

LESSON ONE

FIREFIGHTER II

Fire Behavior

DOMAIN: COGNITIVE

LEVEL OF LEARNING: KNOWLEDGE

MATERIALS

NFPA 497; IFSTA Essentials 5th edition or Jones and Bartlett Fundamentals of Fire Fighter Skills 2nd Edition or Delmar Firefighter's Handbook 3rd Edition; overhead projector or laptop computer and multimedia projector; projection screen.

NFPA 1001 JPR, 2008 edition

6.3.2 Coordinate an interior attack line team's accomplishment of an assignment in a structure fire

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive manner. While it is critical that instructors be constantly aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Firefighter II candidate shall correctly define in writing the terms British thermal unit, Fahrenheit, Celsius, calorie, flash point, fire point, and ignition temperature.

ENABLING OBJECTIVES

1. The Firefighter II candidate shall correctly define in writing the term British thermal unit.
2. The Firefighter II candidate shall correctly define in writing the term Fahrenheit.
3. The Firefighter II candidate shall correctly define in writing the term Celsius.
4. The Firefighter II candidate shall correctly define in writing the term calorie.
5. The Firefighter II candidate shall correctly define in writing the term flash point.
6. The Firefighter II candidate shall correctly define in writing the term fire point.
7. The Firefighter II candidate shall correctly define in writing the term ignition temperature.

LESSON ONE

FIREFIGHTER II

Fire Behavior

MOTIVATION

Effective fire control requires a basic understanding of the chemical and physical nature of fire. The study of fire behavior provides the firefighter with a window into the world of fire. A window that can allow the firefighter to accurately predict what a given fire is going to do. With this understanding, the firefighter can effectively control and extinguish fires with a higher degree of safety that in turn will reduce risk to life and needless loss of property. All this enhances the firefighter's level of professionalism and dramatically increases the odds for the firefighter to remain safe while combating a fire.

NOTE: The information contained in Level II, Fire Behavior, is not specifically addressed in the 2008 edition of NFPA 1001. However, this information is important to the Firefighter II candidate's training.

NOTE: It is the intent of the scientific community to evolve the system of measurements in the United States from the Customary or English System to the International System of Units, or metric system. Most of the world Community uses the International System of Units or SI (after the French System International). Since research into fire behavior is conducted worldwide it will benefit today's firefighter to have an understanding of SI and how it relates to the Customary System used in the United States. An effort will be made to discuss this relationship specific to fire behavior.

PRESENTATION

ENABLING OBJECTIVE #1

The Firefighter II candidate shall correctly define in writing the term British thermal unit.

1. Define the term British Thermal Unit (a Customary System unit of measurement).
2. Describe the amount of BTU's needed to turn one pound of water, at 60⁰F, to steam.
3. Illustrate the difference between a BTU and a Joule (an SI unit of measurement).

Reference:

IFSTA Essentials 5th edition, page 89

PRESENTATION

ENABLING OBJECTIVE #2

The Firefighter II candidate shall correctly define in writing the term Fahrenheit.

1. Define Fahrenheit (a Customary System unit of measurement).
2. Illustrate the Fahrenheit scale to the candidates.

Reference:

Delmar Handbook 3rd edition, page 87

IFSTA Essentials 5th edition, page 89

PRESENTATION

ENABLING OBJECTIVE #3

The Firefighter II candidate shall correctly define in writing the term Celsius.

1. Provide the class with a definition of Celsius.
2. Illustrate the Celsius scale and draw a direct comparison between Celsius and Fahrenheit.

Reference:

Delmar Handbook 3rd edition, page 87

IFSTA Essentials 5th edition, pages 89-90

APPLICATION

After giving instruction on conversion formulas, have each of the candidates perform conversions of temperatures from Celsius to Fahrenheit.

PRESENTATION

ENABLING OBJECTIVE #4

The Firefighter II candidate shall correctly define in writing the term calorie.

1. Define the term calorie (an unapproved unit of measurement of the metric system).
2. Explain the relationship between calorie, BTU, and joule.
3. Provide a detailed explanation of the term Kilowatt and how it is used to determine the heat release rate (HRR) of a fuel or fuel package.

Reference:

IFSTA Essentials 5th edition, pages 102-103

PRESENTATION

ENABLING OBJECTIVE #5

The Firefighter II candidate shall define in writing the term flash point.

1. Ask candidates to provide a definition of flash point.
2. Define flash point.
3. Point out the fact that only liquids have flash points. However, some solids, such as grease, may melt before vaporizing, making it possible to determine a flash point.
4. List examples of the flash points of different products.
5. Point out the fact that flash point is one of the most important determinants of a liquid fuel's flammability.

Reference:
Delmar Handbook 3rd edition, pages 94-95
J&B Fundamentals 2nd edition, page 141
IFSTA Essentials 5th edition, pages 98-99

PRESENTATION

ENABLING OBJECTIVE #6

The Firefighter II candidate shall correctly define in writing the term fire point.

1. Define fire point.
2. Explain the relationship between flash point and fire point.

Reference:
Delmar Handbook 3rd edition, pages 94-95
IFSTA Essentials 5th edition, page 98

PRESENTATION

ENABLING OBJECTIVE #7

The Firefighter II candidate shall correctly define in writing the term ignition temperature.

1. Provide a definition of ignition temperature to the class.
2. Discuss self-sustained combustion as the determining factor of ignition temperature.
3. List the ignition temperatures of different products found at typical fires.
4. Explain the relationship of ignition temperature to a fuel's flammability.

Reference:
Delmar Handbook 3rd edition, pages 94-95
J&B Fundamentals 2nd edition, page 129

APPLICATION

Divide the class into suitable work groups of three to five candidates. Provide the class with the scenario given below, and have each group address the problem. After five minutes, have a spokesperson from each group present their groups opinion on how the incident should be handled, taking fire behavior into consideration. Critique each group's plan.

SCENARIO

A tanker overturns and leaks kerosene at a busy intersection during peak traffic conditions. The temperature at the time of the incident is 98 degrees Fahrenheit.

The time the incident occurred was 9:15 AM and there is no wind blowing.

SUMMARY

Review each of the main points of the lesson concerning units of measurement: B. T. U., Fahrenheit, Celsius, calorie, joule, and kilowatt.

Summarize the evolution for units of measurement, here in the U.S., from the "Customary System" to the "International System of Units".

Review the definition of Flash point and reiterate its significance when dealing with liquid fuels.

Review the definition of Ignition temperature and point out the importance of knowing a fuels ignition temperature when fire fighting.

Reiterate the importance of understanding these terms and their importance in relation to tactical considerations.

LESSON TWO

FIREFIGHTER II

Fire Behavior

DOMAIN: COGNITIVE

LEVEL OF LEARNING: KNOWLEDGE

MATERIALS

IFSTA Essentials 5th edition or Jones and Bartlett Fundamentals of Fire Fighter Skills 2nd Edition or Delmar Firefighter's Handbook 3rd Edition; overhead projector or laptop computer and multimedia projector; projector screen.

NFPA 1001 JPR, 2008 edition

6.3.2 Coordinate an interior attack line team's accomplishment of an assignment in a structure fire

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive manner. While it is critical that instructors be constantly aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Firefighter II candidate shall correctly explain in writing the hazards presented by finely divided fuels as they relate to the process of combustion.

ENABLING OBJECTIVES

1. The Firefighter II candidate shall correctly define in writing the term pyrolysis.
2. The Firefighter II candidate shall correctly explain in writing why a finely divided fuel is more ignitable than fuels with large surface areas.
3. The Firefighter II candidate shall correctly describe in writing why recognizing observations in reading smoke and the warning signs of hostile fire events is important.

LESSON TWO

FIREFIGHTER II

Fire Behavior

MOTIVATION

Firefighters must respond to all types of fire related incidents. Frequently these incidents will involve fuels that are very finely divided such as wood or cotton dust. When the average person thinks of wood or cotton, their mental image is a board or piece of cloth. Both the board and the piece of cloth will ignite and burn when enough heat is applied to their surface. However, if we increase the surface areas by reducing them to a dust, not only will they ignite, but they may do so explosively. It is because of this wide variation in ease of ignitability that every firefighter must understand the potential hazards of finely divided fuels. The firefighter's life will depend on it.

NOTE: The information contained in Level II, Fire Behavior, is not specifically addressed in the 2008 edition of NFPA 1001. However, this information is important to the Firefighter II candidate's training.

PRESENTATION

ENABLING OBJECTIVE #1

The Firefighter II candidate shall correctly define in writing the term pyrolysis.

1. Ask the candidates to define pyrolysis.
2. Provide a formal definition of the term pyrolysis.
3. Illustrate an example of the pyrolysis of a fuel. Wood is the best example.
4. Point out the fact that only solids go through the process of pyrolysis.

5. Discuss the fact that some solids may melt before pyrolysis and vaporize.
6. Explain the difference between pyrolysis and vaporization.
7. Explain that only gases burn, any material must first be converted to a gas before it can actually ignite and burn.

Reference:

Delmar Handbook 3rd edition, pages 93-94,104-105
J&B Fundamentals 2nd edition, page 131
IFSTA Essentials 5th edition, page 90

PRESENTATION

ENABLING OBJECTIVE #2

The Firefighter II candidate shall correctly explain in writing why a finely divided fuel is more ignitable than fuels with large surface areas.

1. Explain how the shape and size of a fuel are important to the ability of the fuel to ignite readily.
2. Illustrate a fuels surface-to-mass ratio and how this affects pyrolysis.
3. Discuss how a finely divided liquid fuel undergoes vaporization more rapidly.
4. Discuss how solid fuels that are finely divided undergo pyrolysis easier.
5. Point out hazards associated with finely divided fuels and how this will affect the firefighter's attack and safety precautions.

Reference:

Delmar Handbook 3rd edition, pages 93-94
J&B Fundamentals 2nd edition, page 135
IFSTA Essentials 5th edition, pages 87, 101

APPLICATION

Demonstrate how difficult it is to ignite a large block of wood, such as a 2" x 4".

Demonstrate how easy it is to ignite shavings or sanding dust from the same piece of wood.

Demonstrate how sawdust can be exploded, when suspended in air, in the presence of an ignition source.

For this demonstration, you will need to acquire or construct an explosive chamber. (Dust Explosion Box)

APPLICATION

Divide the class into suitable size work groups 3 to 5 candidates. Ask the groups to form a list of fuels, industries, processes, etc., where finely divided fuels may present a special hazard. Allow a spokesperson from each group to lead discussion on their findings and be sure that all local hazards are discussed.

PRESENTATION

ENABLING OBJECTIVE #3

The Firefighter II candidate shall correctly describe in writing why recognizing observations in reading smoke and the warning signs of hostile fire events is important.

1. Explain why reading smoke is important to evaluating the fires position within a building.
2. Explain how evaluating the volume of smoke assists in the understanding of the amount of fuel that is off-gassing in a given space.
3. Explain that the velocity of smoke is an indicator of pressure.
4. Describe the two things that can create smoke pressure.
 - a. Heat
 - b. Restricting the volume of smoke within a container
5. Explain how smoke thickens.

6. Discuss the fact that the greater the smoke density, the more likely a hostile fire event can occur.
7. Explain that the color of smoke will only indicate the type of burning material in a single-fuel fire.
8. Point out that smoke can tell the firefighter which stage of burning is taking place.

Reference:

Delmar Handbook 3rd edition, pages 108-110
J&B Fundamentals 2nd edition, pages 142-146

APPLICATION

Divide the class up into suitable size work groups 3-5 candidates. Show them pictures of different fire scenarios and have them evaluate the smoke conditions. Assist them in recognizing the volume, velocity, density, and color of smoke for each picture.

SUMMARY

Review in detail, the process of pyrolysis, and discuss the surface-to-mass ratio.

Reemphasize the hazards of finely divided fuels with a special emphasis on explosive dusts.

Reiterate the need for sound size-up decisions as it relates to smoke reading.

LESSON THREE

FIREFIGHTER II

Fire Behavior

DOMAIN: COGNITIVE

LEVEL OF LEARNING: KNOWLEDGE

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Junior Member Statement:

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TERMINAL OBJECTIVE

The Firefighter II shall correctly identify in writing a minimum of two chemical, mechanical, and electrical energy heat sources.

ENABLING OBJECTIVES

1. The Firefighter II candidate shall correctly identify in writing five sources of heat energy.
2. The Firefighter II candidate shall correctly identify in writing two sources of chemical heat.
3. The Firefighter II candidate shall correctly identify in writing two sources of mechanical heat.
4. The Firefighter II candidate shall correctly identify in writing two sources of electrical heat.

LESSON THREE

FIREFIGHTER II

Fire Behavior

MOTIVATION

Every fire encountered by the fire service has a beginning. It starts by some form of heat energy. Determining the actual cause of a fire requires an understanding of the various types of heat energy. Basic to the understanding of fire growth is an understanding of all types of heat energy. Initiating a successful intervention of fire growth, putting the fire out, requires an in-depth understanding of heat energy. Therefore, if we are to be successful firefighters in all aspects of a given fire incident we must understand heat energy.

NOTE: The information contained in Level II, Fire Behavior, is not specifically addressed in the 2008 edition of NFPA 1001. However, this information is important to the Firefighter II candidate's training.

PRESENTATION

ENABLING OBJECTIVE #1

The Firefighter II candidate shall correctly identify in writing five sources of heat energy.

1. List the five sources of heat energy.
 - a) Chemical.
 - b) Electrical.
 - c) Mechanical.
 - d) Nuclear.
 - e) Solar.

2. Point out the fact that nuclear and solar heat energy sources are not common to the subject of fire behavior since they are rarely the cause of fires encountered by the fire service.

Reference:

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Delmar Handbook 3rd edition, pages 89-92
J&B Fundamentals 2nd edition, pages 129-130
IFSTA Essentials 5th edition, pages 91-93, 963

PRESENTATION

ENABLING OBJECTIVE #2

The Firefighter II candidate shall correctly identify in writing two sources of chemical heat.

1. Provide a definition of chemical heat energy.
2. List and define the four types of chemical heat energy. Ask the candidates to give examples of each type as you list them.
 - a) Heat of combustion – The amount of heat generated by the combustion reaction such as a flame on a candle or cutting torch.
 - b) Spontaneous heating – The heating of an organic substance without the addition of external heat such as with old stored oily rags.
 - c) Heat of decomposition – The release of heat from decomposing compounds, usually due to bacterial action (eg. occurs in composted organic materials, such as leaves).
 - d) Heat of solution – The heat released by the solution of matter in a liquid (eg. some acids dissolved in water produce violent reactions).

Reference:

Delmar Handbook 3rd edition, pages 90
J&B Fundamentals 2nd edition, pages 129-130
IFSTA Essentials 5th edition, pages 91, 102

PRESENTATION

ENABLING OBJECTIVE #3

The Firefighter II candidate shall correctly identify in writing two sources of mechanical heat.

1. Provide a definition of mechanical heat energy, in writing, on the board.
2. Point out the fact that mechanical heat energy is caused by either friction or compression.

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3. List examples of mechanical heat energy, and allow them to offer suggestions.
 - a) Diesel engines.
 - b) Charging air cylinders.
 - c) Bad bearings.
 - d) Slipping drive belts.

Reference:

Delmar Handbook 3rd edition, pages 90-91

J&B Fundamentals 2nd edition, pages 129

IFSTA Essentials 5th edition, page 93

PRESENTATION

ENABLING OBJECTIVE #4

The Firefighter II candidate shall correctly identify in writing two sources of electrical heat.

1. Provide a definition of electrical heat energy.
2. List on the board several forms of electrical heat energy. Ask the candidates to give examples of each type.
 - a) Resistance.
 - b) Dielectric.
 - c) Leakage current.
 - d) Arcing.
 - e) Static.
 - f) Sparking.
 - g) Lightning.

Reference:

Delmar Handbook 3rd edition, pages 91

J&B Fundamentals 2nd edition, pages 129-130

IFSTA Essentials 5th edition, page 92

APPLICATION

Divide the class into three groups, assign each group with one of the three most common forms of heat energy: chemical, mechanical, or electrical. Allow the groups ten minutes to list as many examples of their specific type of heat energy as possible. Have a spokesperson from each group come up and list their findings for the class.

SUMMARY

Review chemical, electrical and mechanical heat energy and how they will play a major roll in the firefighters tactics and strategy.

Re-emphasize the importance recognizing sources of heat energy in the determination of cause in a fire incident.