



Fire Protection Training

Procedures Handbook 4300

FIRE PHYSICS & CHEMISTRY

TOPIC: Physical Properties of Explosions

TIME FRAME: 30 Minutes

LEVEL OF INSTRUCTION:

BEHAVIORAL OBJECTIVE:

Condition: A written quiz

Behavior: The student will identify types and causes of explosions

Standard: With a minimum of 70% accuracy

MATERIALS NEEDED:

- Chalkboard
- Chalk
- Visual aids
- Audio visual equipment

REFERENCES:

- NFPA, Fire Protection Handbook, 17th Edition, Chapter 5
- Explosive and Toxic Hazardous Materials, James H. Meidl, Glencoe Press, 1970

PREPARATION: The term "explosion" in its most widely accepted sense, means a bursting associated with a loud, sharp noise and an expanding pressure front, varying from a supersonic shock wave to a relatively mild wind. Understanding the causes and types of explosions can aid in reducing firefighter injuries and deaths.



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PHYSICAL PROPERTIES OF
EXPLOSIONS

PRESENTATION	APPLICATION
<p>I. EXPLOSION DEFINED</p> <p>A. Violent Bursting, often Accompanied by a Loud Noise; High Pressure is Suddenly Released.</p> <p>B. A Less Scientific Definition would be "Anything That Goes 'Boom' and Does Damage"</p> <p>II. TYPES OF EXPLOSIONS</p> <p>A. Detonation</p> <ol style="list-style-type: none">1. Reaction faster than the speed of sound2. Usually accompanied with shock wave3. Example: - tri-nitro-toluene (TNT) <p>III. CAUSES OF EXPLOSIONS</p> <p>A. There Are at Least Seven Different Ways in which Something Can Explode, Releasing Energy</p> <ol style="list-style-type: none">1. Nuclear fission<ol style="list-style-type: none">a. When the nuclei of certain atoms split2. Nuclear fusion<ol style="list-style-type: none">a. Under heat and pressure, four hydrogen atoms will fuse into one helium atomb. Small mass is converted into a great deal of energyc. Nuclear fusion is the major energy source of both the sun and the H-bomb	<p>What are the different ways something can explode?</p>



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<p>3. Inadequate pressure relief</p> <ul style="list-style-type: none">a. Trapped steam (as in a boiler or pipe)b. Pressurized gas cylinderc. Liquid container exposed to a fire <p>4. BLEVE</p> <p>B = boiling L = liquid E = expanding V = vapor E = explosion</p> <p>5. Rapid oxidation</p> <ul style="list-style-type: none">a. By far the most common type of explosion <p>6. Runaway polymerization</p> <ul style="list-style-type: none">a. Many unstable molecules will form long chains and release energy in doing so <p>7. Decomposition of molecules</p>	<p>Where would we find this type of energy?</p> <p>What are some examples of this type of explosion?</p> <p>What is the most common term used in the fire service for pressure release explosion?</p>



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<ul style="list-style-type: none"> a. Molecules breaking apart into simpler fragments can release energy <ul style="list-style-type: none"> (1) Above certain concentrations, hydrogen peroxide can decompose explosively (2) Pressurized acetylene gas not only decomposes violently, but it is capable of causing explosions 	<p>What are some examples of this type of explosion?</p>
<p>IV. EXPLOSION REACTION</p> <ul style="list-style-type: none"> A. A Wave Will Pass Along the Body of an Explosive B. Ahead of the Wave, the Explosive is Unchanged C. Behind the Pressure Wave, the Explosive has been Instantaneously Converted to Gas 	<p>What happens during an explosion?</p>
<p>V. STRENGTH OF AN EXPLOSIVE</p> <ul style="list-style-type: none"> A. Depends upon the Amount of Gas and Heat It Produces and How Quickly It is Released B. "Brisance" is Determined by the Velocity of Its Detonation Wave C. Rapid Expansion Must Take Place 	<p>What determines the strength of a particular explosive?</p> <p>Brisance - the shattering or crushing effect of an explosion</p>



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<p>D. Gas Pressure Can Soar Above a Million Pounds Per Square Inch</p> <p>E. Temperatures of 6,000o F and Higher are Common</p> <p>F. Pressure Waves Move Out at Enormous Velocities Depending Upon</p> <ol style="list-style-type: none"> 1. The rate of release 2. The pressure at release 3. The quantity of gas released 4. Directional factors governing the release 5. Mechanical effect is coincidental with release 6. The temperature of the released gas 7. Physiological Effect PSI <ol style="list-style-type: none"> a. Knock personnel = 1 down b. Eardrum rupture = 5 c. Lung damage = 15 d. Threshold for = 35 fatalities e. 50% fatalities = 50 f. 99% fatalities = 65 	<p>What must happen for an explosion to occur?</p> <p>What determines the effect of this gas pressure?</p> <p>What would the effects of the shock waves to a person be?</p> <p>Instructor Note: List on chalkboard</p>



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<p>VI. CAUSES OF EXPLOSIONS</p> <p>A. Dusts and Mists</p> <ol style="list-style-type: none">1. Generate high pressure by combustion in air or another reactive gaseous environment2. Explosions are triggered by<ol style="list-style-type: none">a. Electrical dischargeb. Open flamec. Hot surface3. Frequently described as rolling explosions, characterized as sounding like distant thunder<ol style="list-style-type: none">a. Initiated by a primary dust explosionb. Creates and ignites secondary dust dispersionsc. Creates and ignites further dust dispersions <p>B. Physical Explosions</p> <ol style="list-style-type: none">1. Releases of high pressure gas that do not involve chemical reactions2. Confining vessel such as a boiler, gas cylinder or other tank<ol style="list-style-type: none">a. High pressure in the vessel is created by	<p>List some situations in which explosive dusts or mists occur.</p> <p>How are explosions of dust and mists achieved?</p>



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PHYSICAL PROPERTIES OF
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SUMMARY:

An explosion may result from:

1. Chemical changes, such as those which accompany the detonation of an explosive or the combustion of a flammable gas-air mixture
2. Physical or mechanical changes, such as the bursting of a steam boiler, or a high pressure reaction vessel
3. Atomic changes, such as those which occur in a nuclear explosion.

EVALUATION:

A written quiz.

ASSIGNMENT:

To be determined by the instructor(s).