Module: Building Construction and Utilities

Description

This module prepares students to recognize the immediate hazards that are present during a structure fire, including those related to building utility systems. This is important because firefighters with an understanding of building components and how they interact during a fire will be able to predict the location, spread, and unseen hazards of fire. This includes an awareness of structural collapse, entry and egress routes, and effective application of ventilation and overhaul techniques.

Module Outcome

At the end of this module, the Firefighter I student will be able to operate safely during a structure fire by recognizing hazards associated with building construction, predict task assignments based on building use and style, and avoid becoming disoriented or trapped by hazardous finishes or structural collapse.

Standards

This module aligns with applicable standards in:

- NFPA 1 *Fire Code* ()
- NFPA 70 *National Electrical Code* ()
- NFPA 101 *Life Safety Code* (2024)
- NFPA 220 *Standard on Types of Building Construction* (2024)
- NFPA 1403 *Standard on Live Fire Training Evolutions* (2018)
- NFPA 1700 *Guide for Structural Fire Fighting* (2021)
- NFPA 5000 *Building Construction and Safety Code* (2024)

This module directly supports one Job Performance Requirements (JPRs) from NFPA 1010.

Table 1: Module Standards
NFPA 1010 (2024) Standard on Professional Qualifications for Firefighters
Chapter 6 — Firefighter I (NFPA 1001)

Standard	Requisite Knowledge or Skills
6.3.4 Force entry into a structure, given PPE, tools, and an assignment, so that the tools are used as designed, the barrier is removed, and the opening is in a safe condition and ready for entry.	• Basic construction of typical doors, windows, and walls within the community or service area.

Table 1: Module Standards NFPA 1010 (2024) Standard on Professional Qualifications for Firefighters Chapter 6 — Firefighter I (NFPA 1001)	
Standard	**Requisite Knowledge or Skills**
6.3.18 Turn off building utilities, given tools and an assignment, so that the assignment is safely completed.	• Properties, principles, and safety concerns for electrical, gas, and water systems. • Utility disconnect methods and associated dangers. • Use of required safety equipment. • Identify utility control devices, • Operate control valves or switches, • Assess for related hazards.

The NFPA defines requisite knowledge and requisite skills as the minimum a student needs to know and be able to do in order to accomplish the task defined in the JPR.

Module Learning Objectives

By the end of this module, Firefighter I students will:

Table 2: Learning Objectives Module: Building Construction and Utilities		
ID	**Objective**	**Alignment**
LO1	Recognize hazards associated with building construction, given a structure with visible construction features, so that construction type is identified, building materials and assemblies are described, and fire spread and structural collapse risks are predicted.	6.3.4
LO2	Predict life safety hazards, given a structure, observations of occupancy classification, and dwelling style, and incident response information, so that the potential number of occupants, fire load, and presence of fire protection systems is described.	
LO3	Control hazards associated with building utilities, given a residential structure, so that electrical, gas, and water utility sources are located, hazards are described, utility control tools are selected and used as designed, and utility disconnect methods are applied as appropriate.	6.3.18
LO4	Maintain situational awareness, given a structure and interior conditions, so that hazardous finishes are recognized, structural integrity is monitored, potential collapse zones are identified, and safe pathways for entry, exit, and movement are identified.	

Prerequisites

The prerequisite for this module is the Fire Behavior Module. Students need to understand how fire behaves before they can make sense of how buildings respond to it. This module will require students to predict how fire might move through walls, floors, and ceilings, understand which parts of a building are more likely to collapse, recognize hidden spaces that can allow fire to spread, and identify how fire can affect utility systems like gas, electric, and water. Without the Fire Behavior

module, students may struggle to understand the risks connected to different types of buildings and how those risks affect firefighter tasks.

Connections to Other Learning

This module supports other modules by serving as a bridge between the principles of fire science in the Fire Behavior module and the applied firefighting skills taught in subsequent modules.

The knowledge in this module specifically supports the following standards in other modules:

Table 3: Connections to Supported Standards
NFPA 1010 (2024) Standard on Professional Qualifications for Firefighters
Chapter 6 — Firefighter I (NFPA 1001)

Standard	Requirement
6.3.3 Establish and operate in work areas at emergency scenes	• Required knowledge includes potential hazards involved in operating on emergency scenes including utilities.
6.3.6 Set up, mount, ascend, dismount, and descend ground ladders	• Required knowledge includes what constitutes a reliable structural component for top placement.
6.3.9 Conduct a search and rescue in a structure operating as a member of a team	• Required knowledge and skills include the determination of tenability within a structure.
6.3.10 Attack an interior structure fire operating as a member of a team	• Required knowledge includes exposing hidden fires. • Required skills include locating and suppressing interior wall and subfloor fires
6.3.12 Perform vertical ventilation on a structure as part of a team	• JPR requires that structural integrity is not compromised. • Required knowledge includes the effects of construction type and elapsed time under fire conditions on structural integrity.
6.3.13 Overhaul a fire scene	• JPR requires that structural integrity is not compromised, and hidden fires are discovered. • Required knowledge includes methods used to expose hidden fire. • Required skills include remove flooring, ceiling, and wall components to expose void spaces without compromising structural integrity; and exposing hidden fires in walls, ceilings, and subfloor spaces.

Coherence

What Students Have Learned Previously	What Students Are Learning Now	What Students Will Learn Later
▪ **Fire Behavior**. Students have learned about the stages of fire development, types of fuels, and how fire spreads within a compartment.	▪ **Basic Engineering Principles**. How buildings are designed to carry weight, resist forces, and stay stable under normal and fire conditions. ▪ **Building Uses**. How different occupancy types affect life hazards, fire behavior, and fireground operations. ▪ **Utility Systems**. Recognize, locate, and control building utilities and understand how these systems create fireground hazards. ▪ **Structural Collapse**. Warning signs of collapse, how fire weakens building materials.	▪ **Ventilation**. Students will learn ventilation timing, methods, and safety based on fire behavior and building construction in the ventilation module. ▪ **Laddering**. Students will learn to choose safe and effective ladder positions in the ladders module. ▪ **Suppression**. Students will learn fire suppression techniques, water application, and nozzle control in the suppression module. ▪ **Search Patterns**. Students will learn to anticipate floor plans, identify collapse hazards, and navigate spaces in the search and rescue module.

Boundaries of Instruction and Assessment

In the early stages of training, students need to focus on basic skill acquisition and safety. The details of building construction can become too abstract without field context. Entry-level firefighters usually have narrowly defined roles on a fireground. A deep and comprehensive knowledge of structural systems is not typically necessary or practically applicable.

Instructors should focus on meeting the learning objectives and supporting the effective application of entry-level firefighting skills that require knowledge of building construction.

Module Assessments

Table 4: Formative Assessments
Module: Building Construction and Utilities

ID	Description of Skill	Standard	Description of Assessment
FA-01	Classify Construction Type	6.3.4	Students will identify the types of construction for buildings within the community or service area.

Table 4: Formative Assessments Module: Building Construction and Utilities			
ID	**Description of Skill**	**Standard**	**Description of Assessment**
FA-02	Control Natural and Propane Gas Utilities	6.3.18	Students will identify gas utility control devices and operate control valves to shut off natural and propane gas supply to an occupancy.
FA-03	Control Electrical Utilities	6.3.18	Students will identify electrical utility control devices and operate control switches to shut off electrical supply to an occupancy.
FA-04	Control Water Utilities	6.3.18	Students will identify water utility control devices and operate control valves to shut off water supply to an occupancy.
FA-05	Control Photovoltaic Utilities	6.3.18	Students will identify electrical utility control devices and operate control switches to shut off electrical supply from a photovoltaic source.

Table 5: Summative Assessments Module: Building Construction and Utilities	
Standards Assessed	**Description of Assessment**
Identify utility control devices.	When instructed, candidates will shut off a specified utility while maintaining awareness of potential hazards.
Operate control valves or switches.	
Assess for related hazards.	

Module Completion Criteria

To successfully complete this module, students must demonstrate all skills listed in Table 4.

Preparation, Materials, and Resources

Student Preparation

Students should review the relevant materials in their assigned textbook.

Instructor Preparation

- Read and annotate applicable chapters in the student textbook.
- (optional) Review Brannigan's Building Construction for the Fire Service, Sixth Edition
- Review and annotate the associated lesson plans and standard evolutions for this module.

Materials and Resources

- Depending on class size, location, and timing, instructors may choose to bring students to structures of note within the local community or service area to meet the requirements of FA-01 Classify Construction Type.

Revision History

The following table is provided as a quick reference.

Table 6: Revision History Module: Building Construction and Utilities	
Revision Date	**Revision Description**
	No revisions

Module Outline

Module: Building Construction and Utilities

Title Block 1: Online Learning

Lesson 1: Building Engineering Principles
(-- minutes)

Learning Objectives

LO1 Recognize hazards associated with building construction

Enabling Learning Objectives

1. Identify basic structural forces
2. Differentiate types of structural loads
3. Identify major structural components
4. Describe common building materials and their behavior under fire conditions
5. Identify heat effects on structural materials
6. Classify buildings by construction type

Lesson Outline	Resources
▪ Forces • Compression • Tension • Shear • Torsion ▪ Loads • Live load • Static load • Impact load ▪ Components • Foundations & Basements • Floors & Ceilings ▪ Beams, joists, and girders • Walls, Windows, & Doors ▪ Balloon and Platform Framing • Roofs & Attics ▪ Trusses • Stairwells ▪ Materials • Wood • Masonry • Steel • Concrete and Mineral • Glass • Plastic ▪ Construction Types • Type I – Fire Resistive ▪ Protected assembly	**Activities** **Materials** **Facilities** **Notes**

Module: Building Construction and Utilities

- Type II – Non-Combustible
  - Unprotected assembly
- Type III – Ordinary
  - Non-combustible exterior enclosing a wood frame
- Type IV – Heavy Timber
  - Non-combustible exterior enclosing a timber or laminated frame
- Type V – Wood Frame
  - Residential construction

Lesson 2: Building Systems
(-- minutes)

Learning Objectives

LO3 Control hazards associated with building utilities
LO4 Maintain situational awareness

Enabling Learning Objectives

1. Locate water service entry points
2. Explain water supply shutoff procedures
3. Describe hazards related to water systems and water weight
4. Identify fuel entry points and meter locations
5. Explain fuel shutoff procedures
6. Describe hazards associated with fuel systems
7. Locate electrical service entry points
8. Explain power shutoff procedures
9. Describe electrical hazards
10. Describe fireground hazards related to ventilation systems
11. Identify features that support or reduce compartmentation
12. Recognize hazards during utility control

Lesson Outline	Resources
▪ Utilities ▪ Water • Where it enters • How its distributed • How its shut off • What could go wrong ▪ Gas & Oil • Where it enters ▪ Natural gas ▪ Propane ▪ Heating oil • How its distributed • How its shut off	**Activities** **Materials** **Facilities** **Notes**

Module: Building Construction and Utilities

- What could go wrong
- Electric
  - Where it enters
    - Grid power
    - Solar panels
    - Battery backups
  - How its distributed
  - How its shut off
    - (PV) Rapid Shutdown
  - What could go wrong
- Building Ventilation
  - Compartmentation
  - Where air enters
  - How smoke and fire are distributed
  - Ventilation is controlled
  - How ventilation control is defeated

Lesson 3: Building Uses
(-- minutes)

Learning Objectives

LO1 Recognize hazards associated with building construction
LO2 Predict life safety hazards

Enabling Learning Objectives

1. Identify common occupancy classifications
2. Match construction types to occupancy classes
3. Estimate occupant load
4. Describe how time of day affects life hazards
5. Identify fuel loads and contents-based hazards
6. Recognize fire protection systems in different occupancies

Lesson Outline	Resources
▪ Occupancy Classifications • Common classes and their construction types ▪ Application to Firefighting • Number of occupants ▪ Time of day • Fuel loads & hazards • Protection systems	**Activities** **Materials** **Facilities** **Notes**

Module: Building Construction and Utilities

Lesson 4: Dwelling Styles
(-- minutes)

Learning Objectives

LO1 Recognize hazards associated with building construction
LO2 Predict life safety hazards

Enabling Learning Objectives

1. Identify common single-family dwelling styles
2. Describe construction features of each dwelling type
3. Recognize fire spread hazards in single-family dwellings
4. Predict life safety concerns in residential structures
5. Identify multi-unit dwelling types
6. Describe construction hazards of multi-unit dwellings
7. Predict life hazards in multi-unit dwellings

Lesson Outline	Resources
▪ Types of Residences • Cape • Colonial • Ranch • Split ▪ Multi-Unit Dwellings • Townhouses • Taxpayers • Mill Buildings (Type IV Apartment Buildings) • Type V Apartment Buildings	**Activities** **Materials** **Facilities** **Notes**

Lesson 5: Building Construction Under Emergency Conditions
(-- minutes)

Learning Objectives

LO1 Recognize hazards associated with building construction
LO2 Predict life safety hazards
LO4 Maintain situational awareness

Enabling Learning Objectives

1. Identify hazardous interior finishes
2. Describe the hazards associated with hoarding conditions
3. Identify structural features that create void spaces
4. Describe how void spaces contribute to hidden fire spread
5. Describe how common construction materials fail under fire conditions
6. Recognize signs of truss system failure
7. Identify visual indicators of potential building collapse
8. Describe factors that contribute to structural collapse
9. Explain common modes of structural collapse

Lesson Outline	Resources

Module: Building Construction and Utilities	
▪ Finishes • Hazardous finishes • Hoarding ▪ Void Spaces • Causes of void spaces • Extension of fire ▪ Degradation of Construction Materials • Steel • Timbers • Wood • Truss system failure • Plastics and Asphalt • Worcester Cold Storage Case Study ▪ Indicators of Collapse ▪ Factors Contributing to Collapse • Water load • Environment • Fire and Explosion Damage ▪ How Buildings Collapse • Facades • Strand Theater Case Study	**Activities** **Materials** **Facilities** **Notes**

Applicable Standards

NFPA 1

3.3.203 Occupancy.

See NFPA *101*. (FCC-FUN)

3.3.203.2* Apartment Building. A building or portion thereof containing three or more dwelling units with independent cooking and bathroom facilities. [***101*,** 2024] (FCC-FUN)

A.3.3.203.2 Apartment Building. The *Code* specifies that, wherever there are three or more living units in a building, the building is considered an apartment building and is required to comply with either Chapter 30 or Chapter 31 of NFPA *101*, as appropriate. Townhouse units are considered to be apartment buildings if there are three or more units in the building. The type of wall required between units in order to consider them to be separate buildings is normally established by the AHJ. If the units are separated by a wall of sufficient fire resistance and structural integrity to be considered as separate buildings, then the provisions of Chapter 24 of NFPA *101*, apply to each townhouse. Condominium status is a form of ownership, not occupancy; for example, there are condominium warehouses, condominium apartments, and condominium offices. [***101*,** 2024]

11.12 Photovoltaic Systems.

NFPA 70

Article 690

NFPA 220 Standard on Types of Building Construction (2024)

4.3.1 Type I and Type II Construction. Type I (442 or 332) and Type II (222, 111, or 000) construction shall be those types in which the fire walls, structural elements, walls, arches, floors, and roofs are of approved noncombustible or limited-combustible materials. [**5000:**7.2.3.1]

4.4.1 Type III Construction. Type III (211 or 200) construction shall be that type in which exterior walls and structural elements that are portions of exterior walls are of approved noncombustible or limited-combustible materials, and in which fire walls, interior structural elements, walls, arches, floors, and roofs are entirely or partially of wood of smaller dimensions than required for Type IV construction or are of approved noncombustible, limited-combustible, or other approved combustible materials. [**5000:**7.2.4.1]

4.5.1 Type IV Construction. Type IV (2HH) construction shall be that type in which fire walls, exterior walls, and interior bearing walls and structural elements that are portions of such walls are of approved noncombustible or limited-combustible materials, except as allowed for exterior walls in **4.5.6.7**. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood or cross-laminated timber without concealed spaces or with concealed spaces conforming to **4.5.4**and shall comply with the allowable dimensions of **4.5.5**. [**5000:**7.2.5.1]

4.6 Type V (111 or 000) Construction. Type V (111 or 000) construction shall be that type in which structural elements, walls, arches, floors, and roofs are entirely or partially of wood or other approved material. [**5000:**7.2.6]

NFPA 1403 Standard on Live Fire Training Evolutions (2018)

NFPA 1700 Guide for Structural Fire Fighting (2021)

3.3 General Definitions.

3.3.1 Abandoned Building. A building that is unoccupied/unused with no intention of re-occupying and reusing. [**1620**, 2020]

3.3.7 Basement. Any story of a building wholly or partly below grade plane that is not considered the first story above grade plane.

3.3.27 Compartmentation. The interposing of a physical barrier that is not required to be fire or explosion resistant in order to limit combustible particulate solid migration and hence to control the size of a hazard area. [**654,** 2020]

3.3.28 Concealed Space. That portion(s) of a building behind walls, over suspended ceilings, in pipe chases, and in attics whose size might normally range from 44.45 mm (13⁄4 in.) stud spaces to 2.44 m (8 ft.) interstitial truss spaces and that might contain combustible materials such as building structural members, thermal and/or electrical insulation, and ducting. [**96,** 2017]

3.3.31 Construction Type. The combination of materials used in the construction of a building or structure, based on the varying degrees of fire resistance and combustibility. [**5000,** 2018]

3.3.51* Energy Storage System (ESS). One or more components assembled together capable of storing energy and providing electrical energy into the premises wiring system or an electric power production and distribution network. [**70:**706.2]

A.3.3.51 Energy Storage System (ESS). ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., fly wheels and compressed air). These systems can have ac or dc output for utilization and can include inverters and converters to change stored energy into electrical energy.

3.3.59 Exposure — Structure. The side of a structural assembly or separate part of the fireground that is directly exposed to the fire to which the fire could spread.

3.3.64 Fire Alarm System. A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. [**72,** 2019]

3.3.68 Fire Department Connection (FDC). A connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other water-based fire protection systems, furnishing water for fire extinguishment to supplement existing water supplies. [**24,** 2019]

3.3.71 Fire Resistive Construction. Construction designed to provide reasonable protection against fire.

3.3.90 Fuel Load. The total quantity of combustible contents of a building, space, or fire area, including interior finish and trim, expressed in heat units or the equivalent weight in wood. [**921,** 2017]

3.3.108 High-Rise Building. A building where the floor of an occupiable story is greater than 75 ft (23 m) above the lowest level of fire department vehicle access. [**5000,** 2018]

3.3.113 HVAC Ventilation. Air flows due to fixed building heating ventilation and air conditioning systems.

3.3.129 Knee Wall. A short wall, typically under 3 ft (1 m) in height, used to create a room, such as a living space within an attic, and whose creation results in a void space behind the knee wall and the underside of the roof.

3.3.134* Lightweight Construction. Structures that have framework made out of wood or other lightweight materials.

A.3.3.134 Lightweight Construction. Lightweight construction can include, but is not limited to, the following:

(1) Lightweight wood structural members such as engineered-type trusses, laminated beams, oriented strand board (OSB), or other such products that are attached with lightweight nail plates or glued and pressed in place

(2) Lightweight metal structural members of light gauge metal in the form of bar trusses and other such materials

3.3.157 Photovoltaic (PV) System. The total components, circuits, and equipment up to and including the PV system disconnecting means that, in combination, convert solar energy into electric energy. [**70:**100]

3.3.192 Special Amusement Building. A building that is temporary, permanent, or mobile and contains a device or system that conveys passengers or provides a walkway along, around, or over a course in any direction as a form of amusement arranged so that the egress path is not readily apparent due to visual or audio distractions or an intentionally confounded egress path, or is not readily available due to the mode of conveyance through the building or structure. [***101*****,** 2018]

3.3.197 Sprinkler System. A system, commonly activated by heat from a fire and discharges water over the fire area, that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system aboveground is a network of specially sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a system pattern. [**13,** 2019]

3.3.198 Stack Effect. The vertical airflow within buildings caused by the temperature-created density differences between the building interior and exterior or between two interior spaces. [**92,** 2018]

3.3.228 Vacant. No furnishings or equipment present. [**901,** 2016]

3.3.235 Ventilation Control Device. Using an object to limit the amount of air available to the fire.

3.3.246 Void Space. Cofferdams and spaces not normally accessible or used for storage.

7 Building Construction and Structural Considerations

7.4 General.

7.4.1 Compartmentation. Compartmentation is the ability to contain a fire to an area to limit the growth and spread of fire and smoke to other areas of a structure. Internal construction that provides limits to the amount of open spaces within a structure. The type of construction and the occupancy establishes the level of compartmentation and boundary properties such as how the floor, wall, and ceilings are finished along with the thermal properties of those finishes.

7.4.1.1* The compartment size in terms of its area and height, the open volume of rooms, and geometry, such as sloped ceilings within, all play a role in shaping the growth in the size of a fire and the progress of the burning regime(s) to be encountered within the volume.

A.7.4.1.1 Traditional post-WWII home construction was typically one story in height with an area of 90 m^2 (1000 ft^2), consisting of many small volume rooms with 2.4 m2 (8 ft2) ceilings. Fires within these small homes tended to become ventilation controlled fairly quickly as the available oxygen was consumed by the fire. In contrast, modern homes have areas that run from 230 m2 to 420 m2 (2500 ft^2 to 4500 ft^2) with open concept floor plans, great rooms, or foyers with two-story high ceilings. The same fire within a larger volume will tend to grow in scale and be sustained given the available oxygen and the ability of buoyant smoke to spread, mix with air, and be collected in the upper regions of the great room due to the sloped (angled) ceiling well above the fire. Like the smaller volume home, the larger fire will eventually become ventilation controlled. The difference between the two scenarios is the lack of protective compartmentation, degree of fire development, and ultimate danger to occupants and responders due to rapid fire progress upon the reintroduction of air.

7.4.1.2 Compartment size is a factor in determining fire spread within each type of construction.

7.4.2* Finishes. Finishes are non-load-bearing materials that provide for the surface layer of an interior or exterior structural component. Finishes can range from highly combustible to noncombustible materials. Construction finishes can have a high (thermally thick) or low (thermally thin) thermal mass, which can affect the ability of a compartment to absorb and hold heat energy. This can affect the fire growth rate.

A.7.4.2 Once finishes have absorbed the heat energy, they will tend to hold it and this will make it difficult to cool the smoke. Metal claddings have a low thermal mass and an inability to absorb heat but transfers that heat quickly through conduction to other potential combustibles.

Well-insulated linings will hold the heat energy in the fire compartment and this may accelerate fire growth. Combustible linings will produce pyrolysis gases as they are heated to about 572°F to 752°F

(300°C to 400°C) and this will contribute to fuel accumulating in the upper region of the fire room or compartment.

7.4.3 Protective Features. Part of the structural evaluation and the ability to contain or limit fire spread of a fully developed fire is an assessment of the protective features within the structure. Both passive (e.g., fire code drywall, fire walls) and active (e.g., sprinklers, stairwell pressurization systems) methods, and the role they might play in fire control and protecting life, property, and environmental exposures both internal and external to the compartment fire should be considered.

7.4.4 Fire Protection Systems. Fire alarm and suppression systems are designed to provide early notification, prevent or limit fire growth, support intervention, and enhance occupant and fire fighter safety. Knowledge and understanding of these systems, in conjunction with pre-emergency planning and fire prevention activities, are important components of conducting effective structural fire-fighting operations.

7.4.4.1 Fire Alarm Systems. A fire alarm system is a system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal initiating devices and to initiate the appropriate response to those signals. Fire alarm systems are designed to provide notification of alarm, supervisory, and trouble conditions, alert occupants, summon aid, and initiate emergency control functions. *(See NFPA 72 for additional information.)*

7.4.4.2 Fire Command Center. The fire command center is the principal attended or unattended room or area where the status of the detection, alarm communications, control systems, and other emergency systems is displayed and from which the system(s) can be manually controlled. They are typically provided in high-rise or other complex buildings. This area can be used as the incident command post for fire control operations.

7.4.4.2.1 Emergency Voice Communication System. Emergency voice communication systems are for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action. The notification is often both audible and visual.

7.4.4.2.2 Fire Department Communication Systems. Fire department communication systems are usually found in high-rise buildings where normal fire department radio connectivity could be impacted. These systems typically consist of two-way telephone type systems and are used to connect the incident commander with fire response teams deployed in a structure. As an alternative to the dedicated fire communication system, a fire service radio signal enhancement system may be installed. One benefit of these systems is that fire fighters can use radios they regularly use and are familiar with.

7.4.4.3 Fire Suppression Systems.

7.4.4.3.1 Water-Based Systems. A water-based suppression system is an integrated network of piping with water under pressure that allows water to be discharged immediately when a sprinkler head operates. It typically consists of a water supply source(s), network of piping, and sprinkler heads. Sprinkler systems are designed to provide early fire control or extinguishment, helping to mitigate the hazards for occupants and fire fighters. The system is commonly activated by heat

from a fire and discharges water over the fire area. *(See NFPA 13, 13R, and 13D for additional information.)*

7.4.4.3.2 Non-Water-Based Suppression Systems. There are a number of special extinguishing systems that may be found within buildings and structures. They are designed to protect specific hazards, enclosures, or areas within a building. The method of these systems is to suppress the fire through any combination of cooling, displacement of oxygen, and inhibiting the chemical chain reaction. *(See NFPA 12 for additional information.)*

7.4.4.3.3 Standpipe Systems. Standpipe systems are a series of fixed piping typically found in high-rise and larger buildings and storage areas. These systems connect a water supply to hose connections located within the building. They help eliminate the need for long hose lays and are designed for the purpose of manual fire-fighting operations by the fire department or trained building occupants. *(See NFPA 14 for additional information.)*

7.4.4.3.4 Fire Department Connections. Fire department connection is a method for the fire department to supply either a primary or a secondary water supply to standpipe systems or to supplement existing water supplies for fire sprinkler systems. Knowledge of the location and arrangement of fire department connections in advance of an emergency can facilitate more efficient and effective fire-fighting operations. The location can be visually identified on site by the appropriate signage or special lighting.

7.4.5 Building Utilities.

7.4.5.1 Electrical. Fire personnel must be aware of the electrical hazards at all structure fires. Electric hazards should be assumed during all phases, especially during aerial and ground ladder placements. Modern services allow for secondary electrical sources to activate once primary sources fail or are disconnected.

7.4.5.2 Fuel Gas. Gas (i.e., propane/natural gas) size-up at structure fires should assume the presence of gas for cooking or heating. If the fire is gas fed — that is, the gas piping or appliance was part of the ignition source and ultimately failed and is releasing gas into the fire — it is imperative to shut off gas supply before completely extinguishing. Water supply should be directed in a way that does not extinguish fire exiting from gas piping but to direct water stream to extinguish the surrounding areas.

7.4.6 Lightweight Construction. Lightweight construction can present special hazards including the early failure of structural components and collapse. (*For reference see NIOSH ALERT, Preventing Injuries and Deaths of Fire Fighters due to Truss System Failures*.)

7.5 Types of Construction. The five NFPA types of construction (fire resistive, noncombustible, heavy timber, ordinary, and wood frame) provide context for the assessment of fire propagation within that type. Therefore, type of construction is a primary building factor to evaluate.

7.5.1* Type I: Fire-Resistive Construction. These structures are classified as fire-resistive as all structural support members are protected with a fire-rated assembly. Typically, these structures protect a large number of occupants. Examples of Type I construction include high-rise buildings, healthcare facilities, and parking garages.

A.7.5.1 The fire-resistance rating is based upon assembly testing utilizing ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*. A Type I structure will have a minimum of a 3-hour fire-resistance rating. The goal is to compartmentalize and protect the structural integrity of the building permitting interior fire-fighting operations and the evacuation of occupants. An ASTM E119 fire-resistance rating does not necessarily mean an assembly will protect the structure for the designated rating consistently. It is a testing system that utilizes the same testing formulas and stresses to compare dissimilar materials with the results reported in an hourly rating. Fire service members should be aware of the levels of ratings and expectant performances. This is beyond the scope of this document but an important consideration.

7.5.1.1 Type I Building Materials.

Type I building materials are noncombustible materials. These materials can include steel, concrete, masonry, and glazings.

7.5.1.2 Components of Type I Construction.

7.5.1.2.1 Common fire protection features may include the following:

(1) Fire protection suppression systems, which include the following:

(a) Dedicated wet pipe system, which is most common

(b) Clean agent, CO_2, water mist for server room/electrical room applications, which are less common

(2) Common area interior finishes regulated for fire safety

(3) Common area furnishings regulated for fire safety

(4) No unprotected structural components (e.g., fire spray protections of beams, intumescent paint)

(5) Monitored fire alarm system with various detection elements

(6) Fire-rated separations, assemblies, doors

(7) Fire pump rooms

(8) Standpipes

7.5.1.2.2 Common life safety features may include the following:

(1) Travel distances

(2) Signage

(3) Smoke control and evacuation

(4) Emergency lighting

(5) Elevator recalls

(6) Stairwell pressurization control

7.5.1.2.3 Common Occupancies for Type I Construction.

7.5.1.2.3.1* High-Rise. Stack effect is the movement of air into and out of buildings, chimneys, flue gas stacks, or other containers, resulting from air buoyancy. Buoyancy occurs due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences. The buoyant force creates differential pressures that can have significant impact on smoke, air, heat and flame (SAHF) movement and control. Stack effect is usually associated with tall buildings due to the numerous leakage paths, shafts and ductwork that are compounded by operational practices and occupant behavior when opening and failing to close doors. Stack effect can be used to great advantage in clearing stairwells during high-rise operations and even more so in winter conditions.

A.7.5.1.2.3.1 Stack effect is the movement of air into and out of buildings, chimneys, flue gas stacks, or other containers, resulting from air buoyancy. Buoyancy occurs due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences. The buoyant force creates differential pressures that can have significant impact on SAHF movement and control. Stack effect is usually associated with tall buildings due to the numerous leakage paths, shafts, and ductwork that are compounded by operational practices and occupant behavior when opening and failing to close doors. Stack effect can be used to great advantage in clearing stairwells during high-rise operations and even more so in winter conditions.

It should be noted that stack effects in winter are significant even in a one- or two-story house and very significant in tall buildings. Reverse stack effects are another possibility in warm climates within air-conditioned buildings, where smoke flow can be reversed and flows down a shaft can confuse the observer as to the actual fire location.

Extremely low ambient temperatures, for example, can cause rapid cooling of discharged smoke. The cooler smoke will have decreased buoyancy, and entrained water will condense and cause larger particles normally lofted in the smoke plume to be precipitated out to produce a dense white smoke. When combined with “low atmospheric pressure,” an inversion layer can form that will prevent the smoke from rising.

The lack of buoyancy in the smoke may suggest to the observer that the fire intensity is not that great when in fact it may be quite severe.

7.5.1.2.3.2 Other Occupancies. Other common occupancies for Type I construction include the following:

(1) Hospitals

(2) Healthcare facilities

(3) Industrial facilities

(4) University facilities

(5) Newer commercial structures

(6) Parking garages

7.5.1.3 Green Construction Insulating Materials Considerations for Type I Buildings. (Reserved)

7.5.1.4 Vulnerabilities of Type I Buildings. Examples of Type I building vulnerabilities include the following:

(1) Elevators to get to fire floor (high-rise)

(2) Limited ladder truck access (high-rise)

(3) Fire could be remote from building entry

(4) Need controlled evacuation/movement of occupants

(5) Limited entrance and egress to fire floor

(6) Must rely on building fire protection and life safety features (command center, fire pump, sprinkler system, standpipes)

(7) Complex ventilation issues (heat, smoke control, stratification of smoke produced)

(8) Transport of personnel and equipment to upper floors (weight, fatigue)

(9) Delay in response to fire area

(10) Wind-driven

(11) Collapse zone should be considered (larger than other types of construction)

7.5.2 Type II: Noncombustible Construction. Type II is similar to Type I construction and can be considered to be noncombustible. Type II construction may contain protected structural assemblies; however, unlike Type I, they can contain unprotected assemblies. Type II construction can be Type IIA or Type IIB. Type IIA is required to protect structural assemblies with a 1-hour fire-resistance rating. The designer or builder may use a few strategies to achieve the rating, but the most common method is an assembly utilizing gypsum board. Type II may have occupancies including educational, assembly, business, and so forth.

7.5.2.1* Type II Building Materials. Type II building materials are noncombustible materials. These materials can include steel, concrete, masonry, and glazings. Type II B construction utilizes a noncombustible material to construct the structural components of a building. Examples would be metal-bar joist truss, steel I-beams, cold form steel, and so forth.

A.7.5.2.1 While these structural components are noncombustible, they tend to fail very early in a fire when exposed to elevated heat. Steel will elongate and deform when exposed to temperatures of 1000 °F (538°C). The endurance of the steel depends on the mass of the steel. The smaller the structural element the less time until structural compromise. Many of the steel structural components in Type IIB are lightweight and will fail early in an event.

7.5.2.2 Components of Type II Construction.

7.5.2.2.1 Common fire protection features may include the following:

(1) Fire protection suppression systems

(a) Dedicated wet pipe system, which is most common

(b) Clean agent, CO_2, water mist for server room/electrical room applications, which are less common

(2) Common area interior finishes regulated for fire safety

(3) Common area furnishings regulated for fire safety

(4) Monitored fire alarm system with various detection elements

(5) Fire rated separations, assemblies, doors

(6) Fire pump rooms

(7) Standpipes

7.5.2.2.2 Common life safety features may include the following:

(1) Travel distances

(2) Signage

(3) Smoke control and evacuation

(4) Emergency lighting

(5) Elevator recalls

(6) Stairwell pressurization control

7.5.2.2.3 Common occupancies for Type II construction include the following:

(1) Strip malls

(2) Mercantile

(3) Educational

(4) Assembly

(5) Business

(6) Car dealerships

7.5.2.3 Green Construction and Insulating Materials Considerations for Type II Buildings. (Reserved)

7.5.2.4 Vulnerabilities of Type II Buildings. Types of Type IIB occupancies fire fighters will encounter include box stores, strip malls, car dealerships, and so forth. In some cases, these occupancies may be protected with active sprinkler protection, but in many occupancies there is no sprinkler protection leading to catastrophic collapse very early in the event. Fire fighters must use extreme caution in these structures because of the likelihood of early structural collapse due to

the effect of heat on unprotected structural components. Examples of Type II building vulnerabilities include the following:

(1) Large open-area floor plans, achieved by utilizing lightweight truss construction

(2) Elevators to get to fire floor (e.g., elevated, but not full high-rise)

(3) Limited aerial fire apparatus access

(4) Fire remote from building entry

(5) Need controlled evacuation/movement of building occupants

(6) Limited entrance and egress to fire floor

(7) Must rely on building fire protection and life safety features (e.g., command center, fire pump, sprinkler system, standpipes)

(8) Complex ventilation issues (e.g., heat, smoke control, stratification of smoke produced)

(9) Transport of personnel and equipment to upper floors (e.g., weight, fatigue, dehydration)

(10) Delay in response to fire area

(11) High winds

(12) Collapse zone consideration

7.5.3* Type III: Ordinary Construction. Ordinary construction has a noncombustible exterior but the structural components are combustible. Most common Type III structures have a masonry exterior enclosing a wood frame. As with Type II, there are occupancies that are designated as Type IIIA and Type IIIB. Consistent with Type II, the Type IIIA has a 1-hour rating, and Type IIIB is not required to protect the combustible structural components.

7.5.3.1 Type III Building Materials. Type III building materials include noncombustible materials for exterior walls and can include combustible interior building elements. Exterior wall materials can include masonry and glazings. Interior building elements can include conventional or pre-engineered wood framing. Older structures can have solid-sawn wood construction.

7.5.3.2 Components of Type III Construction.

7.5.3.2.1 Common fire protection features may include the following:

(1) Sprinkler systems

(2) Fire alarm systems

(3) Higher rated separations (passive fire protection) in lieu of active fire protection such as sprinklers and fire alarm systems in alternative construction

(4) Common area interior finishes regulated for fire safety

(5) Common area furnishings regulated for fire safety

(6) Fire rated separations, assemblies, doors

(7) Fire pump rooms

(8) Standpipes

7.5.3.2.1.1 Fire protection construction requirements vary by local code for Type III construction.

7.5.3.2.2 Common life safety features may include the following:

(1) Travel distances

(2) Signage

(3) Emergency lighting

(4) Elevators

7.5.3.2.3 Common occupancies for Type III construction include the following:

(1) Residential

(2) Mercantile

(3) Mixed use

(4) Strip malls

7.5.3.3 Green Construction Considerations for Type III Buildings.

7.5.3.3.1 Insulating Materials. (Reserved)

7.5.3.3.2 Light-Weight Construction. (Reserved)

7.5.3.4 Vulnerabilities of Type III Buildings. Type III buildings may be protected with active sprinkler protection but in many occupancies there is no sprinkler protection, leading to catastrophic collapse very early in the event. Fire fighters must use extreme caution in these structures because of the likelihood of early structural collapse due to the effect of heat on unprotected structural components. Common vulnerabilities to Type III construction include the following:

(1) Open floor plans, achieved by utilizing lightweight truss construction

(2) Limited, unknown, or inconsistent building fire protection and life safety features

(3) Ventilation issues (heat, smoke control)

(4) Collapse zone consideration

(5) Fire spread to adjacent separated spaces within the building envelop through penetrations, unprotected openings, interstitial spaces, and so forth

(6) When present, fire sprinkler systems for residential occupancies might not provide coverage in concealed combustible spaces, such as attics

7.5.4 Type IV: Heavy Timber. Type IV Construction has historically been associated with older large industrial sites. Constructed using unprotected heavy timber structural members and wide open floor plans, these structures are associated with large fire events. These occupancies are commonly renovated into mixed-use residential and mercantile occupancies.

7.5.4.1* Type IV Building Materials. Type IV building materials include noncombustible materials for the exterior walls and interior building elements composed of solid or laminated wood without concealed spaces. Older structures can have solid-sawn wood construction.

A.7.5.4.1 Modern Type IV structures utilize a more modern approach to heavy timber. Due to environmental concerns and supply challenges within the timber industry, many Type IV structures are using Glulam or laminated lumber in place of heavy timber. These products are created using pieces of dimensional lumber glued and compressed together to form one solid structural component. The resulting product is designed to carry and distribute an impressive load. The debate is how these structural members perform under fire conditions. Incident commanders should understand the type of construction within the Type IV construction when the structure is involved with fire.

Another form of construction that may fall under the Type IV construction category that is gaining interest is cross laminated timber (CLT). CLT is simply the use of layering of structural lumber boards stacked crosswise (typically at 90 degrees) and glued together on their wide faces and, sometimes, on the narrow faces as well. Manufacturers will layer dimensional lumber, which can consist of 2 × 4, 2 × 6, 2 × 8, and so forth. They will initially set a layer of lumber horizontally, then vertically, then horizontally, and so on until reaching the desired thickness. This thickness may be seven to 11 layers or greater. Manufacturers then calculate the inherent fire-resistance rating based on the established char rate for the used species. Completed products resemble a large block, and they are placed as a wall, floor, or ceiling. The result is similar to modular construction. The CLT slabs are mechanically connected and reinforced with adhesives. This is a rapidly developing market, and fire service members should monitor proposed construction projects in their jurisdictions to understand the buildings in their response districts.

At this time, CLT structures have been proposed for use in high-rise structures, but research is ongoing. Fire services members should be aware of the positives and negatives of this type of construction and remain alert for updated research as it becomes available.

7.5.4.2 Components of Type IV Construction.

7.5.4.2.1 Common fire protection features may include the following:

(1) Sprinkler systems

(2) Fire alarm systems

(3) Common area interior finishes regulated for fire safety

(4) Common area furnishings regulated for fire safety

(5) Fire rated separations, assemblies, doors

(6) Fire pump rooms

(7) Standpipes

7.5.4.2.1.1 Fire protection construction requirements vary by local code for Type IV construction.

7.5.4.2.2 Common life safety features may include the following:

(1) Travel distances may not comply due to older structures

(2) Signage

(3) Emergency lighting

(4) Elevators

7.5.4.2.3 Common occupancies for Type IV construction include the following:

(1) Mixed-use residential and mercantile occupancies

(2) Warehouse

7.5.4.3 Green Construction and Insulating Material Considerations for Type IV Buildings. (Reserved)

7.5.4.4 Vulnerabilities of Type IV Buildings. Due to the open floor plans, heavy fuel load, and combustible construction, Type IV buildings have been a challenge for many fire departments when involved with fire. Much of the current building stock was constructed over 100 years ago and is in various stages of occupancy. While constructed for industrial use, current structures are in use in a wide variety of occupancies, including residential as “loft” apartments or condos. Once a fire gains headway in these structures, it can be a long night. Common vulnerabilities for Type IV construction include the following:

(1) Outdated or unmaintained fire protection features

(2) Vacant structures, unmaintained

(3) Prone to vandalism and large fires

(4) Large open floorplans

(5) Prone to large long duration fire incidents due to heavy timber

(6) Concealed spaces, unknown compartmentation, and interstitial spaces in renovated Type IV buildings

(7) Collapse zones

7.5.4.2 Components of Type IV Construction.

7.5.4.2.1 Common fire protection features may include the following:

(1) Sprinkler systems

(2) Fire alarm systems

(3) Common area interior finishes regulated for fire safety

(4) Common area furnishings regulated for fire safety

(5) Fire rated separations, assemblies, doors

(6) Fire pump rooms

(7) Standpipes

7.5.4.2.1.1 Fire protection construction requirements vary by local code for Type IV construction.

7.5.4.2.2 Common life safety features may include the following:

(1) Travel distances may not comply due to older structures

(2) Signage

(3) Emergency lighting

(4) Elevators

7.5.4.2.3 Common occupancies for Type IV construction include the following:

(1) Mixed-use residential and mercantile occupancies

(2) Warehouse

7.5.4.3 Green Construction and Insulating Material Considerations for Type IV Buildings. (Reserved)

7.5.4.4 Vulnerabilities of Type IV Buildings. Due to the open floor plans, heavy fuel load, and combustible construction, Type IV buildings have been a challenge for many fire departments when involved with fire. Much of the current building stock was constructed over 100 years ago and is in various stages of occupancy. While constructed for industrial use, current structures are in use in a wide variety of occupancies, including residential as “loft” apartments or condos. Once a fire gains headway in these structures, it can be a long night. Common vulnerabilities for Type IV construction include the following:

(1) Outdated or unmaintained fire protection features

(2) Vacant structures, unmaintained

(3) Prone to vandalism and large fires

(4) Large open floorplans

(5) Prone to large long duration fire incidents due to heavy timber

(6) Concealed spaces, unknown compartmentation, and interstitial spaces in renovated Type IV buildings

(7) Collapse zones

7.5.5* Type V: Combustible Construction. The vast majority of Type V construction is residential construction. Type V may be classified as VA or VB. Type VA is required to carry a 1-hour fire-resistance rating.

A.7.5.5 By far the majority of fires encountered by the U.S. Fire Service occur in Type VB construction. Single- and two-family structures are prime examples of Type VB. It would be easy to classify most single-family structures as Type VB and lump the various structural components into one category, but it is not that simple.

7.5.5.1 Type V Building Materials. Type V building materials include structural elements, exterior walls, and interior walls composed of any materials, often combustible. These materials often include conventional wood, glue laminated wood, pre-engineered wood, and other lightweight systems. Older structures can have solid-sawn wood construction.

7.5.5.2 Components of Type V Construction.

7.5.5.2.1 Common fire protection features may include the following:

(1) Sprinkler systems

(2) Fire alarm systems

(3) No requirements for fire resistance of contents

(4) Fire rated separations, assemblies, doors

(5) Fire pump rooms

(6) Standpipes

7.5.5.2.1.1 Fire protection construction requirements vary by local code for Type V construction.

7.5.5.2.2 Common life safety features may include the following:

(1) Travel distances

(2) Signage

(3) Emergency lighting

(4) Elevators

7.5.5.2.3 Common occupancies for Type V construction include the following:

(1) Single-family and two-family dwellings

(2) Multi-family, business, or assisted living facilities

7.5.5.3 Green Construction and Insulating Material Considerations for Type V Buildings. (Reserved)

7.5.5.4 Vulnerabilities of Type V Buildings. Fire fighters can begin to assess the presence of Type V building construction based upon the occupancy of the structure. Even if the structure has a 1-hour rating, caution should be exercised due to the large amount of concealed spaces. These spaces

may potentially conceal fire, unburnt fuel, and fire extension. Opening these spaces can have explosive results as the super-heated gases mix with the newly available oxygen. Common vulnerabilities for Type V construction include the following:

(1) No enforceable fire code in private residences

(2) Vacant/abandoned structures, unmaintained, prone to vandalism

(3) Fire growth can be rapid over non-rated contents

(4) Collapse zones

(5) Highest frequency of accidental fires within this construction type (cooking, smoking, etc.), which can lead to increased fire fighter injuries

(6) When present, fire sprinkler systems for residential occupancies might not provide coverage in concealed combustible spaces, such as attics

7.6 Special Structures or Occupancies. Some structures where fires will occur cannot be classified within the context of building type as defined by the building codes or present unique vulnerabilities due to life safety or internal process. Examples of these types of structures that might require special consideration and planning for fire-fighting activities include the following:

(1) Industrial settings

(2) Silos

(3) Underground buildings and occupancies; below grade

(4) Limited-access structures

(5) Theaters

(6) Churches

(7) Industrial facilities, such as power plants

(8) Special amusement buildings

(9) Piers and water-surrounded structures

7.7 Emerging Building Features. Emerging building features may inhibit fire-fighting operations due to the presence of a new feature (e.g., one that emits energy, increases a load, or creates an obstruction).

7.7.1 Photovoltaic. An often-used green initiative is photovoltaic (PV) solar panels to generate electrical power. A PV system typically includes the PV module (array) that generates electric direct current from the sun's energy, inverters that convert direct current to alternating current, and disconnects that isolate the PV module (array) from the building's electrical circuitry conduit. The system may include an electric storage device (batteries) to store the solar-generated electricity. Even if the PV system is disconnected, a PV module will always generate electricity when the sun

shines. Therefore, the units will almost always contain energy and can present a significant electric shock hazard to fire fighters should a fire occur.

7.7.1.1 In addition to the shock hazard, a PV system poses other safety considerations. Structural collapse is a concern due to the added weight from the system, especially when structural elements experience fire conditions. The PV panels and system components can be combustible and add fuel to a fire, and the PV system can also provide an ignition source.

7.7.1.2 Solar power installations can obstruct access for fire-fighting activities, including vertical ventilation and stretching of hose lines, thereby reducing the effectiveness of suppression operations. Strong building code adoption and enforcement can address structural load requirements and proper installation of the PV system. Fire department standard operating procedures (SOPs) or standard operating guidelines (SOGs) should be in place to clarify response strategies and tactics. Identifying and preplanning such installations are also essential components of effective response.

7.7.1.3 The rapidly growing solar industry throughout North America and much of the world increases the potential for a fire department response to a building fire containing a photovoltaic system. These systems present safety hazards and tactical issues to the responding department.

7.7.1.4 The following are the three types of photovoltaic systems:

(1) Stand-alone. A stand-alone photovoltaic system is not connected to power grid. It may contain solar panels, batteries, combiner boxes, charge controls, and inverters.

(2) Grid interactive. A grid interactive photovoltaic system is connected to the grid and may contain solar panels, combiner boxes, charge controls, and inverters.

(3) Hybrid. A hybrid photovoltaic system is a grid interactive system containing batteries.

7.7.1.5 Photovoltaic systems present a variety of safety hazards, including the following, to fire fighters during and after fire control operations:

(1) Shock hazard due to direct contact with energized components of the system during fire control operations

(2) Shock hazard from water from fire control operations

(3) Shock hazard after fire control operations

(4) Collapse hazard due to weakening of structure members

(5) Tactical issues to fire fighters during fire control from photovoltaic systems connected to and located on buildings

(6) Vertical ventilation issues

(7) Hose stream application

(8) Overhaul issues

(9) Shielded fires

7.7.2 Energy Storage Systems. The following are examples of energy storage systems:

(1) Battery systems

(2) Hydrogen generators

7.7.3 Vegetative Roof. Another popular green initiative is a vegetative, or green, roof on a building to reduce the carbon footprint and improve insulation. Green roofs typically consist of a growth medium on top of a root barrier, drainage and water-retention layers, and a waterproof base. Foliage is planted in the growth medium. A green roof reduces building energy consumption, and the overall positive effect to the environment is unquestioned.

7.7.3.1 A properly designed and well-maintained green roof can actually reduce the threat of a roof fire, since a green roof system contains a large amount of aggregate material that is not combustible. However, a green roof can pose potential risks to the building itself or neighboring buildings if it is not designed and maintained properly. A vegetative roof can accumulate dead or dry plantings that provide a highly combustible fuel source that can cause a fire to spread within the building or to adjacent buildings.

7.7.3.2 Other risks include roof collapse if the underlying structure experiences the effects of fire, possibly enhanced by the saturation of the growth medium from fire streams or a malfunctioning drainage system. Additionally, green roofs may affect fire department access and hinder standard fire-fighting operations, including ventilation and deployment.

NFPA 80 *Standard for Fire Doors and Other Opening Protectives* (2025)

NFPA 220 *Standard on Types of Building Construction* (2024)

Chapter 3 — Definitions

3.3 General Definitions

3.3.1 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this standard. [**5000,** 2024]

Chapter 4 — Types of Construction

4.1 General.

4.1.1* Buildings and structures shall be classified according to their type of construction, which shall be based upon one of five basic types of construction designated as Type I, Type II, Type III, Type IV, and Type V, with fire resistance ratings not less than those specified in **Table 4.1.1** and Sections **4.3** through **4.6**, and with fire resistance ratings meeting the requirements of Chapter **5**. [**5000:**7.2.1.1]

A.4.1.1 The system of designating types of construction also includes a specific breakdown of the types of construction through the use of Arabic numbers. These Arabic numbers follow the roman numeral notation where identifying a type of construction [e.g., Type I(442), Type II(111), Type

III(200)] and indicate the fire resistance rating requirements for certain structural elements as follows:

(1) First Arabic number — exterior bearing walls
(2) Second Arabic number — columns, beams, girders, trusses and arches, supporting bearing walls, columns, or loads from more than one floor
(3) Third Arabic number — floor construction

[**5000:**A.7.2.1.1]

Where **Table 4.1.1** references floor/ceiling assemblies or roof/ceiling assemblies, the term *assembly* refers to a combination of materials comprising the walking surface of the floor or the exterior surfaces of the roof, horizontal supporting construction and possibly the ceiling membrane. Typically, such assemblies include the walking surface of the floor or the exterior surfaces of the roof and all horizontal structural members (elements) supporting the walking surface of the floor or the exterior surfaces of the roof. Where the assembly has a fire resistance rating, cavity insulation, ceiling membrane layers affixed or suspended from the underside of the horizontal structural members (elements), and any required opening protection for penetrations such as, but not limited to, recessed lights, HVAC diffusers, penetrating cables, or pipes are regulated. See Section 8.6 of *NFPA 5000* for requirements governing horizontal assemblies having a fire resistance rating. See 8.12.1.1(1) of *NFPA 5000* for horizontal assemblies not having a fire resistance rating. [**5000:**A.7.2.1.1]

Table A.4.1.1 provides a comparison of similar types of construction for various model building codes. [**5000:** A.7.2.1.1]

4.1.2 Where two or more types of construction are used in the same building, the entire building shall be classified as the least type of construction in the building and shall be subject to the requirements for that type, except as permitted by other provisions of *NFPA 5000*. [**5000:**7.2.1.2]

4.1.3 Requirements for specific materials, types of construction, and fire protection shall be minimum requirements, and any material, type of construction, or fire protection affording safety or a fire resistance rating equal to or greater than that provided in *NFPA 5000* shall be permitted. [**5000:**7.2.1.3]

4.1.4

Materials shall be in accordance with all of the following, except as modified by any special requirements in Section **4.3**:

(1) Chapter 41, Concrete, of *NFPA 5000*
(2) Chapter 42, Aluminum, of *NFPA 5000*
(3) Chapter 43, Masonry, of *NFPA 5000*
(4) Chapter 44, Steel, of *NFPA 5000*
(5) Chapter 45, Wood, of *NFPA 5000*
(6) Chapter 46, Glass and Glazing, of *NFPA 5000*
(7) Chapter 47, Gypsum Panel Products, Lath, and Plaster, of *NFPA 5000*
(8) Chapter 48, Plastics, of *NFPA 5000*

[**5000:**7.2.1.4]

4.1.5 Noncombustible Material.

4.1.5.1* A material that complies with any one of the following shall be considered a noncombustible material:

(1)* The material, in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

A.4.1.5.1(1) Examples of such materials include steel, concrete, masonry, and glass. [**5000**:A.7.1.4.1.1(1)]

A.4.1.5.1 The provisions of 4.1.5.1 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [**5000**:A.7.1.4.1]

4.1.5.2 Where the term limited-combustible is used in this standard, it shall also include the term noncombustible. [**5000**:7.1.4.1.2]

4.3 Type I (442 or 332) and Type II (222, 111, or 000) Construction.

4.3.1 Type I and Type II Construction. Type I (442 or 332) and Type II (222, 111, or 000) construction shall be those types in which the fire walls, structural elements, walls, arches, floors, and roofs are of approved noncombustible or limited-combustible materials. [**5000:**7.2.3.1]

4.4 Type III (211 or 200) Construction.

4.4.1 Type III Construction. Type III (211 or 200) construction shall be that type in which exterior walls and structural elements that are portions of exterior walls are of approved noncombustible or limited-combustible materials, and in which fire walls, interior structural elements, walls, arches, floors, and roofs are entirely or partially of wood of smaller dimensions than required for Type IV construction or are of approved noncombustible, limited-combustible, or other approved combustible materials. [**5000:**7.2.4.1]

4.5 Type IV (2HH) Construction.

4.5.1 Type IV Construction. Type IV (2HH) construction shall be that type in which fire walls, exterior walls, and interior bearing walls and structural elements that are portions of such walls are of approved noncombustible or limited-combustible materials, except as allowed for exterior walls in 4.5.6.7. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood or cross-laminated timber without concealed spaces or with concealed spaces conforming to 4.5.4and shall comply with the allowable dimensions of 4.5.5. [**5000:**7.2.5.1]

4.6 Type V (111 or 000) Construction. Type V (111 or 000) construction shall be that type in which structural elements, walls, arches, floors, and roofs are entirely or partially of wood or other approved material. [**5000:**7.2.6]