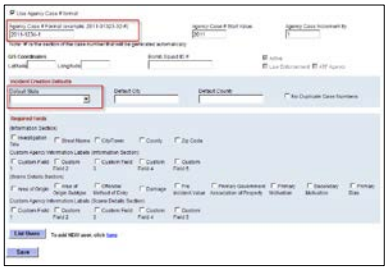
C. Your seals and logos make it look professional.

D. You can print a hard copy for the case file.

AGENCY CUSTOMIZATION

Account managers can control:

- Default case number.
- Default locality.
- Required fields.



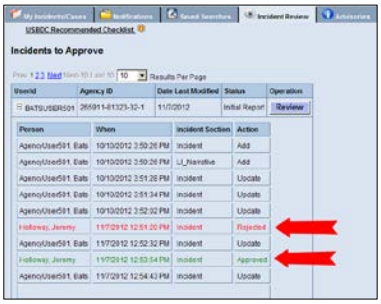
Slide 16-44

E. Account managers can control:

1. Default case number.
2. Default locality.
3. Required fields.

INCIDENT REVIEW

- Electronic workflows.
- Track approvals and rejections.
- See incident updates at a glance.



Slide 16-45

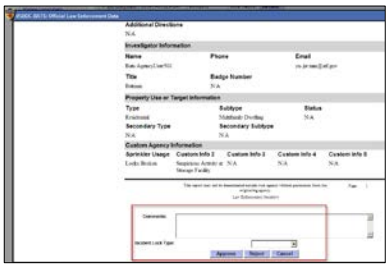
F. Electronic workflows.

G. Track approvals and rejections.

H. See incident updates at a glance.

INCIDENT APPROVAL AND REJECTION

- Supervisors can approve or reject reports.
- Can add comments when rejecting.



Slide 16-46

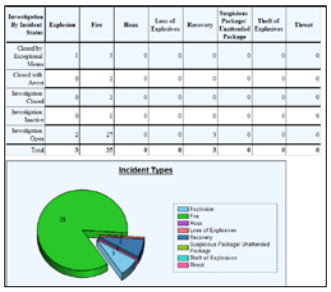
I. Incident approval and rejection.

1. Supervisors can approve or reject reports.

2. Can add comments when rejecting.

INCIDENT MANAGEMENT REPORT

- Detailed profile of incidents at the click of a button.
- Can be used for:
  - Budget requests.
  - Grants.
  - Statistics.



Investigation By Incident State	Explosion	Fire	Hoax	Loss of Explosives	Recovery	Suspicious Package/ Unattended Package	Theft of Explosives	Threat
Closed by Exceptional Means	1	3	0	0	0	0	0	0
Closed with Arrest	0	1	0	0	0	0	0	0
Investigation Closed	0	2	0	0	0	0	0	0
Investigation Inactive	0	1	0	0	0	0	0	0
Investigation Open	2	27	0	0	3	0	0	0
Total	3	35	0	0	3	0	0	0

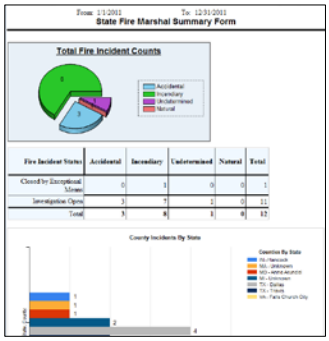
Slide 16-47

J. Detailed profile of incidents at the click of a button. Can be used for:

1. Budget requests.
2. Grants.
3. Statistics.

FIRE MARSHAL SUMMARY REPORT

- Report designed by state fire marshals who requested specific information.



From: 1/1/2001 To: 12/31/2001

State Fire Marshal Summary Form

Fire Incident Status	Accidental	Incendiary	Undetermined	Natural	Total
Closed by Exceptional Means	0	1	0	0	1
Investigation Open	3	7	1	0	11
Total	3	8	1	0	12

Slide 16-48

K. Report designed by state fire marshals who requested specific information.

FIRE MARSHAL SUMMARY REPORT (cont'd)

- Statewide view of:
  - Incidents per county.
  - Damage/Loss by county.
  - Incidents by property type.
  - Incidents by area of origin.
  - Incidents by motivation.

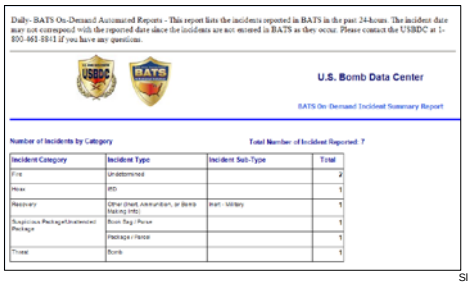
Slide 16-49

L. Statewide view of:

1. Incidents per county.
2. Damage/Loss by county.
3. Incidents by property type.
4. Incidents by area of origin.
5. Incidents by motivation.

ON-DEMAND REPORTS

- Reports are automatically sent to you via email.


Daily- BATS On-Demand Automated Reports - This report lists the incidents reported in BATS in the past 24-hours. The incident date may not correspond with the reported date since the incidents are not entered in BATS as they occur. Please contact the USBDC at 1-800-461-8841 if you have any questions.

U.S. Bomb Data Center

BATS On-Demand Incident Summary Report

Number of Incidents by Category

Total Number of Incident Reported: 7

Incident Category	Incident Type	Incident Sub-Type	Total
Fire	Undetermined		2
Hoax	IED		1
Recovery	Other (Inert, Ammunition, or Bomb Making Info)	Inert - Military	1
Suspicious Package/Unattended Package	Bomb Tag / Purse		1
	Package / Holder		1
Threat	Bomb		1

Slide 16-50

M. On-demand reports: automatically sent to you via email.

ON-DEMAND REPORTS (cont'd)

- Great for weekly/monthly statistics reports for supervisors.
- Monitor investigations, activities and workload.

Slide 16-51

N. Great for weekly/monthly statistics reports for supervisors.

O. Monitor investigations, activities and workload.

XII. DATA IMPORT/EXPORT

DATA IMPORT INTO BATS

- Agencies can import incident data from their current system into BATS.

Slide 16-52

A. Agencies can import incident data from their current system into BATS.

DATA IMPORT INTO BATS (cont'd)

- Agencies must convert their data to the BATS schema and ATF will review it to ensure a successful transfer of data.
- All data must be converted to Extensible Markup Language (XML) by the agency.

Slide 16-53

B. Agencies must convert their data to the BATS schema and ATF will review it to ensure a successful transfer of data.

C. All data must be converted to Extensible Markup Language (XML) by the agency.

DATA EXPORT FROM BATS

- Agencies can export their incident and activity data from BATS.

Slide 16-54

D. Agencies can export their incident and activity data from BATS.

DATA EXPORT FROM BATS (cont'd)

- This process is a manual process and is not automated.
- Data can be exported in XML or Comma Separated Values (CSV) format.

Slide 16-55

E. This process is a manual process and is not automated.

F. Data can be exported in XML or Comma Separated Values (CSV) format.

XIII. SCENARIOS

BOMB ARSON TRACKING SYSTEM HANDS-ON SCENARIOS

Slide 16-56

FIRE INVESTIGATION SCENARIO 1

Juvenile firesetter.

- Incident occurred on **(today's date)** at **(any time)** at **(each student's agency address)** a single-family home.
  - Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.
  - Click on all blue question marks (property use or target and area of origin, etc.) to demonstrate the search feature.

Slide 16-57

A. Juvenile firesetter.

1. Incident occurred on (today's date) at (any time) at (each student's agency address) a single-family home.

2. Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.

3. Click on all blue question marks (property use or target and area of origin, etc.) to demonstrate the search feature.

FIRE INVESTIGATION SCENARIO 1 (cont'd)

- Scene exam indicates area of origin is in the **living room**.
  - **Fire descriptors** (matches, open flame, ignitable liquid).
  - **Motive** (thrills/excitement).
  - **Investigator right of entry** (consent and exigent circumstances).

Slide 16-58

4. Scene exam indicates area of origin is in the **living room.**

   a. **Fire descriptors** (matches, open flame, ignitable liquid).

   b. **Motive** (thrills/excitement).

   c. **Investigator right of entry** (consent and exigent circumstances).

FIRE INVESTIGATION SCENARIO 1 (cont'd)

- Enter three people. (Use fictitious information.)
  - Reporting party/Witness.
  - Owner/Parent/Interviewed party.
  - Juvenile/Occupant/Interviewed party.
- Upload photos/files, "area of origin," "confession," and any other from BATS training folder.

Slide 16-59

5. Enter three people. (Use fictitious information.)

   a. Reporting party/Witness.

   b. Owner/Parent/Interviewed party.

   c. Juvenile/Occupant/Interviewed party.

6. Upload photos/files, "area of origin," "confession," and any other from BATS training folder.

FIRE INVESTIGATION SCENARIO 1 — ANSWER KEY

Final generated report should include:

- Incident information.
- Scene details. **(Use Lookup Wizard.)**
  - Area of origin.
  - Damage.
  - Fire descriptors.
  - Investigator right of entry.
  - Motive.

Slide 16-60

B. Final generated report should include:

   1. Incident information.

   2. Scene details. (Use Lookup Wizard.)

      a. Area of origin.

b. Damage.

c. Fire descriptors.

d. Investigator right of entry.

e. Motive.

FIRE INVESTIGATION SCENARIO 1 — ANSWER KEY (cont'd)

- Two narratives (origin and cause and one interview).
- Three file attachments.
- Three people (all relevant relationships on each selected).
- Case access (group): Bomb/Arson Task Force.

Slide 16-61

3. Two narratives (origin and cause and one interview).

4. Three file attachments.

5. Three people (all relevant relationships on each selected).

6. Case access (group): Bomb/Arson Task Force.

INCIDENT VERSUS ACTIVITY

- Incidents
  - Arsons.
  - Molotov cocktail.
  - Car fires.
  - Threats (bomb/arson).
  - Commercial fires.
  - Residential fires.
- Activities
  - Training/In-service.
  - Fire inspections.
  - Courtroom testimony.
  - Meetings.
  - Search warrant assist.
  - Certifications.
  - Briefings.
  - Protective details.
  - Code enforcement.

Slide 16-62

TRAINING — ACTIVITY

- Activity **(instructor's choice)** occurred on **(today's date)** at **(any time)** at **(each student's agency address).**
- Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.
- Members involved tab.
  - Two hours regular.
  - Two hours overtime.

Slide 16-63

C. Activity **(instructor's choice)** occurred on **(today's date)** at **(any time)** at **(each student's agency address).**

D. Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.

E. Members involved tab.

1. Two hours regular.

2. Two hours overtime.

TRAINING — ACTIVITY ANSWER KEY

- Final generated report should include:
  - Activity information.
  - Members involved: four total hours.
- Activity learning points.
  - Use the activity section like your ongoing résumé.

Slide 16-64

F. Final generated report should include:

1. Activity information.

2. Members involved: four total hours.

G. Activity learning points.

1. Use the activity section like your ongoing résumé.

TRAINING — ACTIVITY ANSWER KEY (cont'd)

- Use the file attachment section for:
  - -- Certificates — never lose another certificate again!
  - -- Course materials or classmate contact list if your activity was a training course.
- If kept up to date and accurate, you will know how many scene examinations, court testimonies and trainings you had at the end of your career.

Slide 16-65

2. Use the file attachment section for:

   a. Certificates — never lose another certificate again!

   b. Course materials or classmate contact list if your activity was a training course.

3. If kept up to date and accurate, you will know how many scene examinations, court testimonies, and trainings you had at the end of your career.

FIRE INVESTIGATION SCENARIO 2

Car fire.

- Incident occurred on **(today's date)** at **(any time)** at **(each student's agency address).**
  - Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.
  - Click on all blue question marks (property use or target and area of origin, etc.) to demonstrate the search feature.

Slide 16-66

H. Car fire.

1. Incident occurred on **(today's date)** at **(any time)** at **(each student's agency address).**

   a. Use the ZIP code lookup ("Skip to the ZIP") to demonstrate the lookup feature.

   b. Click on all blue question marks (property use or target and area of origin, etc.) to demonstrate the search feature.

FIRE INVESTIGATION SCENARIO 2 (cont'd)

- Scene exam indicates area of origin is in the **passenger compartment.**
  - **Door forced open.**
  - **Fire descriptors** (ignitable liquid + student's choice — **choose 2**).
  - **Motive** (insurance fraud). Use Lookup Wizard.

Slide 16-67

2. Scene exam indicates that area of origin is in the **passenger compartment.**

   a. **Door forced open.**

   b. **Fire descriptors** (ignitable liquid plus student's choice — choose two).

   c. **Motive** (insurance fraud). Use Lookup Wizard.

FIRE INVESTIGATION SCENARIO 2 (cont'd)

- Enter two people. (Use fictitious information.)
  - Reporting party/Witness.
  - Owner/Interviewed party.
- Enter one property item (property/evidence tab), and transfer it to lab for prints.

Slide 16-68

3. Enter two people. (Use fictitious information.)

   a. Reporting party/Witness.

   b. Owner/Interviewed party.

4. Enter one property item (property/ evidence tab), and transfer it to lab for prints.

FIRE INVESTIGATION SCENARIO 2 — ANSWER KEY

Final generated report should include:

- Incident information and scene details.
- Two narratives (origin and cause and one interview).
- Two people.
  - Owner/Arrested — arson charges.
  - Witness/Interviewed party.
- Two photos (“car fire” + instructor’s choice).

Slide 16-69

I. Final generated report should include:

1. Incident information and scene details.

2. Two narratives (origin and cause and one interview).

3. Two people.

   a. Owner/Arrested — arson charges.

   b. Witness/Interviewed party.

4. Two photos (“car fire” plus instructor’s choice).

FIRE INVESTIGATION SCENARIO 2 — ANSWER KEY (cont'd)

- Vehicle information: **Select appropriate relationship ("origin of fire").**
- Property information and transfer to lab.
- Case access (group): Bomb/Arson Task Force.

Slide 16-70

5. Vehicle information: **Select appropriate relationship ("origin of fire").**

6. Property information and transfer to lab.

7. Case access (group): Bomb/Arson Task Force.

XIV. FREQUENTLY ASKED QUESTIONS

BOMB ARSON TRACKING SYSTEM CLOSING AND FREQUENTLY ASKED QUESTIONS

Slide 16-71

FREQUENTLY ASKED QUESTIONS

- How do we add users to our BATS account?
  - All users must apply online at www.BATS.gov.
- How many account managers can we have?
  - Agencies may have as many account managers as they wish.

Slide 16-72

A. How do we add users to our BATS account? All users must apply online at www.BATS.gov.

B. How many account managers can we have? Agencies may have as many account managers as they wish.

FREQUENTLY ASKED QUESTIONS (cont'd)

- What happens if I forget my password?
  - Call the Help Desk at 877-875-3723. **(USBDC cannot reset passwords.)**
- How long does it take to process my application?
  - Up to 14 business days after faxing in your complete application.

Slide 16-73

C. What happens if I forget my password? Call the Help Desk at 877-875-3723. **(USBDC cannot reset passwords.)**

D. How long does it take to process my application? Up to 14 business days after faxing in your complete application.

FREQUENTLY ASKED QUESTIONS (cont'd)

- Why am I not getting BATS alert/broadcast emails?
  - You need to update your email address under user information.

Slide 16-74

E. Why am I not getting BATS alert/broadcast emails? You need to update your email address under user information.

BOMB ARSON TRACKING SYSTEM CASE TYPES

- **Restricted**
  - If "hit" is received, only contact info is displayed for the investigator.
  - Must receive permission from the case owner to view.
  - Access is decided by case owner.
  - Local ATF offices cannot view restricted cases.
- **Unrestricted**
  - Law enforcement cases (ORI).
    - -- Can be viewed by any other law enforcement agency.
    - -- **Cannot** be viewed by non-law enforcement agencies.
    - -- Viewing is "read-only" (no changes by viewer).
  - **Non-law enforcement** cases (no ORI).
    - -- Can be viewed by any agency in "read-only" format.

Slide 16-75

FIRE DEPARTMENTS WITH NO ORI

- Option 1: joint account with local police department.
  - Fire department investigators are sponsored by the local police department.
  - Joint letter is submitted to USBDC by fire department and police department.
  - Each user (police/fire) receives a user identification and password from USBDC.
  - Red/Blue team approach.

Slide 16-76

F. Option 1: joint account with local police department.

1. Fire department investigators are sponsored by the local police department.

2. Joint letter is submitted to USBDC by fire department and police department.

3. Each user (police/fire) receives a user identification and password from USBDC.

4. Red/Blue team approach.

FIRE DEPARTMENTS WITH NO ORI (cont'd)

- Option 2: to apply for a National Crime Information Center (NCIC) ORI number.
  - Requests are made to the state Criminal Justice Information System (CJIS) systems officer.
  - Supporting documentation:
    - Department's statutory authority.
    - Budget of the subunit (fire investigation unit (FIU)).
    - Duties and functions of the subunit.
    - Any training and certifications relative to the mission of the subunit.

Slide 16-77

G. Option 2: to apply for a National Crime Information Center (NCIC) ORI number.

1. Requests are made to the state Criminal Justice Information System (CJIS) systems officer.

2. Supporting documentation:

   a. Department's statutory authority.

   b. Budget of the subunit (fire investigation unit (FIU)).

   c. Duties and functions of the subunit.

   d. Any training and certifications relative to the mission of the subunit.

FIRE DEPARTMENTS WITH NO ORI (cont'd)

- Option 3: limited access role.
  - Full case management.
  - Full reporting.
  - Mapping.
  - Statistics.
  - Property tool.
  - Incident review.
  - Electronic case file.

Slide 16-78

H. Option 3: limited access role.

1. Full case management.
2. Full reporting.
3. Mapping.
4. Statistics.
5. Property tool.
6. Incident review.
7. Electronic case file.

PASSWORD CHANGES AND ASSISTANCE

DOJ mandates a password change every 90 days.

- This is the maximum period allowed.
- The 24-hour Help Desk number is 877-875-3723.

Slide 16-79

I. DOJ mandates a password change every 90 days.

1. This is the maximum period allowed.

2. The 24-hour Help Desk number is 877-875-3723.

XV. INFORMATION SECURITY

INFORMATION SECURITY

- BATS operates in a secure Web-based environment.
  - We secure the **connection** to protect **your** information.
  - All transmitted information is encrypted.
  - ATF/USBDC employs a full-time team of information security personnel.

Slide 16-80

A. BATS operates in a secure, Web-based environment.

1. We secure the **connection** to protect **your** information.

2. All transmitted information is encrypted.

3. ATF/USBDC employs a full-time team of information security personnel.

INFORMATION SECURITY (cont'd)

- BATS is routinely scanned and tested for security issues.
- Every version of BATS improves security to stay ahead of threats.
- BATS uses the U.S. government standard for data encryption — National Institute of Standards and Technology (NIST).

Slide 16-81

4. BATS is routinely scanned and tested for security issues.

5. Every version of BATS improves security to stay ahead of threats.

B. BATS uses the U.S. government standard for data encryption — National Institute of Standards and Technology (NIST).

XVI. PASSWORDS

INFORMATION DISCLOSURE

Legal considerations.

- You can only disclose information **your** agency contributed.
- **Privacy act.**
  - BATS is exempt because it is a "system of records maintained by an agency … pertaining to the enforcement of criminal laws …" (5 U.S.C. § 552(a)(j)(2)).

Slide 16-82

A. Legal considerations.

1. You can only disclose information that **your** agency contributed.

2. **Privacy Act.** BATS is exempt because it is "a system of records maintained by an agency … pertaining to the enforcement of criminal laws …" (5 U.S.C. § 552(a)(j)(2)).

INFORMATION DISCLOSURE (cont'd)

- **Freedom of Information Act (FOIA).**
  - BATS is exempt if "… production of such law enforcement records or information … could be reasonably expected to interfere with enforcement proceedings …" (5 U.S.C. § 552(b)(7)).

Slide 16-83

3. **Freedom of Information Act (FOIA).** BATS is exempt if "… production of such law enforcement records or information … could be reasonably expected to interfere with enforcement proceedings ..." (5 U.S.C. § 552(b)(7)).

INFORMATION DISCLOSURE (cont'd)

- **State public records requests and court orders.**
  - Remember: Original documents are maintained by each contributing agency.
  - ATF does not maintain your original documents and does not process non-ATF BATS records requests.

Slide 16-84

4. **State public records requests and court orders.**

   a. Remember: Original documents are maintained by each contributing agency.

   b. ATF does not maintain your original documents and does not process non-ATF BATS records requests.

REMEMBER BATS IS MOBILE

- Anywhere you have an Internet connection.
- BATS is wherever you are!
- Anytime, anywhere, on any device.

Slide 16-85

B. Anywhere you have an Internet connection.

C. BATS is wherever you are!

D. Anytime, anywhere, on any device.

XVII. AGENCY TRAINING

HOST BATS TRAINING AT YOUR AGENCY (cont'd)

- You **do not** need a BATS account for BATS training.
- Contact USBDC at USBDC@atf.gov or 800-461-8841.
- USBDC will locate a trainer in your area.

Slide 16-86

A. You **do not** need a BATS account for BATS training.

B. Contact USBDC at USBDC@atf.gov or 800-461-8841.

C. USBDC will locate a trainer in your area.

HOST BATS TRAINING AT YOUR AGENCY (cont'd)

- Training classroom requirements:
  - Computer for each student.
  - High-speed Internet connection for each student's computer.
  - Suggested sites: fire/police academy or local community college.

Slide 16-87

D. Training classroom requirements.

1. Computer for each student.
2. High-speed Internet connection for each student's computer.
3. Suggested sites: fire/police academy or local community college.

HOST BATS TRAINING AT YOUR AGENCY (cont'd)

- BATS Trainer will provide the training identifications and passwords on the day of training.
- Training will be interactive and scenario based.

Slide 16-88

E. BATS trainer will provide the training identifications and passwords on the day of training.

F. Training will be interactive and scenario based.

XVIII. SUMMARY

SUMMARY

- BATS mission.
- BATS user conferences.
- Incident types.
- Advantages.
- NFIRS.
- Assessment and alerts.
- Advisories and reports.
- Graphical User Interface (GUI).

Slide 16-89

SUMMARY (cont'd)

- Search tools.
- System features.
- Incident reports.
- Data import/export.
- Scenarios.
- FAQs.
- Information security.
- Passwords.
- Agency training.

Slide 16-90

UNIT 17: INVESTIGATIVE RESOURCES

TERMINAL OBJECTIVE

The students will be able to:

17.1 Obtain information to assist in fire scene examinations and follow-up investigations.

ENABLING OBJECTIVES

The students will be able to:

17.1 Identify types of resources available.

17.2 Access this information.

17.3 Apply this information to an investigation.

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UNIT 17:
INVESTIGATIVE RESOURCES

Slide 17-1

ENABLING OBJECTIVES

- Identify types of resources available.
- Access this information.
- Apply this information to an investigation.

Slide 17-2

I. FEDERAL RESOURCES

FEDERAL RESOURCES

Slide 17-3

BUREAU OF ALCOHOL, TOBACCO, FIREARMS AND EXPLOSIVES

- National Response Team (NRT).
- Certified Fire Investigator (CFI).
- Forensic laboratory.
- Accelerant Detection K-9 Teams.

Slide 17-4

A. Access to these resources is via contact with the local Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) office. Specific contact numbers can be obtained at http://www.atf.gov/contact.

1. The National Response Team (NRT) provides an immediate and sustained nationwide response capability with state-of-the-art equipment and veteran special agents, including Certified Explosive Specialists (CESs), Certified Fire Investigators (CFIs), forensic mappers, accelerant and explosives detection canines, explosives enforcement officers, fire protection engineers, electrical engineers, and forensic chemists.

2. ATF CFIs are highly trained special agents who provide technical support, analysis, and assistance to ATF and its state and local partners in fire origin-and-cause determination and arson investigation.

3. ATF maintains three forensic laboratories located throughout the United States that provide ATF and state and local law enforcement agencies with forensic support for arson and explosive cases.

4. The ATF accelerant detection and explosive detection canine program provides specially trained dogs to state and local agencies to support processing fire scenes for the presence of ignitable liquids and to detect explosives at bomb scenes.

BUREAU OF ALCOHOL, TOBACCO, FIREARMS AND EXPLOSIVES (cont'd)

- Arson profilers/Geographic profilers.
- Forensic auditors.
- Certified Explosive Specialists (CESs).
- Explosive Detection K-9 Teams.

Slide 17-5

5. Arson/Geographic profilers assist ATF in bombing, arson and other violent crime investigations by analyzing and interpreting crime scene behavior and victim/witness/suspect statements, as well as assessing the personalities and risk levels of known offenders. A geographic profiler uses an investigative methodology that analyzes the locations of connected crimes in an attempt to pinpoint the most probable area where an offender would live.

6. Forensic auditors plan and conduct forensic financial investigations of people or entities suspected of being involved in highly complex criminal schemes, such as arson-for-profit schemes.

7. CESs maintain a working knowledge of commercial, military, homemade explosives, and improvised explosive devices (IEDs), and respond to all explosions, conduct explosives recoveries and large-scale seizures, conduct disposal operations, provide technical assistance to other public safety entities, and deliver courtroom testimony within their area of expertise.

U.S. SECRET SERVICE'S ELECTRONIC CRIMES TASK FORCES

- Nationwide network of 25 Electronic Crimes Task Forces (ECTFs).
- Comprised of federal, state and local law enforcement, prosecutors, private industry and academia.
- Prioritize cases that involve electronic crimes.
- Provide support and resources to state and local law enforcement.

Slide 17-6

B. The Secret Service's Electronic Crimes Task Force (ECTF) and Electronic Crimes Working Group initiatives prioritize investigative cases that involve electronic crimes that involve significant economic or community impact, participation of organized criminal groups involving multiple districts or transnational organizations and use of schemes involving new technology.

1. They also operate a mobile cellphone forensics program at the University of Tulsa, Oklahoma, that provides state and local investigators with forensic examination of mobile devices, including cellphones, credit card skimmers, and GPS units.

2. Contact information for the ECTFs can be located at http://www.secretservice.gov/ectf.shtml.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Building and Fire Research Laboratory (BFRL).

- Fire on the Web (http://www.fire.nist.gov/).
- BFRL Publications online.
- NIST.GOV/FIRE.

Slide 17-7

C. The Building and Fire Research Laboratory (BFRL) develops, verifies, and uses measurements and predictive methods to quantify the behavior of fire and the means to reduce the impact of fire on people, property and the environment.

1. Fire on the Web is a collection of resources from the BFRL's Fire Research Division at the National Institute of Standards and Technology (NIST). These Web pages provide links to fire-related software, experimental fire data, and mpeg/quick-time movies of fire tests that can be downloaded and/or viewed with a Web browser.

2. BFRL Publications online contains about 3,500 document abstracts and complete publications produced by or for BFRL staff since 1973.

3. NIST.GOV/FIRE is a website that provides training materials, videos, fire reconstructions, and research reports that may be of interest to fire investigators.

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

- Independent federal agency.
- Charged with investigating industrial chemical accidents.
- Headquartered in Washington, D.C.

Slide 17-8

D. The U.S. Chemical Safety and Hazard Investigation Board (CSB) conducts root cause investigations of chemical accidents at fixed industrial facilities.

1. The CSB investigative staff includes chemical and mechanical engineers, industrial safety experts, and other specialists with experience in the private and public sectors. Many investigators have years of chemical industry experience.

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD (cont'd)

- Primarily responds to major industrial fires and explosions.
- Identifies root causes.
- Issues reports to prevent future incidents.

Slide 17-9

2. The agency does not issue fines or citations but does make recommendations to plants, regulatory agencies such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA), industry organizations, and labor groups.

E. http://www.recalls.gov/.

1. A website that provides access to recalls from the U.S. Consumer Product Safety Commission (CPSC), National Highway Traffic Safety Administration (NHTSA), U.S. Coast Guard (USCG), U.S. Department of Agriculture (USDA), Food and Drug Administration (FDA), and the EPA.

2. There is also a mobile phone application that can be downloaded to provide access to the site in the field.

II. PRIVATE SECTOR RESOURCES

INTERNATIONAL ASSOCIATION OF ARSON INVESTIGATORS CERTIFIED FIRE INVESTIGATOR TRAINER

- International Association of Arson Investigators (IAAI) online distance learning platform designed for investigators to register for training programs, track progress, take evaluation tests, and document their participation at no cost.
- Programs can be used to support requirements for IAAI CFI certification.
- http://www.cfitrainer.net/.

Slide 17-12

A. CFI Trainer.Net is managed by the International Association of Arson Investigators (IAAI) (http://www.cfitrainer.net/).

1. CFI Trainer hosts many fire investigation-related training and education programs for public and private sector investigators that can be completed 24 hours a day/seven days a week, free of charge.

2. Tested modules can be claimed for credit toward the IAAI CFI credential.

NATIONAL FIRE PROTECTION ASSOCIATION

- Publishes more than 300 codes and standards.
- Provides training, consultation services, and access to resources.
- http://www.nfpa.org/.

Slide 17-13

B. The mission of the international nonprofit National Fire Protection Association (NFPA), established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education (http://www.nfpa.org/).

1. NFPA develops, publishes and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

2. NFPA technical committees are responsible for the development of NFPA 921, *Guide for Fire and Explosion Investigations* and NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*.

C. Underwriters Laboratories (UL) is a safety consulting and certification company headquartered in Northbrook, Illinois (http://industries.ul.com/building-materials).

1. It maintains offices in 46 countries.

2. UL was established in 1894 and has participated in the safety analysis of many of the last century's new technologies, most notably the public adoption of electricity and the drafting of safety standards for electrical devices and components.

3. UL provides safety-related certification, validation, testing, inspection, auditing, advising and training services to a wide range of clients, including manufacturers, retailers, policymakers, regulators, service companies and consumers.

4. UL is one of several companies approved to perform safety testing by OSHA. OSHA maintains a list of approved testing laboratories, which are known as Nationally Recognized Testing Laboratories (NRTLs).

III. INSURANCE INDUSTRY RESOURCES

INSURANCE INDUSTRY RESOURCES

ISO ClaimSearch — The information system for claims professionals

NICB — NATIONAL INSURANCE CRIME BUREAU

IAAC — Insurance Committee for Arson Control

Special Investigation Units (SIUs)/Fire Investigation Units (FIUs)

Slide 17-15

NATIONAL INSURANCE CRIME BUREAU

- Not-for-profit organization.
- Receives support from nearly 1,100 property and casualty insurance companies and self-insured organizations.
- Partners with insurers, law enforcement agencies, and others to combat insurance fraud.
- https://www.nicb.org/home.

Slide 17-16

A. The National Insurance Crime Bureau (NICB) was formed in 1992 from a merger between the National Automobile Theft Bureau (NATB) and the Insurance Crime Prevention Institute (ICPI).

1. It is headquartered in Des Plaines, Illinois, with regional offices located in Glendora, California; Fife, Washington; Irving, Texas; and Tampa, Florida.

2. NICB special agents work with law enforcement agencies, technology experts, government officials, prosecutors, international crime-fighting organizations, and the public to lead a united effort to prevent and combat insurance fraud and crime, including vehicle theft and arson through data analytics, investigations, training, and public awareness.

3. VINCheck is a service provided to the public to assist in determining if a vehicle has been reported as stolen, but not recovered, or has been reported as a salvage vehicle by cooperating NICB members.

ISO CLAIMSEARCH

- Comprehensive all-claims database and system for claims processing and fraud detection.
- Serves the insurance industry, law enforcement, fraud bureaus, and many state workers' compensation insurance funds.
- https://claimsearch.iso.com/.

Slide 17-17

B. ISO ClaimSearch features a secure Internet platform to research prior loss histories, identify claims patterns, and detect fraud (https://claimsearch.iso.com/).

1. ISO ClaimSearch serves thousands of insurers, representing more than 93 percent of the property/casualty industry by premium volume. The system also serves state workers' compensation insurance funds, self-insureds, third-party administrators (TPAs), fraud bureaus, and law enforcement entities.

2. To request user authorization for system access, law enforcement agencies need to contact the NICB by calling 1-800-447-6282 or by email at techsupport@nicb.org.

INSURANCE COMMITTEE FOR ARSON CONTROL

- Promotes attention to many important fire investigation and arson prosecution issues.
- Works to increase public awareness of arson.
- Provides training and education.

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INSURANCE COMMITTEE FOR ARSON CONTROL (cont'd)

- Disseminates electronic newsletters with updates on significant issues and cases in fire/arson investigation.
- http://arsoncontrol.org/.

Slide 17-19

C. The Insurance Committee for Arson Control (ICAC) (http://arsoncontrol.org/).

1. Founded in 1978, ICAC is the only organization in the fire and investigation industry composed entirely of insurance companies.

2. ICAC sponsors an annual training seminar designed to provide investigators with the most current information in the arson investigation field as it relates to insurance fraud.

SPECIAL INVESTIGATION UNITS/ FIRE INVESTIGATION UNITS

- SIUs.
  - Generally comprised of former law enforcement personnel.
  - Investigate insurance fraud.

Slide 17-20

D. Special Investigation Units (SIUs) and Fire Investigation Units (FIUs).

1. State and local investigators can obtain a wealth of information from these investigators through arson reporting immunity statutes.

2. Most insurance companies staff SIUs with former police or fire officials who have the responsibility to investigate all claims to identify potential fraud.

SPECIAL INVESTIGATION UNITS/ FIRE INVESTIGATION UNITS (cont'd)

- FIUs.
  - Conduct origin-and-cause investigations.
  - Identify cases of arson to support denial of fraudulent insurance claims.
  - Provide access to technical specialists such as electrical, mechanical and fire protection engineers.

Slide 17-21

3. Provide access to technical specialists.

   a. These individuals either conduct origin-and-cause investigations and/or follow-up investigations or retain the services of private investigators to conduct independent investigations.

   b. Some insurance companies also operate FIUs responsible for conducting origin-and-cause investigations to identify cases of arson to support denial of fraudulent insurance claims.

IV. OTHER RESOURCES

OTHER RESOURCES

Slide 17-22

INTERFIRE

- Resource for fire service, law enforcement, the insurance industry, and others whose duties involve fire/arson investigation.
- Includes access to online training, resources, and message boards to support public and private fire investigators.
- http://www.interfire.org/.

Slide 17-23

A. InterFire is a complete resource for fire services, fire insurers, law enforcement, and others whose duties involve arson investigation, fire investigation safety, and fire scene training. The online training center provides interactive tutorials on critical fire and arson investigation procedures (http://www.interfire.org/).

1. The fire investigation resource center provides access to hundreds of resources searchable by subject or date.

   a. The resource files cover fire investigation topics from before the fire through to follow-up and legal preparation.

   b. Access to fire investigation materials include arson investigation abstracts, articles and tutorials, U.S. Fire Administration (USFA) technical reports, and fire investigation links.

2. A hands-on training resource calendar of fire investigation training programs covering topics from arson awareness to fire insurance fraud and fire codes and standards is also available.

   a. The site is updated monthly with the latest addition of fire investigation resources.

   b. Investigators may also sign up to be alerted when new content is added to the site.

NATIONAL WHITE COLLAR CRIME CENTER

- Provides support for state and local law enforcement efforts in the prevention, investigation, and prosecution of economic and high-tech crime.
- Offers a wide range of research, training, and investigative support services for state and local law enforcement.
- http://www.nw3c.org/.

Slide 17-24

B. National White Collar Crime Center (NW3C) is located in Fairmont, West Virginia, and Glen Allen, Virginia. NW3C has more than 4,000 member agencies in the U.S. and its territories as well as 15 other countries throughout the world (http://www.nw3c.org/).

1. Criminal Information Pointer Database (CIPD) is a criminal intelligence database that "points" one law enforcement agency to another when they are working the same criminal target.

   a. For example, when two agencies provide CIPD submissions on the same suspect, investigators will be notified of the "hit" so their agencies can share relevant information.

   b. In addition to submissions, NW3C member agencies are able to perform CIPD searches to see if suspects may be in the database.

2. NW3C member agencies can submit public database search requests and receive results within 24 hours, free of charge.

3. NW3C intelligence technicians perform database searches on individuals and businesses as they relate to white collar crimes, cyber crimes, terrorism or exploitation of children.

4. These resources can be accessed at http://www.nw3c.org/Home.

SEARCH

- Addresses information management and information sharing challenges between the justice and public safety agencies.
- Provides training, investigative tools, and information resources free to agencies.
- http://www.search.org/.

Slide 17-25

C. SEARCH, The National Consortium for Justice Information and Statistics, is a nonprofit membership organization based in Sacramento, California (http://www.search.org/).

1. It was created by and for the states with the primary objective to identify and help solve.

2. Provides justice agencies with diverse products, services and resources through general focus areas of information sharing, high-tech crime and criminal history law and policy.

COMPUTER/INTERNET

- Internet search engines.
  - Google advanced search and alerts.
- Social media sites (Facebook, Twitter, MySpace).
- Forumworld Fire Investigation Bulletin Board.
  - http://www.forumworld.com/arson-investigations/index.php.

Slide 17-26

D. Google advanced search allows you to construct powerful keyword searches for specific text, images, numbers and files.

1. Google Alerts are emails sent to you when Google finds new results — such as Web pages, newspaper articles, or blogs — that match specific preselected search terms.

2. You can use Google Alerts to monitor anything on the Web. For example, people use Google Alerts to find out what is being said about a company or product, monitor a developing news story, or stay up to date on a specific issue relevant to investigations.

3. Forumworld Fire Investigation Bulletin Board is an online forum that provides individuals with a mechanism to ask questions and add to probative and informative discussions associated with the various aspects of the field of fire and arson investigation.

COMPUTER/INTERNET (cont'd)

- Federal Criminal Defense Investigation
  - http://federalcriminaldefenseinvestigator.blogspot.com/.

Slide 17-27

4. The Federal Criminal Defense Investigation blog provides a valuable resource for investigators looking for updates on relevant case law, links to investigative databases, certification programs, publications, crime statistics, and subpoena information for numerous records repositories such as AOL, MySpace and Facebook.

PUBLIC INFORMATION DATA REPOSITORIES

- LexisNexis Accurint LE (Law Enforcement) and KnowX.
  - http://www.accurint.com/lePlus.html.
  - http://www.knowx.com/.
- Thomson Reuters Consolidated Lead Evaluation and Reporting (CLEAR).
  - https://clear.thomsonreuters.com/.
- TLOxp Online Investigative System.
  - http://www.tlo.com/.

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E. Public information data repositories.

1. Lexis Nexis Accurint LE (Law Enforcement) helps investigators quickly identify people and their assets, addresses, relatives, and business associates by providing instant access to a comprehensive database of public records that help provide investigative leads by quickly confirming information such as name, address and Social Security number (http://www.accurint.com/lePlus.html).

2. KnowX is an online public records repository of businesses, people and assets that can be used to conduct background checks on a business, locate assets, investigate property value, and access marriage, divorce, and death records using public records from across the nation compiled from official data sources (http://www.knowx.com/).

3. CLEAR (Consolidated Lead Evaluation and Reporting) is an investigative platform that searches billions of public records to assist investigators to locate people, assets, businesses, affiliations, make connections among individuals, incidents, activities, and locations, and visualize, detect, and analyze patterns and trends in offenses and offenders (https://clear.thomsonreuters.com/).

4. TLOxp Online Investigative System provides a vehicle to conduct background research on people, assets and businesses, including names, aliases, Social Security numbers, bankruptcies, foreclosures, liens, judgments, and criminal histories. It can also identify current and historical addresses, phone numbers including listed and unlisted landlines, cellphones, utility data, and relatives, neighbors, associates, and assets including property, vehicles, driver's licenses, and email addresses and social networks associations (http://www.tlo.com/).

CRIME MAPPING TOOLS

Geographic Information Systems (GISs).

- CrimeStat (National Institute of Justice (NIJ)).
- Bomb Arson Tracking System (BATS).

Slide 17-29

F. Geographic Information Systems (GISs) can be used for creating and using crime maps to identify arson trends and patterns; compiling geographic data; analyzing mapped information; and managing geographic information in a database.

1. CrimeStat is a spatial statistics program for the analysis of crime incident locations that was funded by grants from the National Institute of Justice (NIJ). It is available free of charge.

   a. The program is Windows-based and interfaces with most desktop GIS programs.

   b. The purpose is to provide supplemental statistical tools to aid law enforcement agencies and criminal justice researchers in their crime mapping efforts.

2. Bomb Arson Tracking System (BATS) is a Web-based case management system developed by ATF.

   a. BATS provides state and local fire/arson investigators with access to up-to-date arson and explosives investigative data from across the nation at no charge.

   b. It allows images of arsons, IEDs, and crime scenes to be shared online with law enforcement partners anywhere in the U.S. Investigators can track trends and compare incidents for similarities in motives, leads and potential suspects.

WEATHER INFORMATION

- Weather Underground.
- Weather USA LightningNet.
- WeatherBug®.
- Intellicast.com.
- Thunderstorm.vaisala.com (STRIKEnet®).

Slide 17-30

G. Weather information.

1. Weather Underground is a website that provides local and long-range weather forecasts, weather reports, and lightning strike dates for locations worldwide. It can be accessed at http://www.wunderground.com/.

2. Weather USA LightningNet provides near real-time displays of lightning activity in locations around the U.S.

a. Maps are displayed using similar doppler radar that can plot thunderstorm locations and show locations where thunderstorms are beginning to develop.

b. It can be accessed at http://www.weatherusa.net/lightningnet.

3. WeatherBug® provides live weather data and maintains a network of more than 8,000 weather stations.

a. WeatherBug also operates a dense lightning sensor network that uses broadband technology to constantly track total lightning.

b. It can be accessed at http://cms.weatherbug.com/Affiliate/Download.aspx?zcode=z6164&gclid=CI3bz7PH5bMCFcqY4AodcUkAIA.

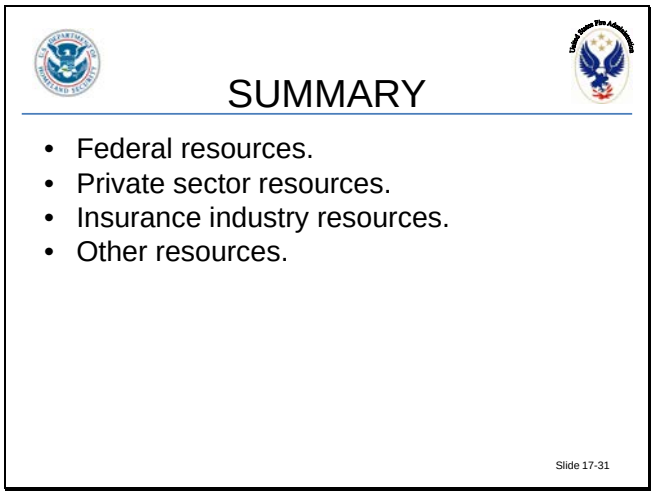
4. Intellicast.com provides local, national, and global weather conditions and forecasts, radar, satellite, interactive weather maps, severe weather alerts, and near real-time lightning strike data. It can be accessed at http://www.intellicast.com/Storm/Severe/Lightning.aspx.

5. Thunderstorm.vaisala.com (STRIKEnet®).

a. Provides detailed data related to thunderstorm and lightning strike occurrences based on either GPS or address information that investigators can use as evidence to support case presentations in court.

b. It can be accessed at http://thunderstorm.vaisala.com/.

V. SUMMARY



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ACRONYMS

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ACRONYMS

AC	alternating current
ACS	Activated Charcoal Strip
AFCI	Arc Fault Circuit Interrupter
AIT	auto ignition temperature
ALF	Animal Liberation Front
APR	air-purifying respirator
ASTM	American Society for Testing and Materials
ATF	Bureau of Alcohol, Tobacco, Firearms and Explosives
ATM	Automated Teller Machine
AWG	American Wire Gauge
BATS	Bomb Arson Tracking System
BFRL	Building and Fire Research Laboratory
Btu	British thermal unit
CES	Certified Explosive Specialist
CFI	Certified Fire Investigator
CIPD	Crime Information Pointer Database
CJIS	Criminal Justice Information System
CLEAR	Consolidated Lead Evaluation and Reporting
CMU	concrete masonry unit
COHb	carbooxyhemoglobin
CPSC	Consumer Product Safety Commission
CSB	Chemical Safety and Hazard Investigation Board

CSI	Crime Scene Investigation
CSST	Corrugated Stainless Steel Tubing
CSV	Comma Separated Values
CT	current transformer
CV	curriculum vitae
DC	direct current
DOJ	Department of Justice
DWI	driving while intoxicated
E	electric magnetic force
ECTF	Electronic Crimes Task Force
EF	electromotive force
ELF	Earth Liberation Front
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
EUO	examination under oath
FAOCI	“Fire/Arson Origin-and-Cause Investigations”
FAQs	frequently asked questions
FDA	Food and Drug Administration
FFFIPP	Fire Fighter Fatality Investigation and Prevention Program
FIU	Fire Investigation Unit
FOIA	Freedom of Information Act
FRT	fire-retardant treated
GC/MS	gas chromatograph/mass spectrometer

GFCI	ground-fault circuit-interrupter
GIS	Geographic Information System
gpm	gallons per minute
GPS	Global Positioning System
GUI	Graphical User Interface
HRC	high resistance connection
HRR	heat release rate
HVAC	heating, ventilating, and air conditioning
IAAI	International Association of Arson Investigators
IBC	International Building Code
IC	Incident Commander
ICAC	Insurance Committee for Arson Control
ICC	International Code Council
ICPI	Insurance Crime Prevention Institute
ICS	Incident Command System
IG	Instructor Guide
IITCT	"Interview-Interrogation Techniques and Courtroom Testimony"
IMS	Incident Management System
IQ	intelligence quotient
IRONIC	**I**ntroduction, **R**apport building, **O**pening statement, **N**arrative, **I**nquiry and **C**onclusion
JPR	job performance requirement
km	kilometer
kW	kilowatt

kW/m^2	kilowatt per square meter
LCD	liquid-crystal display
LE	law enforcement
LEL	lower explosive limit
LFL	lower flammable limit
LODD	line-of-duty death
MDP	main distribution panel
mm	millimeter
MOPC	model rules of professional conduct
MOV	metal oxide varistor
MPD	medium petroleum distillate
mph	miles per hour
NATB	National Automobile Theft Bureau
NCIC	National Crime Information Center
NEC	National Electric Code
NETC	National Emergency Training Center
NFA	National Fire Academy
NFIRS	National Fire Incident Reporting System
NFPA	National Fire Protection Association
NHTSA	National Highway Traffic Safety Administration
NICB	National Insurance Crime Bureau
NIJ	National Institute of Justice
NIOSH	National Institute for Occupational Safety and Health

NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
NRTLs	Nationally Recognized Testing Laboratories
NUC	National Utility Code
NWS	National Weather Service
NW3C	National White Collar Crime Center
OIC	Officer in Charge
OSB	oriented strand board
OS&Y	outside stem and yoke
OSHA	Occupational Safety and Health Administration
PCA	Passive Charcoal Adsorption
PHC	Passive Headspace Concentration
PIV	post-indicator valve
PPE	personal protective equipment
psi	pounds per square inch
PSOB	Public Safety Officer Benefits
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
SCBA	self-contained breathing apparatus
SD	secure digital
SFPE	Society of Fire Protection Engineers
SIU	Special Investigation Unit

SM	Student Manual
SMART	**S**pecific, **M**easurable, **A**ttainable, **R**ealistic and **T**ime-Targeted
SOG	standard operating guideline
SOP	standard operating procedure
SWD	switch breakers
TC	thermal couple
3-D	three-dimensional
2-D	two-dimensional
TPA	third-party administrator
UEL	upper explosive limit
UFL	upper flammable limit
UL	Underwriters Laboratories
URM	unreinforced masonry
USBDC	United States Bomb Data Center
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USFA	U.S. Fire Administration
USSC	United States Supreme Court
UV	ultraviolet
VAC	volts alternating current
V & V	validation and verification
VIN	vehicle identification number

W	watt
WIV	wall-indicator valve
XML	Extensible Markup Language

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