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Building Systems

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Knowledge Objectives (1 of 3)

- Identify construction types in commercial and residential structures.
- Explain fire behavior as it relates to the method of construction.
- Discuss the structural integrity of construction assemblies during a fire.

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Knowledge Objectives (2 of 3)

- Analyze the relationship of building construction on fire investigations, including types of construction, construction assemblies, and finish materials.

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Knowledge Objectives (3 of 3)

- Evaluate fire protection systems and building services, and discuss how their installation affects the ignition of fires in buildings.

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Introduction

- Fire development and movement are influenced by building:
  - Design
  - Materials
  - Construction
- Fire investigator must understand building construction and systems

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Building Systems Overview (1 of 4)

- Some modern building techniques are result of fire analysis
- More than 50% of modern codes are related to fire protection.
- Compartmentation:
  - Confining a fire in its room, area, or structure of origin
  - Interstitial spaces are not afforded as much protection.

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Building Systems Overview (2 of 4)

- Fire investigator should know basics of:
  - Active and passive building systems
  - Manual and automatic fire detection and suppression systems
  - HVAC, utilities, compartmentation

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Building Systems Overview (3 of 4)

- Fire investigator should be familiar with:
  - Fire dampers, smoke dampers
  - Commercial cooking equipment
  - Automatic fire sprinkler systems
  - Fire alarm and voice activation components
  - Signaling systems for monitoring fire alarms

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Building Systems Overview (4 of 4)

- Fire investigator should be familiar with (cont'd):
  - Fire doors and windows
  - Fire resistance-rated wall and ceiling assemblies
  - Automatic extinguishing systems for commercial cooking
  - Standpipe systems

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Design, Construction, and Structural Elements

- Characteristics that affect fire development, spread, and control:
  - Type of construction
  - Integrity and performance under fire load
  - Building systems
  - Number of doors, windows, other openings
  - Interior layout and finish materials

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Building Design (1 of 4)

- Factors affecting fire spread:
  - Room size, interior finish, shape, ceiling height, placement of doors and windows
- Building loads
  - Live loads can change (eg, water from firefighting operation).
  - Dead loads are constant and immobile.
- Loads beyond structure's parameters may create instability

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Building Design (2 of 4)

- Structural changes may be deliberate or accidental.
- Geometry of room is important in fire development.
  - Smaller room reaches flashover faster

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Building Design (3 of 4)

- Compartmentation
  - Examine walls to determine which are load-bearing and if they were constructed to resist passage of fire and/or smoke.
  - Examine fire doors to determine whether automatic closers worked.
  - Consider fire intensity.

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Building Design (4 of 4)

- Interstitial and concealed spaces can provide a mechanism for fire spread.
  - Generally lack fire stops, which may allow for vertical spread
  - Modern building codes sometimes allow concealed spaces if they are constructed on non-combustible material.
- Original plans for a structure may not match what was finally constructed.

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Building Materials

- Chemical composition, thermal conductivity, and density impact fire growth and speed.
- Thermoplastics can greatly increase heat release rates.
- Placement of materials (fuel loads)
  - e.g., carpet on a wall rather than floor increases fire spread
- Steiner Tunnel Test establishes flame spread
  - ASTM E 84

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Occupancy

- Investigator should look for changes in use or occupancy classification.
- Changes can result in introduction of fuel loads beyond designed fire protection system capacity.

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Types of Building Construction

- Ordinary construction
- Wood frame construction
- Mill construction
- Noncombustible construction

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Ordinary Construction (1 of 2)

- Called “ordinary” because used in variety of buildings

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Ordinary Construction (2 of 2)

- Exterior walls are masonry or other noncombustible material.
- Floor, roof, and partition framing are wood.
- Open vertical shafts and multiple ceilings affect fire spread.

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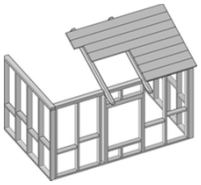
Wood Frame Construction (1 of 9)

- Exterior walls and load-bearing components are constructed of wood or other combustible materials



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Wood Frame Construction (2 of 9)

- Generally associated with residential or lightweight commercial construction
- Buildings are of limited size.
- Building offers little fire resistance.
- Type V as defined in NFPA 220

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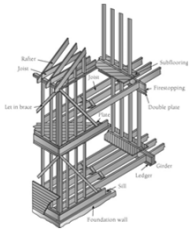
Wood Frame Construction (3 of 9)

- Platform frame construction



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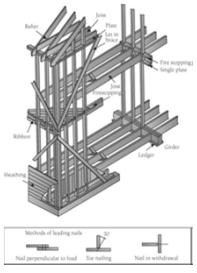
Wood Frame Construction (4 of 9)

- Balloon frame construction



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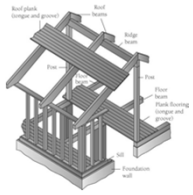
Wood Frame Construction (5 of 9)

- Plank-and-beam construction



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Wood Frame Construction (6 of 9)

- Post-and-frame construction relies on the posts for most of its support.

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Wood Frame Construction (7 of 9)

- Heavy timber construction has wood frame, open spaces, and large areas of interior combustibles.

Courtesy of APA – The Engineered Wood Association

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Wood Frame Construction (8 of 9)

- Alternative residential construction
  - Manufactured homes
  - Modular homes
  - Steel-framed homes
    - Frame is non-combustible but can lose its structural capacity during fire
- Manufactured wood and laminated beams

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Wood Frame Construction (9 of 9)

- Rating of wood frame assemblies
  - Tested after covering with gypsum board
  - Remember that a fire-rated wall may fail in the field sooner than in the test.

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Mill Construction

- Early form of heavy timber construction developed by insurance companies
  - Masonry exterior walls
  - Columns and beams are heavy timber.
  - Walls with fire rating of at least 2 hours
  - Interior walls with rated doors
  - No concealed spaces
  - Sprinkler systems

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Noncombustible Construction

- Used mainly for industrial storage and high-rise construction
- Materials used do not add to fuel load
- Metal construction

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Construction Assemblies

- Manufactured parts put together that may or may not be fire resistance rated
- Investigator must identify any flaws in a component of the overall assembly

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Floor, Ceiling, and Roof Assemblies

- Among the first assemblies to fail
- Factors affecting failure include:
  - Type of structural element
  - Protection from the elements
  - Span, load, and beam spacing
  - Live loads during firefighting (eg, water)
- Potential collapse should be a vital concern.

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Walls

- May or may not be fire-resistance rated or load-bearing
- Fire wall separates buildings or compartmentalizes interior areas
- Fire barrier resists passage of fire and smoke
- Smoke barriers resist smoke movement

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Doors (1 of 2)

- Can serve as critical factor to limiting fire spread
- Have a fire protection rating

Courtesy of SecurallDoors.com

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Doors (2 of 2)

- A fire-rated door assembly must have the following components:
  - Hinges
  - Closure
  - Latching devices
  - Glazing

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Concealed Spaces

- Commonly have been penetrated for utility access
- Examine these penetrations to see if they were properly sealed.

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Effects of Weather on Building Systems (1 of 2)

- Weather severity may require an investigation to be delayed.
- Special clothing and equipment may be needed.

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Effects of Weather on Building Systems (2 of 2)

- Fire can be affected by wind, humidity, ambient temperature
- Weakened structures may require bracing before inspection.

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Summary (1 of 6)

- Modern design considerations and construction features are a direct result of the analysis of (often catastrophic) fires.

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Summary (2 of 6)

- An investigator needs to have an understanding of building systems, including detection, suppression, HVAC, utilities, and building compartmentation ratings.

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Summary (3 of 6)

- Building characteristics affecting the development, spread, and control of a fire include the type of construction, the integrity of its structural elements under a fire load, and its fire protection and other building systems.

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Summary (4 of 6)

- Orientation, position, and placement of materials make a difference in how the materials react under fire conditions.

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Summary (5 of 6)

- The investigator should determine and document the type of construction based on the structural elements of the building. Documentation of structural elements, breaches, structural changes, or other factors that may influence the integrity or fire spread of the structure should be noted.

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Summary (6 of 6)

- Because assemblies are designed as a complete unit, the integrity of the unit and its ability to perform during a fire are dependent on the unit being manufactured, installed, and maintained in the form for which it was intended.