Chapter 11

Explosion Dynamics and Investigation

Section A: True/False

Directions: Write True or False on the blanks provided; if false, write the correct statement on the lines provided.

1. _____ Combustion explosions are the most common mechanical explosions that investigators will encounter. (315, 323)

2. _____ In deflagrations, as the pressure on the fuel increases, the speed of the explosion reaction increases. (316)

3. _____ A detonation may be ignited by a shock and/or a flame. (316)

4. _____ Detonations have intense shock waves that cause much greater damage than the blast-pressure front associated with deflagrations. (316)

5. _____ The closer a fuel-to-air ratio gets to the stoichiometric ratio, the lesser the pressure rise in the explosion. (317)

6. _____ In deflagrations, when the air/fuel mixture increases in richness, the speed of the flame front slows and allows more time for the combustion of available materials. (317)

7. _____ During an explosion, the flame front moves so quickly that there is not sufficient time for heat to transfer to combustible structural members for ignition to occur. (319)

8. _____ Ventilation openings and the shape of compartments or ruptures in a containing vessel cannot affect the shape of a blast-pressure front. (321)

9. _____ The fragmentation effect can be used to map the explosion scene after the fact. (321)

10. _____ The flame front in a deflagration has a shorter duration to transfer heat to other combustibles. (321)

11. _____ Radiated heat from the fireball may be extreme and can contribute to secondary fires and bodily injuries. (321)

12. _____ BLEVEs are deflagrations that may reach the speed and destructiveness of detonations. (323)

13. _____ BLEVEs often occur as a result of the heating of a container under the level that allows its contents to remain in a liquid state. (323)

14. _____ Explosions near the lower explosive (flammable) level (LEL) ratio tend to consume 50 percent of the available fuel, thus reducing the chance for post-explosion fires. (324)

15. _____ Turbulence can enhance the fuel-to-air ratio in other areas of a structure resulting in secondary explosions outside the initial compartment. (328)

16. _____ A deflagration that ignites near the center of compartment will be less powerful than one beginning near a wall or corner. (329)

_____

_____

17. _____ The outside boundary of the scene perimeter cannot be established before the furthest piece of debris is found. (333)

_____

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Section B: Fill in the Blank

Directions: Write the correct answer on the blanks provided.

1. Detonations are most commonly associated with _____ compounds in which the solid fuel and the oxidizer for the fuel are under high pressure. (316)
2. Explosions, under ideal conditions project heat and pressure in a relatively _____ shape, expanding in all directions. (319)
3. Fragmentation is debris moved during the explosion, whether by the _____ or the explosion itself. (321)
4. Fireballs are especially prevalent in _____ that involve flammable vapors. (321)
5. Seated explosions leave an identifiable _____ in the form of a crater or area of greater damage. (322)
6. BLEVEs often occur as a result of _____ damage that has weakened a container's walls. (323)
7. A compartment's _____ ratio is perhaps the most important factor in determining the violence of a gas/vapor explosion. (324)
8. More ignition energy is required to cause a _____ explosion than is required to cause a gas/vapor explosion. (332)

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Section C: Matching

Directions: Write the correct answers on the blanks provided.

Part I: Characterization of Explosion Damage

Match the terminology with its definition.

Choices:

A. Mechanical explosion

B. Explosion

C. BLEVE

D. Explosives

E. Deflagrations

F. Stoichiometric ratio

Definitions:

_____ 1. A chemical or mechanical conversion of potential energy into kinetic energy. (315)

_____ 2. Materials, either a pure single substance or a mixture, that undergo a very rapid chemical or physical change, releasing large volumes of gas(es). (315)

_____ 3. Materials in a container do not undergo a chemical change and as the pressure increases beyond the structural capacity of the container, a rupture forms. (315)

_____ 4. The most common mechanical explosions that investigators will encounter. (315)

_____ 5. Combustion reactions that are generally fueled by diffused gases or dust suspended in air under normal pressure. (316)

_____ 6. The mathematical ratio of fuel and air necessary for complete combustion to occur, leaving no byproducts of combustion such as ash. (317)

Part II: Fuel Gas Explosions

Match the terminology with its description.

Choices:

A. Flame speed

B. Burning velocity

C. Blast-pressure front

D. Turbulence

Descriptions:

_____ 1. Direct result of the explosion's flame speed and burning velocity. (327)

_____ 2. Created by obstructions such as furniture, walls, ceilings, or appliances, within the expanding pressure front of a deflagration. (328)

_____ 3. The velocity of the flame front relative to the center of the explosion. (327)

_____ 4. The velocity of the flame front relative to the unburned gases ahead of it. (327)

Part III: Scene Characteristics

Match the scene characteristic with fuel types.

Choices:

A. Lighter-than-air gases

B. Heavier-than-air gases

C. Liquid vapors

D. Dusts

E. Explosives

Characteristics:

_____ 1. Almost always result in deflagrations accompanied by low-order damage. Post-explosion fires almost always result where liquid vapor fuels are present. (335)

_____ 2. Almost always result in deflagrations; typically produce low-order damage and can contribute to BLEVEs, secondary explosions, and post-explosion fires. (335)

_____ 3. Almost always result in deflagrations and often show evidence of secondary explosions; pre-explosion and post-explosion fires are common. (335)

_____ 4. Almost always result in deflagrations; typically produce low-order damage, secondary explosions, and post-explosion fires. (335)

_____ 5. Almost always result in detonations and seated explosions and high-order damage is likely; never result in secondary explosions at a scene and do not contribute to BLEVEs. (335)

Section D: Multiple Choice

Directions: Write the correct answers on the blanks provided.

_____ 1. High-order damage magnitude is generally associated with: (317)

A. seated explosions and detonations.
B. dislodged and/or broken windows.
C. nonseated explosions and deflagrations.
D. walls bulging away from the explosion or falling outward.

_____ 2. The negative-pressure phase of the blast-pressure-front effect: (320)

A. occurs when the positive-pressure phase heats the surrounding air.
B. is responsible for the majority of damage because of the force it exerts.
C. forms a low-pressure region behind the pressure wave as it moves outward.
D. results from the blast wave moving away from the center of the blast as gases expand.

_____ 3. The seat of an explosion refers to the remaining crater or concentrated area of damage of an explosion and may be _____ in shape. (322)

A. helical
B. cuboidal
C. spherical
D. cylindrical

_____ 4. Which type of thermal effect produces the greatest amount of heat, generating high temperatures that only exist for a brief duration? (321)

A. Fireballs
B. BLEVEs
C. Detonations
D. Deflagrations

_____ 5. Seated explosions may involve: (322)

A. turbines.
B. flashover.
C. explosives.
D. gaseous fuels or liquid fuel vapors in open spaces.

_____ 6. Seated explosions' reaction velocities are _____and cause loud, explosive noises. (322)

A. faster than the speed of light
B. slower than the speed of light
C. faster than the speed of sound
D. slower than the speed of sound

_____ 7. BLEVE is mechanical explosions that can cause: (323)

A. low-order explosion damage, similar to the damage associated with low explosives.
B. high-order explosion damage, similar to the damage associated with low explosives.
C. low-order explosion damage, similar to the damage associated with high explosives.
D. high-order explosion damage, similar to the damage associated with high explosives.

_____ 8. Which is a feature of nonseated explosions? (323)

A. Crater
B. Detonation
C. Deflagration
D. High rates of pressure rise

_____ 9. Low-order explosive damage is mostly produced by _____ explosives. (324)

A. dust
B. moisture
C. gas/vapor
D. fragmentation

_____ 10. High order explosions may have fuel-to-air ratios: (324)

A. near the UEL or LEL.
B. under the UEL or LEL.
C. under the stoichiometric values.
D. near or just above the stoichiometric values.

_____ 11. Where do lighter-than-air gases tend to collect in a compartment? (325)

A. Near the floor
B. Near the walls
C. Near the ceiling
D. Near windows and doors

Section E: Short Answer

Directions: Write the correct answers on the lines provided.

1. List two of the four criteria that must be met for an ignition source to initiate a gas/vapor explosion. (329)

_____

_____

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2. Name two of the four reasons why an investigator examines an explosion scene. (334)

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3. What are four pieces of potential evidence that the investigator should collect and document at an explosion incident scene? (337)

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