

**Fire Inspector Certification
Program****New Jersey Uniform Fire Code
Inspector training program**

Module 7 Building Construction & Plan Review



Start**Part 2 of 2**

**Understanding Building
Loads**

Buildings are subject to many different forces under normal conditions and in extreme weather events.

From the day it is built, a structure is under the continuous effects of gravity, i.e., once built it wants to fall down in response to nature's gravity pull.

A combination of loads may help to expand the effect of gravity.

3

Load Types

- Dead Load: *Defined below*
- Live Load: *Defined below*
- Fuel Load: *The amounts of combustible materials located in the building*
- Impact Load: *Things that may strike the building with speed or force*
- Concentrated Load: *Heavy items located in a small area or space on structural elements*
- Distributed Load: *Heavy weight that is distributed over large areas of the structure*

4

Types of Loads

Dead Load

The weight of all materials of construction incorporated into the building, including but not limited to, walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural components, and fixed service equipment including the weight of cranes.

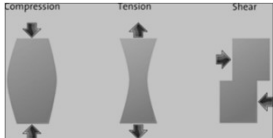
Types of Loads

Live Load

Those loads produced by the occupancy of the building or structure, not including construction loads or environmental loads such as wind loads, snow loads, rain loads, earthquake loads, flood loads or dead loads. Live loads on a roof are those produced during maintenance by workers, equipment and materials, and during the life of a structure by people and moveable objects.

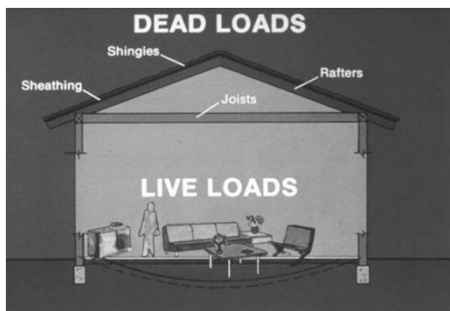
Forces on Loads

- **Axial:** Forces applied to a structure by wind
- **Compression:** Forces applied to a structure that compresses building elements
- **Tension:** Forces that pull structure components in opposite directions
- **Shear:** Forces that separate materials from each other horizontally



7

Dead Vs Live Loads



Loads

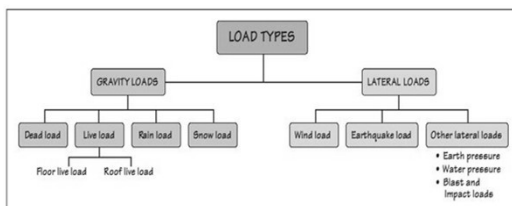
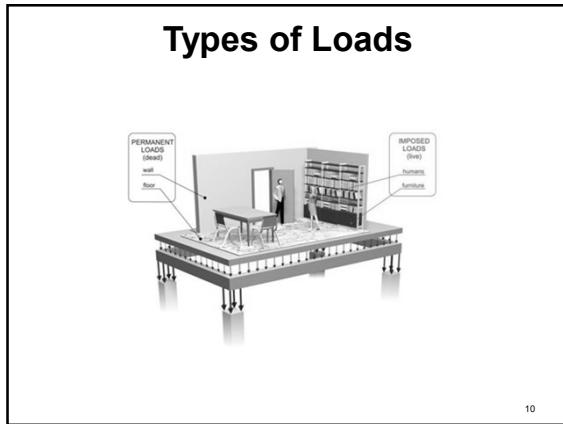
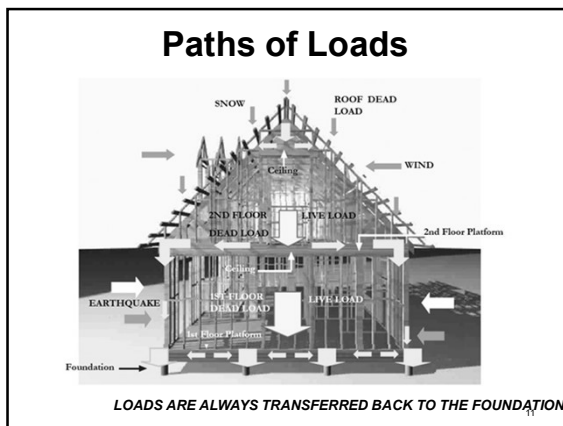
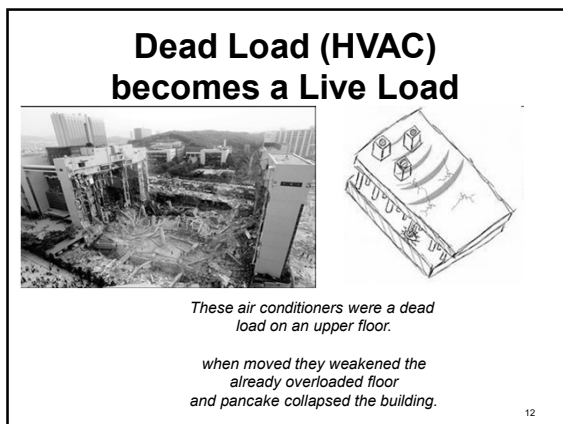


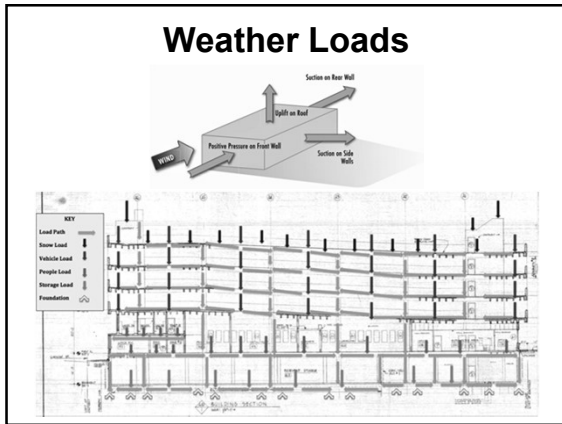
FIGURE 1 Some of the important loads in buildings.

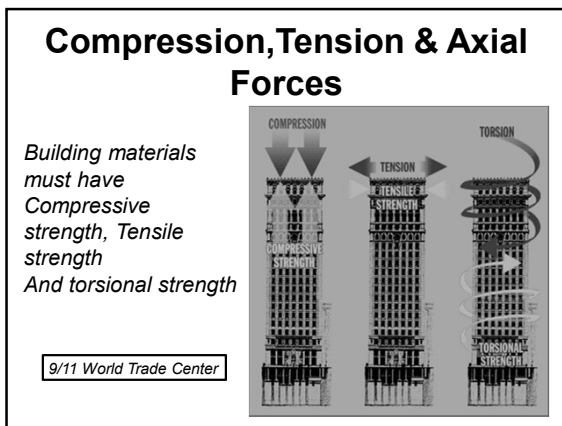
9

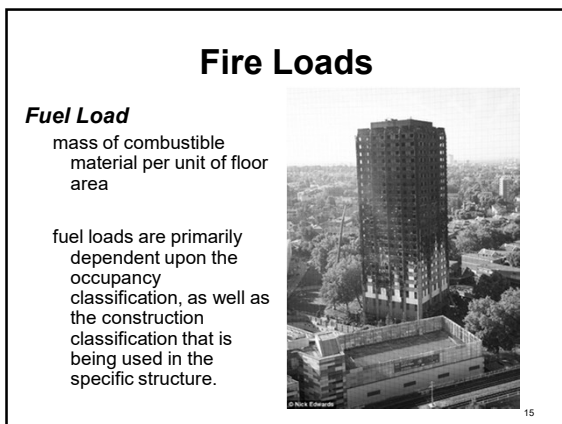












Fuel Load

The contents should be the primary concern when evaluating the fuel. The following items should be taken into consideration in the evaluation:

- 1. *The amount of fuel, measured in lb./sq. ft.*
- 2. *Btu output per lb. of fuel per sq. ft.*
- 3. *Rate of heat release.*
- 4. *Configuration of fuel.*
- 5. *Burning characteristics of the fuel.*
- 6. *Amount of fuel per individual area.*
- 7. *Configuration of the area.*

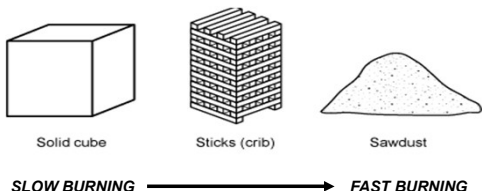
Ordinary combustibles = 8,000 – 9,000 btu/lb.
Plastics, rubber, flammable liqs. = 16,000 – 22,000 btu/lb.

Fire Inspectors often may find storage with BTU potential higher than design

16

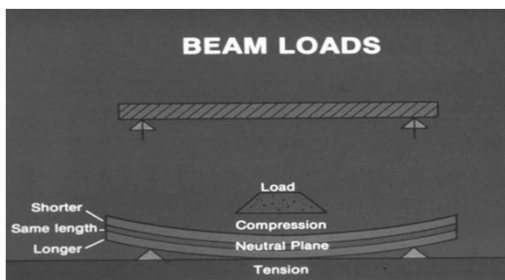
Fuel Load

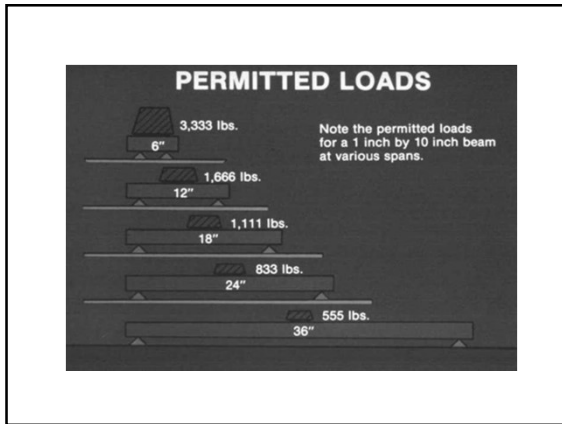
Configuration of Fuel

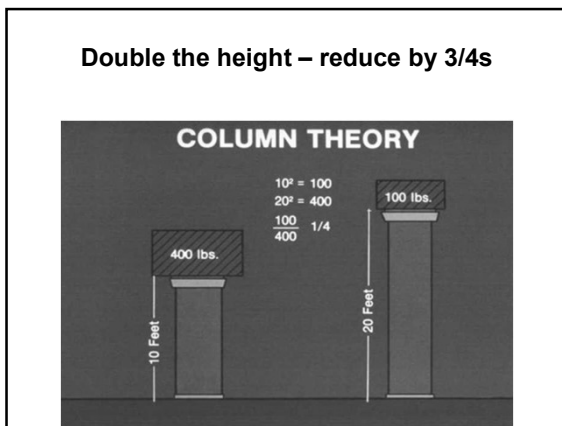


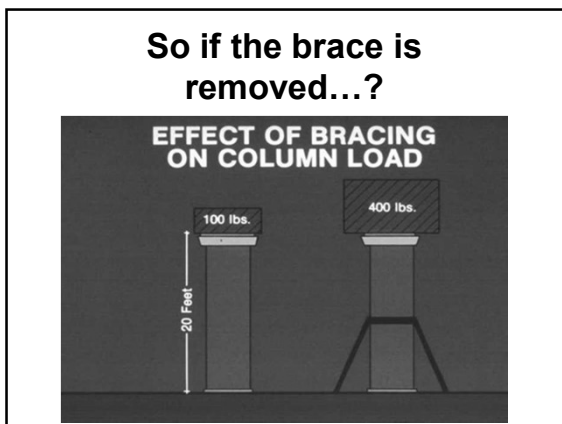
17

Beams and Columns









Planning

The Planning Process

- *Building a new structure or rehabilitating an existing structure follows a process.*
- *This process is established by law and begins with local planning and zoning regulations*
- *The purpose of this process is to regulate community growth and development*

NJSA 40:55-1 et seq.

- *The New Jersey Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq., is the legislation that enables municipalities to establish their own development rules through the adoption of a Zoning Ordinance and a Zoning Map*



Zoning Ordinances

- **The zoning ordinance provides the specifics of what may be built in each zone, such as:**
 - Permitted uses (including conditional uses—such as a place of worship in a residential zone)
 - Permitted lot size and dimensions
 - Allowable building area
 - Allowable building height
 - Required yard setbacks (the distances that a building must be situated away from a lot line)
 - Parking requirements
 - And often much more

Zoning Requirements

- **Communities divide land parcels up into different categories:**
 - Low, medium & high density residential housing
 - Commercial and business use
 - Industrial and factory use
 - Open space
 - Agricultural and farm use
 - Water shed & green spaces



Planning & Zoning Process

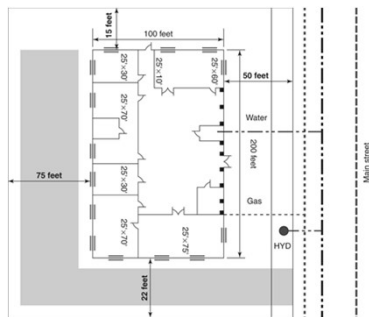
- **Typically planning & zoning boards will review projects and forward copies of the plans to the different agencies for comment. These may be police, fire, EMS, building, code enforcement etc.**



Site Plans

- Two-dimensional drawing of building located on proposed building lot and block
- Locator map assists in identifying area of community
- Site plans show street frontage and interior lot lines and building set backs to adjoining properties
- Site plans also include utility locations

FIGURE 14.1 The site plan details the relation of the building to the lot as well as utilities, parking, driveways, fire hydrants, and other features.

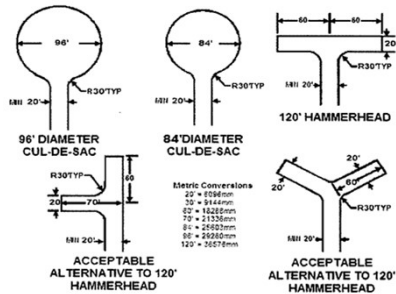


Courtesy of "Principles of Code Enforcement" - J. Foley

Vehicle Access

- Fire code establishes minimum width of fire lane. (IFC 503.2.1)
- Local zoning codes may address road access within community. (IFC 503.1.1.1)
- Width and height of fire apparatus must be considered in reviewing access to the property.
- Cul de sacs or "T" turn around must be of adequate radius and length. (IFC 503.2.5)

Vehicle Access



Grades and Vehicle Weight

- Road surfaces must support at least 75,000 pounds of gross vehicle weight. (IFC 503.2.3)
- Asphalt roads should incline no more than 8–10% grade
- Concrete roads may have inclines of 15% grade
- Topography and access driveways must avoid steep inclines for fire department vehicle access (IFC 503.2.7)

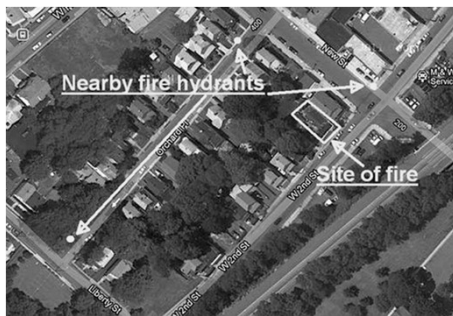
Steep Grades



Fire Hydrant Locations

- Hydrants and other utilities will be identified on site plan (IFC 507)
- Hydrants may be marked to be either; installed, removed, or relocated.
- Spacing depends on fire demand zone.
- Hydrant spacing should follow local requirements of other national standards

Fire Hydrants



Standpipe and Automatic Sprinklers

The Fire Inspector may review:

- Location of the water supply for the building site and the best location for the fire department connection
- Ensure the water supply main size will support the fire protection systems with sufficient fire flows.

Fire Department Connections



What's Next?

■ After planning & zoning approval the next step is applying for construction permits

- Permit application
- Subcode applications
- Approved site plan
- Zoning permit
- Prior approvals
- 2-3 sets of plans
- 20 day review(max)



Uniform Construction Code

■ Fire Inspectors need to understand that installation, repairs, alterations and reconstruction all require building permits under the UCC. Other than ordinary repairs.

■ Once the permit is obtained, the Fire Inspector has no further authority on design, installation, testing, variation

Ordinary Repairs - Fire

■ Ordinary fire protection maintenance projects at N.J.A.C. 5:23-2.7(c)4 do not require a permit application to be filed with the local enforcing agency and therefore, no inspection is required.

- Replacement of ANY sprinkler or smoke alarm, smoke detector, or heat detector head with a like device;
- Repair or replacement of ANY component of a fire alarm or smoke and heat detection equipment (other than the replacement of a fire alarm control panel);
- Installation of ANY battery-powered smoke alarm;
- Installation of ANY battery-powered or plug-in type carbon monoxide alarm.

Minor Work

■ Fire protection projects that fall between ordinary maintenance and full-blown projects would be described as "minor work" at N.J.A.C. 5:23-2.17A(c). These types of projects include:

- Installation of any fire detection or suppression device in any ONE- or TWO-FAMILY DWELLING;
 - Installation of a burglar alarm, security system, or doorbell in structures OTHER THAN one- and two-family dwellings.
- The exception to this (full permit) is controlled, delayed, or sensor released egress doors

Minor Work

- ANY change of an existing transmission means from a digital alarm communicator transmitter to a fire alarm supervising station.

■ Note that a certified fire alarm service company, licensed fire alarm company or licensed electrical contractor is required to submit Form F-391 signed by the contractor to provide a verification statement in writing to the Fire Protection Subcode Official within 24 hours that all required signals remain operational after the new transmission means is installed;

- Repair and/or renovation work in a Group B, Group F, Group M, or Group S occupancy.

All other Projects

- *Everything other than ordinary repair or minor work will require building permits and plans submissions under the UCC*



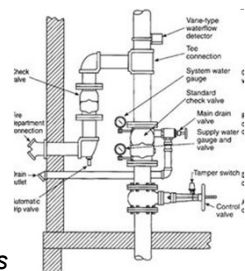
Plans

As a Fire Inspector it is helpful to develop the ability to read and interpret plans of various types and details.



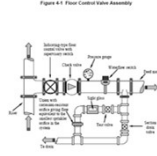
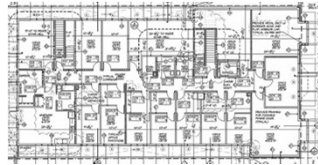
Types of Plans

- *Plot Plans*
- *Site Plans*
- *Architectural Plans*
- *Foundation Plans*
- *Floor Plans*
- *Mechanical Plans*
- *Electrical Plans*
- *Sprinkler System Plans*



Plan Views

- Plan
- Elevation
- Sectional
- Detail
- Notes



Architectural Drawings and Specifications

- Building plans must be organized so each building trade can work on their part without reviewing the entire plan
- Small buildings
 - Foundation, floor plan, electrical, plumbing, and mechanical
- Large buildings
 - Construction Specification Institute's Master Specification 16 divisions

Architectural Drawings and Specifications

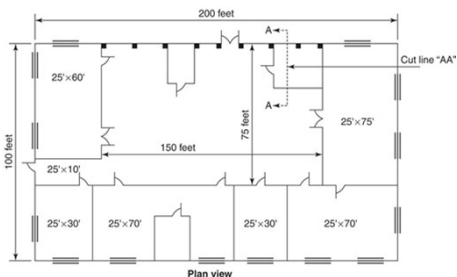
- Blueprints are 2-D representations of a 3-D building.
- Blueprints generally contain four views:
 - Plan views
 - Elevation views
 - Section views
 - Detail views
- Plan view show length and width and elevation views show height

Plan View Drawings

Plan view drawings demonstrate:

- Buildings overall length and width
- All interior room dimensions and partition wall locations
- All doors and window openings
- Multiple plan views drawings will show different building systems such as; electrical, mechanical or fire protection plans

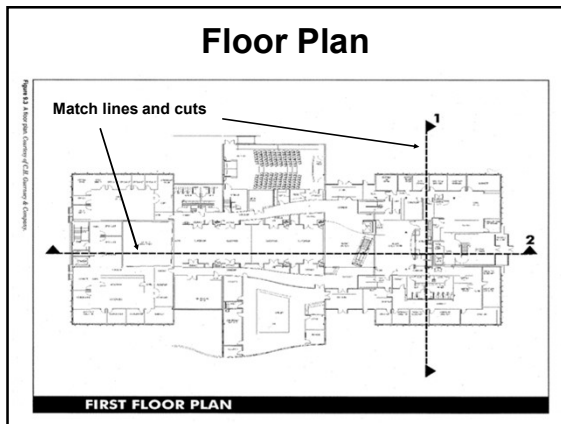
FIGURE 14.2 The plan view drawing represents a two-dimensional aspect of the building and details interior wall and door locations as well as building dimensions.



Courtesy of "Principles of Code Enforcement" – J Foley

Plan View Drawings

- The complexity of building determines number of plan views drawings needed
- Corresponding elevation view are identified on plan views with symbols
- Building match lines on plan view drawings are used when the floor plan is too large for one page
- Cut lines will identify sectional elevation views
- Architect may use standardized symbols



Elevation View Drawings

- Elevation include views of the exterior sides of building or interior wall sections viewed from ground level facing the wall
- Elevation provide height dimensions
- Elevations may illustrate finish materials, egress openings, duct and vent heights, interior ceiling heights, and exterior grade elevation changes

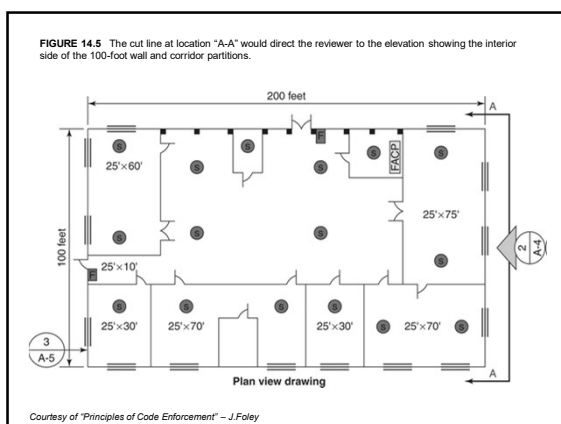


FIGURE 14.3 Symbols, such as those pictured, direct the plan reviewer to the third height dimension of the building and associated design details of walls. The symbol shows the number of the elevation or detail, the arrow indicates viewing direction, and the lower number indicates the page location in the plan set.

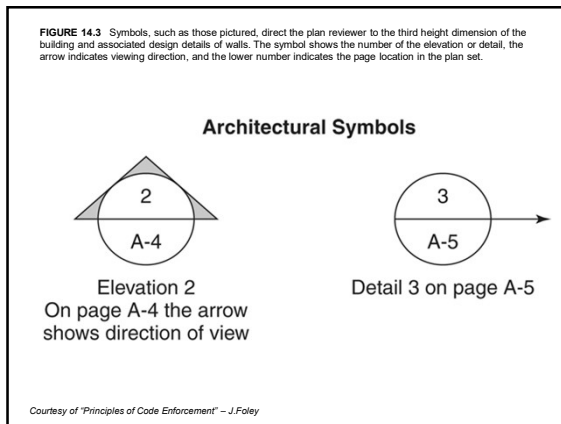
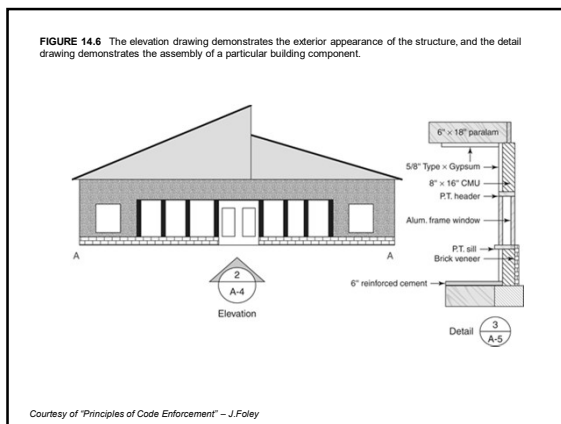
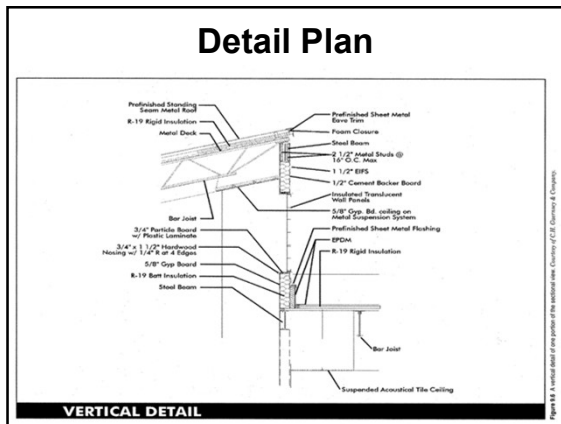


FIGURE 14.6 The elevation drawing demonstrates the exterior appearance of the structure, and the detail drawing demonstrates the assembly of a particular building component.



Detail View Drawings

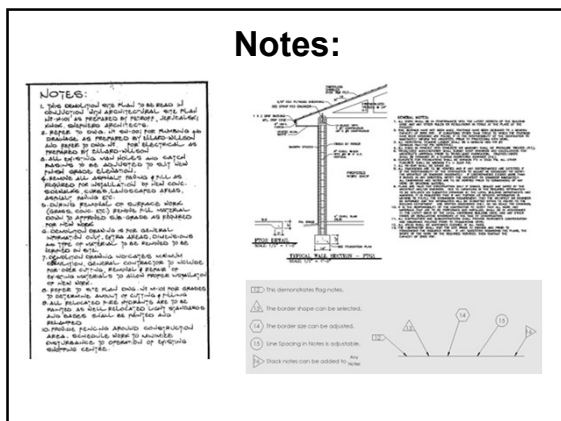
- Details demonstrate specific building system connection methods and fire-resistance rating of construction specification for particular wall or ceiling assembly
- Sectional cuts are also designated by a symbol on the plan or elevation drawings



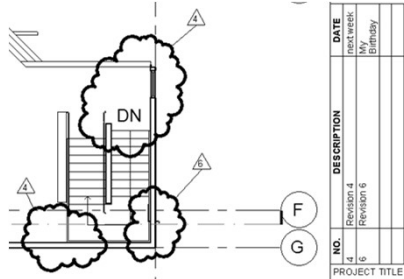
Notes

- Note flags on plans identify additional information about a specific aspects of drawings.
- Notes may be symbolized by a small triangle with a number corresponding to a specific note
- Plan revisions may have a note and a cloud around revised components to help identify the correction on the plan.

Notes:



Plan Revision



Detail Schedules

- *Detail schedules are used for doors, windows, fixtures, and interior finishes identification*
- *The detail schedule identifies:*
 - *Door style, fire rating, opening size, and hardware*
 - *Finishes of doors, windows, and other elements including flame spread ratings for interior finish*

Door Schedule

Door and door hardware schedule

Room type	Interior or exterior	Door leaf/frame type	Fire rating (FRL)	Closer
Entry	Exterior	GA/GA	~	Yes
Office Area off public areas	Interior	SC/ST	~	Yes
Offices off Office Area	Interior	MDF/AL	~	No
Meeting Room	Interior	Dbl MDF/AL	~	No
Toilets - Standard	Interior	SC/ST	~	Yes
Toilets - Disabled	Interior	SC/ST	~	Yes
Stationery Stores	Interior	MDF/AL	~	No
Records Stores	Interior	SC/ST	~	No
Plantroom	Interior	SC/ST	~60/30	Yes
Electrical/Comms Cupboards	Interior	SC/ST	~60/30	Yes
Fire Stairs - Ext	Exterior	SC/ST	~60/30	Yes
Fire Stairs - Int	Interior	SC/ST	~60/30	Yes
Fire Hose Reels	Interior	SC/ST	~	No

Fire Alarm Systems

■ Manual fire alarm pull stations:

- Within 5 feet of exit doors and every 200 feet along exit path
- Device installation height is identified
- Areas that may be prone to false alarms should have protective covers as described in IFC 907.4.2.5

Fire Alarm Systems

Locations of alarm-indicating appliances

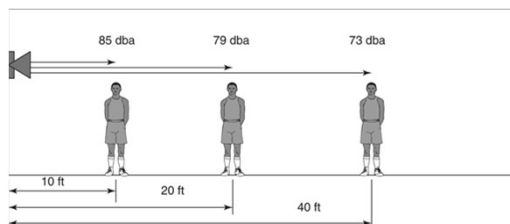
■ Speakers

- Placement depends on watt output
- Voltage drop determines proper operation
- May require Voice intelligibility

■ Visual alarm indicators

- Spaced maximum of 100 feet but separated by 55 feet to be seen from any direction
- Installed at proper heights 80"-96" inches

FIGURE 14.9 Sound pressure decreases inversely with distance. As the distance is doubled, the sound level decreases by 6 decibels. Minimum sound pressure is 15 dba above the ambient noise level but not less than 75 dba.

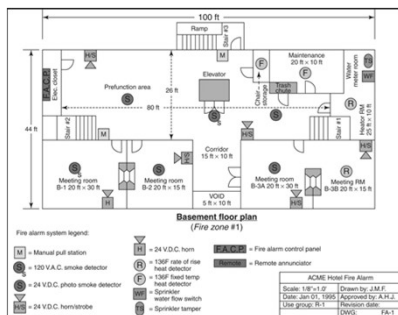


Courtesy of "Principles of Code Enforcement" – J.Foley

Fire Alarm Systems

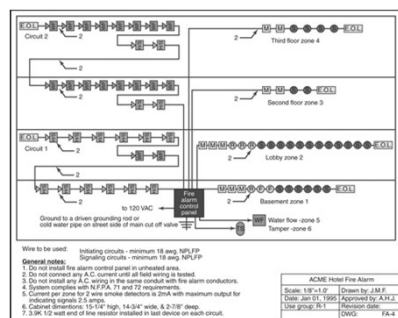
- Plans may not provide all of the necessary review information.
- Shop drawings
 - Fire alarm system riser diagram
 - Point-to-point diagram of control panel
- Alarm matrix describes the sequence of operation
- Battery calculations for secondary power supply
- Voltage Drop for system
- Equipment Cut Sheets

FIGURE 14.10 Typical fire alarm system plan. Note legend of symbols for different alarm system appliances.



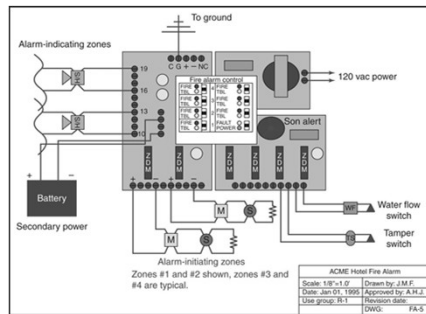
Courtesy of "Principles of Code Enforcement" – J.Foley

FIGURE 14.11 The riser diagram shows each zone circuit and the number of devices attached to it. Note that initiating circuits are on one side, and indicating appliances are on the other.



Courtesy of "Principles of Code Enforcement" – J.Foley

FIGURE 14.12 The point-to-point diagram illustrates each circuit connection to the fire alarm control panel.



Courtesy of "Principles of Code Enforcement" – J. Foley

Mechanical Drawings/Special Construction Reviews

The Fire Inspector should review the following mechanical systems:

- HVAC systems –NFPA 90A
- Smoke control systems specifications
- Stairwell pressurization systems
- Kitchen exhaust ducts
- Appliance chimneys and vents

HVAC

- Mechanical systems are generally joint plan review responsibility with building or mechanical inspector
- Check interconnection of duct smoke detectors and the fire alarm control panel.
- Check locations of air supply and return diffusers with relation to area smoke detectors.
- Check wiring in return air plenums for proper flame spread ratings.

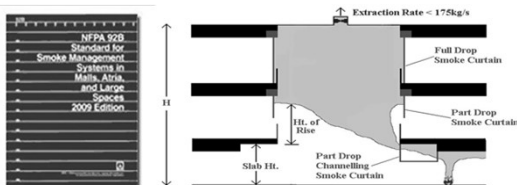
HVAC

- Check for smoke control system.
 - Plan submission must include complete overview of system's operational scheme and design manual on system operation.
 - System must include manual controls.
 - Operational matrix must be provided.
- Check stairwell pressurization system.
 - Ensure proper connection to fire alarm.
 - Proper pressure differentials

Special Inspections



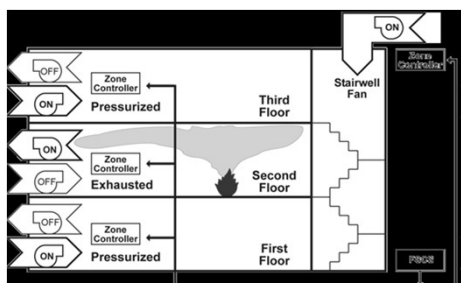
Smoke Control – NFPA 92 (2015)



Smoke Control and Smoke Evacuation Systems

- *Stack effect from atmospheric conditions both inside and outside buildings effects smoke control*
- *Stack effect makes it difficult to remove smoke effectively*
- *Smoke management systems may:*
 - *Pressurize floors around a fire*
 - *Create a negative pressure on fire floor*
 - *May provide smoke bank to maintain egress visibility in atriums*

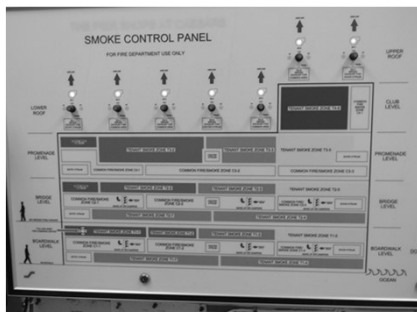
Smoke Management



Smoke Control and Smoke Evacuation Systems

- *Smoke control is usually integrated with HVAC*
 - *Balancing air conditioning and heat is a challenge*
 - *Each system design is unique*
- *Smoke control system design engineer must provide:*
 - *Complete overview of design, operations manual, and operation matrix.*
 - *Perform systematic review and testing.*

FIGURE 14.17 Firefighter smoke control panel. Each switch controls a fan to start or stop the system. Each smoke zone is in a different color. Courtesy of J. M. Foley



Courtesy of "Principles of Code Enforcement" – J. Foley

Automatic Sprinklers

- Sprinkler review will require shop drawings from fire protection installer's engineers
- Included in plan:
 - NFPA standards utilized and any specialized performance characteristics
 - Type of ceiling or roof
 - NFPA –13 Hazard classification, system design density, and design area
 - Water supply and flow test information

Automatic Sprinklers

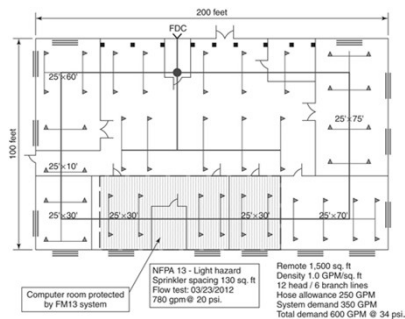
- Included in plan:
 - Type system; Pipe schedule or hydraulic design
 - Types of sprinkler heads used and "K"-factors
 - Riser diagram with connection and valve details
 - Type of sprinkler design method, area or room design
- Sprinkler plan review
 - Systematic 15-point check

Hydraulic Calculation Review

The Fire Inspector should verify:

- All design information on summary sheet is correct.
- Appropriate NFPA standard rules were applied.
- Proper starting pressures were used
- Hose allowances were added if required
- Water flow test data is correct
- System design is below projected water curve

FIGURE 14.13 The plan checker must review the basic system design information for correctness.



Courtesy of "Principles of Code Enforcement" - J.Foley

Standpipes

- Usually required in buildings exceeding three stories above or below grade
- Determine class of standpipe required
- Check for proper spacing and riser size
- Check for proper flow requirements
- Check for interconnection with automatic sprinklers
- Check for cross connection
- Check FDC location

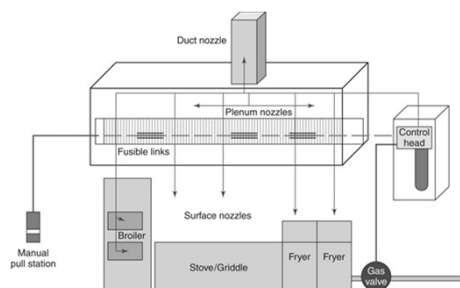
Other Fire Protection Systems

- Building codes allow alternative fire protection systems in lieu of sprinklers
- Most systems utilize specialized fire suppression agents
- All systems have commonalities among different NFPA standards including: storage vessel, detection method, control panel, dispersion piping, manual activation
 - Systems include: wet & dry chemical, foam, Halon, CO₂, and clean agents

Kitchen Range Hoods (Wet or Dry Chemical)

- Different systems use different fire suppression agents.
- All cooking surfaces and plenum and duct must be protected.
- Review should include: System storage, detection and distribution, shutoffs and shunts, appliance coverage, manual operation, equipment specifications and system ventilation rates

FIGURE 14.14 Basic system design for a kitchen fire suppression system.



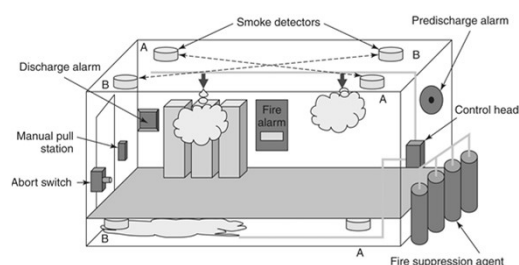
Courtesy of "Principles of Code Enforcement" – J. Foley

Total Flooding Fire Protection Systems

Generally utilize gaseous suppression agents such as; carbon dioxide, Halon,, inert gas agents, clean agents and sometimes dry chemical or water mist

- *Penetration protection of enclosure is critical to proper operation.*
- *System storage, detection, distribution and general operation are similar*
- *Requires pre discharge alarm and abort switch*

FIGURE 14.15 Typical components for gaseous fire suppression systems.



Courtesy of "Principles of Code Enforcement" – J.Foley

Foam Firefighting Systems

- *Generally used in aircraft hangers in accordance with NFPA 409*
- *May require automatic monitor nozzles to ensure proper area coverage.*
- *May require manual pull activation station to operate if no detection method is present such as a helipad*
- *May conform with either: NFPA 11A or NFPA 16*

FIGURE 14.16 Firefighting automatic remote monitor nozzle with 10-minute foam concentrate supply.
Courtesy of J. M. Foley



Courtesy of "Principles of Code Enforcement" – J. Foley

Fire-Resistant Construction Features

- *Generally a joint plan review with the building inspector*
- *Examines and identifies the building's firewalls, fire separation walls, and fire-rated ceiling and floor assembly.*
- *Defines the fire areas for fire alarm audible outputs*

Fire-Resistant Construction Features

The plans review should include:

- *Identify UL design fire-resistance rating of all walls and items penetrating vertical shaft walls.*
- *Identify boundaries of each fire area.*
- *Identify opening protection requirements*

Fire-Resistant Construction Features

- *Identify fire alarm annunciation zones per area or floor*
- *Identify fire stop methods to protect penetrations*
- *Identify locations and fire-resistance ratings of stairwells, vertical shafts, and fire and smoke barriers*
- *Identifies location of duct fire and smoke damper*

Means of Egress

- *Plan components*
- *Total travel distances to closest exit*
 - *Capacity of each egress component*
 - *Total floor occupant load*
- *Ensure all minimum exit requirements have been addressed.*
- *Ensure exit capacity is sufficient for intended occupant load of building.*

As-Built Drawings

- *Required before issuance of certificate of occupancy*
- *Represent actual installation of fire protection equipment*
- *Reflect any changes in design that occurred during the construction process.*
- *Instructions on systems must be provided (IBC 907.18.9)*

Authority and Responsibility of Plan Reviewers

- Specified in adoptive legislation of local or state building codes
- UCC Fire Inspector's responsibility
 - Conducting the fire protection plan and joint plan reviews
 - Final inspection and acceptance testing of all fire protection systems

Building Construction & Plan Review

In this module we discussed...

- Types of construction;
- Height and area limitations;
- Fire resistance ratings;
- Continuity of ratings;
- Truss construction concepts;

Summary

In this module we have discussed...

- ;
- Types of loads;
 - Load carrying design of beams and columns;
 - Recognizing construction deficiencies; and
 - Types of plans
 - Fire protection systems

Homework Assignments

For next module as stated in the syllabus

End of Module

Part 2 of 2

Next Lesson

Module 8

General Fire Safety
