Training Guidelines for the Fire Debris Analyst

Lesson Plan (Module) 1

Date November 2009 **Instructor** Qualified Instructor

Subject Chemistry and Physics of Fire **Total Time:** 4 hours

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Learning Objectives

- Demonstrate a basic understanding of fuels and combustion
- Describe how fire occurs, progresses and behaves
- Describe the properties of ignitable liquids and gases that determine their behavior in a fire
- Describe and evaluate ignition sources with respect to their competence
- Describe the process and conditions required for spontaneous combustion to occur

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Suggested Reading

1. NFPA 921 Guide for Fire and Explosion Investigations, National Fire Protection Association, Quincy MA, current edition. Chapter on Basic Fire Science
2. NFPA Fire Protection Handbook, National Fire Protection Association, Quincy MA, current edition, chapter on "Chemistry and Physics of Fire"
3. Kirk's Fire Investigation, DeHaan, John, Chapters 2 through 5, Brady Publishing, Prentice-Hall, 6th Edition, 2006, ISBN: 9780131719224
4. The Chemical History of a Candle, Faraday, Michael, Kessinger Publishing Company, 2004, ISBN: 9781419156502
5. Principles of Fire Protection Chemistry and Physics, Raymond Friedman, Stephen W. Wuerz, National Fire Protection Association, Jones and Bartlett Publishers, current edition
6. Fire Debris Analysis, Stauffer, Eric, Dolan, Julia, and Newman, Reta, Chapter 4, Elsevier, 2008, ISBN: 9780126639711.
7. Scientific Protocols for Fire Investigation, Lentini, John, Chapter 2, 2005, Taylor & Francis, Inc, ISBN: 9780849320828

Introduction

This lesson plan will cover what fire is and how it behaves in order to apply this knowledge to interpreting a fire scene. In addition, this lesson will review the properties of ignitable liquids that are critical to an evaluation of a potential arson scene.

Outline

1. Combustion Chemistry
    a. What is fire?
    b. Fire triangle/fire tetrahedron
    c. Fuel form and geometry
    d. Heat transfer – conduction, convection, radiation
    e. Ignition – piloted, auto
    f. Smoldering and flaming combustion
    g. Room fire development
    h. Head flux, heat release rate (vs. fuel load)
    i. Flashover

2. Properties of Ignitable Liquids
    a. Ignitable liquids vs. accelerants
    b. Ignition temperature
    c. Flash point
    d. Vapor pressure
    e. Wick effect
    f. Flammable range
    g. Equilibrium (closed environment)
    h. Vapor density (theoretical/actual)
    i. Mixing and concentration gradient

3. Ignition Sources
    a. Cigarettes (and gasoline)
    b Roman candle (and gasoline) test burn
    c. Self-heating/spontaneous combustion
    d. Open flame
    e. Spark/arc

Teaching Aids

Handout
PowerPoint presentation
Demonstrations of properties of ignitable liquids

Summary

Understanding what fire is and how it behaves is critical to understanding a fire scene. Similarly, understanding the properties of ignitable liquids is critical to evaluating a potential arson scene. The primary role of the Fire Debris Analyst is to determine whether or not volatile ignitable liquids can be identified in submitted items to assist the investigator in their determination of cause (i.e. was the fire accelerated). The ability to evaluate potential ignition sources and ignition scenarios is also a valuable tool.

Test Questions

1. The primary role of the Fire Debris Analyst is to determine whether or not accelerants are present in fire debris items. True or **False**

2. The most important property of an ignitable liquid that determines whether or not it can be ignited is:
   a. ignition temperature
   b. **flash point**
   c. wick effect
   d. vapor density

3. Can the type, manufacturer or source of gasoline be identified in either a liquid or debris item submitted to the forensic laboratory? Yes or **No**

4. An indicator that might support the possibility of a spontaneous combustion occurrence is:
   a. a large pile of motor oil soaked cleaning rags
   b. a large bale of dried hay
   c. **the presence of boiled linseed oil**
   d. a very rapid ignition

5. At the lower flammable limit of propane, the actual vapor density of the flammable propane/air mixture is:
   a. 1.6
   b. **1.01**
   c. 0.8

6. A significant hazard at gasoline filling stations is the risk of a cigarette accidentally igniting liquid gasoline or its vapors. True or **False**

7. The fire debris analyst may obtain negative results if:
   a. no volatile ignitable liquid was ever present
   b. any volatile ignitable liquid that was present has evaporated
   c. any volatile ignitable liquid that was present has been consumed by the fire
   d. any volatile ignitable liquid that was present has been lost through improper packaging
   e. **all of the above**

8. Contamination poses a major problem to fire investigations. Could we exclude any of these as a source of contamination?
   a. petroleum fueled generator used in fire suppression
   b. packaging and handling materials from the scene
   c. sample preparation in the laboratory

d. **none of the above**