The Maryland Fire and Rescue Institute of the University of Maryland is the State’s comprehensive training and education system for all emergency services.

The Institute plans, researches, develops, and delivers quality programs to enhance the ability of emergency service providers to protect life, the environment, and property.
Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the role of the plans examiner in the design, permitting, and construction process. The student will perform to a written test accuracy of at least 70%.

Overview

• Components of effective fire prevention
• Reasons for construction permits and plans reviews
• Building fire and life safety components
• Design, permitting, and construction processes
Components of Effective Fire Prevention

- Education
- Code Enforcement
- Engineering

Components of Effective Fire Prevention

- Public education
  - Informing the public about fire hazards, fire prevention techniques, and the steps to take when a fire occurs
  - Providing interpretation and explanation of codes and standards
  - Educating designers and contractors in the necessity of providing adequate levels of fire and life safety in buildings or structures

Components of Effective Fire Prevention

- Code enforcement
  - Enforcing a body of law aimed at reducing fire hazards
  - Mandating the proper installation and maintenance of building/structure fire and life safety features
Components of Effective Fire Prevention

- Engineering
  - Designing buildings properly with respect to fire and life safety
  - Including design and construction features that provide life safety and fire prevention while making buildings useful to occupants

Reasons for Construction Permits and Plans Reviews

- Community safety
- Property conservation
- Responder safety
- Code compliance

Building and Fire and Life Safety Components

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Design, Permitting, and Construction Processes

- Architectural Design Concept
- Planning and Zoning Review
- Site/Civil Engineering
- Complete Architectural Design

- Submittal
- Review
- Corrections
- Approval

The plans examiner must possess a basic knowledge of the design, permitting, and construction process.

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the role of the plans examiner in the design, permitting, and construction process. The student will perform to a written test accuracy of at least 70%.

Review

- Components of effective fire prevention
- Reasons for construction permits and plans reviews
- Building fire and life safety components
- Design, permitting, and construction processes
Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the plans review process. The student will perform to a written test accuracy of at least 70%.

Overview

• Plans review organizations
• Plans submittal and processing
• Legal proceedings
Plans Review Organizations

• Plans review organizations
  – Exist within a unit of government at the state, county, or local level
  – Perform the review of building plans and the issuing of permits
  – Operate on authority granted by state charter, municipal statute, or home rule

Plans Review Organizations

• The authority having jurisdiction (AHJ)
  – Performs required functions of permitting, plans reviews, inspections, and record keeping

Plans Review Organizations

• Plans review authority
  – Authority is contained within the building and/or fire codes.
  – Applicable codes must be adopted by an appropriate legislative act.
  – Duties and powers of the AHJ are described in the applicable code.
  – Situations may exist where the emergency services organization does not have formal authority.
Plans Submittal and Processing

- The issuing of building permits and the review of plans are official government acts.
- Plans review agencies often publish a plans review process guide to inform individuals before the applications are submitted.

Plans Submittal and Processing

- Permits and fees
  - The administrative chapter of the code contains provisions for the manner in which a building permit application is made.
  - Application fees intended to offset the administrative costs of the review are determined by the AHJ.

Plans Submittal and Processing

- Plans/construction drawings
  - The AHJ establishes the manner in which plans are submitted including the size, number of copies, format, and scale of drawings.
  - The plans are meant to convey all information needed for the plans examiners to make informed decisions about code compliance.
• Support documents
  – Calculations
  – Specifications
  – Safety data sheets
  – Manufacturer’s cut sheets

• The plans review sequence
  – Routing of plans through the review process is an administrative matter and depends on the local jurisdiction.
  – Plans should be reviewed by all agencies involved simultaneously when possible.
  – Some large projects are designed and constructed using a fast-track method.

• Deficient plans
  – Code violation
  – Incorrect design
  – Missing information
  – Local code amendment differences
Plans Submittal and Processing

• Deficient plans
  – Deficient plans must be returned to the submitting parties with a plan-correction notice.
  – The plan-correction notice must:
    • Identify the problem
    • Provide code requirements
    • Indicate what is necessary to secure approval
  – The plans examiner must not attempt to design or redesign the project.

Plans Submittal and Processing

• Plan revisions
  – Plan revisions should always be documented.
  – Plans reflecting the change should be resubmitted to the reviewing authority.
  – “As-built drawings” are used in some jurisdictions to reflect how something was actually installed.

Plans Submittal and Processing

• Record keeping
  – Building plans and permits
    • Are official documents and must be retained by the AHJ
    • Provide verification that work was performed legally
    • Establish the code edition under which a project was completed
    • May be requested by outside parties
Legal Proceedings

• Disputes regarding the interpretation, application, or enforcement of codes are resolved through legal proceedings.

• Proceedings can take two different forms: administrative or judicial.

Legal Proceedings

• Administrative proceedings
  - The Board of Appeals exists to resolve differences.
  - The Board of Appeals does not have the authority to waive a provision of a code.
  - The duties of the Board of Appeals includes interpreting the codes, reviewing alternative methods, ruling on challenges, and evaluating alternative proposals.
  - The Board of Appeals is generally made up of qualified individuals outside the governmental unit.

Legal Proceedings

• Judicial proceedings
  - Judicial proceedings involve the court system.
  - The AHJ may be the defendant or the plaintiff.
  - Failure to comply with approved plans or failure to obtain a permit
  - Failure to issue a permit or failure to enforce corrections in deficient plans
  - Plans examiners are often called to testify in these cases.
Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the plans review process. The student will perform to a written test accuracy of at least 70%.

Review

• Plans review organizations
• Plans submittal and processing
• Legal proceedings
Student Performance Objective

• Given information from discussion, handouts, reading materials, and lecture, the student will be able to describe the importance of codes and standards and how they affect the plans examining process. The student will perform to a written test accuracy of at least 70%.

Overview

• Codes, standards, and ordinances
• Code amendments
• Prescriptive and performance codes
• Code references
• Plans review checklist
Codes, Standards, and Ordinances

- Codes
  - Are a body or collection of rules that pertain to one subject such as building, fire protection systems, zoning, etc.
  - Must be adopted into law
    - Fire code violations
    - Building code violations

- Standards — how we make the code work
  - Code requires sprinklers — NFPA 13 tells us how to make it happen

- Ordinances — applies to municipal laws
  - Specific provisions of building and fire codes

Code Amendments

- Submitted amendment to legislative body
  - No code can address all issues.
  - Amendment to a code is a legislative act.
  - Codes should be reviewed periodically.

- Amended code to meet local fire problems
  - General codes are adopted, Uniform Fire Code, e.g., Fire Lane Signs, which specifies the need for signs.
  - The posting, color, and size of signs is a local amended matter.
Code Amendments

- Conversion of old to new occupancies
  - Specify acceptable construction
    - Will existing structure support new occupancy?
    - Fire protection practices for new occupancy
  - Specify new access points and egress areas
    - Occupancy loads
    - Floor configuration
    - Will this be an as-built project

Prescriptive and Performance Codes

- Prescriptive code model
  - Provides detailed specifications of what needs to be done to comply with the code
  - Uses fixed values to establish minimum requirements
    - Standard heights
    - Standard exit travel and egress avenues
    - Standard sprinkler patterns
    - All based on past history and events

Prescriptive and Performance Codes

- Provides information for general situations
  - In the Life Safety Code (LSC) chapter 7, there is a general code for means of egress.
  - Even number chapters are for new occupancies and odd chapters are for existing codes.
  - Specific chapters are for new assemblies, such as chapter 12, and old assemblies, such as chapter 13.
Prescriptive and Performance Codes

Examples of general and specific codes:

- Chapter 7 of the LSC speaks to means of egress, 7.2; capacity of exits, 7.3; number of means of egress, 7.4; arrangement of means of egress, 7.5; travel distance, 7.6.
  - These are all general rules of means of egress.
- Specific chapters are the main sections for topics (e.g., chapter 12, 12.2 is the main section for egress requirements).
- Sometimes the sections in specific chapters will refer back to previous chapters (e.g., chapter 12 refers to chapter 7 for means of egress).
- Note that 7.2 and 12.2.2 both have information about means of egress.

Prescriptive and Performance Codes

- Performance code model
  - Provides goals and objectives that the architect or computer designer must meet to provide life safety, fire protection, weather conditions, building design, etc.
  - Everything considered in the design must be tested, evaluated, documented, and then approved.
  - Some AHJ’s find it difficult to do this.

Prescriptive and Performance Codes

- Goals and objectives are defined by a group called stakeholders.
  - Architects, engineers, owners, tenants, and fire code officials all want this project to be successful.
  - They are all responsible or stakeholders in the success of the project.
Prescriptive and Performance Codes

- Performance-based codes are only as good as the assumptions made during modeling.
  - This is building “out of the box” beyond anything that has been tried before.
  - Performance tests and evaluations are completed before construction.
  - Problems that arise are redesigned and proved through engineering analysis that it will work.

Prescriptive and Performance Codes

- To prove to building and fire officials that the project meets the intent of recognized standards, testing is completed.
- A small percentage of these codes are ever accepted.
  - However, modern modeling and computer design have opened new avenues to consider.

Can you identify performance or prescribed codes?

- All persons shall be able to exit the building without injury not knowing the source of ignition.
- All exit doors will open outward and be a minimum of 36 inches of clear opening.
- Fire protection systems will be provided to confine the fire to the room of origin.
- Fire protection systems will provide 36 gal/minute per 100 ft of coverage.
Prescriptive and Performance Codes

- Performance-based advantages
  - Fire protection designed to the specific building
  - Building for the client's specific needs
  - Integration of building system and design
    - Design may exceed prescribed code requirements.
  - Removes the restrictions of prescribed codes making new designs cost effective

Prescriptive and Performance Codes

- Performance-based disadvantages
  - Who knows if it will work?
  - Engineering cost
  - Change of occupancy may not be protected properly.

Prescriptive and Performance Codes

- Why were codes created?
  - Building codes were originally intended for the public safety.
  - Scope of the code was increased as new technology appeared:
    - Electricity, plumbing, sprinklers, HVAC, ADA access, egress issues, etc.
  - This evolution of construction practices needed to be regulated by new codes specific to the function of the new technology.
Code References

• Specific sections of code cited
  – NFPA 13, chapter 8, table 8.6.3.2.1 – spacing of sprinklers from head to wall
  – NFPA 17A – hood system suppression
  – UFC 13.7.3.6 – alarm signal initiation and water flow
• A plans examiner must have a good working knowledge of code and specifications.
• Codes are organized numerically to facilitate easy use.

Plans Review Checklist

• Plans reviewers cannot keep everything in their heads.
• Checklists ease the process for examiners in a general way.
• Specific codes must still be accessed and interpreted.
• Checklists must remain an internal document so short cuts cannot be done by contractors.
  – Make the contractor build to the code rather than your AHJ documentation.
  – However, contractors do need guidance.

Student Performance Objective

• Given information from discussion, handouts, reading materials, and lecture, the student will be able to describe the importance of codes and standards and how they affect the plans examining process. The student will perform to a written test accuracy of at least 70%.
Review

- Codes, standards, and ordinances
- Code amendments
- Prescriptive and performance codes
- Code references
- Plans review checklist
Lesson 2-1: Plans Sets

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of all six plans groups. The student will perform to a written test accuracy of at least 70%.

Overview

• Purpose of plans sets
• Design analysis process
• Abbreviations and symbols
• Measurements used in construction drawings
• Plans sets organization
Purpose of Plans Set

• Visual depiction of building components and their assembly
• Provides construction crews with component and construction details
• Shows owner the finished building
• Provides information to the subcontractor for bid preparation
• Provides local government information that the structure will be built to code

Design Analysis Process

• Project planners ask plans reviewers to consult on the design
• Provides accurate information to project planners to minimize change orders
• Confer with AHJ
• Purpose, scope, and statement of work to be done
• Budgets, specifications, calculations, and schedules of work
• Statements of work to be done, equipment required, cut sheets, and specifications

Abbreviations and Symbols

• Increases efficiency of interpretation of drawings
• Less clutter on construction drawings, however, no set standard for abbreviations
• Abbreviation sheets should be attached to the plan set and/or plans examiner should ask designer to explain symbols
• NFPA 170: Standard for Fire Safety Symbols
Measurements Used in Construction Drawings

- English customary yards, feet, inches, and fractions of an inch
- Dimensions that are even numbers (e.g., 35 feet are expressed as 35'-0")
- Most construction drawings dimensions are expressed in fractions. HOWEVER, ON SITE AND PLOT PLANS, DIMENSIONS ARE EXPRESSED AS DECIMALS.
  - Example: 35 feet and 6 inches will be shown as 35.5'

Scales

- Architect scale – a three-sided scale that has 11 different scales of measurement to the foot
  - Read scale on p. 52 – Figure 4.5
- Engineers scale – a three-sided scale that reads as 1" = 10 feet or 1' = 60 feet, p. 51

Plans Sets Organization

- Plans sets are lettered and numbered for each section applicable.
- Architectural drawings are listed as "A."
- Structural drawings are listed as "S."
- Electrical drawings are listed as "E."
- Plans work from outside the building to inside.
- Plans examiners must be thoroughly familiar with the plans and examine each one for fire protection and safety.
Plans Sets Organization

- Title page
  - Information for code compliance (see p. 55)
  - Occupancy load, travel distance to exits, and building height
  - Building area, type of building, and area limitation
  - Information in upper right of title page
  - Determine number and adequacy of exits from the above factors

Plans Sets Organization

- Demolition page
  - Demolition permit
  - Termination of utilities
  - Structural and fire protection precautions during demolition are complied with
  - Maintaining sprinklers and standpipe systems during demolition
  - Removal of debris

Plans Sets Organization

- Civil drawings and landscape plans (C and L drawings on Canterbury)
  - Site plans – show topography of the site and some information from the plat
  - Plat plan – is the filed survey drawing of the property
  - Plot plan – shows the location of the building and the finished grading, hydrant locations, water main sizes and location, access roads, and drainage of parking lot
Plans Sets Organization

• Civil drawings and landscape plans (C and L drawings on Canterbury)
  – Vegetation management – location of the bushes to hide the FDC, which is approved by the fire department (landscape plan)
  – The plans examiner must check and verify that the hydrants and connections are not blocked and access can be made with existing fire apparatus.

Plans Sets Organization

• Architectural plans (A drawings on Canterbury)
  – Building size
  – Construction of building and materials used
  – Floor layout
  – Sectional views
  – Fire ratings
  – Details of room

Plans Sets Organization

• Architectural plans (A drawings on Canterbury)
  • Size of the restaurant dining room
  • Seating capacity and number of exits from the room
  • Architectural drawings have a great deal of information and are useful in determining many other parts of the project.
Plans Sets Organization

• Structural plans – skeleton design of building
  – Footings
  – Foundation walls, columns, and beams
  – Floor framing
  – Load and non-load bearing walls
  – Roof framing

  • All structural elements have to be calculated and approved to meet code of AHJ.
  • Structural fire protection applications may also be in this plan.

Plans Sets Organization

• Mechanical/HVAC plans (H drawings on Canterbury)
  – Heating and air conditioning
  – Air handling units, dampers, and exhaust features

• Plumbing (P drawings on Canterbury)
  – Drains, vents, and fixtures for waste and domestic water
  – Standpipe and sprinkler systems and hazardous waste drainage and treatment systems for chemical/biological labs

Plans Sets Organization

• Electrical plans (E drawings on Canterbury)
  – Wiring and emergency lighting
  – Fire alarm panels and wiring
  – Equipment schedules

• Fire protection plans (not on drawings)
  – Standpipe and sprinkler drawings
  – CO₂ extinguishing systems
Plans Sets Organization

- Supplemental documentation
  - Plat plans – survey plan with setbacks, easements, land use, and proper integration of infrastructure into existing use
  - Shop drawings – rough drawing of what is to be installed and generally where; drawings are then fine tuned and measured on job for final location and installation
  - Manufacturer cut sheets – describe the function and listing of unit to be installed (e.g., sprinkler head)
  - SDS – safety data sheet – flash point of material, vapor pressure, and physical and chemical properties

Plans Sets Organization

- Calculations
  - Structural
  - Electrical
  - Sprinkler system
- Specifications
  - Bidder information, start date, fire safety plan, storage of hazmat while construction in progress, debris removal, insurance needed, materials or manufacturers specified by owner or architect, etc.

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of all six plans groups. The student will perform to a written test accuracy of at least 70%.
Review

• Purpose of plans sets
• Design analysis process
• Abbreviations and symbols
• Measurements used in construction drawings
• Plans sets organization
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose of site plans, contour grades, and fire and emergency service access. The student will also be able to describe sets of plans for easements, utilities, and landscaping. The student will perform to a written test accuracy of at least 70%.

Overview

- Site and plot plans
- Contours and grades
- Fire and emergency service access
- Easements
- Utility plans
- Landscape plans
Site and Plot Plans

- Site and plot plans terminologies are sometimes used interchangeably.
- Sheet A-1 Canterbury Homes plan architectural site plan
- Sheet C-1 Canterbury Homes plan civil site plan
- Size and shape of the buildings, parking lot access, sidewalks, loading dock, landscape, overhead obstructions, overhangs, and wires

Contours and Grades

- Contour lines
  - Drawn at fixed intervals 1, 2, 5, 15, 30 feet, etc., from a fixed benchmark
  - Benchmark – fixed point (stake or point in curb line) used as a starting point for elevation surveys
  - Vertical distance measurement – the closer together the contour lines, the steeper the grade
  - Example - Figure 5.1, p. 76

Contours and Grades

- Grades
  - Existing elevation is before grading.
    - Usually shown as a dashed line
  - Finish elevation is after grading is completed.
    - Shown as a solid line
    - Vertical distance divided by horizontal distance = percentage of grade
  - Maximum of 10% grade for access
    - For example, check percentage of grade on Canterbury site drawings for access.
Fire and Emergency Service Access

- Access roads according to fire code
  - Minimum inside/outside radii of access curves
  - Minimum street width 20', vertical clearance 13 1/2", and the ability to set up apparatus, including outriggers on apparatus
  - FD must be involved to ensure that these access issues are considered.

Fire and Emergency Service Access

- Minimum grade change (swales and drainage ditches)
- Surfaces and obstructions
  - Access road must be capable of carrying the weight of fire apparatus and have access to the building (85,000 pounds standard).

Fire and Emergency Service Access

- Turning radius templates
  - Inside turning radius
  - Outside turning radius
  - Angle of departure – tailboard to grade
  - Angle of approach – front bumper to grade
  - Ground clearance

*See supplemental information for templates
Dead end roads in excess of 150 feet in length must be provided with approved turnaround for fire apparatus.

Turning radius:
- Established by local needs
- A half of the larger of the left or right circle, wall-to-wall turning diameter
- Aerial apparatus may have additional needs
- Actual testing may be necessary
Fire and Emergency Service Access

• Access to the building
  — When any portion of the building is more than 150 feet from a public street or access way:
  • Provide sprinkler protection throughout.
  • Provide access for fire department vehicles by all-weather access way.
  • Consult local or state codes.

Fire and Emergency Service Access

• Consider operational sprinklers in building may give AHJ options of extending access.
• Consider other access roads specific to FD use may be installed if required by AHJ.
  – Provide turf pavers or gravel roads to apparatus weight specs.
• Create turnaround areas to alleviate backing issues.
  – AHJ approved 100’ – 150’ dead end length
• Check for obstacles, wires, bridges, speed bumps, vegetation, etc.

Fire and Emergency Service Access

Turf Paving

Sod is placed in and over turf paving. The area must be clearly identified for fire department access.

Adapted from IFSTA material
Easements

• One party must have access over someone's existing property to get to their property.
• Real estate law – grants the right of easement after hearing
• Public utility easements (PUE) – most common
• Reciprocal easement agreement where two owners use the same common easement
• Easements for fire protection across properties with exit discharge areas

Utility Plans

• Wells and septic in building is not near city utilities.
  — Easement issues and zoning requirements
• Natural gas companies provide service, including meter and regulator to building.
• Electrical service is provided to meter on building.
• Information for utilities can be provided on numerous sheets of the plans.
• Reviewer should note location of utilities for easy referral.

Utility Plans

• Dedicated fire protection systems, including wet or dry hydrants
  — Calculate fire flow from hydrants for building fire protection according to AHJ or insurance specifications
  — Thrust blocks, tie rods, and clamps to keep pipes from separating at the fittings (see text)
• Storm water removal and industrial waste lines
• Chemical and fuel lines
Landscape Plans

- Landscaping blocking access for apparatus
- Landscaping or features blocking FD connections to the building
- FD hydrants located where grades prohibit access
- Plants with thorns and thistles located too close to the exit ways
- Look for all the possibilities. “Look well into the future” from the time of examination.

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose of site plans, contour grades, and fire and emergency service access. The student will also be able to describe sets of plans for easements, utilities, and landscaping. The student will perform to a written test accuracy of at least 70%.

Review

- Site and plot plans
- Contours and grades
- Fire and emergency service access
- Easements
- Utility plans
- Landscape plans
Lesson 4-1: Architectural Plans

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of architectural plans. The student will perform to a written test accuracy of at least 70%.

Overview

• Architectural plans
• Exterior elevation drawings
• Floor plans
• Reflective ceiling plans
• Section drawings
• Interior elevation drawings
• Schedules
• Furniture and equipment plans
• Detailed views
• Class exercise
Architectural Plans

• Basic function design of the building
  • Can it be built?
  • What is the occupancy going to be?
  • How high is the building going to be?
  • Sprinklers and standpipes
  • Adequate water
  • Access

Architectural Plans

• Specific details on how the building is going to be constructed including:
  • Building construction classification
  • Exterior elevations
  • Floor and reflective ceiling plan
  • Interior elevations and sectional drawings
  • Schedules of material to use, detail drawings, and furniture and equipment placement

Exterior Elevation Drawings

• Shows finished building
• North, south, east, and west elevations of the building
• Example: A4 Canterbury Plans & Figure 6.1, p. 101, arrows indicate how the building is viewed
Exterior Elevation Drawings

- Elevations
- Bottom of the foundation footing
- Top of the foundation
- Finished grade
- Top of the subfloor
- Top and pitch of the roof
- Example: A4 of Canterbury Plans

Exterior Elevation Drawings

- Dimensions
  - Datum point is an established reference point indicating elevation. From this point, elevation of the building is measured.
  - Another method to show elevation is by using standard line dimensions.
  - Example of datum dimensioning is found on p. 102, Figure 6.5, and Plan A4 of Canterbury Plans.
  - Standard line dimensions are shown in Figure 6.5.

Floor Plans

- The view looking down on the floor of the building as though a horizontal cut has gone through it shows:
  - Layout, partitions, and doors
  - Windows, stairs, cabinets, and plumbing fixtures
  - Fire protection features and exits
  - Scale of 1/4"=1' is used for residential buildings; smaller scale used for commercial
  - Match lines used for larger and more detailed sectional drawings
    - Example: p. 104 in textbook
  - Corridor length may be specified or measured from plans with exits shown
Reflective Ceiling Plans

- A layout of room partitions
- The locations of features mounted on or near the ceiling
- The locations of emergency lighting may also be shown
- Example – A8 of Canterbury Plans
  - View of the ceiling as it reflects from the floor
  - Light fixtures and ceiling material
  - Emergency lighting and signs
  - A legend, provided to describe items in detail

Section Drawings

- Drawings passed through as vertical cutting plane shown with a section line (Figure 6.9a, p. 107).
- Section views are usually shown on a different sheet and not to the same scale.
  - Figure 6.11 shows a sectional drawing that enhances the materials that the wall, roof, and foundation are made of.
  - Transverse section (parallel to shorter dimension)
  - Longitudinal section (parallel to longer dimension)
  - Wall, door, specific items as fireplaces, etc.
- Example: pp. A5 & 6 of Canterbury Plans

Section Drawings

- Canterbury home section drawings:
  - Sheet A4 exterior views
  - Sectional views on sheet A 5 and 5.1
  - Wall types on Sheet A3
    - Wall types are identified on drawings by a letter in a small diamond.
    - The difference between wall types and a section is that the wall type shows only the material and the wall dimension.
    - Examination of the wall type will determine if the walls are fire rated or not. Wall type B has 5/8 inch type X drywall - fire rated assembly.
Section Drawings

- **Section drawings:**
  - Sectional views of vertical shafts
  - Figure 6.12, p. 109
  - Pick out the following items in Figure 6.12:
    - Type of wall enclosure
    - Gage of material that makes up the chute
    - Is the chute sprinklered?
    - Rating of the access door of the chute
    - Projection of the chimney through the roof
  - Figure 6.13, p. 110 shows structural fire proofing of what type of building?

Interior Elevation Drawings

- View perpendicular to the interior surfaces
  - Example: A7 of Canterbury Plans
  - Clarify interior features
  - Features mounted on interior walls
    - Cabinets, plumbing fixtures, shelving, kitchen appliances, etc.
  - Indicated on the floor plan such as section views

Schedules

- Schedule is a listing of specific types of components to be used throughout the project.
  - Doors - A3
    - Size of doors
    - Material that the door is manufactured out of
    - Hardware used - in Canterbury plans provided in the specifications but could be required on drawings
    - What doors are used for common area exits compared to residential units?
Schedules

• Interior finishes - A3
  • Walls are listed north, south, east, and west.
  • Materials to be placed on walls, ceilings, and floors are listed.
  • Finishes flame spread and smoke development may be available on sheets or may have to be determined from cut sheets, UL listings, and/or MSDS sheets.
  • Materials must be identified properly and information verified for compliance.
  • Fire retardant coatings when used should be indicated on the interior finish schedule.

Furniture and Equipment Plans

• Client's desires and needs are shown here.
• Fixtures and equipment are shown so plumbing and other utilities can be run to service those elements.
• Plans examiners must know where these items are and assure that there is no hazards created by using these items or from these items.

Detailed Views

• Example: A6, 8, and 9 of Canterbury Plans
• Detailed views are of items that are too small to show on drawings.
• These drawings are increased in size to show dimensions and critical location.
  • Roof waterproofing
  • Fire stopping for pipe chase through
  • Dampers in duct work and location
  • Example is A3 for a larger drawing on A6 Canterbury Plans or pp. 117-118, Figures 6.18 & 6.19
Class Exercise

• Review steps for calculating means of egress.

Canterbury Home Architectural Drawings
(Egress Calculations Facts)

• Corridor length is used for exit access and travel distance.
• Distance on floor plans are actual travel distances not code distances.
• Total of six exits with no dead end corridors
• Are adequate exits provided?

Canterbury Home Architectural Drawings
Exercise 6-1

• Calculate occupancy load.
• Examine all assembly areas.
• Find the area that is most demanding.
  1) Space ______ on the drawings is the most demanding.
  2) Approximately, how many people in this space?
  3) Two exits allows up to ______ people.
CODE PROVISIONS FOR ESTABLISHING THE MEANS OF EGRESS

• DESIGN OCCUPANT LOAD
• NUMBER AND CAPACITY OF EXITS
• MAXIMUM TRAVEL DISTANCE
• EXIT REMOTENESS
• MINIMUM RATINGS FOR ENCLOSURES

Design Occupant Load Factors

3 Sq Ft / WAITING AREA
7 Sq Ft / CONCENTRATED SEATING
15 Sq Ft / TABLES & CHAIRS
30 Sq Ft / MERCANTILE AREAS
100 Sq Ft / BUSINESS AREAS
X00 Sq Ft / INDUSTRIAL AREAS
X00 Sq Ft / AIRCRAFT HANGARS

Number of Exits

1 EXIT < 50 PEOPLE* < 75' TRAVEL
2 EXITS UP TO 500 PERSONS
3 EXITS 501- 1,000 PERSONS
4 EXITS OVER 1,000 PERSONS
Travel Distance Within the Exit Access: Examples

200 FEET NONSPRINKLERED
250 FEET SPRINKLERED
400 FEET ROOF VENTS
25-125 FEET HIGH HAZARD USES

Step #1
Number of Exits

HOW MANY EXITS OR EXIT ACCESS DOORS ARE AVAILABLE?

Step #2
Remoteness

DO THEY MEET THE REQUIREMENT FOR REMOTENESS?

1/2 THE OVERALL DIAGONAL DISTANCE OF THE ROOM OR SPACE
Calculating Remoteness

Step #3
Travel Distance

DO THEY MEET THE REQUIREMENT FOR MAXIMUM TRAVEL DISTANCE?

GENERALLY
200’ FOR NON-SPRINKLERED
250’ FOR SPRINKLERED DEPENDING ON USE

Three Elements of Egress
Step #4
Capacity

WHAT IS THE CLEAR WIDTH OF THE DOORS, CORRIDORS, RAMPS, AND STAIRS EXTENDING TO THE PUBLIC WAY?

2006 IBC Table 1005.1
2006 NFPA 101 Table 7.3.3.1

Step #5
Floor Area per Occupant

Compare floor area per occupant with the design occupant.

OCCUPANT LOADS CAN NEVER EXCEED 1 PERSON / 3 SQ FT

Step #6
Do the exit components conform?

DOOR SWING
LOCKS
LATCHES
EXIT SIGNS
MEANS OF EGRESS ILLUMINATION
Assessing the Means of Egress
Exercise 6-1 continued:

4. How many exits? (total #)
5. Are they adequately remote?
6. Is travel distance acceptable?
7. Are the exits conforming?
8. Are sprinklers required based on travel distance?
9. Room 106 to exit is ___ feet on the Canterbury plans?

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of architectural plans. The student will perform to a written test accuracy of at least 70%.

Review

• Architectural plans
• Exterior elevation drawings
• Floor plans
• Reflective ceiling plans
• Section drawings
• Interior elevation drawings
• Schedules
• Furniture and equipment plans
• Detailed views
• Class exercise
Lesson 5-1: Structural Plans

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe structural plan terminology, structural loads, design concepts, and design criteria for structural plans. The student will perform to a written test accuracy of at least 70%.

Overview

- Structural plans terminology
- Structural loads
- Seismic design concepts
- Structural design criteria
- Structural design criteria exercise
Structural Plans Terminology

- Structural drawings show what is going to hold the structure up.
- Forces exerted on the building are called a load, caused by wind, gravity, water, earthquakes, soil pressure, and temperature changes.
- The primary purpose of structural plans is to ensure that the building will not fall down.
- Building must be ridged enough to sustain the loads directed on it.

Structural Loads

- Loads caused by gravity have a cumulative effect on a structure.
- Dead load – weight of any permanent part of the building
  - Roofs and their supporting members
  - Interior/exterior walls
  - Stairs and stair enclosures
  - Affixed heating devices, elevators, plumbing, electrical, sprinkler/standpipe systems, and their supporting bracing
- Live load – any load not fixed or permanent
  - Building occupants and contents
  - Snow and rain loads, Figure 7.5, p. 129

Structural Loads

- Distributed load – a load that is applied over a large area or equally on all points, Figure 7.4a, p. 128
  - Large floor area, roof structure, etc.
- Concentrated load – a load that is placed at one specific point in the structure, Figure 7.4b, p. 128
  - Safes, large furniture, air conditioning units, etc.
- Wind load – force exerted on a structure by wind force as determined by velocity of the wind, geographic location, height of the building, openings in the building, and exterior siding
Structural Loads

Seismic load – the movement of the earth’s tectonic plates causing vibrations on the earth’s surface

These vibrations can be three dimensional, however, the horizontal motion will have the greatest effect.

Torsional forces – produced on structural member when the building is twisted creating shear force on the structure

Seismic load (cont.):

Resonant forces – harmonic force that is applied to the natural frequency of the building

Inertia forces – tend to hold the building top in place causing the sheer forces in the interior of the structure

• Acceleration of ground movement causes the severity of the force.
• Seismic design is based on duration and magnitude of force due to ground movement.

Magnitude of force on a building is determined by:
• Type of foundation and soil surrounding structure
• Vibration, mass, and stiffness of building
• Dampening devices built into the building
Seismic Design Concepts

- Increase building stiffness with cross bracing to reduce the ground motion exerted on a structure.
  
  * P. 133, Figure 7.10

- Redundant structural members with fixed joints have the ability to absorb energy rather than twist.

- Redundant design with many structural members will sustain the forces placed on it longer and are less likely to fail if one member fails.

- Dampening systems control building movement, pp. 133-134.
  
  * Installed between joints of columns and beams to absorb energy and movement of the building

Seismic Design Concepts

- Base isolation
  
  * Elastomeric bearing – rubber or neoprene in between foundation and sill plate of structure that changes to frequency of the building
  
  * Sliding system – plates slide on each other, however, this system is less effective

Structural Design Criteria

- Structural design criteria are usually on the first structural sheet.
  
  * They would include the building’s ability to support:
    
    - Live loads
    - Wind loads
    - Snow loads
    - Seismic loads
  
  * Structural design criteria schedule, Figure 7.13, p. 135
Structural Design Criteria

- Soil pressure – pressure exerted against the foundation
  - Pressure exerted by the soil is active soil pressure.
  - Pressure exerted by the foundation is passive soil pressure.
  - Soil acts like a liquid with the least pressure on a wall at the top and the greatest pressure at the bottom.

- Foundation design – designed to carry the load of the structure to the soil below
  - Compression of soil is critical to support weight.
  - If soil compression is not to design specifications, then pilings must be driven into the soil and a grade beam (Figure 7.17, p. 137) is applied to carry the load.
  - Footings are placed under foundation to distribute the load of the foundation to the soil.

- Foundations are made of cinder blocks, concrete masonry units (CMU), and/or wood.
- Foundations are designed with footings, foundation walls, piers to support long beams, and, for full basements, columns to support beams.
Structural Design Criteria

• The two most common structural system designs for walls are bearing walls and frame structure walls.
• Bearing walls carry load to foundation.
• Bearing walls function as a continuous unit, taking the load from the floors to walls to footing to the soil.
• Increase the width between walls, and you must support the center with piers or columns.

Structural Design Criteria

• Frame structures consist of columns and beams that provide the primary support to the structure.
• Beams transfer loads to columns, then to the footings, and then the soil.
• This type of framework has multiple bearing points throughout the footprint of the structure.

Structural Design Criteria

• Structural components
  • Beams – horizontal structural members designed to carry loads perpendicular to the longitudinal dimension
    • Support beam – ends not restrained
    • Rigid support beam – ends fixed
    • Cantilever beam – supported on one end and over the bearing point with the other
    • Continuous beam – supported in several places
  • Column – vertical structural member used to support a compression (straight through column) or eccentric (side) load
Structural Design Criteria

- Truss – designed with a top chord and bottom chord
  - A web is placed between these two cords in a triangular fashion for maximum structural support.
  - Examples on p. 144, Figure 7.28
- Connection points between the web and the chords can be connected by:
  - Pinning
  - Welding
  - Gusset plates
  - Metal tooth plates
  - Strap connectors

Structural Design Criteria

- Arch – a curved structure where structural members are in compression
  - Arches may be hinged for minor movement at the base supports; however, base supports must be stable.
  - Tension rods may be used to tie the base supports together.

Structural Design Criteria

- Three types of lateral bracing (p. 145-148)
  - Diagonal
  - Sheer wall
  - Solid or minimal opening rectangular wall that provides lateral/sheer stability; the rectangle supports the wall (interior triangles in the solid wall)
  - Moment connections
  - A joint between a beam and a column that is designed to be rigid and resist the bending moment of the applied load at the connection
Structural Design Criteria

- Sheer walls can be in the following forms
  - Masonry exterior walls
  - Framed walls covered in drywall or sheathing
  - Pre-cast concrete panels

Moment connections

- Bending moment is the torsion load that is placed on a column by a beam securely fastened to that beam.
- Column and beam connections must resist twisting (bending moment) to maintain rigidity.
- P. 148, Figure 7.36

Structural framing plans

- Contains information for the construction of the walls, floors, and roof of the structure
- Basic outline and supports of the exterior and interior supporting walls and columns
- Engineered trusses with connections shown in detail and never modified in the field
Structural Design Criteria

- Roof framing plans
  - Roof details, roof venting, and equipment mounted on roof are on plan.
  - Roofs must withstand the weight of the roof and the vibration of the equipment on it.
  - Figure 7.38, p. 150, and 7.39, p.151, show roof framing, sectional views of the roof, and size of material.

- Structural details and sectional views
  - Section views show how the structural members are connected

- Wood connectors:
  - Nails
  - Carriage bolt
  - Stove bolt
  - Log screws
  - Beam and joist hangers
  - Framing anchors
  - Split ring connectors
  - Weldments
  - Toothed plates

Structural Design Criteria

Exercise 7-1

- Identify the following items on the foundation plan on p. 137, Figure 7.18.
  1) Size and thickness of the column footing
  2) Width of the footing and exterior wall
  3) Size of the column
  4) Size of the floor joist that will support the first floor
  5) Specifications for the concrete floor to be poured
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe structural plan terminology, structural loads, design concepts, and design criteria for structural plans. The student will perform to a written test accuracy of at least 70%.

Review

- Structural plans terminology
- Structural loads
- Seismic design concepts
- Structural design criteria
- Structural design criteria exercise
Lesson 5-2: Electrical Plans

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, and elements of electrical plans. The student will perform to a written test accuracy of at least 70%.

Overview

• Electricity
• Wiring drawings
• Electrical service
• Emergency systems
• Hazardous location electrical equipment
Electricity

• Flow of electrons through system of conductive electrical components
• Plans examiners need a basic understanding of how it works to understand the drawings.

Electricity

• Two types of electricity
  – A/C (alternating current) – electron flow in one direction, then another (positive to negative to positive)
    • Transformers used to step up or down the voltage
  – D/C (direct current) – current flows in one direction
    • Cannot travel over long distances without loss of current

Electricity

• Three properties of electricity
  – Voltage – the amount of potential energy (power) that the electrons possess or the amount of pressure (push) that the electrons exert in flowing forward toward a positive charge
  – Current – the amount of electrons moving through a circuit in a unit of time
  – Resistance – opposition that the electrons encounter flowing through conductor
Wiring Drawings

- Wiring Diagram – Sheet E 3 Canterbury Home
  - Wiring is referred to as a run.
  - Wiring concealed in a wall is shown as a solid line.
  - Wiring that runs on the surface is shown as a short dashed line.
  - Wiring that runs under the floor is shown in long dashed lines.
  - A wiring run is shown on drawing as curved lines connecting fixture
    and junctions. The number of wires (conductors) in the run is indicated
    by cross lines.
  - Panelboards or switchboards are where the circuits terminate with a
    "HOME RUN" from the last fixture to the panelboard.

Electrical Service

- Electricity brought in by public utility via power lines
  - Above ground lines – low initial cost; lines into the weather
    head thru conduit to meter box
    - Easy to maintain, however, subject to environment
  - Underground lines – high initial cost
    - Difficult assessment/maintenance but almost maintenance free
  - Service connection – designated on the drawings as "SE"
    - Must have a disconnect
    - Each building supplied with a service connection
    - Exception: multiple-occupancy buildings and fire pumps
      and other fire protection devices

Electrical Service

- Transformers
  - Increase or decrease voltage of an A/C current with a
    corresponding increase or decrease in amperage
    - Power distribution system consists of: 750,000 volt
      transmission lines, 40,000 V. feeder lines, 13,200 or 4,800 V.
      primary mains on poles, 240/120 V. transformers for homes
  - Wire windings and an iron core in a transformer are
    used to alter voltage, which creates heat that is
    dissipated by air circulating in a dry transformer or
    liquid oil cooled in larger transformers.
Electrical Service

• Electrical system components
  – Power Riser Diagram -- Canterbury Home -- Sheet E5
  – Wiring and raceways
    • Conduit and cable
  – Power handling equipment
    • Switchboards distribute power from incoming source to smaller feeder lines circuits
    • Circuit breaker and switches
  – Power utilization equipment
    • Motors and lighting

Electrical Service

• Circuits consist of several components
  – Power source – power lines, generators, and batteries
  – Conductor (wire) provides a pathway for the power to flow through.
    • Power provided to a circuit through a hot conductor (black wire)
    • Neutral takes the power back to the source (white wire)
    • Ground gives the power a safe exit point in case the circuit overloads

Electrical Service

• Control devices
  – Switches – regulate the flow of electricity to a load
  – Overcurrent devices
  – Designed to protect wires and devices from overload conditions
    • Fuses – have a metallic strip in them; and if an overload occurs, then the strip either melts or bends to open the circuit
    • Circuit breakers – detect current flow increase; this increase beyond the breaker’s power rating causes the breaker to "trip," opening the circuit
Electrical Service

- **Ground fault circuit interrupters (GFCIs)**
  - Ground fault electrical outlets
  - Ground fault circuit breakers
  - Prevents electrocution of individuals in wet location and activates in 1/40th of a second at under 5 milliamps

- **Arc fault interrupters (AFCIs)**
  - Identifies the characteristics of electrical wave forms of an “arc”
  - Electrical “arc” reaches temperatures of 3600°F
  - Mandatory use on circuits in residential bedrooms

---

Electrical Service

- **Electrical wiring**
  - American wire gauge (AWG)
    - Rates the cross sectional size of wire
    - 10-gauge wire is larger than 12-gauge wire
  - Armored cable
    - Insulated wire enclosed in a flexible metallic cable
    - BX Cable – trade name
  - Non-metallic cable
    - Insulated wire encased in a plastic outer shell
    - Romex cable – trade name

---

Electrical Service

- **Conduit**
  - Isolates electrical conductors from the structure
  - Provides support for conductors
  - Provides a ground for the circuit
  - Conductors are pulled through the conduit

- **Three types of steel conduit**
  - Heavy wall steel – rigid steel conduit – RSC
  - Intermediate - intermediate metal conduit – IMC
  - Thin wall – electric metallic tubing - EMT
  - Only differences are the thickness of the conduit and the ease of assembly
Electrical Service

• Listed and approved wire
  – Circuits generate heat.
  – The higher the amperage is, the higher the heat is.
  – Circuit interrupters detect this heat and open the circuit.

• Switches
  – Switches control branch electric circuits.
  – Two conductors are mechanically brought together and complete the circuit and parted to open the circuit.
  • Operated by:
    – Hand
    – Spring loaded
    – Electric motor
  – Switches can be solid state with no moving parts
Electrical Service

- Switches are rated by amperage.
- Rated by the duty or function they perform:
  - Single-pole – single circuit in and out
  - Double-pole – two circuits in and out
  - Three-way – three switches control one load
  - Four-way – four switches control one load
- Light duty – general use
- Heavy duty – frequent use

Electrical Service

- Contactors
  - Silver-coated copper contacts
  - Can be hand operated
  - Most operated by an electromagnet
  - Excellent for remote-controlled operations

Electrical Service

- Switchboards and panelboards
  - Supply power from the main to smaller circuits
  - Equipped with switches, fuses, circuit breakers, and meters
  - Located inside or outside the structure
- Panelboards are smaller switchboards.
  - Divide feeder circuits from the switchboard into individual circuits
  - Switchboard supplies the complex while panelboards supply individual units in the complex
  - Sheet E5 of Canterbury Plans main panel MDP supplying smaller panels L and P
Electrical Service

- Rating of the switchboards or panelboards are marked in amperage on the exterior of the box.
- Service rating is determined by the load-carrying capacity of the service entrance cable (SEC) coming into the box.
- A 100-amp service has an SEC rated at 100 amps and a main circuit breaker of 100 amps.
- Electrical circuits are designed for total demand.

Electrical Service

- Residential has different load demands than commercial occupancies.
  - Load calculations determine supply demands.
  - A single-family house may need a 120/240-volt 200-amp service to supply needs.
  - A commercial hotel or condo unit may need 3-phase 277/480-volt service to supply all the needs of the building.

Electrical Service

- Special considerations
  - Unapproved or listed electrical equipment
    - Experimental or research apparatus
    - Plans examiner must never approve on their own; have a third party electrical-safety evaluation
  - Hospitals and health care facilities
    - Electrical components used where flammable liquids should be explosion proof
    - Electrical disconnect when ventilation system not operating
    - Nurse signal system, fire alarm systems, emergency requirements for lighting, machinery, and receptacles
  - Laboratories
    - Explosion proof wiring and motor operations
Emergency Systems

- Standby power – automatically supplies power to services that are essential to public health and safety
  - Supplied by other devices – generators or battery storage
- Level 1 – stored power – supply power when there could be a loss of human life or critical injury
  - Separate 2-hour fire rated room
  - Minimize damage from flooding or sewage back up
  - Basement of the building
- Level 2 – supplies power when power is less critical
  - Different circuit in the building for emergency lights and exits

Emergency Systems

- Emergency power supplies (NFPA Standard 110)
  - Automatic – detects power loss
  - Nonautomatic – must be manually operated
- Generator fuels
  - Day tank – stores fuel for generator in the structure
  - Integral fuel tank – mounted on generator
  - Main fuel tank – provides fuel for generator or day tanks
- Enclosure for generator
  - 2-hour fire rated room with battery powered emergency lighting
  - Heated, cooled, and has an exhaust system

Emergency Systems

- Stored electrical power
  - Emergency power systems employ stored electrical energy to provide a source of power when main power is disrupted consisting of:
    - Uninterruptible power supply
    - Central battery system
      - Lead acid, nickel-cadmium, and other batteries
    - Automatic transfer switch
    - Control equipment
Emergency Systems

• Emergency and exit lights
• Provide illumination for and identification of means of egress
• Illumination of one foot-candle
  – Illumination equal to the light of a candle 1 foot away from a surface
  – Emergency illumination no less than 1½ hours

Emergency Systems

• Exits and exit signs
  – Identified with approved signs
  – Each exit door equipped with an exit sign
  – Sign color contrasts with interior finish of area
  – Visible from any point in the exit way up to 100 feet
  – Floor proximity signs may be required
  – Internal illumination on regular and emergency power or self-luminous signs
  – External illuminated signs of no less than 5 candlepower

Hazardous Location Electrical Equipment

• Hazardous location electrical is equipment classified by:
  – SEE p. 242-243 PLANS EXAMINER FOR EXPLANATION OF ITEMS BELOW
  • Class – physical state of the hazardous material
    • Class I (gases), II (dust), III (fibers)
  • Division – relative likelihood that the material will be in the atmosphere
    • Division 1 (anticipated to be airborne) & 2 (normally confined)
  • Group – specific materials that the electrical equipment can be used with
Hazardous Location Electrical Equipment

- Grounding protection
  - Wiring connects the service to the ground in case of an overload.
- Static protection
  - Humidification — moisture to keep static charge down
  - Fuel additives — reduces resistance or increases conductivity
  - Grounding between object and earth
    - Grounding a flammable liquid tank
  - Bonding equalizes static charge between objects
    - E.g., fuel truck or airplane
- Lightning protection
  - Conductive rod on top of the structure; conductor to ground
  - Can be on the electrical plans or architectural set

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, and elements of electrical plans. The student will perform to a written test accuracy of at least 70%.

Review

- Electricity
- Wiring drawings
- Electrical service
- Emergency systems
- Hazardous location electrical equipment
Lesson 6-1: Fire Alarm and Detection Systems

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the different components of fire alarm and fire detection systems. The student will perform to a written test accuracy of at least 70%.

Overview

- Fire alarm circuits
- Alarm control units
- Detectors
- Notification appliances
- Battery calculations
- Voltage-drop calculations
- Riser diagrams
Fire Alarm Circuits

- Initiating device circuits
  - IDC
- Notification appliance circuits
  - NAC
- Signaling line circuits
  - SLC

Initiating device circuits
- Circuit(s) to which automatic or manual initiating devices are connected
  - Detectors
  - Manual pull stations
  - Water flow switches
  - Duct detectors
  - Inputs

Initiating circuit(s) for supervisory functions
- Water level and temperature
- Air pressure
- Power supply to fire pump
- Inputs
Fire Alarm Circuits

- Notification appliance circuits
  - Circuit(s) to which notification appliances are connected
  - Horns
  - Speakers
  - Bells
  - Strobes
  - Outputs

Fire Alarm Circuits

- Circuit(s) for ancillary functions
  - Door release and lock release
  - Fuel shutoff
  - Elevator recall
  - Smoke management
  - Stairway pressurization
  - HVAC shutdown

Fire Alarm Circuits

- Signaling line circuits
  - Circuit(s) that carry SIGNALS
    - More than one direction
    - More than one signal
    - Ancillary functions/off-premise reporting
Fire Alarm Circuits

- Circuit path survivability
  - Level 0 – no special provision for pathway survivability
  - Level 1 – circuit pathways in fully sprinklered buildings
  - Level 2 – circuit pathway with 2-hour protection
  - Level 3 – circuit pathway in fully sprinklered building with 2-hour protection

Fire Alarm Circuits

- Fire alarm wire and cable
  - Non-power limited – for circuits with voltage up to 600 volts
  - Power limited – for circuits attached to power source, which limits the power available to the fire alarm circuit
Fire Alarm Control Units

- The fire alarm control unit (FACU) is the heart of the alarm system.
- FACU varies in size and complexity.

FACU components include:
- Relays
- Fuses
- Circuit boards
- Batteries
- Graphic displays

Fire alarm signals – Once the initial device activates and sends a signal to the FACU, the FACU processes the signal and takes appropriate action, such as:
- Sounding alarms
- Lighting of local alarms
- Transmission of emergency signal to a local, central fire dispatch system
Fire Alarm Control Units

- Notification devices
  - Local notification devices include:
    - Bells
    - Buzzers
    - Strobe lights
    - Horns
    - Recorded messages
  - Depending on the system, the notifications may be localized or throughout the entire facility.

Detectors

- A fire alarm makes use of a variety of fire detection devices that report to a central location. The most commonly encountered detection devices in plans reviews are smoke and heat detectors.

Detectors

- There are many types of heat detectors including:
  - Fixed temperature
  - Rate-of-rise
  - Linear
  - Rate compensation
Detectors

- There are many types of smoke detectors including:
  - Ionization
  - Light scattering photoelectric
  - Light obstruction
  - Air sampling
  - Gas sensing
  - Radiant energy

Detectors

- Locations for smoke and heat detectors
  - Locations depend on code requirements.
  - In healthcare facilities, code may require detectors in every room, corridor, and common area.
  - In residential facilities, code may only require detectors in sleeping rooms.

Detectors

- Heat detector spacing
  - Spacing between detectors depends on the type of detector being used.
  - Maximum spacing is listed by the manufacturer.
  - Spacing can be influenced by several factors:
    - Ceiling height
    - Ceiling configuration
    - Shape of the compartment being protected
Detectors

- Smoke detector spacing
  - Spacing between detectors is based on engineering judgment and evaluation of the environment in which the detectors are placed.
  - Spacing can be influenced by several factors:
    - Ceiling height
    - Ceiling configuration
    - Shape of the compartment being protected

Detectors

- Smoke detector spacing (cont.)
  - Spacing can be influenced by several factors:
    - Room ventilation
    - Combustion characteristics of the fuel
    - Ambient temperature
    - Air velocity
    - Humidity

Table 11.2

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Detectors
A notification appliance is a component of the fire alarm system that provides audible, tactile, or visual output for notification of occupants. These appliances may include:

- Bells
- Horns
- Strobe lights
- Speakers

### Audible notification appliances

- **Public mode** – Notification signals must have an output throughout the protected space 15 decibels (dB) above the average ambient sound level and 5 dB above the maximum sound level with a duration of 60 seconds.
- **Private mode** – Notification signals must only be heard by persons directly involved with emergency procedures in the area protected.

### Visible notification appliances

- Visible alarm notification devices (strobes) are required in public and common areas.
- Visible alarm notification devices are not required in all dwelling and sleeping units.
- Visible alarm notification devices are required in certain types of hotels and institutional occupancies.
- Visible device intensity will be indicated on the drawing by a small number adjacent to the device.
Notification Appliances

- Visible notification appliances
  - Must be mounted on the ceiling or wall of a room
  - Must be positioned so that the devices are viewed directly by occupants or the surrounding area is illuminated

Notification Appliances

- Fire alarm system plans
  - Buildings that require fire alarm systems and the type of fire alarm are specified in the applicable fire or building code.
  - Jurisdictions may use the International Building Code as their applicable building code.
  - Plans for fire alarm systems can be simple or complex, just like all building systems.
Notification Appliances

• Fire alarm system plans (cont.)
  • Sprinkler system details appear on sprinkler drawings, but the connections for the sprinkler system water flow and supervisory devices appear on the fire alarm drawing.
  • The equipment legend shows symbols used to identify the equipment on the drawings and the number of individual devices.

• Plans for a typical fire alarm system are more complex than the example shown before and include items such as:
  • Floor plan
  • FACU diagrams
  • Annunciation devices
  • Primary power connection
  • Conductor type and sizes
  • Names of manufacturers and model numbers
  • Ceiling height details
  • Battery calculations
  • Voltage drop calculations
  • Riser diagram
  • Name and qualification of system designer
  • Address list and/or zone list
Battery Calculations

- Batteries alone must supply power to system for 24 or 60 hours in non-alarm conditions (depending on system).
- Batteries must supply power for 5 (horn/strobe) or 15 (voice fire alarm) minutes after the 24-hour time in alarm mode depending on occupancy.
- Emergency generator batteries must supply power for 4 hours.

Voltage-Drop Calculations

- Fire alarm systems require a minimum voltage to provide power to devices.
- The operating range of a battery is called the nameplate range.
- Resistance is a function of the length of the wire and material of which the wire is made.
- In order to ensure proper voltage at the system appliances, the FACU must supply a higher voltage than what is required by the appliance to overcome the voltage drop in a wire.

<table>
<thead>
<tr>
<th>Device</th>
<th>Quantity</th>
<th>Appliance to Monitorper Hour</th>
<th>Appliance to Monitorper Second</th>
<th>Monitor Alarm Hours</th>
<th>Alarm Hours (5 Min)</th>
<th>Total Alarm &amp; Nonalarm Alarm Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main</td>
<td>1</td>
<td>0.600</td>
<td>1.50</td>
<td>7.2</td>
<td>0.041</td>
<td>7.24</td>
</tr>
<tr>
<td>Annunciator</td>
<td>1</td>
<td>0.025</td>
<td>0.15</td>
<td>7.56</td>
<td>0.032</td>
<td>7.57</td>
</tr>
<tr>
<td>Horn</td>
<td>8</td>
<td>0.0</td>
<td>0.06</td>
<td>0.0</td>
<td>0.019</td>
<td>0.019</td>
</tr>
<tr>
<td>Strobe</td>
<td>12</td>
<td>0.0</td>
<td>0.02</td>
<td>0.0</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Intercom System</td>
<td>10</td>
<td>0.0</td>
<td>0.02</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Line In Detectors</td>
<td>20</td>
<td>0.02</td>
<td>0.02</td>
<td>0.096</td>
<td>0.13</td>
<td>0.226</td>
</tr>
</tbody>
</table>
Voltage-Drop Calculations
- Wire lengths used in calculating the voltage drop are usually scaled from a drawing of the system.
- When determining wire length between appliance and FACU, the distance between the appliance and the FACU should be doubled to account for both supply and return sides of the circuit.
- Since fire alarm circuits supply more than one device, the requirements of all the appliances in a circuit must be added together.

Riser Diagrams
- Fire alarm plans for multistory buildings include riser diagrams.
- Riser diagrams are schematic representations of fire alarm systems in a vertical pane.
- Riser diagrams show the number of devices in each floor level and their arrangement of the circuits.
- Riser diagrams DO NOT show the locations of the devices or lengths of the wires in the circuits.

Student Performance Objective
- Given information from lecture, discussion, and reading materials, the student will be able to describe the different components of fire alarm and fire detection systems. The student will perform to a written test accuracy of at least 70%.
Review

- Fire alarm circuits
- Alarm control units
- Detectors
- Notification appliances
- Battery calculations
- Voltage-drop calculations
- Riser diagrams
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of all mechanical plans. The student will perform to a written test accuracy of at least 70%.

Overview

- Plumbing systems
- Fuel gas systems
- Specialized piping
- Hazardous processes
- Plumbing system reviews
- HVAC systems
- Ductwork
- HVAC systems review
- In-class Exercise 7-1
Plumbing Systems

- Plans examiners must be familiar with fixtures, supply, and waste water in a system—WHY?
- Plumbing code and occupancy type determines the number of fixtures.
  - Water flow rates and pressures for fixtures must be determined.
  - Estimate number of fixtures that will be in use at one time.
  - Not enough water is poor hygiene.
  - Too much supply is wasteful.
  - Supply lines and waste lines must be determined and sized properly with proper pressure (60 – 100 PSI).
  - Too much pressure needs pressure reducing valves.

- Drains – low points of the system to drain water for repair
- Shutoff valves are at all fixtures for repair.
- Supply piping routed for easy access.
  - Basement – (Sheet P5 Canterbury Plans)
  - Above ceiling with access panels (Sheet P3)
- Risers – provide water to upper floors
  - Runouts at the end of supply line – (Figure 8.2, p. 168)
  - Air in that end to reduce the effect of water hammer

- Domestic pump systems
  - Up-feed system
  - Supply water to multistory buildings
  - Several smaller, variable-speed pumps
  - Pressure switch detects drop in PSI
  - As demand increases, pumps are started in series
  - Alternate daily to maintain consistent ware on both pumps
  - Water supply from city main cannot supply peak demand
Plumbing Systems

- Wastewater system design
  - All buildings have provisions for wastewater.
  - Systems have piping requirements.
- Three types of wastewater
  - Storm water – rain runoff to ground ponds
  - Gray water – laundry, sinks, and dishwashers
  - Black water – lavatories and sewage

Plumbing Systems

- Wastewater system hydraulics and piping
  - Supply piping is under pressure and full.
  - Waste piping is nonpressurized and not full at all times.
  - Waste piping must have a fall of ¼ inch per foot for small diameter pipe and 1/16 inch per foot for large waste pipe.
  - All waste piping must be trapped and vented to prevent odor from entering the building.
- Industrial wastewater treatment process
  - Provides safe discharge, neutral PH, and storage and removal of hazardous materials

Fuel Gas Systems

- Used to convey:
  - Natural gas
  - Propane
  - Butane
- Components listed or approved (AGA tagged)
- Piping plan to AHJ for approval
- Must have pressure regulators that:
  - Reduces, controls, maintains system pressure
**Fuel Gas Systems**

- Overpressure relief devices
  - Reduce, restrict, or turn off gas supply
- Vents
  - To outside air
  - Sized to manufacture’s specifications
- Backpressure devices
  - Eliminate other gases from entering pipes
- System must be flexible
  - For expansion
  - At points of connections
  - Forces on anchor points

**Fuel Gas Systems**

- Systems are constructed of:
  - Copper
  - Brass
  - Aluminum
  - Iron
  - Plastic
- Plans examiner must insure the type of pipe used is correct for application.
- Insure that clearances, damage protection, piping in approved locations, and others (listed on p. 177-178) are according to code of AHJ.

**Specialized Piping**

- In the chemical industry:
  - Specialized piping is virtually limitless.
  - Drawings are designed on a case by case bases.
  - Gases and liquids used may include:
    - Oxygen, hydrogen, nitrogen, flammable and combustible liquids, carbon dioxide, etc.
  - Drawings must show piping location and size.
  - Coaxial piping (pipe within a pipe for leakage or expansion) is used for liquids with special fire or environmental hazards (Figure 8.13, p. 180).
Hazardous Processes

- Some buildings are constructed to facilitate hazardous processes including:
  - Flammable and combustible liquid storage
  - Spray finishing operations
  - Semiconductor manufacture
  - Chemical laboratories
  - Petroleum refineries

To establish design criteria, the plans examiner must be provided with the following information:

- Class of liquid
- Occupancy classification
- Facility location
- Process facilities and equipment
- Storage configurations
- Size and construction of tanks and containers
- Loading and unloading capabilities

Once the hazard analysis has been conducted, appropriate safeguards can be determined to mitigate the hazard.

The plans examiner should consult the appropriate code for specific guidance.
Plumbing System Reviews

- Plumbing drawings are two-dimension representations of basic components.
- Plumbing drawings are overlaid on floor plans.
  - Floor plans are drawn in lighter line weight than plumbing.
  - Supply and waste are on most residential drawings.
    - Sometimes drawings become cluttered.
    - Details are often hard to find on the drawing.

In application larger than residential structures, waste and supply drawings are drawn separately.
- Example: P3 (Supply) and P2 (Waste and Vent) are shown in the Canterbury Plan
  - Symbols are used for individual valves and fixtures.
  - Specifications are on detail sheet or schedule.
- Waste riser drawings show clearer picture of pipe sizes, vertical locations, and roof clearances.

Example: S4 (Waste) and S5 (Riser), an isometric drawing (three-dimensional), is shown for riser and waste.
- Sheet P6 shows plumbing details in pictorial and schematic drawings.
  - Hot water heaters
  - Water meters
  - Wall hydrants
- Pictorial drawings show how things look.
- Schematic drawings show symbols of various components.
Plumbing System Reviews

• Common practice to arrange plumbing fixtures opposite of each other on a common or “wet or plumbing” wall
  • Back-to-back fixtures
    • Bath to bath
    • Bath to kitchen
    • Apartment to apartment baths and kitchens
  • Wall larger to incorporate all piping
  • Fire stopping is a must

Plumbing System Reviews

• Core design
  • Grouped in a central core are the following building services:
    • Plumbing, electric, elevators, telephone, etc.
  • Utilizing a central core provides maximum amount of usable floor space for occupancy.
  • Wet column provides for extra plumbing access caused by renovation.
  • Penetration and fire stopping must be done with an approved assembly.
    • Intumescent fire stopping expands to fill the void created by the pipe burning away.

HVAC Systems

• HVAC – provides a comfortable interior environment conducive to activities within
  • Aspects of the building’s contents, location, orientation, and function affect the design of a HVAC system.
    • Ovens in a commercial kitchen
    • Spray booths in a paint shop
    • Northern climates – larger heating systems
    • Large glass windows facing south require more A/C
  • Initial and operating cost also affect design and operation.
HVAC Systems

• Heating systems
  • In cold weather, because of the temperature difference, heat flows from inside to outside.
  • Amount of heat needed depends on how well the building is insulated.
  • Three types of heating systems (next slides)

HVAC Systems

• Forced-air systems
  • Heat derived from solid fuel, natural gas, oil, or electricity
  • Heated air forced through heat exchanger into supply ducts
  • Air returns through return air ducts
  • Make-up air (air that replaces interior air that has been lost due to leakage) added to system
  • Humidifier on the supply side for moisture
  • Automatic dampers installed where duct penetrates the fire barrier

HVAC Systems

• Hydronic heating systems
  • Components:
    • Boiler – heats water where a furnace heats air
    • Expansion tank
    • Circulating pump
    • Terminal units (cast iron radiators, baseboard units, finned tube radiators, etc.) to transfer heat
    • Water treatment unit
    • Piping, valves, and zone controls
    • Thermostat
HVAC Systems

- Four different piping arrangements
  - Series loop – all water passes through each terminal unit
  - One-pipe system – single pipe with diverter tee
  - Two-pipe system – continuous loop system of water from boiler to individual terminals; then water returns to return pipe then to boiler
  - Two-pipe reverse – Shortest supply and longest return
    - Longest supply shortest return

HVAC Systems

- Radiant systems
  - Boiler heated water
  - Piping coil in the concrete floor
  - Uniform heating
  - Must be kept on continuously
  - Coils closer together near exterior wall
  - Water temperature in system is typically not more than 120°F

HVAC Systems

- Cooling systems
  - Refrigerant is circulated in a closed system.
  - Compressor increases the pressure on the refrigerant and increases it’s temperature.
  - Hot refrigerant flows through a condenser where it gives up its heat to the air or water (cooling towers).
HVAC Systems

• Cooling system (cont.)
  • Refrigerant flows through an expansion valve reducing its temperature and turning it into a vapor.
  • Refrigerant flows through cooling coils and absorbs the heat from the space being cooled.
  • In the case of forced-air conditioning, air is forced over the coils and into the ducts to the rooms.

HVAC Systems

• Refrigerants
  • Chlorofluorocarbon (CFC) – Freon – used up in till the 1990s; better than ammonia but destroyed the ozone
  • Ammonia – return to ammonia especially in commercial-use, chilled-water systems
  • Used where large volumes of cool air are needed
• Cooling towers
  • Water is forced down and air is forced up; heat exchange occurs.
  • Interior of large towers are combustible and have a sprinkler system for protection.

Ductwork

• Penetration
  • NFPA 90A – best explanation for rules of penetration through fire-rated assemblies
  • Fire and smoke dampers are required when a duct penetrates a fire-rated assembly.
    • Ductwork in a fire-rated shaftway
    • Shaftways – 1-hour fire rating for less than 4 stories
    • Shaftways – 2-hour fire rating for 4 stories or more
    • Fire dampers are not usually required in nonrated penetrations of a wall with a rating of less than 1 hour
HVAC System Reviews
- Sheets H 1-4 of Canterbury Homes
  - Four separate systems
  - Three forced-air and one hydronic
  - Two mechanical rooms with furnaces on H1
  - One-story radiant panels are the choice
  - Three A/C condensers on H1
  - Hot water supply and return on H2
  - Radiant hydronic heat on H3
  - Equipment schedule on H4

HVAC System Reviews
- HVAC shutdown in emergency automatic or manual shutdown procedure
  - Acceptance test should be performed
  - Smoke detectors
    - "Downstream" to air filters
    - On each floor and before any return air plenum
  - Before any connection to a fresh air system
- Return air plenum
  - Return to HVAC system, ceiling cavities, and HVAC mechanical rooms, raised floors, occupied spaces, and open areas

In-class Exercise 7-1
Use the Canterbury Drawings:
1) Identify the largest and smallest size ductwork in the Canterbury Drawings.
2) Identify the room numbers for the mechanical rooms.
3) Identify the type of heat used in the structure.
4) Identify the type of cooling system used.
5) Identify where the waste lines exit the structure.
6) Are there any fire dampers/stops in the ductwork?
7) Identify the sheet where the plumbing pipe penetration detail is located.
8) Does ductwork need to have a damper in this type of structure when it crosses a fire-rated wall according to code?
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, measurements, scales, and basic facts of all mechanical plans. The student will perform to a written test accuracy of at least 70%.

Review

- Plumbing systems
- Fuel gas systems
- Specialized piping
- Hazardous processes
- Plumbing system reviews
- HVAC systems
- Ductwork
- HVAC systems review
- In-class Exercise 7-1
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe various types of plans reviews related to fire protection, including hazardous materials processes, storage, and membrane structures. The student will perform to a written test accuracy of at least 70%.

Overview

- Hazardous materials storage areas
- Hazardous processes
- Membrane structures and tents
Hazardous Processes

- Paint booths and powder coating, manual or automatic
  - Very little information from floor plan drawing (sectional drawing)
  - Water wash booths and dry filters
  - Dry filters are more of a fire hazard
  - Exhaust air velocity of 100 feet per minute with interlock so spraying cannot be started until exhaust is on
  - Electrical equipment listed for hazardous location (electrical drawing)

- Swimming pool installations
  - Surrounded by public assembly areas, apartments, schools, hotels, and single family homes
  - Codes for gaseous chlorine are specific
  - Exhaust fans
  - Fresh air intake
  - Window for observation into storage area

- Dip tanks
  - Paint application, heat treating, parts cleaning, and impregnation
  - Few gallons to several hundred
  - Toxic, corrosive, flammable, and explosive
  - Fire codes specific to dip tank installation and operation (NFPA 34)
  - Plans reviewer needs to match the prescribed protection with the material in the dip tank.
Hazardous Processes

- Flammable liquid processes
  - Cabinet storage
  - Mixing paint and solvents for spraying
  - Stored in separate room if material is over a certain quantity
- Explosion suppression and venting
  - Fuels that explode are vapors or dust
  - NFPA 61 for dust
  - NFPA 69 for vapors
  - Explosion venting NFPA 68 – venting before structural damage will occur

Membrane Structures and Tents

- Air supported structures
  - Canopy – supported by a structure with 75% or greater of its side walls opened
  - Tents – a structure, enclosure, or shelter that is supported by its own structure

Membrane Structures and Tents

- Tents and membrane structures greater than 200 sq ft and canopies of more than 400 sq ft must have a permit to erect for 180 days or less.
- Exceptions:
  - Canopies of 700 sq ft with all sides open
  - Multiple smaller canopies with a total of 700 sq ft
Membrane Structures and Tents
- Means of egress shall be illuminated 1 candle power.
- Guy wires can cross a means of egress or pathway if it is maintained above 8 ft.
- Consult local adopted fire codes for further details.

Student Performance Objective
- Given information from lecture, discussion, and reading materials, the student will be able to describe various types of plans reviews related to fire protection, including hazardous materials processes, storage, and membrane structures. The student will perform to a written test accuracy of at least 70%.

Review
- Hazardous materials storage areas
- Hazardous processes
- Membrane structures and tents
Lesson 8-1: Automatic Sprinkler and Standpipe System Plans

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, and measurements of automatic sprinkler and standpipe systems. The student will perform to a written test accuracy of at least 70%.

Overview

• Automatic sprinkler systems
• Standpipe systems
Automatic Sprinkler Systems

- Drawings should be shop drawings showing the entire system and how it is to be installed.
- These drawings are not cluttered with other items.
  - Shop drawings show pipe size, pipe length, hanger locations, head location, and types of heads.
- Sprinkler systems are simple, consisting of a water source, distribution piping, and the number of heads required.

Automatic Sprinkler Systems

- Sprinkler system design
  - Occupancy hazard and building construction determine sprinkler system design in accordance with NFPA 13.
  - NFPA 13 – regulates the majority of systems
  - NFPA 13R – residential occupancies up to 4 stories
  - NFPA 13D – one- and two-family dwellings

Automatic Sprinkler Systems

- Occupancy hazards classifications
  - Light hazard – heat release is low
    - Exhibition hall, classroom
  - Ordinary hazard
    - Group I – moderate rate of heat release
      - Bakery, cannery
    - Group II – moderate to high heat release
      - Textiles, mercantile occupancies
Automatic Sprinkler Systems

- **Extra hazard**
  - **Group I** – High rate of heat release
    - Plywood/particle board manufacturing, rubber reclamation plant
  - **Group II** – moderate to high volumes of flammable liquids
    - Open oil quenching, paint dipping

- **Commodity classifications**
  - **Class I** – noncombustible products placed on wood pallets, single layer cartons, shrink wrapped or paper wrapped
  - **Class II** – noncombustible products placed on wooden crates, boxes, or multiple layered cartons

- **Commodity classification (cont.)**
  - **Class III** – products made out of wood, paper, natural fiber, and pallets
  - **Class IV** – Group B and up to 25% by volume of Group A plastics with or without pallets
Automatic Sprinkler Systems

- Hydraulic design method
  - Contemporary sprinkler systems are designed using hydraulic calculations.
  - A minimum required rate of flow from sprinklers is specified.
  - The rate of flow is determined by a required discharge density expressed in gpm/ft².

- Discharge density is the flow from a sprinkler divided by the area covered by the sprinkler.

**EXAMPLE:**
A sprinkler discharging 25 gpm over a 150 ft² area
Average discharge would be 25 gpm/ft²

- The size of the pipes used to supply sprinklers is determined by calculating the cumulative flow and pressure loss of the water flowing to the sprinklers.
- The use of hydraulic design permits more economical selection of pipe sizes while ensuring the minimum acceptable water discharge.
Automatic Sprinkler Systems

- Hydraulic design method (cont.)
  - Required discharge destiny for a system is selected depending on hazard groups as listed in NFPA 13.
  - Design will vary with different types of specialized sprinklers.
  - Insurers may require higher sprinkler densities and larger design areas in some occupancies.

- The area of sprinkler operation may be increased or decreased without a change in density.
  - The higher the ceiling, the longer it will take sprinklers to react to a fire.
  - When quick response sprinklers are used, the area of operation may be reduced.

- The area of application used for calculations is the most remote part of the sprinkler system.
  - The design area of application is always indicated on the sprinkler system working drawing.
Automatic Sprinkler Systems

Hydraulic design method (cont.)

- The amount of water discharged from a sprinkler depends on the pressure supplied to the sprinkler discharge orifice.

  Discharge formula
  \[ Q = K \sqrt{P} \]

  \( Q \) = flow in gpm (L/min)
  \( K \) = discharge coefficient (k factor) for the particular sprinkler
  \( P \) = pressure in psi (kPa and bars)

Automatic Sprinkler Systems

Pipe-schedule design method

- Before hydraulic design methods were used, systems were designed using the “pipe-schedule method.”
- In the pipe-schedule method, a set of rules were used for determining spacing between sprinklers and sizes of pipes.
- Occupancies were classified as light, ordinary, and extra hazard.
- A minimum end head pressure was assumed.
Automatic Sprinkler Systems
• Sprinkler system plans
  • Sprinkler system components and designs can vary.
  • In addition to density and area of operation, designers can choose different:
    • Pipe size
    • Pipe thickness
    • Sprinkler type
    • Sprinkler spacing

The design of hydraulically calculated systems have become very sophisticated.
The working drawings submitted for review include a number of details such as:
  • Name of owner
  • Location of partitions
  • Location of fire walls
  • Occupancy class
  • A full list of working drawings details can be found on pages 261 and 262 of the textbook.
Automatic Sprinkler Systems

- Sprinkler system plans
  - The drawings for a hydraulically calculated system must always include hydraulic calculations, summary sheet, actual calculations, and a graph sheet.

- Summary sheet
  - The summary sheet contains basic information such as:
    - Date prepared
    - Structure location
    - Description of hazard
    - Total water requirements
    - Limitations of system

A full list of information included in a summary sheet can be found on page 266.
Automatic Sprinkler Systems

- Sprinkler system plans
  - Calculations sheet
    - The calculations sheet contains basic information such as:
      - Proper density and area of operation hazard
      - Sprinkler K factors
      - Elevation losses
      - Type of piping
    - A full list of information included in a calculation sheet can be found on page 267.

- Graph sheet
  - The graph sheet is a means of comparing the system water demand with the available supply.
  - It shows system supplies from several sources.
  - Sources include city water mains, fire pumps, and fire pumps from a city main.

Automatic Sprinkler Systems

- Sprinkler system plans
  - Residential sprinklers
    - In recent years, small residential buildings have become prevalent in fire protection systems.
    - The main purpose of residential sprinkler systems is life safety.
    - Two NFPA standards exist for the installation of residential sprinkler systems:
      - NFPA 13D for one- and two-family dwellings
      - NFPA 13R for residential occupancies up and including four stories in height
Standpipe Systems

- A standpipe system is a system of piping, valves, hose connections, and water supply installed to supply hoselines within a building.

- The standard most often used for the installation of standpipes is NFPA 14: Standard for the Installation of Standpipes and Hose Systems.

Standpipe Systems

- NFPA 14: Standard for the Installation of Standpipes and Hose Systems classifies standpipes as follows:
  - Class I – standpipes equipped with 2.5-inch valves used by fire department personnel
  - Class II – standpipes equipped with 1.5-inch hose stations used by building occupants and firefighters on initial response
  - Class III – standpipes equipped with both 2.5-inch valve and 1.5-inch hose stations that can be used by either fire department personnel or building occupants

- Automatic – standpipe permanently connected to an automatic water supply capable of supplying the system on demand

- Manual – required water supply provided through a fire department connection
Standpipe Systems

- Wet – system that is full of water at all times and can be manual or automatic
- Dry – system that does not contain water and can be manual or automatic

Standpipe Systems

- Fire-pump controller
  - Buildings requiring both sprinklers and standpipes are supplied by the same water source.
  - Most automatic standpipe systems require a pump.
  - The fire-pump controller controls the operation of the fire pump.
  - The pressure-sensing switch inside the fire-pump controller senses drops in system pressure and controls the pump to compensate for the loss.

Standpipe Systems

- Locations
  - Plans reviewer must ascertain the proper location of the standpipe and hose connections.
  - Class I standpipes must be located within stairwells and other locations accessible to firefighters.
  - Class II standpipes must be located within 130 feet of all points on the floor when equipped with a 1.5-inch hose and 120 feet from all points on the floor when equipped with hose smaller than 1.5 inches.
Standpipe Systems

- Locations
  - Class III standpipe must be located to meet the requirements of both Class I and Class II.
  - The locations of those hose stations are shown on the architectural floor plans as well as the fire protection drawing set.

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose, design elements, abbreviations, and measurements of automatic sprinkler and standpipe systems. The student will perform to a written test accuracy of at least 70%.

Review

- Automatic sprinkler systems
- Standpipe systems
Lesson 9-1: Automatic Elevators, Fire Command Centers, and Fire Extinguishers, and Smoke Control Systems

Student Performance Objective

• Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose and elements of automatic elevators, fire command centers, extinguishing agents, and smoke control systems. The student will perform to a written test accuracy of at least 70%.

Overview

• Automatic elevators
• Fire command center
• Restaurant kitchen fire extinguishing systems
• Gaseous fire extinguishing agents and systems
• Smoke control systems
• Portable fire extinguishers
Automatic Elevators

- Automatic elevators (AE) play an important role during fires in multistory buildings.
- AE can be called to the floor within a fire.
- AE can assist responding firefighters in high-rise buildings.
- AE can facilitate the evacuation of occupants.

Automatic Elevators

- ASME and ANSI Standards require that whenever a smoke detector is activated in an elevator lobby, elevator machine room, or hoistway, the elevators automatically return to a floor designated by the AHJ.

Automatic Elevators

- Manual recall system
  - Elevators that rise 25 ft or more are required to have a key operated manual recall or fireman's service system.
  - The manual recall or fireman's service system allows FD to control the operation of the elevators during an emergency.
Automatic Elevators

- Manual recall system:
  - The manual recall or fireman’s service system allows FD to control the operation of the elevators in two operating phases.
    - Phase I – Brings all elevators to the lobby, ground floor or floor determined by the FD
    - Phase II – FD has total control of elevator function so elevators can be sued for rescue and fire suppression activities

Automatic Elevators

- Backup power and additional requirements for manual recall systems
  - The elevator must be equipped with emergency backup power for the lighting and alarm bell inside the car.
  - When the AHJ adopts additional requirements, they must be identified on the plans.
  - The plans examiner should ensure that the elevator provisions are called out in the elevator plans of the structure.

Automatic Elevators

- Recall smoke detectors
  - NFPA 72 has requirements for installing elevator recall smoke detectors.
  - Normally, only smoke detectors in elevator lobbies, machine rooms, and hoistways initiate the elevator recall.
  - High-rise buildings often have more than one set of elevators.
  - NFPA requires lobby smoke detectors to be within 21 ft of the centerline of the door of each elevator.
Automatic Elevators

- Elevator shunt trip
  - Elevator hoistways and machine rooms can be sprinklered.
  - The discharge from the sprinkler can cause short circuit elevator controls.
  - ANSI requires the main power must shut off before sprinklers activate in the machine room.
  - The mainline power disconnect to prevent a short circuit is known as the shunt trip.
  - The most common way to disconnect mainline power is using a heat detector.

Automatically Elevators

- Other code provisions
  - The plans examiner may need to check other code provisions such as:
    - Emergency power to each elevator on a high-rise building
    - Annunciated fire command centers
    - Elevator controls located elsewhere in the building
    - Other code requirements as prescribed by the AHJ

Fire Command Center

- A fire command center is the location where the status of the fire alarm, fire communication, and fire protection/life safety systems can be monitored and manually controlled.
- The fire command center provides a communications center for arriving firefighters.
- The fire command center may or may not include the FACU depending on the system's design.
Fire Command Center

- Fire command center requirements can vary between jurisdictions.
- The fire command center can be attended or unattended.
- Fire command center requirements usually include:
  - Fire alarm system annunciator
  - Elevator status indicator
  - Emergency voice communications
  - Controls for unlocking stairwell doors
  - Emergency and standby power indicators
  - Fire pump status indicators
  - Status indicators and controls for air handling system

Fire Command Center

- Command center plans
  - Usually required by building codes
  - Must be located where it is accessible to fire and emergency personnel
  - Commonly located in the main building lobby
  - May be located within a fire-rated enclosure

Fire Command Center

- Emergency voice communications
  - Command centers must have a fire department emergency communications center with one of two types of systems:
    - One-way paging system – speakers located throughout the building that give messages to building occupants
    - Two-way telephone communication system – intended to overcome possible difficulties of FD radios in large buildings but may also be used by occupants to call for assistance
Restaurant Kitchen Fire Extinguishing Systems

- The fire extinguishing systems most commonly used in cooking facilities are pre-engineered wet chemical systems.
- System installation varies from one manufacturer to another.
- All systems share certain common requirements.

Restaurant Kitchen Fire Extinguishing Systems

- The standard for wet chemical extinguishing systems is NFPA 17A and includes the following requirements:
  - Agent storage tank
  - Distribution piping
  - Heat detectors
  - Manual pull station
  - Control mechanism
  - Nozzles
  - Fuel shutoff

Gaseous Fire Extinguishing Agents and Systems

- Gaseous extinguishing agents (GEA) are commonly used in food service.
- GEA are efficient for putting out flammable liquid fires and other materials that would react with water.
- GEA systems are generally divided into:
  - Carbon dioxide (CO2)
  - Halogenated Agents
Gaseous Fire Extinguishing Agents and Systems

- Carbon dioxide (CO₂)
  - Is a noncombustible gas, heavier than air
  - Can be liquefied for compression for fire extinguishing applications
  - Is primarily used for protecting areas with flammable liquids and electrical equipment

Gaseous Fire Extinguishing Agents and Systems

- Carbon dioxide extinguishing systems
  - CO₂ extinguishing systems come in two varieties:
    - Total flooding system – discharges in an enclosed space, such as a flammable liquid storage room
    - Local application system – non-enclosed hazards, and discharge is designed to engulf the hazard, such as a cooking range

Gaseous Fire Extinguishing Agents and Systems

- Carbon dioxide extinguishing systems
  - CO₂ extinguishing systems displace oxygen, which can be a hazard to occupants.
  - CO₂ is stored in high-pressure cylinders or low-pressure refrigerated tanks.
  - When a CO₂ system activates, the entire supply of the agent is discharged and will need to be refilled.
Gaseous Fire Extinguishing Agents and Systems

- Carbon dioxide extinguishing systems
- Concentrations and flooding factors
  - In the design of a CO₂ system, the designer must first analyze the hazards.
  - Different fires require different minimum concentrations of CO₂; actual design concentration must be 20% greater than the theoretical minimum.
  - The volume of the space protected must also be determined in the design process.

Gaseous Fire Extinguishing Agents and Systems

Carbon dioxide system components:

- CO₂ storage tanks
- Heat detectors
- Distributing piping
- Control panel
- Manual pull stations
- Warning siren
- Horn strobes
- Lockout valve
- Door releases
- Discharge daily timer
- Warning signs
Gaseous Fire Extinguishing Agents and Systems

- Halon replacement agents:
  - Halon systems design standard is NFPA 2001.
  - NFPA 2001 contains data for safe exposure of halon to humans.
  - The design of the halon system has provisions for evacuation of personnel from area prior to discharge.
  - The designer must analyze the area and nature of the hazard to be protected to determine agent concentration.
Gaseous Fire Extinguishing Agents and Systems

- Halon replacement agents:
  - Horns, strobes, or bells can be wired to function as pre-discharge alarms.
  - Abort stations must be present to allow occupants to stop the discharge in case of accidental activation.
  - Signs must be posted stating area is protected by halocarbon, and occupants must exit space when system activates.

Smoke Control Systems

- Fire can generate large amounts of smoke.
- Smoke is one of the primary causes of fire deaths.
- Smoke also contributes to property damages.
- Contemporary fire protection includes smoke control systems as part of the fire protection systems, especially in high-rise buildings and healthcare facilities.

Smoke Control Systems

- Smoke can travel through several areas of a building including:
  - Vertical shafts
  - Cracks
  - Atria
  - Stairwells
  - HVAC system
Smoke Control Systems

- The goal of smoke control systems is to limit the spread of smoke to the area where the smoke or fire occurs.

Smoke Control Systems

- Automatic control
  - HVAC systems can monitor interior conditions of a building and maintain specific interior temperature and humidity.
  - The HVAC system can be programmed to adjust to changing conditions.
  - Automatic transfer of an HVAC to fire operations can be accomplished by heat detectors or water flow alarms.

Smoke Control Systems

- Manual control
  - The transfer of an HVAC system to the fire mode can be accomplished manually through controls.
  - Manual controls can prevent system disruption due to false alarms.
  - Manual system can be controlled from a control panel, main control room, fire command center, or firefighters smoke control station.
Smoke Control Systems

- Manual control
  - In buildings with both manual and automatic controls, the manual controls must take priority over the automatic.
  - Buildings with smoke control systems must have a FSCS.
  - The FSCS should contain a diagram of the building showing the types and locations of the smoke control systems in the building.

Smoke Control Systems

- Stairwell pressurization
  - It is important to keep exit stairwells free of smoke during a fire.
  - Keeping stairwells smoke free is accomplished by using a stairwell pressurization system.
  - Fans are a common way to supply pressure to the stairwell enclosure.

Smoke Control Systems

- Stairwell pressurization
  - The design of a stairwell pressurization system requires precise engineering analysis.
  - When a system is used, the activation of the fan will be by smoke detectors located at the entrance of the stairwell.
  - During a fire event, doors to the stairwell will be opened causing loss of pressure, and the airflow will have to be increased.
  - Airflow increases are activated by pressure sensors located throughout the stairwell.
Smoke Control Systems

• System testing
  • Smoke control systems must be tested upon completion and periodically over the life of the building.
  • The system must be tested and meet the designed minimum or maximum pressure in a stairwell with various doors open or closed.

Smoke Control Systems

• System testing
  • There are two types of testing:
    • Commissioning – the process of testing to insure compliance with design criteria
    • Acceptance testing – testing undertaken upon completion of a system

Smoke Control Systems

• System testing includes
  • HVAC system test
  • Test system under normal and emergency power
  • Test automatic operation (if available)
  • Test manual override
  • Test all smoke control devices
  • Verify proper return to normal mode
Smoke Control Systems

- Smoke and heat vents
  - Building codes usually require smoke and heat vents in roofs of large one-story buildings or buildings that house hazardous processes.
  - There are two general types of vents available:
    - Mechanically operated vents – controlled by a fusible link and opened by a spring or manual release
    - Gravity opened vents – made from plastic that softens from the heat of a fire and falls down
  - Locations of heat and smoke vents appear in the architectural drawing of the roof of the building.

Portable Fire Extinguishers

- Fire codes have requirements for the placement of fire extinguishers.
- Travel distances and protection limitations are easily checked on the plans.
- Fire extinguishers are rated according to their intended use and firefighting capability based on the five classes of fire.
- When an extinguisher is capable of extinguishing several classes of fire, it will be labeled with the appropriate fire letter designation (i.e., A:B or A:B:C).

Portable Fire Extinguishers

- NFPA 10 makes requirements for fire extinguishers based on occupancies classified as follows:
  - Light hazard – occupancies with minor amounts of Class A and B combustibles (e.g., classrooms, churches, halls)
  - Ordinary hazard – occupancies where Class A and B are present in amounts greater than those found in light hazard occupancies (e.g., stores, parking garages)
Portable Fire Extinguishers

- Extra hazard – occupancies where the amount of Class A and B combustibles are greater than those encountered in an ordinary hazard occupancy (e.g., woodworking shop, vehicle repair shop, painting facilities)

Portable Fire Extinguishers

- The occupancy classification determines the maximum area protected by the extinguisher and the minimum size of the extinguisher.
  - Light hazard occupancies – Class A extinguishers with a minimum rating of 2-A can protect 3,000 sq ft
  - Ordinary hazard occupancies – Class A extinguishers with a minimum rating of 2-A can protect 1,500 sq ft
  - Extra hazard occupancies – Class A extinguishers with a minimum rating of 2-A can protect 1,000 sq ft

Portable Fire Extinguishers

- The occupancy classification determines the maximum area protected by the extinguisher and the minimum size of the extinguisher.
  - Light hazard occupancies (Class B) – minimum size extinguisher can be either 5-B or 10-B
  - Ordinary hazard occupancies (Class B) – minimum size extinguisher can be either 10-B or 20-B
  - Extra hazard occupancies (Class B) – minimum size extinguisher can be either 40-B or 80-B
Portable Fire Extinguishers
- The locations of fire extinguishers are normally indicated in the architectural floor plans.
- The extinguishers are to be placed in recessed fire extinguisher cabinets in the corridors.
- Fire extinguishers are required to be placed in locations where they are accessible.
- Fire extinguishers cannot be placed in guest rooms, closets, or other locations that are not generally accessible.

Student Performance Objective
- Given information from lecture, discussion, and reading materials, the student will be able to describe the purpose and elements of automatic elevators, fire command centers, extinguishing agents, and smoke control systems. The student will perform to a written test accuracy of at least 70%.

Review
- Automatic elevators
- Fire command center
- Restaurant kitchen fire extinguishing systems
- Gaseous fire extinguishing agents and systems
- Smoke control systems
- Portable fire extinguishers
Lesson 10-1: Alternative Design Methods

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe alternative design methods. The student will perform to a written test accuracy of at least 70%.

Overview

- Alternative materials, alternative methods, and equivalencies
- Board of Appeals
- Performance-based codes
- Performance-based design process
Alternative Materials, Alternative Methods, and Equivalencies

- Field-based building is difficult to regulate.
- Evolutions in technology
- New designs and innovations
- Diversity of buildings
- New methods and materials
- Codes cannot be written for every situation.

Alternative Materials, Alternative Methods, and Equivalencies

- Alternative methods
  - Used when emergency operation is necessary
  - Not specific to code (whistles for bells and additional fire extinguishers for sprinklers) but will work in a pinch
- Alternative materials
  - Structure is in place, and occupancy has changed with renovation.
  - Door that is not rated but meets the intent of the code
- Equivalencies - use of different methods and materials to meet the intent of the code

Board of Appeals

- Appeal process when the applicant's application is turned down
  - Applicant's proposed alternative is rejected.
  - Applicant disagrees with the code officials interpretation.
  - The situation presented is unique and not covered by the code.
Board of Appeals

- Board cannot simply wave the code.
- Board must have qualified members.
  - Engineers, architects, and tradesmen
- Board can bring in a qualified expert in the field.
- Any decision rendered by the board must be in writing and be understood by all parties involved.

Performance-based Codes

- Advantages to these codes
  - Buildings are changing and codes do not change.
  - These codes are a way to integrate old with new.
  - Once established as an alternate code, it can be used for future projects.
- Engineering approach to fire protection is based on:
  - Established fire protection and safety goals
  - Fire scenario analysis
  - Quantitative assessment of design alternatives

Performance-based Design Process

- Define scope of project.
  - Establish the extent and nature of the project.
  - Identify goals.
  - Develop performance-based criteria.
    - What do we want to achieve?
  - Develop fire scenarios.
    - Analysis of how the fire might react given the altered design
Performance-based Design Process

- Develop trial designs.
  - How to use established methods (suppression systems, detection systems, material selection, compartmentation, ventilation, etc.) to detect or combat the fire if the alternative is to be used

- Evaluate trial designs.
  - Did it work more than once the same way?

- Select final design.
  - Design meets the goals and objectives established in the beginning.

Performance-based Design Process

- Prepare design documentation.
  - Complete and accurate documentation
  - Very clear understanding of goals and how they were achieved
  - All parties involved must know the limitations and requirements of the design.
  - Document must include all steps of the process and the quantitative analysis.

Performance-based Design Process

- Exercise
  - Using the example on p. 365 of the text, determine the acceptance of this proposal.
  - The group will determine the acceptance of these alternatives and justify their response using code sections to bolster their position.
Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe alternative design methods. The student will perform to a written test accuracy of at least 70%.

Review

- Alternative materials, alternative methods, and equivalencies
- Board of Appeals
- Performance-based codes
- Performance-based design process
Lesson 10-2: Renovations and Tenant Improvements

Student Performance Objective
- Given information from lecture, discussion, and reading materials, the student will be able to describe plans sets for renovations and tenant improvements. The student will perform to a written test accuracy of at least 70%.

Overview
- Building renovations
- Speculative building and tenant improvements
- Historic building conversions
- Change of occupancy/use
Building Renovations

• Alteration of the building characteristics
  • Change of space
  • Modification of walls, windows, or doors
  • Modification or upgrade of wiring, heating, and/or HVAC
• Remodeling is changing the appearance of the building, room, or rooms.

Building Renovations

• Buildings are renovated for many reasons.
  • Change of occupancies
  • Replacement of obsolete equipment
  • Deteriorating fire protection systems
  • No fire protection system
• Building renovations must be carefully scrutinized to ensure compliance.

Building Renovations

• Damaged building requirements
  • Must be brought to current code levels when renovated
• Fire protection modifications
  • Modifications are made intentionally or unintentionally.
  • New openings, walls, or enclosed areas alter the fire protection calculations and system effectiveness.
• Building record updates
  • Classification of structure and age
  • Original fire protection must be consulted.
  • New alternate designs must be evaluated against the original.
Building Renovations
- Building enlargement
  - Must meet all code height and area limitations
  - Engineering analysis of structural stability

Speculative Building and Tenant Improvements
- Developers frequently construct buildings without having a final occupant and can include:
  - Condominiums, offices, and mercantile or industrial facilities
- Tenant improvement
  - The phase of construction of a speculative building in which additional permits are required to finish the building interior

Historic Building Conversions
- Constructed when codes were not in place
- Special provisions made by building code
- Change of use and the difficulties that may arise
- Candidates for performance-based codes
Change of Occupancy/Use

- Review the structure for how it will be used now.
- Major changes could require changes for systems such as sprinklers.
- A change of occupancy can be difficult for the plans examiner because there may be numerous fire code issues to address.
- Many occupancy changes are discovered after a new tenant has opened for business.

Student Performance Objective

- Given information from lecture, discussion, and reading materials, the student will be able to describe plans sets for renovations and tenant improvements. The student will perform to a written test accuracy of at least 70%.

Review

- Building renovations
- Speculative building and tenant improvements
- Historic building conversions
- Change of occupancy/use