

# LESSON ONE

## FIREFIGHTER II

### Building Construction

**DOMAIN:** COGNITIVE

**LEVEL OF LEARNING:** COMPREHENSION

#### **MATERIALS**

Slide projector and screen; overhead projector or laptop computer and multimedia projector; VCR and monitor; IFSTA Essentials 5th edition or Jones and Bartlett Fundamentals of Fire Fighter Skills 2<sup>nd</sup> Edition or Delmar Firefighter's Handbook 3<sup>rd</sup> Edition; Building Construction for the Fire Service 4<sup>th</sup> Edition; NFPA 220; NC Building Code classifications, Volume 1 General Construction, current edition; IFSTA Building Construction Related to the Fire Service 2<sup>nd</sup> Edition; Building Construction for the Fire Service 4<sup>th</sup> Edition.

#### **NFPA 1001 JPR, 2008 edition**

6.3.2 Coordinate an interior attack line for 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 forces that are exerted on a building, define and identify the various loads and their application to a building, identify the various structural members, and identify the various types of connections and how they behave under fire conditions.

## **ENABLING OBJECTIVES**

1. The Firefighter II candidate shall correctly define, in writing, the term gravity resistance system.
2. The Firefighter II candidate shall correctly define, in writing, the term loads as it relates to building construction.
3. The Firefighter II candidate shall correctly define, in writing, the terms: Compression, Tension, and Torsion forces and identify an example of each
4. The Firefighter II candidate shall correctly define, in writing, the terms: Dead load, Added Dead load, Live load, Added Live load, Impact load, Lateral Impact load, Static load, Repeated load, Wind load, Concentrated load.
5. The Firefighter II candidate shall correctly define, in writing, the term Fire load.
6. The Firefighter II candidate shall correctly identify and define, in writing, the following structural elements: Beams, Columns, and Walls.
7. The Firefighter II candidate shall correctly identify, in writing, the types of connections, reasons connections fail, and some important connection defects.

# **LESSON ONE**

## **FIREFIGHTER II**

### **Building Construction**

#### **MOTIVATION**

The purpose of buildings is to protect the occupants and contents from the weather. Buildings are constructed to defeat the force of gravity. Firefighters must be aware of the principles involved in defeating gravity in order to make sound judgments to keep crews safe.

#### **PRESENTATION**

##### **ENABLING OBJECTIVE #1**

The Firefighter II candidate shall correctly define, in writing, the gravity resistance system.

1. Gravity is the eternal enemy of a building.
2. The force of gravity is at work 24 hours a day, seven days a week.
3. Define the term "Gravity Resistance System."

Reference:

Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 12-13

#### **PRESENTATION**

##### **ENABLING OBJECTIVE #2**

The Firefighter II candidate shall correctly define, in writing, the term loads as it relates to building construction.

1. Define the term "Load."
2. A load in a building works to destroy the gravity resistance system.

Reference:  
Delmar Handbook 3rd edition, pages 385-386

Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, page 13

## **PRESENTATION**

### **ENABLING OBJECTIVE #3**

The Firefighter II candidate shall correctly define, in writing, the terms: Compression, Tension, and Torsion forces.

1. Define the term "Compression."
2. Define the term "Tension."
3. Define the term "Torsion."
4. Identify examples of each one.

Reference:  
Delmar Handbook 3rd edition, pages 386-387  
IFSTA Essentials 5th edition, page 158  
Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, page 13

## **PRESENTATION**

### **ENABLING OBJECTIVE #4**

The Firefighter II candidate shall correctly define, in writing, the terms: Dead load, Added Dead load, Live load, Added Live load, Impact load, Lateral Impact load, Static load, Repeated load, Wind load, Concentrated load.

1. Define the term "Dead load."
2. Discuss why fire resistance is a function of mass.
3. Define the term "Added Dead load."
4. Define the term "Live load."
5. Discuss the difference in Dead and Live loads from a design standpoint.

6. Define the term "Added Live Load."
7. Define the term "Impact load."
8. Define the term "Lateral Impact load."
9. Define the term "Static load."
10. Define the term "Repeated load."
11. Define the term "Wind load."
12. Discuss how a building can be braced to resist wind loads.
13. Define the term "Concentrated load."
14. Identify examples of each one.

Reference:

Delmar Handbook 3rd edition, pages 385-386

Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 13-18

## **PRESENTATION**

### **ENABLING OBJECTIVE #5**

The Firefighter II candidate shall correctly define, in writing, the term Fire load.

1. Define term "Fire load."
2. Discuss how the building itself can contribute to the fire load.
3. Review the term "British Thermal Unit."
4. List the BTU output of wood and plastic products.

Reference:

Delmar Handbook 3rd edition, pages 386-387

IFSTA Essentials 5th edition, pages 89, 152

Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> Edition, pages 19-20

## **PRESENTATION**

### **ENABLING OBJECTIVE #6**

The Firefighter II candidate shall correctly identify and define, in writing, the following structural elements: Beams, Columns, and Walls.

1. Define the term "Beam."
2. Discuss the behavior of a beam under load.
3. Discuss the load-carrying capacity of beams.
4. Define the following types of beams:
  - a. Simple beam
  - b. Continuous beam
  - c. Fixed beam
  - d. Joist
  - e. Girder
  - f. Lintel
  - g. Cantilever beam
  - h. Suspended beam
5. Define the term "Column."
6. Discuss diagonal columns.
7. Discuss the load-carrying capacity of columns.
8. Discuss the efficiency of columns based on their shape.
9. Define the purpose of a "Wall."
10. Discuss the two main divisions of walls.
  - a. Load-bearing
  - b. Non-load bearing
11. Define the following types of walls:
  - a. Cross wall
  - b. Veneer wall
  - c. Composite wall
  - d. Panel wall
  - e. Curtain wall
  - f. Party wall

- g. Fire wall
- h. Partition wall
- i. Cantilever wall

Reference:

Delmar Handbook 3rd edition, pages 387-388

J&B Fundamentals 2<sup>nd</sup> edition, pages 169-171

Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 23-31

## **PRESENTATION**

### **ENABLING OBJECTIVE #7**

The Firefighter II candidate shall correctly identify, in writing, reasons connections fail.

1. Discuss that connections are the weakest link in a building.
2. Discuss the two general types of connections.
  - a. Pinned
  - b. Rigid-framed
3. Discuss the ways that connections may fail.
4. Discuss sand-lime mortar.
5. Discuss Gravity connections.
6. Discuss gusset plates and the reason for plate failure.
7. Discuss the purpose of fire-cut beams.

Reference:

Delmar Handbook 3rd edition, page 389

Reference: Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 34-37

## **APPLICATION**

The Instructor may be able to utilize scrap lumber to demonstrate loads and forces, while photos of various building components or a trip through the local community may be utilized to show these components.

## **SUMMARY**

Reiterate the need for firefighters being able to recognize the various loads and forces that are acting on buildings and building components.

Emphasize how these loads are important to the firefighter in order to understand the possibility and probability of potential collapse.

# LESSON TWO

## FIREFIGHTER II

### Building Construction

**DOMAIN:** COGNITIVE

**LEVEL OF LEARNING:** COMPREHENSION

#### **MATERIALS**

Slide projector and screen; overhead projector or laptop computer and multimedia projector; VCR and monitor; IFSTA Essentials 5th edition or Jones and Bartlett Fundamentals of Fire Fighter Skills 2<sup>nd</sup> Edition or Delmar Firefighter's Handbook 3<sup>rd</sup> Edition; Building Construction for the Fire Service 4<sup>th</sup> Edition; NFPA 220; NC Building Code classifications, Volume 1 General Construction, current edition; IFSTA Building Construction Related to the Fire Service 2<sup>nd</sup> Edition; Building Construction for the Fire Service 4<sup>th</sup> Edition.

#### **NFPA 1001 JPR, 2008 edition**

6.3.2 Coordinate an interior attack line for 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 five types of construction classifications, identify the effects fire has on combustible and non-combustible construction materials and identify the associated hazards that can be created at a structure fire incident.

### **ENABLING OBJECTIVES**

1. The Firefighter II candidate shall correctly define in writing Type I Construction, and the fire hazard characteristics associated with it.
2. The Firefighter II candidate shall correctly define in writing Type II Construction, and the fire hazard characteristics associated with it.
3. The Firefighter II candidate shall correctly identify in writing Type III Construction, and the fire hazard characteristics associated with it.
4. The Firefighter II candidate shall correctly define in writing Type IV Construction, and the fire hazard characteristics associated with it.
5. The Firefighter II candidate shall correctly define in writing Type V Construction, and the fire hazard characteristics associated with it.
6. The Firefighter II candidate shall correctly identify in writing the effects of fire on building materials.
7. The Firefighter II candidate shall correctly identify hazardous conditions created by fire within a structure.

# **LESSON TWO**

## **FIREFIGHTER II**

### **Building Construction**

#### **MOTIVATION**

Buildings are designed and constructed to withstand the elements of nature such as wind, rain, snow, and gravity. These forces of nature and their influences can be predictable and, for this reason, they are taken into account during the planning and construction phase of a building. However, the occurrence of a fire and what it can do to a building is not predictable. The probability of a fire is low in many occupancies, but does exist, nonetheless. It's apparent that codes often permit construction materials to be used that give little or no consideration to the effect of fire. Subsequently, fire can quickly have a devastating effect in some occupancies, creating hazardous conditions for both the occupants and the firefighters. A good knowledge of building materials and the impact of fire on these materials shall prepare the firefighter for what to expect during firefighting operations and will allow them to operate at a greater margin of safety.

#### **PRESENTATION**

##### **ENABLING OBJECTIVE #1**

The Firefighter II candidate shall correctly define in writing Type I Construction, and the fire hazard characteristics associated with it.

1. Define the term "Fire Resistive Construction."
2. Discuss the fire-resistive ratings of the construction components used in Type I Construction.
3. Point out that the intent of Type I Construction is to confine any fire to its location.
4. Point out that the contents can represent the greatest fire hazard.

5. Discuss the problems associated with openings made in partitions. Example: HVAC systems, plumbing, and communication wiring.

**Note: Buildings are normally designed and constructed to meet the needs of the owner and the occupancy. They also need to be aesthetically pleasing. Buildings are constructed in a variety of ways utilizing many different types of materials in a single structure. However, building construction types can be generally grouped into a few classifications.**

6. Discuss the types of concrete used in construction.
7. Discuss the methods of providing fire resistance for steel, including concrete

Reference:

Delmar Handbook 3rd edition, pages 393-395

J&B Fundamentals 2<sup>nd</sup> edition, pages 157-158

IFSTA Essentials 5th edition, page 146

Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 225-240

## **PRESENTATION**

### **ENABLING OBJECTIVE #2**

The Firefighter II candidate shall correctly define in writing Type II Construction, and the fire hazard characteristics associated with it.

1. Define the term "Non-combustible Construction."
2. Discuss the fire-resistive ratings of the construction components used in Type II Construction.
3. Point out the differences in Type I and Type II construction.
4. Discuss the fire problems associated with insulated metal deck roofs.
5. Discuss the types of protection for steel structures.

Reference:

Delmar Handbook 3rd edition, page 395

J&B Fundamentals 2<sup>nd</sup> edition, page 158  
IFSTA Essentials 5th edition, page 147  
Brannigan's Building Construction for the Fire Service 4<sup>th</sup>  
edition, pages 212-217

## **PRESENTATION**

### **ENABLING OBJECTIVE #3**

The Firefighter II candidate shall correctly define in writing Type III Construction and the fire hazards associated with it.

1. Define the term "Ordinary Construction."
2. Discuss the fire-resistive ratings of the construction components used in Type III Construction.
3. Point out that the wood framing used in Type III Construction is of lesser dimension than that used in Type IV Construction.
4. Discuss the importance of fire stops that are sometimes used in Type III Construction.
5. Point out the general problems of Type III Construction.
6. Discuss the problems of walls and wall components of Type III Construction.
7. Discuss the collapse indicators and factors that can lead to collapse of Type III Construction.
8. Discuss the effects of interior structural elements and building contents have on exterior walls.
9. Discuss the interior structural support systems for Type III Construction, including floors.
10. Discuss the roof construction and roof hazards of Type III Construction.
11. Discuss the inherent hazard of fire and smoke spread through void spaces in Type III Construction.

Reference:

Delmar Handbook 3rd edition, pages 395-397

J&B Fundamentals 2<sup>nd</sup> edition, pages 158-159, 162-172  
IFSTA Essentials 5th edition, page 148  
Brannigan's Building Construction for the Fire Service 4<sup>th</sup>  
edition, pages 172-188

## **PRESENTATION**

### **ENABLING OBJECTIVE #4**

The Firefighter II candidate shall correctly define in writing Type IV Construction and the fire hazard characteristics associated with it.

1. Define the term "Heavy Timber."
2. Discuss the fire-resistive ratings of the construction components used in Type IV Construction.
3. Point out that the heavy timbers used in Type IV Construction retain their stability under fire conditions for long periods.
4. Point out the problems of a heavy fire load created by the heavy timbers.

References:

Delmar Handbook 3rd edition, pages 397-398  
J&B Fundamentals 2<sup>nd</sup> edition, pages 159-160  
IFSTA Essentials 5th edition, page 148

## **PRESENTATION**

### **ENABLING OBJECTIVE #5**

The Firefighter II candidate shall correctly define in writing Type V Construction and the fire hazard characteristics associated with it.

1. Define the term "Wood-frame Construction."
2. Discuss the fire-resistive ratings of construction components used in Type V Construction.
3. Point out that Type V Construction has a greater potential for rapid fire spread than the other types of construction.
4. Discuss the uses of wood in buildings.

5. Discuss the types of wood frame buildings.

Reference:

Delmar Handbook 3rd edition, page 398

J&B Fundamentals 2<sup>nd</sup> edition, pages 160-162

IFSTA Essentials 5th edition, pages 141-142, 149

Brannigan's Building Construction for the Fire Service 4<sup>th</sup> edition, pages 131-136

## **PRESENTATION**

### **ENABLING OBJECTIVE #6**

The Firefighter II candidate shall correctly identify in writing the effects of fire on building materials.

#### **Wood**

1. Discuss the reaction of wood to fire.
2. Discuss the factors that determine how fast wood burns.
3. Discuss the reaction of wood when water is applied to extinguish a fire.
4. Discuss the fire-retardant treatment of wood
5. Discuss the wide variety of wood products used in construction.

#### **Masonry**

1. Identify three products categorized as Masonry Components.
2. Identify and discuss the structural support systems where masonry is commonly used.
  - a. Fire walls
  - b. Cantilever walls
  - c. Veneer walls
3. Discuss the reaction of masonry to fire.
4. Discuss the reaction of masonry when water is applied to extinguish a fire.

5. Discuss the function of mortar to individual masonry units.

### **Cast Iron**

1. Point out that cast iron is seldom used in modern construction.
2. Discuss how it was used as a veneer wall in older buildings.
3. Point out that cast iron holds up well under fire conditions.
4. Discuss the primary concern with cast iron veneer walls under fire conditions.

### **Steel**

1. Point out that steel is the primary support material used in modern construction.
2. Discuss the effect fire has on steel.
3. Discuss the reaction of steel when water is applied for fire control and how it may prevent building collapse.
4. Discuss the fire characteristics of steel and steel as a construction material.
5. Discuss the factors in which unprotected steel fails

### **Reinforced Concrete**

1. Define the term "Reinforced Concrete."
2. Discuss the reaction of reinforced concrete to fire.
3. Discuss the damage indicators that firefighters should be alerted to.
4. Discuss the difference between cement and concrete.

### **Gypsum**

1. Define the term "Gypsum Board" and where it is used in construction.

2. Discuss the reaction of gypsum board to fire.
3. Point out that it provides a fire resistive covering to other structural members.
4. Discuss the six types of gypsum board and their applications.

### **Glass/Fiberglass**

1. Discuss the different types of glass.
2. Point out that glass is used in sheet form for windows and doors.
3. Discuss the fact that glass is an ineffective barrier to fire extension.
4. Point out that heated glass may crack and shatter when exposed to a cold fire stream.
5. Point out that fiberglass is used mainly for insulation purposes.
6. Point out that while glass component itself is not a significant fuel, the materials that bind it may be combustible and difficult to extinguish.

### **Plastics**

1. Define the term "Plastic."
2. Discuss how thermoplastics behave when exposed to heat.
3. Discuss the uses of plastics in construction.
4. Discuss the terms "thermoplastic materials" and "thermoset materials."

### **Other Materials**

1. Discuss the variety of other materials used in construction and their use in construction.

Reference:

Delmar Handbook 3rd edition, pages 390-392  
J&B Fundamentals 2<sup>nd</sup> edition, pages 153-157  
IFSTA Essentials 5th edition, pages 141-145

## PRESENTATION

### ENABLING OBJECTIVE #7

The Firefighter II candidate shall correctly identify hazardous conditions created by fire within a structure.

1. Discuss why it is important for each firefighter to be aware of hazards that may develop at a structural fire.
2. Discuss the two dangerous conditions that may be present at a structural fire.
  - a. Those conditions that may contribute to rapid fire spread.
    - i. Fire load
    - ii. Combustible furnishing and finishes
    - iii. Roof coverings
    - iv. Wooden floors and ceilings
    - v. Large open spaces
  - b. The indicators of building collapse.
3. Discuss safety precautions for personnel when dealing with possible structural collapse.
4. Discuss the hazards of construction, renovation, and demolition sites.
  - a. Rapid fire spread
  - b. Breached walls
  - c. Open stairwells
  - d. Potential for arson
  - e. Construction debris possibly blocking entrances and exits

Reference:

Delmar Handbook 3rd edition, pages 402-409  
IFSTA Essentials 5th edition, pages 152, 154-1566, 158-158

**Note: All the above points relating to building designs, construction materials, and fire loading can contribute to fire spread and building collapse.**

## APPLICATION

Slides on various types of building construction may be available to the instructor. If available, divide the class into small groups and have the students identify construction classifications, various building materials and hazardous conditions that may be present. An alternative to this exercise would require a trip through the community to allow each group to assess assigned areas to identify different types of construction classifications, various building materials, and hazardous conditions that may be present.

### **SUMMARY**

Reiterate the need for firefighters being able to recognize the general classification of building construction and the construction materials, which constitutes each classification.

Re-emphasize the need for firefighters to recognize dangerous conditions that may be present at a structure fire and possess the skills to safely mitigate the hazards.

**OBJECTIVE PAGE**

# **LESSON THREE**

# **FIREFIGHTER II**

# **Building Construction**

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**LEVEL OF LEARNING:** COMPREHENSION

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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 different material used in lightweight construction as well as identify lightweight construction components, describe their reaction to fire and truss locations found in structures.

## **ENABLING OBJECTIVES**

1. The Firefighter II candidate shall identify in writing, what is considered lightweight construction and the materials used in the components of lightweight construction.
2. The Firefighter II candidate shall describe in writing, the reaction of lightweight structural components to fire.
3. The Firefighter II candidate shall identify in writing, the locations where trusses can be found in structures.

# **LESSON THREE FIREFIGHTER II**

# Building Construction

## MOTIVATION

Lightweight construction is found just about everywhere today. Lightweight construction costs less and provides the building owner with an engineered building to suit their needs. Lightweight construction provides for a strong structure under normal conditions, but when subjected to fire can collapse without warning leading to injuries and deaths to firefighters and civilians alike. Lightweight construction will forever change the way structure fires are fought.

## PRESENTATION

### ENABLING OBJECTIVE#1

The Firefighter II candidate shall identify in writing, what is considered lightweight construction and the materials used in the components of lightweight construction.

1. Define the term "Truss construction."
2. Discuss "surface to mass ratio."
3. Discuss "Open web steel joists."
4. Discuss "Wood trusses."
5. Point out the different types of trusses.
6. Label the different parts of a truss.
7. Point out the difference between a steel truss and a wood truss.
8. Discuss the function of gusset plates to wooden trusses.
9. Define the term "Engineered wood structural member."
10. Define the term "Plywood."
11. Define the term "Oriented Strand Board."

12. Discuss compression and tension forces as it relates to truss construction.

Reference:

J&B Fundamentals 2<sup>nd</sup> edition, pages 168-169, 422-424  
IFSTA Essentials 5th edition, pages 101, 140, 156, 158  
Brannigan's Building Construction for the Fire Service 4<sup>th</sup> Ed.  
pages 52 and 136-137

## **PRESENTATION**

### **ENABLING OBJECTIVE#2**

The Firefighter II candidate shall describe in writing, the reaction of lightweight structural components to fire.

1. Discuss the statement – “Our trusses are engineered.”
2. Discuss hazards associated with a “truss void.”
3. Discuss the fire characteristics of steel trusses.
4. Discuss the fire characteristics of wood trusses.
5. Discuss the fire characteristics of wooden I beams.

Reference:

IFSTA Essentials 5th edition, page 156  
Brannigan's Building Construction for the Fire Service 4<sup>th</sup> Ed.  
pages 52 and 136-140

## **PRESENTATION**

### **ENABLING OBJECTIVE# 3**

The Firefighter II candidate shall identify in writing, the locations where trusses can be found in structures.

1. Discuss floor trusses.
2. Discuss roof trusses.

Reference:

J&B Fundamentals 2<sup>nd</sup> edition, pages 163-169, 422-423

## **APPLICATION**

Review the following NIOSH Firefighter Fatality reports found at:

<http://www.cdc.gov/niosh/fire/reports/face200707.html>

<http://www.cdc.gov/niosh/fire/reports/face200318.html>

<http://www.cdc.gov/niosh/fire/reports/face200127.html>

Review the NIOSH alert Preventing Injuries and Deaths of Firefighters Due to Structural Collapse. The document can be found at <http://www.cdc.gov/niosh/99-146.html>

## **SUMMARY**

Reiterate the need for firefighters to identify the locations of trusses and the procedures to take once they are identified to be under attack by fire.

Review the other types of lightweight construction and how it behaves when exposed to fire.