



Fire Protection Training

Procedures Handbook 4300

FIRE PHYSICS & CHEMISTRY

TOPIC: Extinguishing Agents

TIME FRAME: 1 Hour

LEVEL OF INSTRUCTION:

BEHAVIORAL OBJECTIVE:

Condition: A written quiz

Behavior: The student will describe the principles of extinguishment, physical characteristics, and the limitations and advantages of specific extinguishing agents

Standard: With a minimum 70% accuracy

MATERIALS NEEDED:

- Chalkboard
- Appropriate visual aids

REFERENCES:

- IFSTA, Essentials of Fire Fighting, 2nd Edition, Chapter 2
- NFPA, Fire Protection Handbook, 17th Edition

PREPARATION: The effective extinguishment of fire in various types of fuel requires knowledge of the proper extinguishing agent. There is no single agent that can be used to control all types of fire. It is important for the firefighter to make the proper selection of extinguishing agents for the material involved.



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EXTINGUISHING AGENTS

PRESENTATION	APPLICATION
<p>I. EXTINGUISHING AGENTS</p> <p>A. Water</p> <ol style="list-style-type: none">1. Extinguishing principles<ol style="list-style-type: none">a. Remove heat/lower temperature below ignition temperatureb. Removes oxygen on flammable liquids with specific gravity greater than onec. Fans, blows, pushes flammable vapors away from flammable liquid fires2. Water can be used on:<ol style="list-style-type: none">a. Class A firesb. Class B fires - certain instancesc. Class D fires - very limited3. Physical characteristics<ol style="list-style-type: none">a. Freezes at 32oF, 0oC.b. Boils at 212oF, 100oC.c. Weighs 8.33 pounds per gallond. Non compressiblee. High surface tensionf. Takes shape of containerg. Needs expellant force in most cases4. Advantages	<p>Discuss fire tetrahedron</p>

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<ul style="list-style-type: none">a. Absorbs a large amount of heat<ul style="list-style-type: none">(1) At 212oF one unit of water expands approximately 1700 times its original volume(2) Approximately 8000 B.T.U.s per gallon(a) BTU is the amount of heat required to raise 1 pound of water 1oFb. Plentifulc. Relatively cheapd. Non-toxice. Easily transported and/or storedf. Can be used with specialized agents	<p>What is a BTU?</p> <p>British Thermal Unit</p>
<p>5. Limitations</p> <ul style="list-style-type: none">a. Conductor of electricityb. High surface tensionc. Freezes at or below 32oFd. Reacts violently with certain chemicalse. Weight	<p>What are some limitations on using water?</p> <p>List on board.</p>



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<ul style="list-style-type: none">b. Readily turns from liquid to gasc. Provides its own pressure/expellantd. Nonconductor <p>5. Limitations</p> <ul style="list-style-type: none">a. Slightly toxicb. Water solublec. Forms condensation which may contaminate or turn to rust <p>C. Halogenated Hydrocarbons (Halons)</p> <ul style="list-style-type: none">1. Extinguishing principle<ul style="list-style-type: none">a. Break chain reactionb. Some cooling2. Types<ul style="list-style-type: none">a. Halon 1301 Bromotrifluoromethaneb. Halon 1211 Bromochlorodifluoromethane3. Halons can be used on:<ul style="list-style-type: none">a. Class A - special instances<ul style="list-style-type: none">(1) Only extinguishes flaming combustion(2) Rekindle commonb. Class B<ul style="list-style-type: none">(1) Most effective in confined spacesc. Class C	

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<ul style="list-style-type: none">(1) Extinguishing agent of choice for sensitive electronic equipment4. Physical characteristics<ul style="list-style-type: none">a. Liquid under pressureb. 2 1/2 times as effective as CO25. Advantages<ul style="list-style-type: none">a. High expansion ratiob. Provides own pressure(1) Generally given nitrogen boost for optimal effectc. Nonconductor6. Disadvantages<ul style="list-style-type: none">a. Not effective in open spaceb. Toxic fumes when heatedc. Expensive to recharged. Will be in limited supply in the futuree. Depletes ozone layer7. Health aspects<ul style="list-style-type: none">a. 20% in atmosphere is toxicb. Treat as known carcinogenic agentc. Heat breaks down Halon into toxic gasesD. Dry Chemicals<ul style="list-style-type: none">1. Extinguishing principle	



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<ul style="list-style-type: none">a. Breaking of chain reaction2. Regular dry chemicals can be used on:<ul style="list-style-type: none">a. Class Bb. Class C3. Tri-class dry chemicals can be used on:<ul style="list-style-type: none">a. Class Ab. Class Bc. Class C4. Physical characteristics<ul style="list-style-type: none">a. Ordinary dry chemicals<ul style="list-style-type: none">(1) Sodium bi-carbonate - ordinary(2) Potassium Bicarbonate - Purple K(3) Potassium Chloride - Super K(4) Urea-Potassium Bicarbonate - Monnexb. Tri-class dry chemicals<ul style="list-style-type: none">(1) Monammonium Phosphate - Multi-purpose(2) Barium sulphatec. Additives for free-flowing and water repulsion	<p>Emphasis that labels must be checked to determine whether agent is "ordinary" or "tri-class"</p>



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<ul style="list-style-type: none">d. Finely ground powdere. Needs expellant force <p>5. Advantages</p> <ul style="list-style-type: none">a. Many applications<ul style="list-style-type: none">(1) Tri-class extinguishing agent (A, B, C)b. Large fire knock-down potentialc. Nonconductord. Some dry chemicals are foam compatible <p>6. Limitations</p> <ul style="list-style-type: none">a. Can become packedb. Cannot intermix dry chemicalsc. Application of large containers can cause seeing and breathing difficultiesd. No cooling - may reignitee. Some dry chemicals are corrosive <p>E. Dry Powders</p> <ul style="list-style-type: none">1. Extinguishing principle<ul style="list-style-type: none">a. Remove oxygen	<p>What are some advantages of using dry chemicals?</p> <p>What are some of the limitations of dry chemical?</p>



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<ul style="list-style-type: none">b. Cover burning metal to smother fire2. Dry powders can be used on:<ul style="list-style-type: none">a. Class D3. Physical characteristics<ul style="list-style-type: none">a. Wide variation4. Advantages<ul style="list-style-type: none">a. Can control some types of Class D fires5. Limitations<ul style="list-style-type: none">a. No one agent works on all combustible metal firesb. Can become packedc. Cannot intermix dry powdersF. Wetting Agents (wet water)<ul style="list-style-type: none">1. Extinguishing principle<ul style="list-style-type: none">a. Remove heat/lower temperature below ignition temperatureb. Pushes flammable vapors away from flammable liquid fires2. Uses<ul style="list-style-type: none">a. Increase extinguishing efficiency of water by:<ul style="list-style-type: none">(1) Decreasing surface tension(2) Aiding penetration	<p>What are wetting agents?</p>

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<ul style="list-style-type: none">(3) Decreasing run-off3. Methods of adding to water<ul style="list-style-type: none">a. Pre-mixed in booster tanksb. Proportioning equipment4. Advantages<ul style="list-style-type: none">a. Cuts down amount of water usedb. Effective longer than water5. Limitations<ul style="list-style-type: none">a. Agent can freezeb. Corrosive with certain metals(1) Including tanks on engine, plumbing, pumps, nozzlesG. Firefighting Foam<ul style="list-style-type: none">1. Uses<ul style="list-style-type: none">a. Class A - special applicationsb. Class B2. Physical characteristics<ul style="list-style-type: none">a. Mass of gas filled bubblesb. Lighter than the solutions it is formed fromc. Floats on flammable liquids	<p>When would foam be used to suppress fires?</p>



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<ul style="list-style-type: none">d. Produces air - excluding, cooling, vapor sealing, water bearing solution3. Types and characteristics<ul style="list-style-type: none">a. Protein foaming agent<ul style="list-style-type: none">(1) Liquid concentrate<ul style="list-style-type: none">(a) Proportioning 3% = 97 gallons water 3 gallons foam(b) 6% = 94 gallons water 6 gallons foamb. Manufactured from natural protein solidsc. Normal use temperatures from 20oF to 120oFd. Sticks to objects4. Aqueous Film Forming Foam (AFFF)<ul style="list-style-type: none">a. Liquid concentrate and proportioning, 3% or 6%b. Manufactured from syntheticsc. Forms film capable of self-sealing after disruptiond. May be used with some dry chemicals5. High expansion foam<ul style="list-style-type: none">a. Liquid concentrate and proportioning, 2%b. Manufactured from syntheticsc. Expansion ratios from 100x to 1000x	

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<ul style="list-style-type: none">d. Flooding agent used for confined spacese. Manufactured by passing air through a net or screen that is wetted with the foam solutionf. Engine powered or hand-held units are available	
<p>6. Other foams</p> <ul style="list-style-type: none">a. Chemical<ul style="list-style-type: none">(1) Aluminum sulfate<ul style="list-style-type: none">(a) Sodium bicarbonate(b) Not used much any moreb. Alcohol typec. Low temperature	<p>When would high expansion foam be used for firefighting?</p>
<p>7. Rapid water</p> <ul style="list-style-type: none">a. Agent designed to reduce friction lossb. Increases delivery of gallons per minutec. Increase reach of streamsd. 1 gallon additive per 6000 gallons of water increases the flow 40% <p>8. Polar Solvent Liquid (PSL)</p>	<p>What is rapid water foam?</p>

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<ul style="list-style-type: none">a. May be used on water soluble fuel fires (alcohols, acetone, ketones)b. Forms foam blanket over polymeric membranec. Compatible with structural nozzles (NFPA 2)d. Effective hydrocarbon agent	

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SUMMARY:

Fighting fires is the primary responsibility of any firefighter. Without a knowledge of extinguishing agents, their capabilities, advantages and limitations a firefighter cannot make proper decisions on which agent to use on different type combustibles.

EVALUATION:

A written quiz.

ASSIGNMENT:

To be determined by instructor(s).