A Division of New York Department of State

September 29, 2020

General Construction Principles

Course 9D

Building Systems and Equipment And Structural Requirements

Books for the week ....
Covered So Far

9A - Administration and Enforcement
9B - Fire Safe Design
  – International Building and Fire Codes
9C - Inspection of Existing Structures
  – International Property Maintenance, Fire and Existing Building Codes

Coming Up

• 9E
  – The International Residential Code
    • Plan review
• 9F
  – The International Building Code
    • Plan review

19-NYCRR, Part 1208
Minimum Standards for Code Enforcement Training in NYS
Section 1208-3.2 (d)

**Must be completed in the Shorter of:**
18 months from the first course or
18 months from appointment date

**May** be extended for good cause shown.

Request in writing with reason(s) for request
Reply in writing, may include conditions
Course 9D
The Basics of…

• Systems and equipment
  – Which Code to use and when
  – Organization and applicability
  – General requirements

• Structural requirements
  – Loads
  – Soils and foundations
  – Materials used in construction

Module One:
Systems and Equipment
Mechanical Code of New York State
Fuel Gas Code of New York State
Plumbing Code of New York State

2020 ECCNYS

Module Two
Structural Requirements

• Introduction to Load and Design Theory
• Structural Requirements and Documentation
• Foundation Systems
• Materials and Structural Assemblies
• Wood Framing
Agenda and Procedures

- Course materials
- Course meeting times
- Breaks and Lunch
- Make-Up procedures
- Competence Exam
In this lesson, we will…….

- Look at the layout of the Mechanical Code
- Review the application of the Code
- Review some of the important definitions
- Review specific chapters for content and use

Mechanical Code Organization

Chapter 1 – Administration
Chapter 2 – Definitions
Chapter 3 – General Regulations
Chapter 4 – Ventilation
Chapter 5 – Exhaust Systems
Chapter 6 – Duct Systems
Chapter 7 – Combustion Air
Chapter 8 – Chimneys and Vents
Chapter 9 – Specific Appliances, Fireplaces and Solid Fuel Burning Equipment
Chapter 10 – Boilers, Water Heaters
Chapter 11 – Refrigeration
Chapter 12 – Hydronic Piping
Chapter 13 – Fuel Oil Piping and Storage
Chapter 14 – Solar Thermal Systems
Chapter 15 – Referenced Standards

Chapter 1

[NY] 101.2 Scope

“This code shall regulate to the design, installation, maintenance, alteration and inspection of mechanical systems that are PERMANENTLY INSTALLED and utilized to provide control of environmental conditions …"
102.3 Existing Installations

102.3 Existing installations. Except as otherwise provided for in this chapter, a provision in this code shall not require the removal, alteration or abandonment of, nor prevent the continued utilization and maintenance of, a mechanical system lawfully in existence at the time of the adoption of this code.

Chapter 3
General requirements for installation of equipment and appliances.

Listing and Labeling

- 301.7 Appliances shall be listed and labeled
- 301.8 Labeling by an approved agency
- 301.9 Required label information
302.1 Structural Safety

Don’t make the building structurally unsafe when installing mechanical systems. See 302.1 through 302.5

302.2 Penetrations of floor/ceiling assemblies, and fire resistance-rated assemblies.

• Comply with BC Chapter 7
• Walls
• Horizontal Assemblies

Protection of the Structure

• 302.3.1 Joist Notching

Holes and notches
### 302.3.2 Stud cutting and Notching

**Interior and exterior walls**

- 25% load-bearing walls
- 40% non-load-bearing walls

### 302.3.3 Bored Holes

- 40% of stud depth: load-bearing walls
- 60% of stud depth: non-load-bearing walls

### 302.3.4 Engineered wood products

**Wooden I Joist**

**Microlam**
303.3 Prohibited locations

Fuel-fired appliances are prohibited in the following locations:

- Sleeping rooms
- Bathrooms
- Toilet rooms
- Storage closets
- Surgical rooms

303.9.1 Condition 1?

901.4 Solid Fuel Prohibited

304.3 Elevation of Ignition Source

- 18” elevation
- Where located in:
  - All types of garages
  - Hazardous locations
- Exception:
  - Flammable vapor
  - Ignition resistant

304.5 Hydrogen Generating and Refueling

Natural Ventilation
Minimum of 2 openings
Maximum 850 SF area

Mechanical ventilation
Minimum of 2 openings required

Specially Engineered System
Hydrogen vehicles – a little background
They’ve come a long way

304.6 Public Garages

304.7 Private Garages
### 306 Access and Service Space

**306.3 Appliances in Attics**
- Large enough Opening for appliance
- Passageway not < 22"
- Service space
- Access opening
- Electricity

### 307.2.5 Drain Line Maintenance

- Maintenance to clear blockages without cutting line

### 307.3 Condensate Pumps

- Located in attics or uninhabited spaces
- Required to be connected to:
  - Appliances
  - Equipment served
- If pump fails, equipment will not operate

### 308 Clearance Reduction

**Table 308.3.2**

<table>
<thead>
<tr>
<th>Typology of Protective Assembly</th>
<th>Required Clearance</th>
<th>Required Clearance with Protection Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 inch sheet metal, having a minimum thickness of 0.025&quot;</td>
<td>12 12 12 6 6 3 3</td>
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312 Heating/Cooling Load Calculations

- Calculated in accordance with ASHRAE/ACCA 183, or
- Approved equivalent procedure with design parameters of the Energy Code

What is ACCA?

- **ACCA**
  - Air Conditioning Contractors of America
  - Manual D - Residential Duct Systems
  - Manual J - Residential Load Calculation
  - Manual S - Residential Equipment Selection
  - 183 - Peak Cooling and Heating Load Calculations in Buildings Except Low-rise Residential Buildings

[NY] 401.2 - Natural or Mechanical Ventilation

- Natural Ventilation in accordance with 402
- Mechanical Ventilation in accordance with:
  - Air changes 3/hr for dwelling units per [NY] R402.4.1.2 of the ECCNYS follows MCNYS 403
  - Ambulatory care and I-2 follow MCNYS 407
401.4 Intake openings

401.6 Contaminant Source

- Must be provided with an exhaust system in accordance with Chapter 5
  - Air Borne Particulates
  - Heat
  - Odors
  - Fumes
  - Spray
  - Vapors

403 Mechanical Ventilation

- Important definition
  - **Breathing zone**
  …region within an occupied space between 3 and 72 inches above the floor and more than 2 feet from the walls…
403 Mechanical Ventilation

- 403.3.1.1.1
  - Supply & return or exhaust
    - Positive or negative pressure ok
    - R2, R3 & R4
    - Exhaust system
    - Supply system
    - combination

\[ P_{d} = P_{r} + P_{a} \] (Equation 4-1)

403 Mechanical Ventilation

- Equation 4-1
  - \( R_{p} \) - People outdoor air rate: the outdoor airflow rate required per person from Table 403.3.1.1.
  - \( P_{z} \) - Zone population: the number of people in the space or spaces in the zone.
  - \( R_{a} \) - Area outdoor air rate: the outdoor airflow rate required per unit area from Table 403.3.1.1.
  - \( A_{z} \) - Zone floor area: the net occupiable floor area of the spaces in the zone.

403 Mechanical Ventilation

- Table 403.3.1.1.1.1
  - DEPARTMENT CLASSIFICATION
  - EXHAUST VENTILATION RATES
  - AIRFLOW RATE REQUIRED FOR VENTILATION
  - AIRFLOW RATE REQUIRED FOR EXHAUST
  - AIRFLOW RATE REQUIRED FOR COMBINATION
  - LOW- VOLUME
  - HIGH VOLUME
  - MEDIUM VOLUME

403 Mechanical Ventilation

- Figure 4-1
  - Ventilation systems schematic
  - Supply and exhaust connections
  - Pressure distribution diagram
403.3 Exhaust air overflow rates
- Must meet ASHRAE 62.1 ventilation requirements
- 403.3.2.1 Outdoor Air for dwelling units
  - Required outdoor air for R2, R3 & R4 dwellings
  - Mechanical exhaust system
  - Supply System
  - Combination of both
  - Required for each dwelling unit

404 Enclosed Parking Garages
- 404.1 Enclosed Parking Garages
  - Full on at no less than 0.75 CFM/SF
  - Standby at no less than .05 CFM/SF
  - Shall be operated by automatic CO detection in conjunction with Nitrogen dioxide detection
  - Installed per manufacturers instructions

Exhaust Systems
- 501.1 Regulates the design, construction and installation of exhaust systems
Section 502 Required Systems

- Aircraft fueling operations
- Battery charging areas
- Energy storage systems
- Dry cleaning plants
- Application of flammable finishes
- Hazardous materials - general
- Hazardous materials – specific materials
- HPM Hazardous Production Materials
- Motion picture projectors
- Organic coating processes
- Public garages
- Motor vehicle operation
- Repair garages
- Repair garages for lighter than air fuels
- Tire rebuilding or recapping
- Specific rooms
- Indoor firing ranges
- Manicure / Pedicure stations

Example

502.14 Motor Vehicle Operation

- Mechanical ventilation (fresh air) provided as in Section 403
- Where stationary vehicles are operated:
  - Source capture system, directly connected to exhaust

502.20 Manicure & Pedicure Stations

- Exhaust inlets
  - Not more than 12" from point of chemical application
  - Horizontal
  - Vertical
### 503 – 514 Specific Situations

#### 504.8 - Domestic clothes dryer ducts

- Metal ducts w/ smooth interior finish
- Terminate on the outside of the building
- Nominal size - 4" ONLY
- Transition duct lengths max of 8'
- Maximum length not to exceed 35'
- Manufacturer installation length may supersede

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#### Table 504.8.4.1 Domestic Clothes Dryer Duct Reduction

<table>
<thead>
<tr>
<th>DRYER EXHAUST DUCT FITTING TYPE</th>
<th>EQUIVALENT LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; sheet metal 45-degree elbow</td>
<td>2 feet 6 inches</td>
</tr>
<tr>
<td>4&quot; sheet metal 90-degree elbow</td>
<td>5 feet</td>
</tr>
<tr>
<td>6&quot; sheet metal 45-degree elbow</td>
<td>1 foot</td>
</tr>
<tr>
<td>6&quot; sheet metal 90-degree elbow</td>
<td>1 foot 9 inches</td>
</tr>
<tr>
<td>8&quot; sheet metal 45-degree elbow</td>
<td>1 foot</td>
</tr>
<tr>
<td>8&quot; sheet metal 90-degree elbow</td>
<td>1 foot 7 inches</td>
</tr>
<tr>
<td>10&quot; sheet metal 45-degree elbow</td>
<td>9 inches</td>
</tr>
<tr>
<td>10&quot; sheet metal 90-degree elbow</td>
<td>1 foot 6 inches</td>
</tr>
</tbody>
</table>

---

#### Dryer Exhaust

- **504.5 Dryer Exhaust Power Vents**
  - Shall be listed / labeled to UL 705
  - Shall be installed per manufacturer

- **504.8.4.3 Duct power vent length**
  - Shall be determined by the power vent manufacturer installation instructions
505.5 Domestic Kitchen Exhaust in Multistory Buildings

12 items:
1. Fire rated shaft per BCNYS
2. Dampers prohibited in exhaust duct
3. Rigid 26 gauge ductwork within shaft
4. No offsets within shaft
5. Exhaust fan motor per 503.2
6. Exhaust fan motor located outside airstream
7. Continuous running exhaust fan w/ backup power
8. Exhaust fan monitored w/ alarms
9. > 400 cfm exhaust rate requires makeup air
10. Cleanout opening at shaft base, min 12" x 12"
11. No screens at duct terminations
12. Only kitchen exhaust into duct, no others allowed

503 – 514 Specific Situations

- 507 - Commercial Kitchen Hoods
  - 507.2 – Type I Hood required where cooking produces grease laden vapors
  - 507.3 – Type II Hood cooking and dishwashing appliances producing heat or steam
  - 507.5 – Capacity of hood based on quantity of exhaust air necessary based on light, medium or heavy or extra heavy duty cooking appliances served

507.1.1 Commercial Kitchen Hood Exhaust System

- Operation
  - Systems shall operate during cooking
- Type I hood
  - Automatic controls
  - System interlock to prevent appliance use
- 507.1.1.1
  - Multiple hoods in a single system require multiple sensors
508.1.2 Air Balance

- Commercial Kitchen Ventilation Systems
  - Design plans
    - Indicate outdoor air balance by
      - Schedule
      - Diagram
  - Design outdoor air balance
    - All exhaust + replacement air

509 Fire Suppression Systems

- Shall comply with BCNYS and FCNYS

Chapter 6  Duct Systems
601.5 Return Air Openings

8 items for compliance:

1. Min 10’ from heat source in same room
2. No return air from unsanitary location
3. Return air rate < supply air rate
4. Return / transfer openings per ACCA manual D
5. No discharge of return air into other dwellings
6. No direct connection from furnace return to crawl space
7. No return air from toilet rooms, closets, uninhabited attics, kitchens, etc
8. No return air from indoor swimming pool enclosures or associated decks

602 Plenum

EXERCISE 1: What are the 6 requirements a plenum must meet if it is installed in a stud cavity, and what section applies?

Exercise 2

1. What is the maximum length of a flexible air duct?
2. If a service opening is concealed by a duct covering, what must be done?
3. How is the access point for damper inspection have to be labeled?
Chapter 7  Combustion air

• 701.1 Scope
  • Oil fired appliances shall comply with NFPA 31
  • Gas-fired shall comply with the FGCNYS
    • Does not apply to fireplaces, direct vent appliances and fireplace-stoves

• 701.2 Dampered Openings
  • Interlock required on dampers
  • No manual dampers
  • Where ducts pass through rated construction comply with BCNYS

Chapter 8  Chimneys & Vents

• 801.1 - Regulates the installation, maintenance, repair, and approval of:
  • Factory built chimneys
  • Chimney liners
  • Vents
  • Connectors

Chimney Types and Parts

• Masonry
  • All fuels

• Factory Built Chimney
  • All fuels
    • Double wall and insulated
    • Stainless Steel

• Vent
  • Generally double wall with air gap
    • Type L vents
      • High efficiency oil burners and pellet stoves
    • Type B and B-W for Gas appliances only
801.2 General

- Every fuel-burning device shall discharge the products of combustion to the exterior and be a:
  - Vent
  - Factory-built chimney
  - Masonry chimney
    - Except for appliances vented in accordance with (804)
  - Type 1 hoods over commercial cooking per 507

Exercise 3

7 questions

1. Can an abandoned inlet opening be left open?
2. Can a solid fuel-burning device be vented into a chimney flue being used by another appliance?
3. Does a masonry chimney need a lining?
4. Can appliances on different floors of a building be tied into a common vent?
5. What is used to determine the size, installation and termination point of a vent?
Exercise 3

6. When is the only time a manual damper can be installed in a connector?

7. Can an appliance using a power exhauster continue to operate if the power exhauster is “off”?

Chapter 9 Specific Appliances, Fireplaces and Solid Fuel-Burning Equipment

• 901.1 Scope

“This chapter governs the approval, design, installation, construction, maintenance, alteration, and repair of the appliances and equipment specifically identified here-in, and factory-built fireplaces.”

Chapter 9 Specific Appliances, Fireplaces and Solid Fuel-Burning Equipment

917 – Cooking Appliances

918 – Forced-air Warm-air Furnace

913 – Clothes Dryers
Chapter 9: Specific Appliances, Fireplaces and Solid Fuel-Burning Equipment

- [NY] 901.5 Solid fuel-burning heating appliances, chimneys and flues.
  - Building permits
  - Inspection requirements, and compliance
  - Certificates for the installation, inspection, etc.

Chapter 9
Specific Appliances, Fireplaces and Solid Fuel-Burning Equipment

- [NY] 922 – Kerosene and oil-Fired Stoves and Heaters
  - Approved for sale by the Secretary of State
  - Packaged for sale shall comply with New York State Real Property Law Article 7A Section 239-a(7)
  - Tested and listed to UL 647
  - Prohibited use in A, E, I, R-1, R-2, R-3 and R-4
  - Never used in bathrooms, toilet room, bedrooms, closets

Chapter 10: Boilers, Water Heaters and Pressure Vessels

- [NY] 1004.1.1 Other standards
  - Low pressure boilers
    - Regulated by NYS Dept of Labor
    - 12 NYCRR, Industrial Code Rule 4
  - High pressure boilers
    - Regulated by NYS Dept of Labor
    - 12 NYCRR, Industrial Code Rule 14
1102.3 Refrigerant Access Port Protection

Refrigerant access ports

Shall be protected per 1101.10
If refrigerant is added or recovered
Refrigeration systems
Air conditioning systems
New and existing systems

The Residential Code is a stand alone document, and contains everything you need!
Summary

• Mechanical Code regulates the mechanical systems permanently installed in buildings.
• Residential Code has its own Chapters to regulate mechanical systems.
• Both Codes have Chapters specific to parts of the mechanical systems.
• Both Codes have the Chapters for specific appliances or applications.
Minimum requirements of Fuel Gas systems

Lesson 2
2020 Fuel Gas Code of New York State

What we will look at

- Main portions and use of the Code.
- Review some of the sections as they relate to specific equipment or appliances
- The Fuel Gas Code is very similar to the Mechanical Code, so it won’t be as detailed…
Table of Contents
- Chapter 1 – Scope and Administration
- Chapter 2 - Definitions
- Chapter 3 - General Regulations
- Chapter 4 - Gas Piping Installations
- Chapter 5 - Chimneys and Vents
- Chapter 6 - Specific Appliances
- Chapter 7 - Gaseous Hydrogen Systems
- Chapter 8 - Referenced Standards

[NY] 101.2 Scope

The provisions of this code shall apply to the design, installation, maintenance, alteration and inspection of fuel gas piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems that are permanently installed and specifically addressed herein.

What the Fuel Gas Code does NOT apply to
- Portable LP-Gas equipment not connected to fixed fuel piping
- Farm Equipment
- Feedstock Applications
- Welding and Cutting
- Industrial Gas Applications
- Refineries, Plants, or storage farms for production of fuel gas
- Certain chemical plants
- LP-Gas at utility gas plants
- LNG installations
- Piping in atomic energy plants
- Proprietary items of equipment, apparatus, or equipment
- LP-Gas equipment for vaporization, gas mixing, and gas manufacturing
- Temp LP-Gas piping
- Railroad switch heating
- Gas piping on vehicles
- Equipment used by supplier
- Building design
- Certain gas-air mixtures
- Portable fuel cells
Chapter 3 – General Regulations

301 General provisions
302 Structural safety
303 Appliance location
304 Combustion, ventilation, and dilution air
305 Installation
306 Access and service space
307 Condensate disposal
308 Clearance reductions
309 Electrical
310 Electrical Bonding

301.3 Listed and Labeled

• Testing
• Inspection and identification
• Independent agency
• Equipment used
• Personnel

301.5 Label information

• Label information:
  • Manufacturers name
  • Model number
  • Serial number
  • Seal/mark of the testing agency
  • Hourly rating in Btu/h
  • Type of fuel
  • Minimum clearance
302.1 Structural Safety

Structural Safety

- 302.2 - Specifics on the design of penetrations through walls, floors, and fire-rated construction
- 302.3 – Cutting, notching and boring in wood members.
- 302.4 – Alterations to Trusses
- 302.5 – 302.7 Cutting, notching and boring of steel members

Class Exercise 4

1. What is the maximum depth of a notch cut in the end of a joist?
2. What is the maximum that a load bearing stud in an exterior wall can be cut or notched?
3. What is the maximum diameter hole that can be bored in a wood stud (bearing wall)
4. How is the size of a hole bored in a structural steel framing member determined?

303.3 Prohibited Locations

- Sleeping Rooms
- Bathrooms
- Toilet Rooms
- Storage Closets
- Surgical Suites

Unless…
304.1 Combustion, Ventilation and Dilution Air

304.1 General. Air for combustion, ventilation and dilution shall be provided by application of one of the methods prescribed in Sections 304.5 through 304.9.

• Section doesn’t apply to
  • Direct Vent Equipment and vented gas appliances other than Category I
    — Follow Manufacturer’s instructions

202 Definitions

Vented Appliance Categories
• Category I: Non-positive pressure, avoids condensate
• Category II: Non-positive pressure, capable of condensate
• Category III: Positive pressure, avoids condensate
• Category IV: Positive pressure, capable of condensate

Combustion air (5) methods
• Sections 304.5 through 304.9
  • All Air from Indoors
  • Outdoor Combustion Air
  • Combination Indoor and Outdoor Air
  • Mechanical Combustion Air Supply
  • Engineered Installations
Combustion Air

If there is NOT enough volume – proceed to the next option(s).

304.1 General. Where the requirements of Section 304.5 are not met, outdoor air shall be introduced in accordance with one of the methods prescribed in Sections 304.6 through 304.9.

- 304.6 Outdoor combustion air.
- 304.7 Combination indoor and outdoor air.
- 304.8 Engineered installations.
- 304.9 Mechanical combustion air supply.

304.5 Indoor air

- Simplest approach (start here)
- Provides two methods to determine the required VOLUME of air need for combustion
  - Standard method
  - Known infiltration method

304.5 Indoor Air

304.5.1 Standard method. The minimum required volume shall be 50 cubic feet per 1,000 Btu/h (4.8m³/kW) of the appliance input rating.
304.5 Indoor Air

• 304.5.2 Known air-infiltration-rate method. Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows:

\[
\text{Required Volume}_{\text{min}} \geq \frac{21 \times L_{\text{infil}}} {\text{ACH}} \left( \frac{1000 \text{ BTU/hr}}{1000} \right)
\]

Equation 3-1

• for fan assisted appliances, use:

\[
\text{Required Volume}_{\text{min}} \geq \frac{15 \times L_{\text{infil}}}{\text{ACH}} \left( \frac{1000 \text{ BTU/hr}}{1000} \right)
\]

Equation 3-2

Determination of Air Infiltration Rate

• ASTM E779
  – Determine the Air Flow (CFM)
  – Convert to % of Volume of Building (ACH)
304.6.2 Outdoor Air

Elevation of ignition sources

EXCEPTION:
Gas fired appliances listed and labeled as flammable vapor ignition resistant
Proper clearances and reductions

Section 306: Access and service space
Section 307: Condensate disposal
Section 308: Clearance Reduction
Section 309: Electrical

310.2 Corrugated Stainless Steel Tubing (CSST)

Bonding Details
- 6 AWG copper or equivalent
- Listed or Approved Bonding Clamp
- NOT to the CSST or the hexagonal nut
- CSST not supported by other electrically conductive systems
**CSST Bonding Detail**

#6 min. Bonding Jumper

Bonding Clamp
Not on CSST or
Hexagonal Nut

Meter pan or other entry point into building

Stub out of solid pipe, at least 3" in length

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**Typical lightning strike of CSST**

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**Chapter 4**

- 401.1: Applicable from point of delivery to equipment connections
- 401.2: LP-Gas Storage - Use Fire Code and NFPA 58
- 401.4: Adding a new appliance, must have the existing piping checked for proper size
**401.5 Identification**

Gas Piping must be marked (other than steel pipe) Not to exceed 5 feet

---

**402 Pipe Sizing**

402.1 Piping shall be of such size…. to provide supply of gas sufficient to meet the maximum demand and supply……not less than the minimum supply pressure…..

---

**402.2 Maximum Gas Demand**

- Volumetric flow shall be the sum of the maximum input
  - Sum of all appliances served
  - Volumetric flow
  - Adjusted above 2000 ft. elevation
402.3 Sizing

- Allows one of three methods
  - Tables or equations in 402.4(1) – 402.4(37)
  - Manufacturer’s instructions for sizing
  - Other approved engineering practice

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402 Pipe Sizing

EHD

CSST Piping
Table 402.4(15) – 402.4(19)

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403.6 Plastic pipe, tube and fittings

- PVC and CPVC shall not be used for fuel gas
404 Installation

- **404.3 Prohibited locations** (piping)
  - Not installed in or through a circulating air duct...

- **404.4 Solid Walls and Partitions**
  - Piping shall be in a chase or casing

404.5 Fittings in concealed locations

Following **are allowed** in concealed locations:

- Threaded elbows, tees and couplings
- Brazed
- Welded
- Listed in ANSI LC-1/CSA 6.26 or ANSI LC-4

404.6 Underground Penetrations

Underground penetrations are **PROHIBITED**

- Piping must enter and exit above ground
- Annular space shall be sealed
404.7 Protection against physical damage

- piping other than black or galvanized steel through holes or notches less than 1.75 inches from the nearest edge

- Protect with Shield Plate
  - 4 inches above sole plates,
  - below top plates and
  - to each side of a stud, joist or rafter

404 Installation

- 404.15 - Gas outlets not connected to an appliance must be capped gas tight.
- 404.16 – Location of the outlets
  - Minimum 1” unthreaded portion through finished ceiling or walls
  - Minimum 2” unthreaded portion through floors and outdoor slabs
  - In the room where the appliance is located
- 404.17 – Plastic pipe installation
  - Outdoors only with exceptions

406 – Inspection, Testing and Purging

- 406.1.1 Inspections
  - required
- 406.3 Test preparation
  - Piping to be left open for inspection
- 406.5 Detection of leaks and defects
  - Approved method
Leak detection methods

Non-corrosive leak detection fluid

409 Shutoff Valves

- **409.1 General**
  - 409.1.2 not concealed or in furnace plenums
  - 409.1.3 Accessible / protected from damage
- **409.3 Multiple-house/users**
  - Shutoffs for each building / tenant
- **409.5 Equipment shutoff**
  - Each appliance, in the same room, < 6’ from appliance
  - Decorative appliances remote area shutoff allowed
  - At a manifold, valve < 50’ from appliance

Chimneys and Vents

- **501.1 Scope**
  - Factory-built chimneys, liners, vents and connectors and the use of masonry chimneys serving gas-fired appliances
- **501.8 - Appliances not required to be vented**
  - Ranges and listed domestic cooking units
  - Hot plates and laundry stoves
  - Type 1 clothes dryers
  - And more ...
  - Gas Refrigerator – no vent required
Extra Credit

What is a LAUNDRY STOVE?
Fuel Gas Code 501.8 Item 3.

Laundry Stove

This IS a laundry stove
Scary?

GAS FIRED LAUNDRY IRON

502.7.1 Clearance to vent terminals

Door swing
Minimum 12" clearance

Chimneys and Vents

- Table 503.4 - Equipment that needs venting and the type of vent.
- Types of Vents
  - Connector- single wall
  - Type B – double wall
  - Type B-W - oval
  - Type L – gas and oil

UL Listed, Type B Gas Vent
Chimney Construction

- **503.5.1 Factory-Built**
  - Installed by listing and instructions
- **503.5.2 Metal**
  - NFPA 211
- **503.5.3 Masonry**
  - NFPA 211
  - Approved lining or material to resist 1800°F flue gases
  - Exception – Category I appliances with specific listed lining system

Exercise 5

Using Table 503.4, what type of vent needs to be used for:
1. Listed vented wall furnace
2. Incinerator
3. Combination gas/solid fuel burning equipment
4. Gas-fired toilet
503.5.4 Chimney Termination
Low-heat and Residential-type

Less than 10 feet

More than 10 feet

503.6.5 Gas Vent Termination

A 12/12 pitch is a 45 degree angle
Scenario

There was a vent, then a new roof......

503.8 Vent Termination Location

503.6.10.3 Sizing of Plastic Vent Pipe

- Category II, III & IV Appliances
  - Sizing shall be per manufacturers instructions
503.8 Vent termination location

- Minimum of 3’ above any forced air inlet within 10’
- Minimum of 4’ below, 4’ horizontal to, 1’ above:
  - Doors
  - Windows
  - Gravity air inlet

Chapter 6 Specific Appliances

- Most products referenced to ANSI, NFPA, or UL test
- Specific Issues:
  - Fireplaces
  - Unvented room heaters
  - Clothes dryers
  - Gas fired toilets

602 Decorative Appliances in Fireplaces

- Must be approved for solid fuel fireplaces
- Tested to ANSI Z21.60

Is the appliance meant to be vented or unvented?
614 Clothes Dryer Exhaust

- Exhausted per manufacturer’s instructions
- Terminate on the outside of the building
- Ducts may be connected with screws that protrude a maximum of 1/8” into the duct.
- Maximum length of the ductwork serving the dryer:
  - 35’ from transition duct from dryer to the outlet terminal
  - Manufacturer installation instructions

[M] 614.5 Dryer Exhaust Power Vents

Domestic Dryer ducts
- Shall be listed and labeled to UL 705
- Installed per manufacturer

[M] 614.8.4.3 Power Vent Length

- Maximum duct length per power ventilator manufacturer

621 Unvented Room Heaters

- ANSI Z21.11.2
- 1 or more cannot be used as sole source of comfort heating in a dwelling unit
- Max. input rating of 40,000 BTU/h
- Prohibited in Group A, E, and I
- Oxygen-depletion switch installed
626 Gas-fired toilet

- ANSI Z21.61
- Installed per manufacturer’s specifications
- Provide appropriate clearance for use, cleanout and servicing

631 BOILERS

[NY] 631.1.1 Other standards

Low pressure boilers
- Regulated by NYS Dept. of Labor
  - 12 NYCRR, Industrial Code Rule 4

High pressure boilers
- Regulated by NYS Dept. of Labor
  - 12 NYCRR, Industrial Code Rule 14

635.1 Installation

- Requirements are found:
  - Chapter 7 of this code
  - FCNYS
  - BCNYS
Exercise 6

Give answer and appropriate section

1. Can plastic pipe be run through a building to serve the equipment to be installed.

2. How is the nonmetallic pipe ‘marked’ when installed underground?

3. Can a clothes dryer vent ever terminate inside a structure?

Residential Code Sections

- Part VI Chapter 24
  - Almost direct copy from Fuel Gas Code
  - Modified to remove irrelevant information and coordinate Building Code issues to the specific sections of the Residential Code
  - "Stand alone document"
## Summary

- The Fuel Gas Code regulates the installation of fuel-gas piping, utilization equipment and related accessories.
- Very similar to the Mechanical Code.
- Similar to the National Fuel Gas Code.

### Residential Code similar chapters

<table>
<thead>
<tr>
<th>Residential Code</th>
<th>Fuel Gas Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>G2401 General</td>
<td>Chapter 1 Scope &amp; Application</td>
</tr>
<tr>
<td>G2412 Gas Piping</td>
<td>Chapter 3 General Regulations</td>
</tr>
<tr>
<td>G2425 – G2430 Chimneys and Vents</td>
<td>Chapter 4 Gas Piping Installation</td>
</tr>
<tr>
<td>G2431 – G2454 Specific Appliances</td>
<td>Chapter 5 Chimneys and Vents</td>
</tr>
<tr>
<td></td>
<td>Chapter 6 Specific Appliances</td>
</tr>
</tbody>
</table>
What might just be the most important system in your building?
What we will cover in this topic...

- Review the how the Plumbing Code is organized.
- Highlight key parts of the Plumbing Code.
- Do some exercises to reinforce how the Plumbing Code works.
- Look at the plumbing requirements of the Residential Code.

What is a Plumbing System?

- Ways We Use Water
- Water Source and Transmission
- Get Rid of the Waste

Use Table of Contents

- Chapter 4. Fixtures
- Chapter 5. Water Heaters
Water Source and Transmission

Table of Contents

- Chapter 6. Water Supply and Distribution

Get the Stuff Out

Table of Contents

Chapter 7. Sanitary Drainage
Chapter 8. Indirect / Special Waste
Chapter 9. Vents
Chapter 10. Interceptors and Separators

A Few Other Items

Table of Contents

11. Storm Drainage
12. Special Piping / Storage systems
13. Non-potable Water Systems
14. Subsurface Landscape Irrigation Systems
15. Reference Standards
What about Chapters 1, 2 and 3?

Chapter 1. General Requirements
Chapter 2. Definitions
Chapter 3. General Regulations

General Requirements

• [NY] 101.2 Scope
  Shall apply to installation, alteration, repair, relocation, replacement, addition to, use or maintenance of...
  
  plumbing systems

102 Applicability

• [NY] 102.3 Existing installations
  • Lawfully in existence
  • Allowed to continue and maintain if it's not a hazard to:
    • Life
    • Health
    • Property
Chapter 2: Definitions

- **Toilet Facility**
  - Space containing not less than
    - 1 water closet
    - 1 lavatory

Chapter 3

- **301.1** — governs the general installation of plumbing
- **301.3** — all plumbing that handles waste or sewage must be directly connected to the building’s drainage system.
  - Does not prohibit indirect waste regulated under Chapter 8.
  - Exception – Non-potable water systems (chapter 13)
303.4 Third Party Certification

305 – Protection of Pipes and Plumbing System Components

- 305.4 – Freezing
  - Not less than 12"
  - Water supply not less than 6" below frost
  - Pipe in an exterior wall

Section 306 – Trenching, Excavation and Backfill

306.2 – Trenching and Bedding
306.2.1 – Overexcavation

Continuous bedding shall be tamped in 6" maximum layers.

306.3 - Backfilling

Not to be filled with construction debris!

Structural Safety
Appendix C (example)

C101.1 Joist notching. Notches on the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.
308 Piping Support

• 308.4 Structural attachment shall be attached in an approved manner.

311.1-Toilet facilities shall be provided for construction workers.

312 Tests and Inspections

• 312.1 – the permit holder shall make the applicable tests….
• 312.2 – 312.10 – responsible for the following inspections:
312 – Required Tests and Inspections

- 312.2 - Drain and vent water test
- 312.3 - Drain and vent air test
- 312.4 - Drain and vent final test
- 312.5 - Water supply system test (not air for plastic pipe)
- 312.6 - Gravity sewer test
- 312.7 - Forced sewer test
- 312.8 - Storm drainage system test
- 312.9 – Shower liner test
- 312.10 - Inspection and testing of backflow prevention assemblies

312.9  Shower Liner Test

- Pipe drain plugged
- Water depth 2” minimum
- 15 minutes minimum

Chapter 4
Fixtures, Faucets and Fixture Fittings

401.1 – Scope
Governs the materials, design, and installation of plumbing fixtures, faucets, and fixture fittings in accordance with the type of occupancy, and shall provide for the minimum number of fixtures for various types of occupancies.
403.1 Minimum Number of Fixtures

Based on actual use

- Not occupancy classification based
- Uses per Table 403.1
- Determination individually by code official for uses not shown in the code

### Table 403.1

- Service sinks required in almost all occupancies except:
  - I-2 employees & visitors, other than residential care
  - R-2 apartment houses
  - R-3 1 & 2 family dwellings and lodging houses

- **Footnote e**
  - In Business and Mercantile occupancies
  - Not required if occupant load is ≤ 15
Water Closet or Toilet?

Common terminology, or code language?

403.1.1 Fixture Calculation

Table 403.1 sends you to 403.1.1 which covers “potty parity”. The required fixtures are based on the design occupant load that assumes 50% of each sex.

– Exception: Approved statistical data.

Example

- GIVEN:
  - Proposed – Night Club (A2)
  - Occupant load – 450 people
  - Using Table 403.1: How many Water Closets must be provided
Solution

- 450 ÷ 2 = 225 (breakdown between men and women)
- Using Table 403.1
  - (1) water closet for every 40 males
  - (1) water closet for every 40 females
- 225 (men) ÷ 40 (water closets) = 5.6 required
  - Round up – 5.6 becomes 6 required
- The same number is required for women
- TOTAL REQUIRED WATER CLOSETS - 12

[NY]424.2 Urinals

- In the men’s restroom, not more than 67% of the required water closets can be replaced by urinals in Assembly and Educational Occupancies.
- 6 required water closets X 67% = 4
- New configuration:
  - 2 water closets
  - 4 urinals
- In other occupancies – 50%
Exercise 7

- Proposed – 1,000 seat theater
- Determine the minimum number of water closets, urinals, lavatories and drinking fountains needed per Table 403.1 (male & female)

<table>
<thead>
<tr>
<th>Fixture type</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water closet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lavatories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking fountain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[NY]403.2 Separate Facilities

Where plumbing fixtures are required, separate facilities shall be provided for each sex.

Exceptions:
- Dwelling Units and Sleeping Units
- Structures or Tenant Spaces, occupant load of 15 people or less
- Mercantile with occupant load of 100 or less
- Business with occupant load of 25 or less
- Single-user toilet and bathing rooms in accordance with 403.1.2 must be gender neutral

403.3 Employee and Public Toilet Facilities

In accordance with 403

Required for all employees in all occupancies
May be combined with public facilities

Exception: Public toilet facilities shall not be required for:
1. Parking garages with no attendant
2. Structures / tenant spaces < 300 SF public access area for quick transition
403.3.5 Pay Facilities

Toilet facility location

403.3.3 Location (other than malls)
- Within one story above or below
- Not more than 500 feet

403.4.1 Directional Signage
- Indicating route to the facilities

404 Accessible Plumbing Facilities

404.1 - in accordance with the Building Code.

Chapter 11 Section 1109.2 of the Building Code requires that toilet rooms and bathing facilities be accessible.
1109.2.1 Family or Assisted-Use Toilet and Bathing Rooms

- As required by 1109.2.1 of the BCNYS
  - 6 or more aggregate water closets
- Fixture count included in required fixtures, in A and M occupancies
- Minimum of 1 in recreational where separate sex facilities are provided
- These shall be accessible facilities

[NY] 403.1.1 Fixture Calculations

The plumbing fixtures located in single-user toilet facilities and bathing rooms, including family or assisted use toilet and bathing rooms, shall contribute toward the total number of required plumbing fixtures for a building or tenant space, and shall be deducted proportionately, from the required gender ratios of Table 403.1.

405.3 Setting

These are not accessibility requirements
Washroom and Toilet Room Requirements

405.3.4 Water Closet Compartment
405.3.5 Urinal Partitions

Section 406 - 427
Specific information based on fixture or equipment

EXAMPLE
• 410 – Drinking Fountains
  − Conform to listed standards
  − Not required in restaurants if water is served
  − Water dispensers can be substituted for not more than 50% in other occupancies
  − Available to each tenant
  − If central/common facilities are provided, available on each floor
  − Not permitted in the public restroom

410 Drinking Fountains

410.1 Drinking Fountains
Electric, refrigerated drinking water coolers
• Conform to UL 399
• Shall be listed and labeled

410.2 Small Occupancies
• Not required with 15 or fewer occupants

410.3 High and low drinking fountains
423 Specialty Plumbing Fixtures

423.3 Footbaths and pedicure baths

- Temperature shall be limited to 120 degrees F
- Device conforms to:
  - ASSE 1070/ASME112.1070/CSA B125.70 or
  - CSA B125.3

Exercise 8

- What is the minimum size for a bathtub waste outlet?
- What is the minimum size of a shower compartment?
- What is the minimum size of a waste outlet serving a sink?
- What is the maximum temperature for a tub-shower mixing valve faucet?

Chapter 5 - Water Heaters

502.1 - installed in accordance with manufacturers installation instructions.

AND

- must also comply with:
  - MCNYS - for oil fired and solar thermal systems
  - NFPA 70 – for electric units
  - FGCNYS - for gas fired units
502 Installation

Comply with MCNYS &
FGCNYS

Ignition Source elevated 18’

EXCEPTION:

... Gas fired appliances
listed and labeled ... as
resistant to flammable
vapor ignition.

504.4 – Relief Valve

504.6 Requirements for Discharge Piping

- Not direct to drain
- Air gap discharge
- Full size
- Serve only one valve
- Discharge to the floor
- Not cause injury or damage
- Visible discharge location
- Not trapped
- Flow by Gravity
- Discharge max 6” above
- No threads, valves or tees
- Approved materials
- One nominal size larger with insert fittings
Chapter 6
Water Supply and Distribution

602 Water Required

602.3 Individual Water Supply

IF potable public water supply, not available, individual water supply may be used

602.3.1 Private water supplies.

Private water supplies (private wells) shall be installed by a well driller registered with the New York State Department of Environmental Conservation and shall be in compliance with the provisions of Appendix 5-B (Standards for Water Wells) or 5-D (Special Requirements for Wells Serving Public Water Systems), as applicable, of the New York State Department of Health (10 NYCRR).
603 Water Service

603.1 Sized to supply water to the structure in quantities and pressures required in this code. Minimum size shall be ¾”.

603.2 – Separation of Water and Sewer Piping

Water and Sewer separated by a minimum of 5 Feet. If materials are from Table 702.2.

< 5’ separation:
Water min 12” above sewer.
603.2 – Separation of Water and Sewer Piping

Water supply piping to be sleeved to a minimum of 5' either side of the sewer pipe.

604.3 - Water Distribution System Design Criteria

The water system shall be designed so that the pipes will provide the water required by Table 604.3 at peak demand.

604.4 Maximum Flow and Water Consumption
604.5 – Size of Fixture Supply

<table>
<thead>
<tr>
<th>Fixture Description</th>
<th>Minimum Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathtub* (60&quot; to 72&quot;) and smaller</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>Bathtub* (larger than 60&quot; to 72&quot;)</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Bidet</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Combination sink and tap</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>Dishwasher, dishwasher</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>Drinking fountain</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

604.10 – (Manifold Systems)

- Water Supply
- Individual Shut Off Valves
- To individual fixtures

66
605 Materials, Joints and Connections

Table 605.3  Water Service Pipe
Table 605.4  Water Distribution Pipe
Table 605.5  Fittings

605.2.1  Lead Content
≤ .25% by weighted average for drinking water

Table 605.3, Table 605.4, section 605.15 CPVC / AL / CPVC piping

• Specific composite material
• 2 methods of connection
  • Mechanical joints
  • Solvent cemented

606.7 Labeling in Bundles

Where water distribution piping is bundled:
Stenciling or commercial labels
• Pipe contents and direction of flow
• Intervals not > 25'
• At least 1 in each room, space and story
607 Hot Water Supply System

607.1 Where required. *Hot water shall be supplied* …

Residential
• Hot Water for bathing, washing, culinary purposes, cleaning, laundry, or building maintenance

Nonresidential occupancies
• Hot Water for culinary purposes, cleansing, laundry or building maintenance
• Hot water or tempered for bathing and washing

607.2.1 Circulation and Heat Trace System…

• Pumps and heat trace
  • In compliance with the Residential Energy Code
  • Must turn off automatically
• R2, R3, R4 < 3 stories shall follow ECCCNYS
  R403.5.1

607.2.1.1 Pump Controls for Hot Water Storage Systems

• Pump Control limits
  • Between storage tank and water heater
  • No > than 5 minutes operation of the pump from end of heating cycle
607.3 Thermal Expansion Controls

- Where cold water passes thru a:
  - check valve
  - backflow preventer
  - pressure reducing valve
- Thermal expansion control device (tank) connected to cold water downstream of the devices

607.4 – Hot Water Supply to Fixtures

608.9 Identification of Non-potable water systems

Specific language for marking
“Caution: Non-potable water – Do Not Drink”
  - Corrosion proof material
  - Minimum 1/8” high letters
  - Pictograph signage also required
  - Hose bibs
  - Faucets
  - Open ended pipes
NYS Dept. of Health References

[NY] 608.1.1  Public water supply protection
• per Subpart 5-1.31  (10 NYCRR)

[NY] 608.7.1  Private water supplies
• Prohibits cross connection public / private systems

[NY] 610.1  General.
• Purging of potable water systems

608 - Protection of Potable Water Supply

[NY] 608.18  Protection of individual water supplies. An individual water supply shall be located and constructed so as to be safeguarded against contamination in accordance with Appendix 5-B (Standards for Water Wells) or Appendix 5-D (Special Requirements for Wells Serving Public Water Systems) of the New York State Department of Health (10 NYCRR).

Drain, Waste and Vent Diagram

DRAINAGE SYSTEM COMPONENTS

---

A Division of New York Department of State
Chapter 7  Sanitary Drainage

[NY] 701.2 Sewer required. Buildings in which plumbing fixtures are installed and ……..
- Individual residential sewage treatment < 1000 gal a day per 1NYCRR
- Individual sewage treatment > 1000 gal a day per 6NYCRR
- Publicly owned sewage treatment per 6NYCRR
- The Adirondack Park Agency.
- Local county health departments
- Other applicable statutes, local laws, ordinances or regulations.

702 - Materials

- Table 702.1 – above ground drain and vent pipe
- Table 702.2 – underground drain and vent pipe
- Table 702.3 – building sewer pipe
- Table 702.4 – pipe fittings

702.5 Temperature Rating

- Wastewater greater than 140 degrees F
- Material rated for highest temperature
  - Dishwashers
  - Kitchen cooking kettles
### 703.6 Public Sewer Combined

Building storm and sanitary shall be independently connected.

- [Diagram of building storm and sanitary connection]

---

### 704 – Drain Pipe Installation

#### TABLE 704.1 Slope of Horizontal Drainage Pipe

<table>
<thead>
<tr>
<th>Size (inches)</th>
<th>Minimum Slope (inch per foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>1/4</td>
</tr>
<tr>
<td>3-6</td>
<td>1/8</td>
</tr>
<tr>
<td>7 or larger</td>
<td>1/16</td>
</tr>
</tbody>
</table>

Drain pipe shall not be reduced in size in the direction of flow.

- Drain pipe for future fixtures have to be properly capped.
- Dead ends are not permitted.

---

### 708 Cleanouts

#### 708.1.3 Building drain and sewer junction

- Within 10' of developed length upstream of junction

#### 708.1.6 Cleanout Plugs

- Copper alloy allowed only for metallic pipes
- Specific head style required

#### 708.1.10 Cleanout access

- Shall not be installed in concealed locations
  - Plenums
  - Within walls, floors, ceilings
  - Crawl spaces < 24' height
709 – Fixture Units

- Sets the Drain Fixture Units (DFU) for plumbing fixtures (see definition)
- Table 709.1 for fixture type
- Table 709.2 for fixture drains and traps
- Table 710.1(1) and 710.1(2) uses DFU for establishing drain size

Exercise 9
Verify the DFU and minimum trap size for the following fixtures:

<table>
<thead>
<tr>
<th>FIXTURE</th>
<th>DFU</th>
<th>TRAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathtub</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic kitchen sink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private water closet (1.6gpf)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Confirming the Pipe Capacity

Table 710.1(1)

Exercise 10

Step 1 – Verify the total proposed DFU
- (1) domestic kitchen sink
- (3) private WC (1.6 gpf)
- (3) lavatories
- (1) bathtub with a shower
- (1) shower
- (1) residential clothes washing machine
- (1) domestic dish washer

Total of DFU

Step 2 – Verify that a 2½" pipe with a slope of 1/4" meets the DFU requirements

2½" pipe @ 1/4" slope =
What is a branch interval?

A vertical measurement of distance, 8 feet or more in developed length, between the connections of horizontal branches to a drainage stack. Measurements are taken down the stack from the highest horizontal branch connection.

Step 3 – compare the proposed DFU to the allowable DFU.

Proposed: DFU =

Allowed: DFU =

COMPLIANT?
712 Sumps and Ejectors

- **712.1 Building sub-drains**
  - If unable to drain by gravity:
    - Tightly covered and vented sump required
    - Shall discharge in building drain by automatic pump

- **712.2 Check valve required on discharge side**

- **712.3.2 Sump pit**
  - 18” diameter, 24” deep minimum
  - Gastight removable cover
  - Vented per chapter 9

715 Vacuum Drainage Systems

715.2 System Design
- Per manufacturers instructions
- DFU’s per chapter 7
- Water supply values per Chapter 6
- Trap and cleanout values per Chapters 7 & 10
- Material as specified in Chapter 7

715.3 Test and demonstration
- Minimum 19” of mercury
- Recorded proof supplied to code official
- Written instructions for system maintenance provided to owner

716 Replacement of Underground Pipes by Bursting Method

716.2 Applicability
- Limited to gravity type systems
- 6” and smaller

716.3 Pre-installation inspection
- Recorded video camera survey
- Notation include cleanouts and depth of connections

716.7 Post-installation inspection
- Recorded video camera survey
- Video shall be reviewed by CEO
Chapter 8 – Indirect / Special Waste

- 802.1.1 Food handling
  - Specific requirements for discharge of water
  - Air gap will keep “clean” water from becoming contaminated

Chapter 9 - Vents

- Plumbing systems shall have a vent to prevent the seal of any trap from being subjected to pneumatic pressure greater than 1” of water column
- Every trap and trapped fixture shall be vented per Chapter 9

Chapter 9 - Vents

- 901.1 Scope. The provisions of this chapter shall govern the materials, design, construction and installation of vent systems.
- 901.2 Trap seal protection. The plumbing system shall be provided with a system of vent piping that will permit the admission or emission of air so that the seal of any fixture trap shall not be subjected to a pressure differential of more than 1 inch of water column (249 Pa).
- 901.2.1 Venting required. Traps and trapped fixtures shall be vented in accordance with one of the venting methods specified in this chapter.
The difference between a Vent Stack and a Stack Vent

903 – Vent Terminals

903.1 Roof Extension

18” Minimum
7’ Minimum

• Good reason to extend vent 18” above the roof
903.2 Frost Closure

- Vent pipe increase in size
  - Not less than 1 foot inside building thermal envelope
  - No longer just through the roof

903 – Vent Terminals

- Not be located directly beneath any door, window, or other air intake opening
- Not within 10 feet of a lot line
- Not within 10' of another building opening unless more than 3' above the opening

904 – Outdoor Vent Extensions

- 904.1 – At least one vent to the outdoors
  - 904.1.1 Installation. Shall be a DRY VENT
  - 904.1.2 Size. Sized not less than ⅛ the drain (906.1)
- 904.2 – Vent Stack required if 5 branch intervals or more
904 – Outdoor Vent Extension

• 904.3
  • Termination outdoors OR Stack-type Air Admittance Valve
  • In accordance with Section 918

Table 906.1

Maximum developed length and minimum sizing based on the (DFU)

<table>
<thead>
<tr>
<th>Diameter (DFU)</th>
<th>Maximum Developed Length (Feet)</th>
<th>Minimum Size (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1</td>
<td>1 1/2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2 1/2</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>3 1/2</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>6 1/2</td>
</tr>
</tbody>
</table>

106 – 108
### 909 – Fixture Vent

#### TABLE 909.1 MAXIMUM DISTANCE OF FIXTURE TRAP FROM VENT

<table>
<thead>
<tr>
<th>SIZE OF TRAP</th>
<th>SLOPE</th>
<th>DISTANCE FROM TRAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(inches)</td>
<td>(inch per foot)</td>
<td>(feet)</td>
</tr>
<tr>
<td>1/4</td>
<td>1/8</td>
<td>5</td>
</tr>
<tr>
<td>1/2</td>
<td>2/8</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>3/8</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>1/4</td>
<td>12</td>
</tr>
</tbody>
</table>

---

### 909 – Fixture Vent

![Diagram of fixture venting](image)

---

### 916 - Island Fixture Venting

![Diagram of island fixture venting](image)
Exercise 11

Determine the maximum length of the vent for the following:

1. 3” soil stack, 21 DFU, vent diameter is 2½”
2. 4” waste stack, 100 DFU, vent diameter is 3”
3. 10” soil stack, 12,000 DFU, vent diameter is 8”
4. 15” waste stack, 39,000 DFU, vent diameter is 5”

918 – Air Admittance Valve

Where Permitted

Individual, branch and circuit vents
Limited - fixtures on the same floor, connected to a horizontal branch drain
Stack Vents and Vent Stacks

918.4?

Individual, branch or stack type?

$30 Air Admittance Valve

$6 Mechanical Vent
Chapter 10
Traps, Interceptors and Separators

- Each fixture shall have a liquid-seal trap
- Maximum vertical distance from the fixture outlet to the trap weir is 24”
- Maximum horizontal distance 30”
- No double traps

1002.3 – Prohibited Traps

1002.4.1 Trap Seal Protection

- For emergency floor drains and those subject to evaporation
  - 1002.4.1.1 Potable
  - 1002.4.1.2 Gray
  - 1002.4.1.3 Waste
  - 1002.4.1.4 Barrier Type Trap Seal
1002.6 – Building Traps

1003 – Interceptors and Separators

1003.3.7 Gravity Grease Interceptors

- Interceptors must comply to IAMPO/ANSI Z1001
- Systems shall be installed to manufacturers instructions
1003.3.8 Direct Connection

- Requires direct connection from the interceptor discharge to the sanitary drainage system
- Inlet side may require indirect connection (P802)

1003.6 Clothes Washer Interceptors

- Interceptors for all appliance discharge
- Exceptions for:
  - Single dwelling units
  - Those designed for individual dwelling units installed elsewhere
  - A restaurant washing towels for example

1003.9 Venting of Interceptors & Separators

- All required to be vented
- Per methods in Chapter 9
Chapter 11 – Storm Drainage

- **1101.2 Disposal**
  - Other than One- and Two-family dwellings and where approved
- **1103 Traps**
- **1104 Conductors and connections**
  - 1104.2 Floor drains shall NOT be connected to a storm drain

1105 Roof Drains

- **1105.2 Roof Drain Flow Rate**
  - Based on anticipated ponding at the drain
- **1106.2 Sizing of Storm Drain Piping**
  - Based on the flow rate through the roof drain.

1106 Size of Conductors, Leaders and Storm Drains

- **1106.3 Vertical Leader sizing**
  - Simplified table based on flow rates
- **1106.6 Sizing of roof gutters**
  - Simplified table based on flow rates
## Comparison

<table>
<thead>
<tr>
<th>Residential Code</th>
<th>Plumbing Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 26 – General</td>
<td>Chapter 3 – General</td>
</tr>
<tr>
<td>Chapter 27 – Fixtures</td>
<td>Chapter 4 – Fixtures</td>
</tr>
<tr>
<td>Chapter 28 – Water Heaters</td>
<td>Chapter 5 – Water Heaters</td>
</tr>
<tr>
<td>Chapter 29 – Water Supply</td>
<td>Chapter 6 – Water Supply</td>
</tr>
<tr>
<td>Chapter 30 – Sanitary Drainage</td>
<td>Chapter 7 – Sanitary Drainage</td>
</tr>
<tr>
<td>Chapter 31 – Vents</td>
<td>Chapter 8 – Indirect Waste</td>
</tr>
<tr>
<td>Chapter 32 – Traps</td>
<td>Chapter 9 – Vents</td>
</tr>
<tr>
<td>Chapter 33 – Storm Drainage</td>
<td>Chapter 10 – Traps…</td>
</tr>
<tr>
<td>Chapter 34 – Storm Drainage</td>
<td>Chapter 11 – Storm Drainage</td>
</tr>
</tbody>
</table>

## Summary

- Plumbing Code and the Residential Code requirements are similar
- Determined requirements for water supply and drain, waste and vent systems
- Calculated size requirements for a drainage system, using DFU
- Reviewed the required inspections
- Found that plastic is a permitted material
A Division of New York Department of State

September 29, 2020

2020 Energy Conservation Construction Code of New York State

Minimum prescriptive and performance regulations for the design and construction of energy-efficient buildings and systems...

…but WHY an energy code?

• A little history lesson........
  – Federal Government
    • The Department of Energy Organization Act of 1977
    • ANSI/ASHRAE/IES 90.1
      – Minimum Standard for Energy Conservation for Commercial buildings (Except low rise residential)
New York State

- Time frame for states to review
  - 2 years
- Agreeing to meet or exceed DOE
- NYS follows SAPA to enact

Major Energy Use Concerns

- Commercial
  - Lighting and Power
  - Mechanical
  - Building Envelope
- Residential
  - Building Envelope
  - Lighting
  - Efficient Equipment

NYS Energy Code

- Commercial
  - 2020 ECCCNYS Commercial
  - ASHRAE 90.1-2016
- Residential
  - 2020 ECCCNYS Residential
  - RCNYS Chapter 11
2020 Energy Code Organization

Residential Building:
- One- and Two-Family dwellings
- R2, R3, R4 Multiple-dwelling structures, 3 stories or less
- HUD Code Manufactured Home
- Modular Factory Manufacture Home

Chapter 1: Administration
Chapter 2: Definitions
Chapter 3: General Requirements
Chapter 4: Commercial/Residential Energy Efficiency
Chapter 5: Existing Buildings
Chapter 6: Referenced Standards

Commercial Energy Efficiency

- Commercial Structures
  - All buildings not defined as residential
  - ASHRAE 90.1 - 2016
[NY] C101.5 Compliance
Residential or Commercial, shall meet the proper provisions

[NY] C101.5.1 Compliance Software
COMcheck
REScheck
Home Energy Rating System
and other energy modeling software as approved by NY Secretary of State

[NYC103 Interpretation of Energy Code Requirements

[NYC103
• Interpretations issued by Secretary of State
• Subsequent enforcement to be consistent with interpretation.
• [NYC103.7 – Local official interprets local energy code.

[NYC105 Construction Documents
Construction Documents shall be
• Drawn to scale…
• Electronic media documents permitted… with the approval of CEO
• Of sufficient clarity to indicate the location, nature and extent of work…
• Details showing features of the building, systems and equipment
[NYC105 Construction Documents]
Details shall include, but are not limited to:
1. Insulation materials and their R-values.
2. Fenestration U-factor and solar heat gain coefficient (SHGC).
3. Area-weighted U-factor and solar heat gain coefficient (SHGC) calculations.
4. Mechanical system design criteria.
5. Mechanical and service water heating system and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Fan motor horsepower (hp) and controls.
9. Duct sealing, duct and pipe insulation and location.
10. Lighting fixture schedule with wattage and control narrative.
11. Location of daylight zones on floor plans.
12. Air sealing details

[NYC105.2.1 Building thermal envelope depiction.]
[NYC105.2.2 Written statement.]
[NYC105.3. Examination of documents]
### [NY]C105 Construction Documents

- [NY]C105.3.1 Approval of Construction Documents
- [NY]C105.3.2 Previous approvals.
- [NY]C105.3.3 Phased approval.
- [NY]C105.4 Amended construction documents

### [NY]C106 Inspections

- Footing and Foundation Insulation
- Thermal Envelope
- Plumbing System
- Mechanical System
- Electrical System
- Final Inspection
  - HVAC Certification

### Definitions
Definition

Building Thermal Envelope.
The exterior walls (above and below grade), floors, ceilings, roofs and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space.

Definition

Conditioned Space.
An area, or room that is enclosed within the building thermal envelope and is directly or indirectly heated or cooled using fossil fuel or electricity as the energy source. Spaces are indirectly heated or cooled where:
- They communicate through openings
- Are separated by uninsulated assemblies
- Contain uninsulated ducts, piping, etc.
### Chapter 3 General Requirements

- **Climate Zones**
  - Basic information used in determining requirements in Chapter 4
  - Table C301.1

### Climate Zones

<table>
<thead>
<tr>
<th>Climate Zone 4A</th>
<th>Bronx</th>
<th>Nassau</th>
<th>Queens</th>
<th>Suffolk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Zone 5A</td>
<td>Albany</td>
<td>Erie</td>
<td>Ontario</td>
<td>Saratoga</td>
</tr>
<tr>
<td>Climate Zone 6A</td>
<td>Allegany</td>
<td>Franklin</td>
<td>Montgomery</td>
<td>Schoharie</td>
</tr>
</tbody>
</table>

#### Climate Zones

- Climate Zone 4A: Bronx, Nassau, Queens, Suffolk
- Climate Zone 5A: Albany, Erie, Ontario, Saratoga
- Climate Zone 6A: Allegany, Franklin, Montgomery, Schoharie

### Chapter 4 [CE]

**Commercial Energy Efficiency**

- 2020 ECCCNYS
- ASHRAE 90.1-2016
Compliance Options for Commercial Buildings

ASHRAE/IES Standard 90.1-2016

1. Purpose
2. Scope
3. Definitions, Abbreviations and Acronyms
4. Administration and Enforcement
5. Building Envelope
6. Heating Ventilation and Air Conditioning
7. Service Water Heating
8. Power
9. Lighting
10. Other Equipment
11. Energy Cost Budget Method
12. Normative References
Compliance Options for Commercial Buildings

- Commercial Energy Compliance
- COMcheck
- 2020 ECCNYS
- Prescription
- Total Building Performance
- ASHRAE 90.1 2016

Chapter 4 – Commercial Energy Efficiency

- C401 General
- C402 Building Envelope Requirements
- C403 Building Mechanical Systems
- C404 Service Water Heating (Mandatory)
- C405 Electrical Power and Lighting Systems
- C406 Additional Efficiency Package Options
- C407 Total Building Performance
- C408 Maintenance Information and System Commissioning
2020 ECCCNYS Commercial Provisions

C402 Building Envelope Requirements

- C402.1.1 Low energy buildings
- C402.2.2 Equipment buildings
- C402.1.4.1 Cold formed steel walls
- C402.4 Fenestration

C402 Building Envelope Requirements

- Building Envelope Assemblies
  - Air Barriers
  - Air Leakage (Fenestration)
  - Penetrations of the Building Envelope
  - Air Curtains (Vestibules)
  - Rooms w/ fuel burning equipment

C402.4 Fenestration (prescriptive)

C402.4.2 Minimum skylight fenestration area.

- Enclosed spaces greater than 2,500 SF
- Not < 75% of ceiling 15' or higher
  - Lobby
  - Atrium
  - Warehouse
  - Automotive service bays
  - Convention center
  - Etc.
- Daylight zone not < ½ floor area (with exceptions)
**2020 ECCCNYS Commercial Provisions**

C403 Building Mechanical Systems
- System Design (Mandatory)
- Heating & Cooling equipment efficiencies (Mandatory)
- Heating and Cooling system controls (Mandatory)
- Economizers (Prescriptive)
- Mechanical Systems – Multiple Zones
- Ventilation and Exhaust Systems (Mandatory)
- Fans and Fan Controls
- Heat Rejection Equipment
- Refrigeration Equipment Performance
- Construction of HVAC System Elements (Mandatory)
- Mechanical Systems outside of BTE (Mandatory)

---

**Definition**

**Economizer, Air**
A duct and damper arrangement and automatic control system that allows a cooling system to supply outside air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

---

**Definition**

**Economizer, water**
A system where the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling.
Definition

Heat Recovery Ventilation System

Systems that employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.

2020 ECCNYS Commercial Provisions

C403 Building Mechanical Systems

• Includes specific types of equipment
  • 10 Tables for Minimum Efficiencies of HVAC Equipment
  • Efficiency Values and Test Procedures
  • Demand Control Ventilation and Economizers
  • HVAC controls
  • Duct/Plenum Insulation and Sealing Criteria
  • Details for various types Refrigeration Equipment

2020 ECCNYS Commercial Provisions

C403 Building Mechanical Systems

C403.2.1 Zone isolation required (Mandatory)

HVAC serving zones that are:
• Over 25,000SF or,
• Span more than 1 floor and designed to operate or be occupied non-simultaneously,
  ...shall be divided into isolation areas...

• Isolation devices and controls for all air supply
2020 ECCCNYS Commercial Provisions
C403 Building Mechanical Systems
C403.5.5 Economizer fault detection and diagnostics (Mandatory)
- Air cooled unitary expansion units
- Variable refrigerant units
- If equipped with economizers
- Sensors required to monitor all airflow systems
- FDD (Fault Detection and Diagnostic) system required
- Capable or reporting diagnostics to operations personnel

2020 ECCCNYS Commercial Provisions
C403 Building Mechanical Systems
C403.7.5 Kitchen exhaust systems
- Replacement air to hood
- Not > 10% of hood exhaust rate
- If total hood exhaust rate >5000 cfm
  - Hood tested to UL 710
  - Factory Built
- Additional requirements for airflow

2020 ECCCNYS Commercial Provisions
C403 Building Mechanical Systems
C403.10 Refrigeration equipment performance
C403.10.1 (Mandatory) Warehouse coolers & freezers
- Larger than 3000SF
- Not site assembled nor site constructed

11 items to comply with
2020 ECCCNYS Commercial Provisions

C403 Building Mechanical Systems

C403.10 Refrigeration equipment performance

C403.10.2 (Mandatory) Walk-in coolers & walk-in freezers
- Less than 3000SF
- Not site assembled nor site constructed

11 items to comply with

C403.10.3 (Mandatory) Refrigerated Display cases
- Site assembled or site constructed
- Lighting controls
- Defrost termination controls
- Anti-sweat heater controls

2020 ECCCNYS Commercial Provisions

C404 Service Water Heating (Mandatory)

C404.2 Minimum Efficiencies
- Insulation of pipes serving heated water systems
- 7 Exceptions for Tubing

C404.5 Heated water supply piping
- C404.5.1 Max. allowable Pipe Length Method
- C404.5.2 Max. allowable Pipe Volume Method
2020 ECCCNYS Commercial Provisions

C404 Service Water Heating

C404.6 Heated-Water circulating and temperature maintenance systems
  C404.6.1 Circulation systems
  C404.6.2 Heat trace systems
  C404.6.3 Controls for hot water storage

C404.7 Demand recirculation controls
C404.8 Drain water heat recovery units

---

2020 ECCCNYS Commercial Provisions

C405 Electrical Power and Lighting Systems

C405.2 Lighting Controls (Mandatory)
  • Occupant sensor controls
  • Time switch controls
  • Daylight-responsive controls

---

Definition

Daylight Zone: That portion of a building’s interior floor area that is illuminated by natural light.
  • Sidelit zone
  • Toplit zone
C405 Electrical Power and Lighting Systems

C405.2.2.2 Light Reduction Controls

- Manual reduction control
  - Allows at least 50% reduction of lighting load
- Exception: where daylighting controls exist

Example
2020 ECCCNYS Commercial Provisions

C405.3 Interior Lighting Power

- Interior Lighting Power Allowances
  - Building Area Method-Table C405.3.2(1)
  - Space by Space Method-Table 405.3.2(2)
- Based on area use

C405.3.2 Lighting Power Allowances (LPD)

The total interior lighting power allowance (watts) is determined according to Table C405.3.2(1) using the Building Area Method, or Table C405.3.2(2) using the Space-by-Space Method, for all areas of the building covered in this permit.

C405.4 Exterior Lighting Power Requirements (Mandatory)
C405.7 Electric Motors (Mandatory)

- Minimum efficiencies in 4 tables
- Per DOE 10 CFR 431
- Shall be certified with 5 exceptions

202 NEMA Design A Motor

A NEMA Design A motor is a squirrel-cage motor that:
1. Can withstand full-voltage starting and develop locked-rotor torque
2. Has pull-up torque not less than the values in NEMA MG1.
3. Has breakdown torque not less than those in NEMA MG1.
4. A locked-rotor current higher than the values per NEMA MG1
5. A slip at rated load of less than 5 percent for motors with fewer than 10 poles.

202 NEMA B Design Motor

A NEMA B Design Motor is a squirrel-cage motor that:
1. Is designed to withstand full-voltage starting
2. Develops locked-rotor, breakdown, and pull-up torques adequate for general application per NEMA MG1.
3. Draws locked-rotor current not to exceed those in NEMA MG1 for 60 hertz
4. Has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

<table>
<thead>
<tr>
<th>Torque Characteristics of NEMA A, B, C, D, &amp; E Motors</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Horsepower</td>
<td>15-25</td>
<td>25-50</td>
<td>30-80</td>
</tr>
<tr>
<td>Slip at Rated Load</td>
<td>0.5-1%</td>
<td>0.5-1%</td>
<td>0.5-1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
202 NEMA Design C Motor

A NEMA C Design motor is a squirrel cage motor that:
1. Designed to withstand full-voltage starting and develop locked-rotor torque for high-torque applications up to the values shown in NEMA MG1.
2. Has pull-up torque not less than the values shown in NEMA MG1.
3. Has breakdown torque not less than the values per NEMA MG1.
4. Has a locked-rotor current not to exceed the values per NEMA MG1 for 60 hertz.
5. Has a slip at rated load of less than 5 percent.

202 IEC Design H and M Motors

IEC Design H and M motors are:
1. An induction motor designed for use with three-phase power.
2. Contains a cage rotor.
3. Is capable of direct-on-line starting.
4. Has four, six or eight poles.
5. Is rated from 0.4 kW to 1600 kW at a frequency of 60 hertz.

C406 Additional Efficiency Package Options

8 options – must comply with at least 1
1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power density in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9.
2020 ECCCNYA Commercial Provisions

C407 - Total Building Performance

- Full calendar year simulation
- DOE 2 platform
- Additional Efficiency Package energy cost shall be equal to or less than 85 percent of the standard reference design building

C407.6.3 Exceptional Calculation method allowed

2020 ECCCNYA Commercial Provisions

C408 Maintenance Information and System Commissioning

- Building operations and maintenance information.
  - Means of illustrating to the owner how the building, equipment and systems are intended to be installed, maintained and operated.
### 2020 ECCNYS Commercial Provisions

**C408 Maintenance Information and System Commissioning**
- Mechanical systems and service water-heater systems commissioning and completion requirements.
  - Commissioning plan.
  - Systems adjusting and balancing.
  - Functional performance testing.
  - Preliminary commissioning report.

### Residential Provisions

### Residential Energy Efficiency
- One and 2 Family structures
- R2, R3, R4 Multiple-dwelling structures, 3 stories or less
- HUD Code Manufactured Home
- Modular Factory Manufacture Home
**Terminology**

**BTU.** Abbreviation for British Thermal Unit, which is the quantity of heat required to raise the temperature of 1 pound of water 1° F.

**Definition**

**Dwelling Unit.** A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

**Definition**

**R-Value (Thermal Resistance)** The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area (h • ft2 • °F/Btu) [(m² • K)/W ]
Definition  
U-Factor (Thermal Transmittance) The coefficient of heat transmission (air-to-air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h • ft² • °F) [W/(m² • K)].

Definition  
RESIDENTIAL BUILDING. The term “residential building” includes:
(1) detached one-family dwellings having not more than three stories above grade plane;
(2) detached two-family dwellings having not more than three stories above grade plane;
(3) buildings that (i) consist of three or more attached townhouse units and (ii) have not more than three stories above grade plane;
(4) buildings that (i) are classified in accordance with Chapter 3 of the 2020 BCNYS in Group R-2, R-3 or R-4 and (ii) have not more than three stories above grade plane.
(5) **factory manufactured homes** (as defined in section 372(8) of the Executive Law); and
(6) **mobile homes** (as defined in section 372(13) of the Executive Law).

**Building Thermal Envelope.** The exterior walls (above and below grade), floors, ceiling, roofs, and any other building elements that enclose *conditioned space* or provides a boundary between *conditioned space* and *unconditioned space.*
Chapter 3 General Requirements

- Climate Zones
  - Basic information used in determining requirements in Chapter 4
  - Table 301.1

R303 Materials, Systems and Equipment

- R303.1 Identification
  - Fenestration Rating, Certification and Labeling
R303 Materials, Systems and Equipment

- **R303.1 Identification**
  - Envelope and Roof Insulation
  - Batts
  - Blown in
  - Sprayed on
  - Markers

**R303.1.3 Fenestration Example**

- Thermal resistance (R-value) of insulated siding to be tested per ASTM C1363
R303 Materials, Systems and Equipment

- R303.2 Installation
  - R303.2.1 Protection of Exposed Foundation Insulation

[NY] R303.2 Installation. Materials, systems and equipment shall be installed in accordance with the manufacturer’s instructions and the Uniform Code, as applicable.

Exception: In the case of a building that is subject to the New York City Construction Codes, materials, systems and equipment shall be installed in accordance with the manufacturer’s installation instructions and the applicable provisions of the New York City Construction Codes.
R401 General

- **R401.2 Compliance.** Projects shall comply with one of the following:
  - R401 through R404
    - R401 General
    - R402 Building Thermal Envelope
    - R403 Systems
    - R404 Electrical Power & Lighting
  - R405 and R401 – R404 labeled Mandatory
  - ERI approach in R406

R401.3 Certificate

- Certificate posted on a wall in the space where the furnace is located.
  - List R-values
  - List U-factors and SHGC
  - Duct system and building envelope air leakage testing
  - Equipment and efficiencies
The building thermal envelope shall meet the requirements of Table R402.1.2, based on the climate zone specified in Chapter 3.

In climate zone 6, the building thermal envelope shall meet either the requirements of the climate zone 6 "option 1" row in Table R402.1.2 or the requirements of the climate zone 6 "option 2" row in Table R402.1.2.

**Table 402.1.2 FENESTRATION REQUIREMENTS**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>SkyLite U-factor</th>
<th>SkyLite SHGC</th>
<th>Glazed U-factor</th>
<th>Glazed SHGC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.32</td>
<td>0.40</td>
<td>0.30</td>
<td>0.55</td>
</tr>
<tr>
<td>5</td>
<td>0.30</td>
<td>0.55</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.30</td>
<td>0.55</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Option 1</td>
<td>0.30</td>
<td>0.55</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Option 2</td>
<td>0.28</td>
<td>0.55</td>
<td>NR</td>
<td></td>
</tr>
</tbody>
</table>
Table R402.1.2

Insulation Requirements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Ceiling R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>49</td>
</tr>
<tr>
<td>6 option 1</td>
<td>60</td>
</tr>
<tr>
<td>6 option 2</td>
<td>60</td>
</tr>
</tbody>
</table>

R-values are minimums

Holy Cow!!!
That's a lot of insulation.

Table R402.1.2

Insulation Requirements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Wood Framed Wall R-value</th>
<th>Mass Wall R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>20 or 13 + 3h</td>
<td>6/13</td>
</tr>
<tr>
<td>5</td>
<td>20 or 13 + 3h</td>
<td>13/17</td>
</tr>
<tr>
<td>6 option 1</td>
<td>20 + 3 or 13 + 10h</td>
<td>15/20</td>
</tr>
<tr>
<td>6 option 2</td>
<td>23 cavity</td>
<td>19/21</td>
</tr>
</tbody>
</table>

Heavy walls hold heat if insulated on the exterior side

Option based on structural sheathing percentages.

Options for Walls in Zones 5 & 6
(for R-13 cavity + R-5 insulated sheathing option)

R402.2.7

- R-13 Cavity + R-2 supplement over structural BRACED PANELS, R-5 in other locations.
R402 Building Thermal Envelope

- **402.2.2 Ceilings without attic spaces**
  - Reduction to R-30/R-38 minimum
  - Maximum 500 SF or 20% of total ceiling area
  - Whichever is less
  - Does NOT apply to U factor alternative or Total UA

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Insulation Type</th>
<th>R-value</th>
<th>Slab R-value and depth</th>
<th>Crawl Space R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Baseline</td>
<td>10/13</td>
<td>10, 2 ft.</td>
<td>10/13</td>
</tr>
<tr>
<td>5</td>
<td>Option 1</td>
<td>15/19</td>
<td>10, 4 ft.</td>
<td>15/19</td>
</tr>
<tr>
<td>6</td>
<td>Option 2</td>
<td>15/19</td>
<td>10, 4 ft.</td>
<td>15/19</td>
</tr>
</tbody>
</table>

**Continuous insulation Interior / exterior**

R402.2.10 Slab Edge Insulation

- Diagram of slab edge insulation
**Section R402.2.3 Eave Baffle**
- Required for air permeable insulation
- Extend over top of insulation
- Of any solid material

**Steel Frame Conversions**

<table>
<thead>
<tr>
<th>Wood Frame R-Value Requirement</th>
<th>Cold-Formed Steel Equivalent R-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-20</td>
<td>R-0 + 14 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or...</td>
</tr>
<tr>
<td>R-21</td>
<td>R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or...</td>
</tr>
</tbody>
</table>

* Cavity insulation R-value is listed first, followed by continuous insulation R-value.

Also lists conversions for:
- Steel Truss Ceilings
- Steel Joist Ceilings
- Steel Joist Floors

**R402.2.7 Partial Structural Sheathing**

R-13 Cavity + R-2 supplement over structural BRACED PANELS, R-5 in other locations

Allows smoother surface
Building Thermal Envelope

- For calculated assemblies
- Also for the Total UA Alternative (weighted average)

Table 402.1.4 Equivalent U-factors

<table>
<thead>
<tr>
<th>Zone</th>
<th>Roof</th>
<th>Wall</th>
<th>Ceiling</th>
<th>Floor</th>
<th>Basement</th>
<th>Crawl Space Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.32</td>
<td>0.55</td>
<td>0.026</td>
<td>0.060</td>
<td>0.047</td>
<td>0.059</td>
</tr>
<tr>
<td>5</td>
<td>0.30</td>
<td>0.55</td>
<td>0.026</td>
<td>0.050</td>
<td>0.033</td>
<td>0.050</td>
</tr>
<tr>
<td>6</td>
<td>0.30</td>
<td>0.55</td>
<td>0.026</td>
<td>0.045</td>
<td>0.033</td>
<td>0.050</td>
</tr>
</tbody>
</table>

R402 Building Thermal Envelope

- R402.2.13 Sunroom Insulation
  - With Thermal isolation
  - Insulation Requirements Exceptions:
    - Ceiling Insulation R-values –
      - Zone 4 = R19 , Zones 5 & 6 = R24
    - Wall Insulation R-value = R13
    - Wall adjoining house meets Building Thermal Envelope requirements

R402 Building Thermal Envelope

- R402.3.2 Glazed Fenestration SHGC
  - Permitted in Zones 5 & 6
  - Alternative to SHGC
    - Ratio of higher to lower SHGC > 2.4
    - Automatically controlled
    - Separate consideration from other fenestration
Air Leakage

• R402.4.1.1 - Installation
  • Materials installed per manufacturer's instructions

• [NY]R402.4.1.2 - Testing
  • CEO approved 3rd party testing required
  • ASTM E 779 or E 1827
  • Air changes required at 3 per hour

[NY]R402.4.1.2 Testing. During testing:
1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed…
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed…
3. Interior doors, if installed at the time of the test, shall be open.
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.
R402 Building Thermal Envelope

Air Leakage

- [NY]R402.4.1.3 Optional testing procedure for buildings with two or more dwelling units within the building thermal envelope
  - 2 or more dwelling units
  - Each unit tested individually
  - ALR < .3 CFM 50 / SF of enclosure surface area
  - May be used as an alternative to R402.4.2.1

[R402 Building Thermal Envelope]

Section R402.4.2 – Fireplaces

- Wood-burning Fireplaces
  - Tight-fitting flue dampers or doors
  - Outdoor combustion air required
  - Factory built fireplaces – listed / labeled to UL 127
  - Masonry fireplaces – listed / labeled to UL 907

- Reminder – Residential Code Requirements
  - Fireplaces – Ventilation requirements in Section R1006
R402 Building Thermal Envelope

402.4.4 Rooms containing fuel burning appliances

- Open combustion fuel burning appliances
- Open combustion air duct location
  - Outside building thermal envelope, or
  - Isolated in an enclosed insulated room
- Min room insulation values
  - Table 402.1.2
  - basement wall R 10

R403: Systems

403.1 Controls (Mandatory)

- 1 Programmable thermostat minimum in every dwelling unit

R403 Systems

R403.3 Ducts

- R403.3.1 Insulation (Prescriptive)
  - Ducts in attics
    - 3' and greater in diameter : R8
    - Less than 3' in diameter : R6
  - Other locations in the building
    - 3' and greater in diameter : R6
    - Less than 3' in diameter : R4.2
R403 Systems

403.3 Ducts

- [NY]R403.3.2 Sealing (Mandatory)
  - Shall be sealed
  - Air Handlers must meet ASHRAE 193
  - Except 2: ducts with less than 2" water column

“Only listed duct tape can be used to seal ducts”

MCNYS 603.9  M1601.4.1

R403 Systems

403.3 Ducts (cont.)

- 403.3.3 Duct Testing (Mandatory)
  - Rough-in, or
  - Post construction
  - If all ductwork within BTE, no test required
  - Signed test required to be supplied to the CEO
**R403 Systems**

403.3 Ducts (cont.)

- **R403.3.4 Duct Leakage (Prescriptive)**
  - **Rough-in:**
    - With air handler installed
      - Total leakage < 4 cfm/100 sf
    - Without air handler installed
      - Total leakage ≤ 3 cfm/100 SF
  - **Post-construction:**
    - Total leakage ≤ 4 CFM / 100 SF

---

**R403 Systems**

403.3 Ducts (cont.)

- **403.3.5 Building Cavities (Mandatory)**
  - MAY NOT be used as:
    - Ducts
    - Plenums

---

**Duct Leakage Testing**

R403 Systems

R403.4 Mechanical system piping insulation.

- Insulate if outside of the building envelope min R3
- SHALL be protected from damage

R403 Systems

R403.5.3 Hot Water Piping Insulation (prescriptive)

- Minimum R-3 7 criteria
  1. ¾” and larger piping
  2. Serves more than 1 dwelling unit
  3. Outside conditioned space
  4. Feeding a distribution manifold
  5. Under a slab
  6. Insulation only where, circulating, buried or outside of building envelope
  7. Supply and return in other than demand system

R403 Systems

R403.6 Mechanical Ventilation (Mandatory)

- Table R403.6.1
  - Mechanical Ventilation System Efficacy

<table>
<thead>
<tr>
<th>Fan Location</th>
<th>Air Flow Rate Minimum (CFM)</th>
<th>Minimum Efficacy (CFM/WATT)</th>
<th>Air Flow Rate Maximum (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRV or ERV</td>
<td>Any</td>
<td>1.2 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>Range Hoods</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>In-line fan</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>10</td>
<td>1.4 cfm/watt</td>
<td>&gt;90</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>90</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
</tbody>
</table>
R403 Systems

403.7 Equipment sizing and efficiency rating. (Mandatory)

• Equipment sized in accordance with ACCA Manual S
• Loads sized per ACCA Manual J or other approved heating and cooling calculation methodologies
• Sized in accordance with Section N1103.7 of the RCNYS (ACCA Manual J)

R403 Systems

R403.8 System Serving Multiple Dwelling Units (Mandatory)

• Shall comply with C403 and C404 of 2020 ECCNYS

R403.9 Snow Melt and Ice System Controls (Mandatory)

• Automatic controls required

R403 Systems

R403.10 Pool / Spas (Mandatory)

• R403.10.1 Heaters
  • Electric Heaters
    • Readily accessible controls
    • In addition to required circuit breaker

• R403.11 Spas
  • Energy consumption controlled per APSP-14
R403 Systems

R403.10 Pool / Spas (Mandatory)
- [NY] R403.10.3 Covers
  - Outdoor heated pools and permanent spas
  - Vapor retardant covers
  - If heated >90⁰ minimum R12 insulation value

R403.11 Portable Spas (Mandatory)
- Electric powered portable spas
- Comply with APSP – 14 2014

R403.12 Residential Pools / Permanent Residential Spas
- Accessory to 1 / 2 family res and < 3 story townhouses
- Comply with APSP-15a 2011

R404 Electrical Power and Lighting Systems

404.1 Lighting equipment (Mandatory).
- What is efficacy?
Efficacy is the measure of lighting efficiency and is calculated by dividing the light output (measured in lumens) by the electricity used (measured in watts).

Efficawhat???
R404 Electrical Power and Lighting Systems

R404.1.1 Lighting equipment (Mandatory)
• fuel gas lighting system
• no continuously burning pilot lights

RCNYS Section R202 - High-Efficacy Lamps
Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy of not less than the following:
1. 60 lumens per watt for lamps over 40 watts;
2. 50 lumens per watt for lamps over 15 watts to 40 watts;
3. 40 lumens per watt for lamps 15 watts or less.

405 Simulated Performance Alternative
• Analysis of Heating, Cooling, Mechanical Ventilation, and Service Water Heating.
• MANDATORY provisions must be met
• Based on Annual Energy Cost
  • Proposed Design less than Standard Design
### 405 Simulated Energy Performance

**R405.4 Documentation**
- Compliance Report
- Location of proposed home
- Inspection Checklist
- Individual responsible for the report
- Software used
- Additional Documentation if required by CEO
- Component characteristics of the Standard Design
- Certification by the Builder for the Proposed Design
- Actual values used in software calculations

### R406 Energy Rating Index

**Maximum Energy Rating Index**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Energy Rating Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>01</td>
</tr>
<tr>
<td>7</td>
<td>01</td>
</tr>
<tr>
<td>8</td>
<td>01</td>
</tr>
</tbody>
</table>

### Existing Buildings
**Existing Buildings**

[NY]R501.4 Compliance
- Alterations, Repairs, Additions, Change of Occupancy comply with pertinent code
- Unaltered portion(s) may remain as-is
- Do not create an unsafe or hazardous condition

[NY]R501.6 Historic Buildings
- Exempt from compliance

---

**R502 Additions**

**R502.1.1 Prescriptive**
- [NY]Building Envelope - shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5.
- Heating & Cooling - shall comply with Section R403.
- Service Hot Water - shall comply with Section R403.5.
- Lighting - shall comply with Section R404.1.
- Simulated performance alternatives allowed - shall comply with Section R405.
R503 Alterations

[NY]R503.1.1 Building envelope

There are seven exceptions that do not require alteration to comply with the requirements for new construction if the energy use of the building is not increased.

R503 Alterations

• R503.1.3 Service Hot Water
  • New parts of the alteration shall comply

• R503.1.4 Lighting
  • New parts of the alteration shall comply

• R503.2 Change in Space conditioning
  • Non-conditioned or low energy
  • If now conditioned = full compliance
  • Exception: simulated performance option
  • Heating and cooling system compliance required
  • Duct extensions < 40 feet in unconditioned space no testing required

R504 Repairs

• R504.1
  • Routine maintenance exempt from permit
  • Abatement due to wear

• [NY]R504.2 Application
  • Glass only in existing sash and frame
  • Roof repairs
  • Bulb / ballast replacement not increasing lighting power
  • New vestibule not required, existing vestibule to remain
SUMMARY:

• Residential Compliance
  – 2020 ECCCNYS or Chapter 11* of the 2020 RCNY
  – REScheck

• Commercial Compliance Methods
  – 2020 ECCCNYS and/or ASHRAE 90.1-2016
  – COMcheck
Lesson 5

Design Load Importance

Chapter 16 – Structural Design

Why we worry about loads.
Why snow is a four-letter word (especially in Buffalo).

Why beachfront property is so expensive.

Why the little things (like structural connections and live loads) count.
Why we admire the third little pig.

Why “Shake, Rattle and Roll” could be a New York theme song.

Why Noah might have had the right idea.
Introduction to Loads and Design Theory

The intention is NOT to make you an Architect or Engineer.

In This Lesson:

- Explain basic FORCES acting on buildings
- How the Code establishes minimum design LOADS as the result of those forces
- Variables that affect minimum design loads
Forces that act on a building

- Vertical gravity loads
  - Weight of the building
  - Weight of the occupancy
- Lateral loads
  - Wind forces
  - Earthquake forces

Uniform and Concentrated Forces

- Uniformly distributed
  - Weight on floors
  - Wind pushing on a wall
- Concentrated
  - A beam bearing on a post
  - A column bearing on a footing
For every action there MUST be an EQUAL and OPPOSITE reaction . . . or a failure will result . . .

Forces and “Loads”  
(Chapter 2)

- LOADS are FORCES (or other actions) that result from:
  - the weight of building materials
  - occupants and their possessions
  - environmental effects
  - differential movement
  - restrained dimensional changes
- If variations over time are rare or small, the loads are PERMANENT (Static)
  - Vertical gravity loads
- Other loads are VARIABLE (Dynamic)
  - Lateral wind and earthquake forces

“Dead Loads”  
(Chapter 2)

The weight of construction materials incorporated into the building, including:
- Walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding
- Other architectural/structural items
- Fixed service equipment, including cranes
“Live Loads” (Chapter 2)

Loads produced by the use and occupancy

- Does not include loads such as wind, snow, rain, earthquake, flood or dead loads
- Roof Live Loads produced by:
  - Maintenance by workers, equipment and materials
  - Movable objects such as planters and by people

Other Loads to be Considered

- 1608 Snow - Push down
- 1609 Wind Snow - Push and pull against
- 1610 Soil - Push against
- 1611 Rain - Push down
- 1612 Flood - Push and pull against
- 1613 Earthquake – Push and pull against

Predictability of Loads

The more PREDICTABLE a load is, the simpler its determination and the documentation

- Dead and Live loads

The more UNPREDICTABLE a load is, the more complex its determination and the more documentation is required.

- Wind and Seismic loads
The Practical Application

• A structural system must:
  – Resolve the forces (loads)
  – Channel them to the ground

• There must be a "load path" from the roof to the foundation consisting of the structural, load-bearing elements of a building
  – Resolves both VERTICAL and LATERAL Loads

Load Path Design MUST Account for Vertical Loads

Up and Down forces

Vertical

Dead loads, live loads, and other loads

Carried to the soils

Simple Vertical Load Path of a Deck

[Diagram of a deck with load paths and reaction forces]
Load Path Design MUST Account for Lateral Loads

- Forces parallel to the ground.
- High winds and Earthquakes.
- Resisting elements transfer loads to vertical elements then to the foundation.

Load Path for Lateral Forces

Loads transmitted by Lateral Force Resisting Assemblies

- Braced frames
- Diaphragms
- Shear walls

Simple Structural System

- Roofs
- Walls
- Floors
- Foundations
The Structural System

- Columns
- Spandrels
- Girders
- Beams
- Lateral Bracing

Chapter 16 Structural Design: What Does it Do?
- Establishes MINIMUM Design Loads
- Factors in Probability, Safety and Cost
- Evaluates the different loads into safe, cost effective combinations
- Relies on the DESIGNER or the CONSTRUCTION MATERIALS and METHODS to withstand those FORCES

Structural Chapters Organization Overview

- Chapter 16: Structural Design Requirements
- Chapter 17: Special Inspections and Tests
- Chapter 18: Soils and Foundations
- Chapters 19 through 23: Primary Structural Materials
Minimum Design Loads

• Evaluate forces to determine these loads…
  – Dead loads - Section 1606
  – Live loads - Section 1607
  – Snow loads - Section 1608
  – Wind loads - Section 1609
  – Soil Lateral loads - Section 1610

Section 1606 Dead Loads

• Weight of the building itself
• For design, the actual weights of materials and construction are used
  – Includes fixed service equipment, such as:
    • Plumbing stacks and risers
    • Electrical feeders
    • HVAC system
    • Fire sprinkler systems
• If no definite information, values used are subject to the approval of the CEO
Section 1607 Live Loads

- Loads produced by use and occupancy
- Uniformly distributed loads
  - Shall be the maximum expected, but not less than required by Table 1607.1
- Concentrated loads on floors and other similar surfaces
  - Shall meet 1607.4 or the concentrated loads in Table 1607.1, whichever produces greater load effects

Load Not Specified
Section 1607.2

“For occupancies or uses not designated in Table 1607.1, the live load shall be determined in accordance with a method approved by the Building Official.”
Environmental Loads

Where, because of the variables, things get complicated...

Environmental Load Variables

• Location
  – Determines predominant forces and loads
    • Snow zones
    • High wind regions
    • Exposure Categories

• Building Importance
  – Essential facility or failure unimportant?

Table 1604.5
Risk Category of Buildings and Other Structures

<table>
<thead>
<tr>
<th>Occupancy Category</th>
<th>Nature of Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Low hazard</td>
</tr>
<tr>
<td>II</td>
<td>Typical buildings</td>
</tr>
<tr>
<td>III</td>
<td>Substantial hazard to life</td>
</tr>
<tr>
<td>IV</td>
<td>Essential facilities</td>
</tr>
</tbody>
</table>
Risk Category Exercise 12

Using Table 1604.5, determine the Risk category based on the nature of the occupancy.

Exercise 12 - Table 1604.5

<table>
<thead>
<tr>
<th>NATURE OF OCCUPANCY</th>
<th>RISK CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium with an occupant load of 1000</td>
<td></td>
</tr>
<tr>
<td>Fire station</td>
<td></td>
</tr>
<tr>
<td>Farmer Ted’s cow barn</td>
<td></td>
</tr>
<tr>
<td>Eight unit apartment building</td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td></td>
</tr>
<tr>
<td>County jail</td>
<td></td>
</tr>
<tr>
<td>Self-storage building</td>
<td></td>
</tr>
<tr>
<td>Power station</td>
<td></td>
</tr>
<tr>
<td>Your house</td>
<td></td>
</tr>
</tbody>
</table>

Section 1608
Snow Loads

- **Design snow loads**
  - Determined from Chapter 7 of ASCE 7 (2010 edition)
- **Figure [NY] 1608.2**
- **Ground snow loads**
  - Used to determine design snow load -Figure [NY] 1608.2
  - Elevations above 1000 feet increased 2 psf for every 100 feet above 1000 feet.
Snow Load Variables

- Flat or sloped roof
- Surface of roof (slippery or not)
- Exposure
- Warm or cold roof surface
- Roof configuration

Section 1609 Wind Loads

- Section 1609.1.1 - Determined with
  - Chapters 26-30 of ASCE 7
  - 6 Exceptions

Section 1609 Wind Loads

- Wind Speed Maps
  - Specific to Risk Category of the building or structure.
    - Figure 1609.3(1) – Category II Buildings
    - Figure 1609.3(2) – Category III Buildings
    - Figure 1609.3(3) – Category IV Buildings
    - Figure 1609.3(4) – Category I Buildings
  - Risk categories – from Table 1604.5
Figure 1609.3(1) For Risk Category II
Buildings or Structures

Figure 1609.3(2) For Risk Category III
Buildings or Structures

Figure 1609.3(3) For Risk Category IV
Buildings or Structures

Figure 1609.3(4) For Risk Category I
Buildings or Structures

Section 1610
Soil Lateral Loads

- Used to determine minimum design lateral soil loads for
  - Basements
  - Foundations
  - Retaining walls
- Soil loads specified in Table 1610.1
  - Unless soil investigation report requires otherwise
Table 1610.1 
Soil Lateral Loads

<table>
<thead>
<tr>
<th>DESCRIPTION OF BACKFILL MATERIAL</th>
<th>UNIFIED SOIL CLASSIFICATION</th>
<th>DESIGN LATERAL SOIL LOAD (pound per square foot per foot of depth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-graded, clean gravels, gravel-sand mix</td>
<td>GW</td>
<td>30 Active pressure</td>
</tr>
<tr>
<td>Poorly graded clean gravels, gravel-sand mix</td>
<td>GP</td>
<td>30 Active pressure</td>
</tr>
<tr>
<td>Silty gravels, poorly graded gravel-sand mix</td>
<td>GM</td>
<td>40 Active pressure</td>
</tr>
<tr>
<td>Clayey gravels, poorly graded gravel-and-clay mix</td>
<td>GC</td>
<td>45 Active pressure</td>
</tr>
</tbody>
</table>

Section 1611 Rain Loads

- Roof design must sustain accumulated rainwater load
  - *This only applies to roofs flat enough to accumulate rain*
- ASCE 7 Section 8.4
- Controlled Drainage

Flood Loads - Section 1612

- Section [NY]1612.3
  - For design and construction within flood hazard areas
  - Flood hazard areas are established
**Flood Loads - Section 1612**

- [NY] 1612.3.1 Design flood elevations.
  - For design and construction within flood hazard areas

- [NY] 1612.3.1.1 Freeboard.
  - Elevation + 2 foot of freeboard

**FREEBOARD.** A factor of safety expressed in feet (mm) above the design flood elevation.

---

**Section 1613 Earthquake loads**

- Structures must be designed and constructed to RESIST earthquakes
  - Damage is acceptable, collapse is not
- Seismic design is similar to wind design
  - Both are lateral forces
- Seismic loads are different from wind loads ...
  - Wind loads are proportional to surface
  - Earthquake forces are inertial (affected by the structure’s mass)

---

**Earthquake Loads are the result of INERTIA Forces**

- Acceleration
- Deceleration
Earthquake Load Variables

- Probability of an earthquake
- Probable earthquake magnitude (shaking)
  - Strength of quake
  - Soil characteristics
- Seismic Use Group
  - Similar to Importance Category
- These variables are used to determine "SEISMIC DESIGN CATEGORY"

What Seismic Design Category does...

- Quantifies the RISK
  - No risk, no additional seismic requirements
- If there is a risk ...
  - Special calculations may be required
  - PRESCRIPTIVE construction methods may not apply, or they may include ADDITIONAL requirements

How much Risk?

As of 4/17/2020

5km = 3mi
From the USGS Website for the year 2018.

The Problem Areas of New York

Generally...
- Northern-most Counties
- Lower Hudson Valley
- Niagara
- And anywhere where soils are poor
Section 1613 Earthquake Loads

- Maps
  - Figures 1613.2.1 (1) and 1613.2.1 (2)
- Maps developed based on information from USGS National Seismic Hazard Mapping Project
- Basic Formulas
- Tables 1613.2.5 (1) and (2)

The Bad News and Good News

LIMITED calculations need to be done
And the Code Enforcement Official SHOULD do the determination for the community
They only need to be done ONCE
Probability, shaking and safety factors are pretty constant
Results for MOST of the State …
Limited Seismic Risk?
Layman’s Directions

Step 1: How hard will the quake shake?
Step 2: What does the shaking do to the Soils?
Step 3: Combine the two using Tables and Factors
Step 4: Reduce 1/3 for “Acceptable Damage”
Step 5: Assess the Importance of the Building
The result - SEISMIC DESIGN CATEGORY

Step 1 – How hard will the quake shake?
Spectral Response Acceleration

Method to estimate the expected ground motion (acceleration) and the effect on the building
Figures 1613.2.1(1) and (2) provide “contours” for NY
Numbers are PERCENT values, calculations are done with DECIMAL (20 = .20)
Based on history, experience and scientific assumptions
S_s – acceleration at short periods (JOLT)
S_1 – acceleration at 1 second (SHAKE)

Shown here are the New York portion of the figures.
Step 2: What does the shaking do to the Soils?

Used to factor in local ground conditions
- Site Class A – Hard rock
- Site Class B – Rock
- Site Class C – Very dense soil and soft rock
- Site Class D – Stiff soil
- Site Class E – Soft clay soil
- Site Class F – Soils requiring site response analysis in accordance with Chapter 20 (ASCE 7)

**ASSUME Site Class (soil type) D without professional determination**

Let the Magic Begin

- Based on SPECTRAL RESPONSE ACCELERATION and SITE CLASS
- Formulas and Tables produce the DESIGN PARAMETERS
- Factor in the IMPORTANCE (Risk) of the building
- This leads to the SEISMIC DESIGN CATEGORY

Figure 1613.2.1 (1) and (2)

Shown here are the New York portion of the tables.
Seismic Design
Determination of Seismic Design Category

Step 1:  Spectral Response Acceleration (Section 1613.2.1)
\[ S_s = .18 \]
\[ S_1 = .07 \]

Step 2:  Determine Site Class (Section 1613.2.2)
Assume Site Class D

Why D?

---

Step 3:  Determine Site Class Coefficients (page 382)

Table 1613.2.3(1)  \[ F_a = 1.6 \]
Table 1613.2.3(2)  \[ F_v = 2.4 \]

---

Step 4:  Determine Maximum Considered Earthquake (page 379)

Equation 16-36
\[ S_{MS} = F_a \times S_s \]
\[ .288 = 1.6 \times .18 \]

Equation 16-37
\[ S_{MH} = F_v \times S_1 \]
\[ .14 = 2.4 \times .07 \]

---
**Seismic Design**

**Determination of Seismic Design Category**

**Step 5:** Reduce for Acceptable Damage  
Eq’n 16-38 \( S_{DS} = \frac{2}{3} S_{MS} \)  
Eq’n 16-39 \( S_{D1} = \frac{2}{3} S_{M1} \)  
\( 2/3 \times 0.66 \times 0.288 = 0.19 \)

**Step 6:** Determine Risk  
Category with Table 1604.5

<table>
<thead>
<tr>
<th>Value of ( S_{DS} )</th>
<th>I or II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S_{DS} = 0.19 )</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value of ( S_{D1} )</th>
<th>I or II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S_{D1} = 0.11 )</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

**I and II = Typical buildings**  
**III = Loss of Life threat**  
**IV = Essential Facility**

**Step 7:** Determine SEISMIC DESIGN CATEGORY  
(Page 383)

The building is assigned the MOST SEVERE Seismic Design Category
It's not as bad as you think…

The only things that can change:
- Site Class (Step 2) Soils are different
- Buildings Risk category (Step 5)

Always the same, regardless:
- The $S_s$ and $S_i$ for your area
- Reading Tables and performing calculations

---

**Sample Seismic Design Category Worksheet**

Appendix Page 10

---

<table>
<thead>
<tr>
<th>Location:</th>
<th>Zip Code:</th>
<th>SAMPLE FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_s =$</td>
<td>$S_i =$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site Class (Soils)</th>
<th>Risk Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ... $S_{AS}$ =</td>
<td>I or II</td>
</tr>
<tr>
<td>$S_{AI}$ =</td>
<td>III</td>
</tr>
<tr>
<td>B ... $S_{BS}$ =</td>
<td>IV</td>
</tr>
<tr>
<td>$S_{BI}$ =</td>
<td></td>
</tr>
<tr>
<td>C ... $S_{CS}$ =</td>
<td></td>
</tr>
<tr>
<td>$S_{CI}$ =</td>
<td></td>
</tr>
<tr>
<td>D ... $S_{DS}$ =</td>
<td></td>
</tr>
<tr>
<td>$S_{DI}$ =</td>
<td></td>
</tr>
<tr>
<td>E ... $S_{ES}$ =</td>
<td></td>
</tr>
<tr>
<td>$S_{EI}$ =</td>
<td></td>
</tr>
</tbody>
</table>
Exceptions to 1613.1

1. Detached One- and Two-family dwellings in Seismic Design Category A, B or C or located where $S_S$ is less than 0.4g
2. Wood frame construction conforming to 2308
3. Agricultural storage structures intended only for incidental human occupancy
4. Structures that require special considerations that are not addressed by this code or ASCE 7 and are subject to other regulations
5. References within ASCE 7 to Chapter 14 shall not apply, except as specifically required herein.

Wind Loads versus Seismic Loads

1. 1604.9 Wind and seismic detailing
   Lateral force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7 Chapters 11, 12, 13, 15, 17 and 18 as applicable, even where wind load effects are greater than seismic load effects.
   Exception: References within ASCE 7 to Chapter 14 shall not apply, except as specifically required herein.

Summary

Explain forces and resulting loads on buildings
Familiarization with the terminology of structural design and design theory
Understand what Chapter 16 requires to ensure adequate design to withstand forces and loads
Next lesson – Structural Requirements and Documentation
In This Lesson:

- Required Permit Application Documentation
- Structural Documentation for Plan Review
- Inspections, Observations and Tests of Construction Activities

Construction Documents

The KEY for Code Enforcement

- Construction Documents may include:
  - Design drawings
  - Specifications
  - Structural calculations
  - Soil Reports
- Submission allows the CEO to determine that:
  - Structural design is based on the minimum design loads specified by the Code
  - Chosen structural elements are substantiated by design calculations
1603 Construction Documents: Required Design Load Information

Shall Show Structural elements
- Size, section and location
- Floor levels, column centers and offsets fully dimensioned
- NYCRR Title 19 Part 1203.3 (a)/2(y) requires a minimum of two sets of the plans

1603 - Construction Documents: Required Design Load Information

Clearly indicated on the construction documents
1. Floor and Roof Live Loads
2. Roof Snow Load P1
3. Wind Speed and wind exposure, risk category
4. Seismic design category, risk category and site class
5. Flood design data, if located in flood hazard areas established in Section 1612.3
6. Geotechnical information on soil load bearing values
7. Rain load data
And information required by Sections 1603.1.1 through 1603.1.9

Additional Construction Documentation

- 1603 for minimum design load information
- MATERIAL CHAPTERS require information about specific ELEMENTS
  - Example: Chapter 19 Concrete
    - 1901.5 Construction Documents (page 431)
      - Compressive strength for each element
      - Reinforcement strength and grade
      - Size and location of structural elements and reinforcement
      - Provisions for dimensional change
      - Details for reinforcement anchorage and splices
      - Etc.
Conventional Light-Frame Limitations: 2308.2

- Limits stories above grade
- Maximum 11’ 7” floor to floor wall height
- Chapter 16 load limitations
  - Dead 15 psf
  - Live 40 psf
  - Ground snow 50 psf
- 40’ maximum truss/rafter span
- Seismic limitations

Additional Construction Documentation Chapter 23 Wood

- 2303.4.1.1 Truss design drawings
  - By a registered design professional
  - Provided to the CEO prior to installation
  - Information includes
    - Slope or depth, span and spacing
    - Location of joints
    - Required bearing widths
    - Design loads as applicable
    - Etc.
  - Truss placement drawings provided with trusses delivered to the job site and in the Truss submittal package.

Your Role as the Code Official

- In a complicated building
  - Collect documentation from the designer
  - If you are an expert, check the calculations
  - If not, check what you can and rely on the design professional’s expertise
- In a simpler building using prescriptive methods
  - Confirm that the prescriptive approach is ALLOWED
  - VERIFY through plan review and inspection
1603.1.1 Floor Live Load

Construction Documentation

Shall be Indicated …

- Uniformly Distributed
- Concentrated
- Impact Floor Live Load
- Live Load Reductions, if used

---

Table 1607.1 Live Loads

<table>
<thead>
<tr>
<th>Occupancy or Use</th>
<th>Uniform (psf)</th>
<th>Concentrated (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apartments (see residential)</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Access floor systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office use</td>
<td>50</td>
<td>2,000</td>
</tr>
<tr>
<td>Computer use</td>
<td>100</td>
<td>2,000</td>
</tr>
<tr>
<td>3. Armories and drill rooms</td>
<td>150</td>
<td>---</td>
</tr>
<tr>
<td>4. Assembly areas and foyers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed seats (fastened to floor)</td>
<td>60</td>
<td>---</td>
</tr>
<tr>
<td>Follow spot, projection and control rooms</td>
<td>100^</td>
<td>---</td>
</tr>
<tr>
<td>Lobbies</td>
<td>100^</td>
<td></td>
</tr>
<tr>
<td>Mezzanine rooms</td>
<td>100^</td>
<td></td>
</tr>
<tr>
<td>Staged seats</td>
<td>150^</td>
<td></td>
</tr>
<tr>
<td>Platforms (assembly)</td>
<td>100^</td>
<td></td>
</tr>
<tr>
<td>Other assembly areas</td>
<td>100^</td>
<td></td>
</tr>
</tbody>
</table>

---

Live Load Exercise

Appendix Page 11

Using Table 1607.1, determine the uniform load based on the occupancy or use…
Live Load Exercise

<table>
<thead>
<tr>
<th>Occupancy or Use</th>
<th>Uniform Load psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Manufacturing</td>
<td></td>
</tr>
<tr>
<td>Office Building Offices</td>
<td></td>
</tr>
<tr>
<td>Wholesale Store</td>
<td></td>
</tr>
<tr>
<td>Stairs and exits (not in one-and two-family dwellings)</td>
<td></td>
</tr>
<tr>
<td>School Classrooms</td>
<td></td>
</tr>
<tr>
<td>Jail Corridor</td>
<td></td>
</tr>
<tr>
<td>Private room in a hotel</td>
<td></td>
</tr>
<tr>
<td>Marquees</td>
<td></td>
</tr>
</tbody>
</table>

1603.1.2 Roof Live Load

- The roof live load used in the design shall be indicated for roof areas (Section 1607.13)
  - 1607.13.1 Distribution of roof live loads
  - 1607.13.2 Reduction in roof live loads
    - 1607.13.2.1 Ordinary Roofs, Awnings and Canopies
  - 1607.13.3 Occupiable roofs
    - 1607.13.3.1 Vegetative and Landscaped roofs
  - 1607.13.4 Awnings and canopies
  - 1607.13.5 Photovoltaic Panel System

1603.1.3 Roof Snow Load

Construction Documentation

Shall be Indicated ...
- Ground Snow Load \( P_g \)
  - Where greater than 10 PSF ...
    - Flat Roof Snow Load, \( P_f \)
    - Snow Exposure Factor, \( C_e \)
    - Snow Load Importance Factor, \( I_s \)
    - Thermal Factor, \( C_t \)
    - Slope Factor, \( C_s \)
    - Drift Surchage Load, \( P_d \)
    - Width of Snow Drift, \( w \)
Snow Loads
Flat Roof Snow Load Formula

- Chapter 7 of ASCE 7
- \( p_f = 0.7 C_e C_t I p_g \)
- \( C_e \) = Exposure Factor
- \( C_t \) = Thermal Factor
- \( I \) = Importance Factor
- \( p_g \) = Ground Snow Load

1603.1.4 Wind Design Data
Construction Documentation

- Loads shall be shown regardless ...
- Basic Design Wind Speed, \( V \)
  - Nominal Design Wind Speed, \( V_{nom} \)
- Risk Category
- Wind Exposure
- Applicable Internal Pressure Coefficient
- Design wind pressures for Components and Claddings not specifically designed by the professional

Wind Load Determinations

- Wind loads shall be determined in accordance with Chapter 26 to 30 of ASCE 7 (2016)
- Chapters 26 to 30 of ASCE 7 or Section 1609.6
  - Type of opening protection
  - Basic design wind speed \( V \)
  - Exposure categories
- Wind presumed come to from any horizontal direction and wind pressures shall be presumed to act normal to the surface considered.
High Wind Regions

- Hurricane Prone regions
  - Atlantic coast where wind speed exceeds 115 mph (LONG ISLAND)
- Wind-borne debris regions
  - Areas within hurricane prone regions
- Both require specific wind design considerations
  - Basic design wind speed $V$

Surface Roughness Category

1609.4.2

- Surface Roughness B
  - Urban and suburban areas
  - Wooded areas or closely spaced buildings
- Surface Roughness C – Open terrain
  - Scattered obstructions, >30' height
  - Flat open country, grasslands
- Surface Roughness D
  - Flat unobstructed areas
  - Water surfaces

Exposure Category

1609.4.3

- Exposure B – Typically Surface roughness B areas
  - Wooded areas or closely spaced buildings
  - Building ht. < or = 30’ – SR B for upwind 1500’
  - Building ht. > 30’ – SR B prevails upwind for > 2600’ / 20x bldg. ht.
- Exposure C – Open terrain
  - All cases that do not fall into B or D
- Exposure D – Flat unobstructed areas
  - SR D prevails upwind for 5000’
  - SR B, C within 600’ of site
1603.1.5 Earthquake Design Data

Construction Documentation

Loads shall be shown ... regardless ...

1. Risk category
2. Seismic importance factor, I_e.
4. Site class.
5. Spectral response coefficients S_3d and S_1d.
6. Seismic design category.
7. Basic seismic-force-resisting system(s).
8. Design base shear.
9. Seismic response coefficient(s), C_s.
10. Response modification factor(s), R.
11. Analysis procedure used.

1603.1.7 Flood Design Data

Construction Documentation

• Buildings located in whole or part in flood hazard areas ...
  information shall be shown ...
  [NY] 1612.3

• Flood hazard areas (other than coastal high hazard or A zones):
  – Elevation of proposed lowest floor
  – Elevation of nonresidential building’s dry floodproofing

• Coastal high hazard and Coastal A zones:
  – Proposed elevation of the lowest horizontal structural member of
    the lowest floor

• 1603.1.8 Special Loads

Design Flood Elevations

• [NY] 1612.3.1 Exception
  • If DFE is not possible to obtain:
    • DFE shall be 3’ above highest adjacent grade

• [NY] 1612.3.1.1 Freeboard requirements
  • DFE in accordance with 1612.3 – 1612.3.1
    • Building elevation shall be DFE plus 2’ of freeboard

Exception: Freeboard is not required when the exception to 1612.3.1 is
applied.

DFE is Design Flood Elevation
Definition

• DESIGN FLOOD ELEVATION. The elevation of the “design flood,” including wave height, relative to the datum specified on the community’s legally designated flood hazard map. In areas designated as Zone AO, the design flood elevation shall be the elevation of the highest existing grade of the building’s perimeter plus the depth number (in feet) specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number shall be taken as being equal to 2 feet (610 mm).

Definition

COASTAL A ZONE. Area within a special flood hazard area, landward of a V zone or landward of an open coast without mapped coastal high-hazard areas. In a coastal A zone, the principal source of flooding must be astronomical tides, storm surges, seiches or tsunamis, not riverine flooding. During the base flood conditions, the potential for breaking wave height shall be greater than or equal to 1 1/2 feet (457 mm). The inland limit of the coastal A zone is (a) the Limit of Moderate Wave Action if delineated on a FIRM, or (b) designated by the authority having jurisdiction.

Definition

COASTAL HIGH-HAZARD AREA. Area within the special flood hazard area extending from offshore to the inland limit of a primary dune along an open coast and any other area that is subject to high-velocity wave action from storms or seismic sources, and shown on a Flood Insurance Rate Map (FIRM) or other flood hazard map as velocity Zone V, VO, VE or V1-30.
Top Ten Reasons to LOVE Chapter 17

GET OUT OF CHAPTER 16

10. Someone else has to plan ahead
9. A list of materials/work requiring special inspections must be submitted with a permit application
8. A list of individuals/agencies/firms performing special inspections must be submitted with a permit application
7. Special inspections are paid for by the owner
6. Special inspectors must keep records and provide them to the CEO
5. Certificates of Compliance must be provided to the CEO for special seismic and wind systems when completed.
4. Contractors must submit statements of responsibility to the CEO for special seismic or wind resisting systems
3. Chapter 17 helps to ENSURE what was SPECIFIED is CONSTRUCTED
2. All you have to know is when Chapter 17 applies
1. Less potential for liability for you!
Chapter 17 Requires…

- Special inspections
- Documentation
- Structural observations and tests

3 Types of Inspections

Ensures Construction Conforms with Approved Plans

- Local Code Enforcement Authority:
  - Local law reference to 19 NYCRR 1203
  - Special Inspections (1704)
    - Two types, continuous or periodic
  - Structural “Observations” (1704)
    - By a registered design professional

Definition

[NY] REGISTERED DESIGN PROFESSIONAL. An individual who is a licensed and registered architect (RA) in accordance with Article 147 of the New York State Education Law or a licensed and registered professional engineer (PE) in accordance with Article 145 of the New York State Education Law.
Definition

SPECIAL INSPECTION. Inspection of construction requiring the expertise of an approved special inspector in order to ensure compliance with this code and the approved construction documents.

Definition

STRUCTURAL OBSERVATION. The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents.

Section 1701 General

Scope
• Quality, workmanship and requirements
• Conform to applicable standards
**Section 1702 New Materials**
The following shall be subject to tests to determine character, quality, and limitations of use;
- New building materials, equipment, appliances, systems, or methods of construction
- Material of questioned suitability

**1703 Approvals**
- 1703.1 Approved Agency
  - Tests and inspection services
- Approvals shall be written, kept as records, and document performance
- 1703.5 Labeling
  - By an Approved Agency
  
  *Everything must be “Approved”*

**1704 Special Inspections**
- [NY]1704.2 Special Inspections and Test
  - [NY]1704.2.3 Statement of Special Inspections
- 1704.4 Contractor Responsibility
- 1704.5 Submittals to the Building Official
- [NY]1704.6 Structural Observations
[NY] 1704.2 Special Inspections and tests

- Inspections in ADDITION to those performed by the Code Official
- Statement submitted as a condition of permit issuance
- Reports required
- Exceptions...

[NY] 1704.2 Special Inspections

- The OWNER shall employ ... inspectors
- The SPECIAL INSPECTOR shall be qualified
- The CEO approves the special inspectors

[NY] 1704.2.3 Statement of Special Inspections

Exceptions:

- Not required for structures designed:
  - 2211.1.2 cold formed steel lightweight frame
  - 2308 conventional light frame construction (wood)
### Special Inspections

**Operations Requiring Special Inspections**

- Steel Construction
- Concrete Construction
- Masonry Construction
- Wood Construction
- Soils
- Driven deep Foundations
- Cast-in-place Foundations
- Helical pile Foundations
- Fabricated Items
- Spec insp. Seismic Resistance
- Spec insp. Wind Resistance
- Testing for Seismic Resistance
- Sprayed Fire-Resistance Material
- Mastic and Intumescent fire-resistant coatings
- Exterior Insulation Finish System
- Fire-resistant penetration & joint systems
- Testing for Smoke Control

### Periodic or Continuous Inspection?

**TABLE 1705.3**

**REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION**

<table>
<thead>
<tr>
<th>#</th>
<th>Component and/or Location</th>
<th>Periodic</th>
<th>Continuous</th>
<th>Reference</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Inspect reinforcement, including protruding anchors and embedment</td>
<td>X</td>
<td></td>
<td>AISC 360-10, 360-16, 360-18</td>
<td></td>
</tr>
</tbody>
</table>
Special Inspections
Periodic or Continuous Inspection?

- Table 1705.6
  - Required Special Inspection and Tests of Soils

- Table 1705.7
  - Required Special Inspection and Tests of Driven Deep Foundation Elements

<table>
<thead>
<tr>
<th>Required Special Inspection and Tests of Soils</th>
<th>Required Special Inspection and Tests of Driven Deep Foundation Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properly compacted soils</td>
<td>X</td>
</tr>
<tr>
<td>Drilled shafts</td>
<td>X</td>
</tr>
<tr>
<td>Rejected or rejected materials</td>
<td>X</td>
</tr>
<tr>
<td>Properly proposed and rejected deep foundations</td>
<td>X</td>
</tr>
<tr>
<td>Validation of proper deep foundations</td>
<td>X</td>
</tr>
<tr>
<td>Properly compacted and rejected</td>
<td>X</td>
</tr>
<tr>
<td>Properly proposed and rejected</td>
<td>X</td>
</tr>
<tr>
<td>Required special inspection and tests of soils</td>
<td>X</td>
</tr>
<tr>
<td>Required special inspection and tests of driven deep foundations</td>
<td>X</td>
</tr>
</tbody>
</table>

Special Inspections
Periodic or Continuous Inspection?

- Table 1705.8
  - Required Special Inspection and Tests of Cast-in-Place Deep Foundations
Summary

- Chapter 16 specifies what documentation is required as part of the permit application
- This documentation is the basis for design considerations and necessary for plan review
- Chapter 17 ensures proper construction through inspections, observations and tests
In This Lesson

Soil considerations
- Investigations
- Classifications
- Soil load-bearing values

Foundation Systems
- Footings
- Foundations
Foundation and Soil Investigations

- Purpose is to classify soil to determine its bearing properties
- Typical, known soils - just classify
- INVESTIGATE if
  - Unusual soils/conditions
  - Unknown soil
  - Seismic Design Categories C or D
Investigation Methods

- Test pits
- Soil boring and sampling
- Subsurface explorations
- Additional studies

Investigations - Soil Borings

Soil Boring Record
Result of Investigation: Soil is CLASSIFIED...

<table>
<thead>
<tr>
<th>CLASS OF SOIL</th>
<th>MINERAL CONTENT (%)</th>
<th>LOAD-bearing</th>
<th>PENETRATION</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diffuse mud</td>
<td>12.00</td>
<td>1.20</td>
<td>0.20</td>
<td>—</td>
</tr>
<tr>
<td>2. Silty sand</td>
<td>14.00</td>
<td>2.00</td>
<td>0.20</td>
<td>—</td>
</tr>
<tr>
<td>3. Clay loam: 60% clay and 40% sand</td>
<td>2.00</td>
<td>1.00</td>
<td>0.20</td>
<td>—</td>
</tr>
<tr>
<td>4. Clay loam: 50% clay and 50% sand</td>
<td>2.00</td>
<td>1.00</td>
<td>0.20</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: 1. Permeability factor = 0.1474, Foundation stress factor = 0.4175X/in.
2. Conditions to be specified by the architect.
3. Values to be used only for construction, not load tests discussed in Section D.4.5.

After the Soil has been Classified

Soil characteristics and load-bearing value affect the design of the foundation system:
- Materials to be used
- Type of foundation
- Depth of bearing
- Size or amount of the foundation
**Section 1803.5.6 Rock Strata**

Where site explorations indicate variations
  - Cracks
  - Depressions
  - Variations

  • Sufficient Number of borings
    - Assess soundness of material
    - Load bearing capacity

---

**Excavation, Grading and Fill**

• Excavation near Foundations
  - Sections 1804.1

• Placement of Backfill
  - Section 1804.3 and 3304.1
    - Material used
    - Lifts and compaction
    - Manner not to damage foundation, waterproofing or dampproofing.

• Site Grading – 1804.4
  - 5 % Sloped away for 10 feet
  - Alternatives due to obstructions

---

[Image of a section of a wall with cracks and debris on the ground.]
Foundation Wall Materials

• Concrete
• Masonry
• Steel
• Preservative Treated Wood

If the Prescriptive Method is Allowed, Compliance with Tables

Verifying compliance requires:
– Soil classification for site
– Foundation material
– Reinforced or plain wall
– Wall thickness
– Unbalanced backfill height

“Unbalanced Backfill”

• The difference in height of the exterior and interior finish ground levels.
• Where an interior concrete slab is provided, height is measured from the exterior finish ground level to the top of the interior concrete slab.
### TABLE 14.2

<table>
<thead>
<tr>
<th>LOCATION (X, Y)</th>
<th>MEASURED OR DETERMINED MINIMUM CONSTRUCTION LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
<td>5</td>
</tr>
</tbody>
</table>

### TABLE 14.3

<table>
<thead>
<tr>
<th>LOCATION (X, Y)</th>
<th>MEASURED OR DETERMINED MAXIMUM CONSTRUCTION LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
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</tr>
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</table>

### TABLE 14.4

<table>
<thead>
<tr>
<th>LOCATION (X, Y)</th>
<th>MEASURED OR DETERMINED MEDIAN CONSTRUCTION LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
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<tr>
<td>1.5</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
<td>5</td>
</tr>
</tbody>
</table>

### TABLE 14.5

<table>
<thead>
<tr>
<th>LOCATION (X, Y)</th>
<th>MEASURED OR DETERMINED NOISE CONSTRUCTION LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
</tr>
<tr>
<td>2.0</td>
<td>5</td>
</tr>
</tbody>
</table>
Examples of Table Use

Plain masonry foundation wall
- Height 8', 6' backfill, soil class (Table 1610.1) GC...
- Acceptable minimum wall thickness?
  12" wall thickness Table 1807.1.6.3(1)

10" Reinforced Masonry foundation wall
- Height 7'-4", 6' backfill, soil class GC...
- Required reinforcement size and spacing?
  #4 (bar size) at 56in (spacing) Table 1807.1.6.3(3)
Examples of Table Use

8 foot high 8 inches thick Concrete Foundation with 7 feet of backfill with GC soil

TABLE 1610.1 GC soil has an Active Pressure of 45 psf

Table 1807.1.6.2
Footing Materials

- Plain Concrete 1809.8
- Masonry 1809.9
  - No longer commonly used
- Steel Grillage 1809.11
  - No longer commonly used
- Timber 1809.12
  - Type V construction ONLY

Types of Footings: Spread Footing

- Most common type
- Called spread because it “spreads” the weight of the building over a greater soil area
  - Also called continuous or wall footings
- May be concrete, masonry, wood

Shallow Foundations

Chapter 2

SHALLOW FOUNDATION. A shallow foundation is an individual or strip footing, a mat foundation, a slab-on-grade foundation or a similar foundation element.
1808.6.2 Shallow Foundations

- May be proposed due to regional preference
- May be REQUIRED due to soil characteristics

1808.6.2 Slab-on-ground foundations

Footings on or Adjacent to Slopes 1808.7.1

- Requirements for buildings on or adjacent to slopes steeper than 1 unit vertical in one unit horizontal
Concrete Footings:
Workmanship and Placement

1808.8.1 Strength  Table 1808.8.1
1808.8.2 Concrete Cover  Table 1808.8.2
1808.8.3 Placement of concrete
1808.8.4 Protection from freezing and water
1808.8.5 Forming
1808.8.6 Seismic

---

Frost Penetration Depth Factors
U.S. Department of Commerce
Weather Bureau

- Air temperature
- Length of time air temp is < 32°F
- Soil's thermal conductivity

---

1809.3 Stepped Footings

![Diagram of stepped footings with required depth and cover specifications]

Minimum required depth to cover
Maintain required cover
Minimum cover at exposed wall
Maintain req'd cover

---
Exterior Footing Requirements: Depth Below Frost - 1809.5

- Placed below frost line
  - Prevents frost heave and settlement
  - Exceptions:
    - Frost-protected footings
    - Footings/foundations on solid rock
- Never placed on frozen ground
  - Exception where frozen condition is permanent

1809 Shallow Foundations

Footings supporting walls of light-frame construction shall be permitted to be designed in accordance with Table 1809.7.

Plain Concrete Footings—1809.8

- Minimum dimensions based on
  - Building OR designer’s specifications
  - Load-bearing value of soil
  - Material used
  - Width of foundation wall
- W = width of footing
- T = thickness of footing
- P = Projection on either side of foundation wall
Footing Designs

- ...so designed that the allowable bearing capacity of the soil is not exceeded.
- The minimum width of footings shall be 12 inches. See 1809.4
- The minimum thickness of plain concrete footings shall be 8 inches. See 1809.8
- Footings in expansive soils... designed in accordance with... See 1808.6

When “Common” Won’t Work: Deep Foundation Systems

Distance to useable stratum too great for shallow foundation
Situation with high potential for erosion makes shallow foundation undesirable

Upper strata suitable for bearing
But underlying soil subject to excessive settlement
Requires use of lower, denser stratum to assure control of settlement
1810 Deep Foundation System - Piles

Deep Foundation System - Piles

- Specialized footing
  - Transfers load through poor soil to deeper soil of adequate strength
  - Usually pre-cast and driven
- Materials used for pile footings
  - Cast-in-place concrete
  - Pre-cast concrete
  - Steel H piles
  - Treated wood

- Hammered in place (shown), or cast in place
  - When hammered … Pile drive formula
    - Weight of hammer
    - Number of blows
    - Depth of penetration
- Friction fit, end bearing, or both

- Multiple piles to distribute the building load
- Joined by “pile cap”
Cast-in place Concrete Piles and Pile Cap

1810 Deep Foundation System - Caissons

Types of Footings: Deep Foundation System - Caissons

- Specialized footing
  - Similar to piles in function, but much larger diameter
- Usually cored with a huge auger
- Caissons are typically site-cast plain or reinforced concrete
1810 Deep Foundation System - Piers

- Specialized footing
  - Short columns below grade transmit load to footing
- Several advantages over conventional foundations

SUMMARY

- Soils must be classified
  - Investigation may or may not be necessary
- Soil load-bearing values directly affect the foundation system
- Foundation systems
  - May be engineered or may be permitted prescriptive methods of compliance
  - The type, characteristics and materials used are usually based on soil conditions, geographic considerations and regional preferences
Materials of Construction and Structural Assemblies

A Division of New York Department of State

September 29, 2020

In This Lesson

• The BASICS of materials used in structural assemblies
  – Concrete
  – Masonry
  – Steel
• Use of the material specific chapters
  – Applicable reference standards
  – Details

Structural Chapters

Building Code Organization and Overview

Chapter 16
Design Loads Chapter

Chapters 19 through 23
Material Specific Chapters
General Design Requirements 1604.1

Buildings shall be designed as permitted by the APPLICABLE MATERIALS CHAPTER

- Strength Design
  (Concrete and Masonry)
- Load and Resistance Factor Design
  (Steel and Wood)
- Allowable Stress Design
  (Concrete, Masonry, Steel, Wood)
- Empirical Design
- Conventional Construction Methods

Permitted Designs Based on Materials

- 2101.2 Masonry design shall be one of the following methods
  - TMS 402
  - TMS 403
  - TMS 404
  - 2101.2.1 Masonry Veneer – Chapter 14

Permitted Designs Based on Materials

- 2302.1 Wood design shall be one of the following methods
  - Allowable stress design
  - Load and resistance factor design
  - Conventional light-frame wood construction
  - AWC WFCM in accordance with Section 2309
  - ICC 400 (log structures)
Concrete Basics

Ellie Mae's Cement Pond Quiz

True or False?
1. Cement and concrete are the same thing.
2. Nearly all cement is called Portland cement.
3. Portland cement comes from Portland, Oregon.
4. Concrete is the most widely used building material in the world.

Advantages and Disadvantages of Concrete for Structural Applications

- Advantages:
  - Strength
  - Economy
  - Aesthetics
  - Versatility
  - Fire resistance

- Disadvantages:
  - Weight
  - Labor intensive
  - Curing time and protection
What is Concrete?

- Cement + H₂O + Aggregates = CONCRETE
- “Cement paste” MUST cover the aggregate and fill the voids

Types of Portland Cement

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Normal – General purpose use</td>
</tr>
<tr>
<td>II</td>
<td>Moderate – Moderate sulfate resistance and heat of hydration</td>
</tr>
<tr>
<td>III</td>
<td>High early strength – High strengths within 7 days</td>
</tr>
<tr>
<td>IV</td>
<td>Low heat of hydration – Minimizes hydration heat</td>
</tr>
<tr>
<td>V</td>
<td>Sulfate resisting – Resists severe sulfate exposure</td>
</tr>
<tr>
<td>IA, IIA, or IIIA</td>
<td>are air entrained – Improves resistance to freeze/thaw and deicing chemicals</td>
</tr>
</tbody>
</table>

Concrete Admixtures

- Specified by the designer
- Added for the beneficial effect immediately before or during mixing
- Classified according to function:
  - Air-entraining
  - Water-reducing
  - Retarding
  - Accelerating
  - Super plasticizers
  - Specialty
Concrete Air Entrainment

- For freeze/thaw and chemical deicing resistance
- Improves workability
- Tiny “bubbles” relieve pressures
- Usually 5% - 8% of concrete volume
  - All concrete has air – 3% – 5%

Why Test Concrete?

- Material is as specified
- Estimate actual in-place strength
- Verifies adequacy of mix proportions
- Quality control
- Assures specific properties are obtained

Concrete Test Methods

- Fresh
  - Slump
  - Air content
  - Unit weight
  - Compressive strength
- Hardened
  - Various strength tests
Slump Test
A measure of consistency and workability

- Described in ASTM C143
- Slump is the difference between the height of the mold and the height of the concrete specimen

Types of slump concrete:
(a) True slump
(b) Shear slump
(c) Collapse slump

September 29, 2020

Air Content

- Pressure Method (ASTM C231) is a common method
- Measures concrete volume change when subjected to a given pressure

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Casting Cylinders
Compressive Strength
An indicator of cured concrete strength

- Test for specified design strength
  - ASTM C31 for field tests
  - Cylinders broken at 7 and 28 days

- Passing the tests:
  - No test > 500 psi below design strength
  - AND average of 3 ≥ to design strength

Concrete
Chapter 19

How Chapter 19 Works

- General Requirements and Information
  - 1901 General
  - 1902 Definitions
  - 1903 Specifications for Tests and Materials

- What to Use
  - 1904 Durability Requirements

- How to Use It
  - 1905 Modifications to ACI 318
  - 1906 Structural Plain Concrete
  - 1907 Minimum Slab Provisions
  - 1908 Shotcrete
**ACI 318 “Building Code Requirements for Structural Concrete”**

- Provisions that work with For the WHAT, WHEN and HOW of Concrete...
- As modified by 1905

---

**Chapter 19 Responsibilities**

- Designer
- Plant
- Contractor
- Special Inspector
- Code Enforcement Official

---

**Documentation and Inspection**

- **1901.5** Construction documentation for structural concrete
  - Strength, size, location of structural elements and reinforcement
  - Details
- **1901.6** Comply with Chapter 17 for special inspections
What to Use: Durability Requirements

Section 1904

- Required concrete properties, such as
  - Air entrainment
  - Water-cementitious materials ratios
  - Compressive strength requirements
- Are based on exposure to...
  - Freezing and thawing conditions
  - Deicing chemicals
  - Sulfate-containing solutions

Modifications to ACI 318

1905.1.1 – 1905.1.8

This section of the code makes modifications to certain sections of ACI 318. For example;

ACI Section 18.13.1.1 This section shall apply to foundations resisting earthquake-induced forces between structure and ground in structures assigned to SDC D, E, or F. was modified by Section 1905.1.6 to read:

Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 unless modified by Chapter 18 of the Building Code of New York State.
Concrete Use Examples:

Pre-cast Concrete Plank

Concrete Use Examples:

Reinforced Concrete

Concrete Detail Exercise 14

• Answer the following questions using Chapter 19…
Concrete Detail Exercise 14

Questions

• What is the minimum thickness of a concrete floor slab supported directly on the ground?

• What is the maximum size of the reinforcement when used in Shotcrete?

• Structural plain concrete shall comply with what ICC Building Code Section?

History of Masonry

• Since about 8000 BC, masonry has been a PRIMARY building material…

• Historical Uses
  – Walls, Arches, and Domes
  – Cathedrals, Churches, and Temples
  – Pyramids and Coliseums
  – Dams and Aqueducts, Roads and Bridges

• Steel and concrete did not become legitimate building materials until the 1800’s

Modern Structural Uses of Masonry

• Walls
  – Load or non-load bearing
  – Reinforced or unreinforced
  – Single or multiple wythe
  – Grouted or ungrouted

• Beams, Lintels, Sills
Advantages and Disadvantages of Masonry for Structural Applications

• Advantages:
  – Abundance
  – Economy
  – Aesthetics
  – Versatility
  – Insulating qualities (sound, heat)

• Disadvantages:
  – Moisture penetration and thermal expansion
  – Performance dependent on quality of labor
  – Low strength-to-weight ratio

Components of Masonry Construction

• Masonry units
• Mortar
• Reinforcement
• Grout
• Accessory Materials

Types of Masonry Units

• Clay masonry units (brick)
• Concrete masonry units (concrete block)
• Stone (artificial shape)
• Rock (natural shape)
• Glass
• Tile (roofing, floor, wall, etc.)
• Adobe (unfired clay)
Clay Masonry Units (Brick)

- Raw materials are usually clays
- Materials must be moldable and have sufficient tensile strength to permit forming
- Manufacturing process:
  - Mine clay
  - Mix clay with water
  - Mold (form) into shape
  - Dry and fire

Sizes and Shapes of Clay Masonry Units

- Standard or modular sizes
  - \( \frac{3}{8} \)" less than nominal size to accommodate a \( \frac{1}{2} \)" typical mortar joint
- Most bricks about \( 4" \times \frac{2}{3}" \times 8" \) nominally
  - If modular, \( 3\frac{5}{8}" \times 2\frac{1}{4}" \times 7\frac{5}{8}" \)
- However, many other sizes are available

Concrete Masonry Units (CMU)

- Raw materials:
  - Portland cement
  - Graded aggregates
  - Water
  - Pozzolanic materials
  - Admixtures
- CMU's are manufactured in a method similar to precast concrete
Strength Properties of CMUs

- Compressive strength on NET area
  - Voids not considered, only effective area that resists loads
- Typical strength properties for CMU:
  - Compressive strength: 1900 to 6000 psi
  - Tensile strength: 250 to 500 psi

Sizes and Shapes of CMUs

- Normally modular sizes
  - ⅜" less than nominal size to accommodate a ¼"
    typical mortar joint
- Common nominal face dimensions of 8”H x 16”L x 4, 6, 8, 10, or 12”T
- ASTM C90 specifies minimum width of webs and face shells

Mortar

- Basic ingredients:
  - Cement
  - Lime
  - Sand
  - Water
  - Admixtures
- Per 2103.2.1, Conform to Articles 2.1 and 2.6 A of TMS 602, for mortar for masonry
What Mortar Does

- Separates units
- Bonds units
- Provides strength
- Seals against moisture between units
- Equalizes unit size variations
- Seals unit irregularities

How Chapter 21 Works

- General Requirements and Information
  - 2101 General
  - 2102 Notations

- What to Use
  - 2103 Masonry Construction Materials

- How to Use It and Assurance
  - 2104 Construction
  - 2105 Quality Assurance

- Design Requirements and Methods
  - 2106 Seismic Design
  - 2107 Allowable Stress
  - 2108 Strength Design of Masonry
  - 2109 Empirical Design of Adobe Masonry

- Details
  - 2110 Glass Unit Masonry
  - 2111 Masonry Fireplaces
  - 2112 Masonry Heaters
  - 2113 Masonry Chimneys
### How to Use It: Construction 2104

- **2104.1 Masonry Construction**

### How to Use It: Cold Weather Construction

**Cold Weather**
- is defined as a period when the average daily ambient temperature is below 40°F (5°C) for a period of more than 3 days.

### How to Use It: Cold Weather Construction

**DURING Construction**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Component</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 40°F</td>
<td>Glass block</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Below 40°F</td>
<td>Mortar and grout</td>
<td>Mixed to 90°F</td>
</tr>
<tr>
<td>Below 32°F</td>
<td>Mortar sand and mixing water</td>
<td>Heated to produce mortar temperature between 10°F - 120°F</td>
</tr>
<tr>
<td>Below 32°F</td>
<td>Mortar</td>
<td>Maintain above freezing until used</td>
</tr>
<tr>
<td>Below 20°F</td>
<td>Mortar sand and mixing water</td>
<td>Heated to produce grout temperature between 70°F - 120°F, maintain grout above 70°F until used</td>
</tr>
<tr>
<td>Below 20°F</td>
<td>Masonry surfaces</td>
<td>Heated to 40°F</td>
</tr>
<tr>
<td>Below 20°F</td>
<td>Masonry structure</td>
<td>Installed and sealed if wind speed &gt; 15 mph</td>
</tr>
<tr>
<td>Below 20°F</td>
<td>Masonry structure Grout</td>
<td>Heated to 90°F prior to grouting</td>
</tr>
<tr>
<td>Below 20°F</td>
<td>Masonry structure Bricks and tile</td>
<td>Heated to &gt; 32°F</td>
</tr>
</tbody>
</table>
### How to Use It: Cold Weather Construction

<table>
<thead>
<tr>
<th>Mean Daily Temperature*</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Units</td>
<td>Maintain above 40°F for 48 hours</td>
</tr>
<tr>
<td>Between 40°F and 20°F</td>
<td>Weather-resistant membrane protection for 24 hours</td>
</tr>
<tr>
<td>Between 20°F and 15°F</td>
<td>Covered with insulating blankets or equal, 24 to 48 hours</td>
</tr>
<tr>
<td>Below 15°F</td>
<td>Enclose and heat to maintain &gt; 32°F, 24 to 48 hours</td>
</tr>
</tbody>
</table>

*when either the ambient temperature falls below 40°F (4°C) or the temperature of masonry units is below 40°F (4°C).

### How to Use It: Hot Weather Construction

- Hot weather construction provisions, IF
  - Ambient temperature > 90°F AND wind velocity > 8 mph
- Fog spraying of brick
- Wetting of brick

### Masonry Use Examples:

**CMU Wall with Reinforcement**
Masonry Use Examples:
CMU Wall with Vertical Reinforcement

Masonry Use Examples: Details

Masonry Use Examples: Wall Bracing
Masonry Use Examples: Not Enough Bracing

Masonry Detail Exercise 15

- Answer the following questions using Chapter 21...

Steel Basics

Chapter 22
Steel Basics

Advantages and Disadvantages of Steel

• Advantages:
  – Strength
  – Economy
  – Versatility

• Disadvantages:
  – Loss of strength in fire conditions
  – Corrodes

Steel in Construction

• Manufactured product
• Fabricated to desired shapes/sizes
• Delivered to job site finished ready to be installed
• Fastened through welding or bolting
Identification exercise

Structural Tee example:

- **S** – Name of steel member
- **A** - Member depth of X”
- **B** – Flange width
- **C** – Web thickness
- **D** - Flange thickness
- **W** - Weight per linear foot of X pounds

**S 8 x 31.5**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Shape</th>
<th>Name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>(W18 x 35)</td>
<td>Wide Flange beam</td>
<td>Parallel flange surfaces</td>
</tr>
<tr>
<td>S</td>
<td>(S12 x 31.5)</td>
<td>American Standard I Beam</td>
<td>Sloped inner flange</td>
</tr>
<tr>
<td>M</td>
<td>(M8 x 6.5)</td>
<td>Miscellaneous Beams</td>
<td>Cannot be classified as W, S or HP</td>
</tr>
<tr>
<td>C</td>
<td>(C8 x 11.5)</td>
<td>American Standard Channel</td>
<td>Sloped inner flange</td>
</tr>
<tr>
<td>L</td>
<td>(1.6 x 31 x 31/4)</td>
<td>Angle</td>
<td>Equal or unequal legs, constant thickness</td>
</tr>
<tr>
<td>T</td>
<td>(W18 x 80)</td>
<td>Structural Tee</td>
<td>Cut from W, M or S on center of web</td>
</tr>
<tr>
<td>HP</td>
<td>(HP12 x 84)</td>
<td>Bearing Pile</td>
<td>Parallel flange and equal flange and web thickness</td>
</tr>
<tr>
<td>Designation</td>
<td>Shape</td>
<td>Name</td>
<td>Characteristics</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>---------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>PL</td>
<td>Plate</td>
<td>Standard plate</td>
<td>thickness</td>
</tr>
<tr>
<td>TS</td>
<td>Structural tubing</td>
<td>Square, rectangular, or circular</td>
<td></td>
</tr>
<tr>
<td>Bar</td>
<td>Bars</td>
<td>Flat, rounded, or square</td>
<td></td>
</tr>
<tr>
<td>18K13</td>
<td>Open web steel joists and girders</td>
<td>Fabricated from rods and angles</td>
<td></td>
</tr>
</tbody>
</table>

**Structural Steel Shapes**

**Fastening Steel**

- **Rivets**
  - Before high-strength bolts developed
- **High-strength bolting**
  - Still used for fit up prior to welding, and fastening of secondary members
- **Welding**
  - Replaced use of bolts for high-rise construction

**How Chapter 22 Works**

- **General Requirements and Information**
  - 2201 General
  - 2202 Identification of Steel for Structural Purposes
  - 2203 Protection of Steel for Structures
  - 2204 Connections
  - 2205 Structural Steel
  - 2206 Composite Structural Steel and Concrete Structures
- **Materials and Design Standards**
  - 2207 Steel Joists
  - 2208 Steel Cable Structures
  - 2209 Steel Storage Racks
  - 2210 Cold-Formed Steel
  - 2211 Cold-Formed Steel Light-framed Construction
Steel Definitions 202

Steel Construction, Cold-Formed
Steel Joist
Steel Element, Structural

Identification of Steel for Structural Purposes 2202

• Identification
  – structural steel elements shall be in accordance with AISC 360
  – cold-formed steel members shall be in accordance with AISI S100
  – cold-formed steel light-frame construction shall also comply with the requirements contained in AISI S240 or AISI S220

Beyond this Point in Chapter 22

• Everything is based on
  – Materials
  – Referenced Standards
  – Design Requirements
• 2205 Structural Steel Construction
  – AISC (American Institute of Steel Construction)
• 2207 Steel Joists
  – SJI specifications (Steel Joist Institute)
• 2210, 2211 Cold-Formed Steel
  – AISI (American Iron and Steel Institute)
  – ASCE (American Society of Civil Engineers)
Open Web Steel Joists

- For design, manufacturing and use, comply with appropriate SJI Standard Specification:
  - Open Web Steel Joists, K Series
  - Longspan Steel Joists, LH Series and Deep Longspan Steel Joists, DLH Series
  - Joist Girders

Special Inspection of Steel

- Welding - inspection standards and qualifications
- Details - compliance with approved construction documents
- High-strength bolt installation
- Table 1705.2.3
  - What, when, standard and citation
Steel Use Examples: 2210 Cold Formed Steel

Light-gauge Steel: 2211 example
Summary:

- The BASICS of materials used in structural assemblies
  - Concrete
  - Masonry
  - Steel
- Use of the material specific chapters
  - Applicable reference standards
  - Details

Up Next … Wood Framing
Advantages and Disadvantages of Wood

- Advantages:
  - Familiarity
  - Strength
  - Economy
  - Versatility
  - Appearance
- Disadvantages:
  - Combustible
  - Decay/Infestation
How Chapter 23 Works

- General Requirements and Information
  - 2301 General
  - 2302 Design Requirements
  - 2303 Minimum Standards and Quality
- For ANY Wood Construction
  - 2304 General Construction Requirements
- Design Requirements and Methods
  - 2305 General Design Requirements for Lateral-Force-Resisting Systems
  - 2306 Allowable Stress Design
  - 2307 Load and Resistance Factor Design
- Prescriptive Compliance
  - 2308 Conventional Light-Frame Construction
  - 2309 Wood Frame Construction Manual

General Rules of Wood Construction

*Engineered or Prescriptive Methods*

- May be used in conjunction with other materials
  - A wood roof may be used on a masonry building
- Load-bearing dimensional lumber shall be identified
- Meet appropriate standard for the component

General Design Requirements

2302.1

Allowable stress design – 2304, 2305, 2306
Load and Resistance Factor – 2304, 2305, 2307
Conventional Light-Frame – 2304, 2308
AWC WFCM - 2309
Log structures in accordance with ICC 400
Allowable stress design
2306
• Specific design standards for engineered lumber
  - Allowable Stress Design

Engineered wooden I-joists
Specific type of engineered lumber
Specific requirements for use

[NY]2303.1.1 Sawn Lumber
Species and Grade of Wood
Alternative to Grade Stamp

[NY]2303.1.1 Exception

Allows use of ungraded lumber when:
- Sold directly to end user
- Certification filed as part of building permit application
- Limited to 3 stories for Group R, and cumulative building area (10,000 SF) and height (35’) for other occupancies
- Similar allowance in the Residential Codes

2303.1.11 Structural Log Members

- Non-rectangular logs
  - Identified by grade mark per ASTM D 3957
  - Certificate of Inspection

Trusses

2303.4
2303.4 Trusses

- Shall be designed
  - Permitted to be joined by nails, glue, bolts, timber connectors, metal connector plates, or other approved framing devices

Seal and Signature for Truss Drawings

Where required by... shall bear the seal and signature of the... designer:
1. Registered design professional; or
2. Code enforcement official; or
3. Statutes of the jurisdiction in which the project is to be constructed.

Remember, these drawings shall be provided to the CEO PRIOR to installation

Truss Information

1. Slope or depth, span and spacing;
2. Location of joints;
3. Number of plies if greater than 1
4. Required bearing widths;
5. Design loads as applicable, including:
   5.1 Top chord live load;
   5.2 Top chord dead load;
   5.3 Bottom chord live load;
   5.4 Bottom chord dead load;
   5.5 Additional loads and locations
   5.6 Environmental design criteria;
6. Other lateral loads;
7. Adjustments to lumber and metal connector plate
8. Maximum reaction force and direction;
9. Metal connector plate type, size, thickness or gage, and the location;
10. Lumber size, species and grade for each member;
11. Truss to truss connection and truss field assembly requirements
12. Calculated deflection ratio and maximum vertical and horizontal deflection;
13. Maximum axial tensile and compression forces; and
14. Required permanent individual truss member restraint location and methods and details of restraint / bracing per Section 2303.4.1.2
Roof Truss Certificate

Truss Bracing
2303.4.1.2

- From the truss manufacturer
  - Identify location of each truss
  - Part of truss submittal package
  - Delivered to the job site

Truss Placement Diagram
2303.4.2
Truss Construction:
Members Cut

Truss Construction:
Cut Members for Assembly

Truss Construction:
Members Assembled in Jig
Truss Construction:
- Truss Plate Positioned
- Truss Plate Pressed into Place
- Completed Truss
Truss Handling - Erection

UNLOADING & LIFTING
AVOID LATERAL BENDING

NEVER HANDLE TRUSSES FLAT

Truss Alterations

2303.4.5
... without written concurrence and approval of a registered design professional .... NO

- Cutting
- Notching
- Drilling
- Splicing
- Or other alterations
- Additional loading conditions

When BAD Things Happen to Good Trusses...
The Moral of this Truss Story

- Someone needs to read the plans and directions
- Treat them carefully
- Don’t alter them
Remember
Part 1264
Commercial Truss marking

Part 1265
Residential Truss marking

2304
General Requirements

Applicable regardless of the design method (includes prescriptive)
Specifies:
  Sheathing Thickness
  Spans for Floor and Roof Sheathing
  Connections
  Other important details
Structural Panel Sheathing

Specific tables with prescriptive requirements for sheathing depending on the locations

- 2304.6 Exterior wall sheathing
- 2304.7 Interior paneling
- 2304.8 Floor and roof sheathing

### TABLE 2304.6.1
Maximum Allowable Stress Design

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Design Stress Grade</th>
<th>Minimum Thickness (in.)</th>
<th>Maximum Thickness (in.)</th>
<th>Maximum Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; CDX (12 1/2&quot;)</td>
<td>A</td>
<td>9</td>
<td>17</td>
<td>130</td>
</tr>
<tr>
<td>5/8&quot; CDX (12 1/2&quot;)</td>
<td>A</td>
<td>9</td>
<td>17</td>
<td>130</td>
</tr>
<tr>
<td>3/8&quot; CDX (12 1/2&quot;)</td>
<td>A</td>
<td>9</td>
<td>17</td>
<td>130</td>
</tr>
</tbody>
</table>
TABLE 2304.10.1 Fastening schedule

<table>
<thead>
<tr>
<th>Description of Unified Climates</th>
<th>Material and Type of Nailer</th>
<th>Spacing and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>2.5 mm minimum 0.010&quot; (0.25)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>1.6 mm minimum 0.0062&quot; (0.16)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>0.6 mm minimum 0.0024&quot; (0.10)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td>Standing between columns, posts, or trusses</td>
<td>2.5 mm minimum 0.010&quot; (0.25)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>1.6 mm minimum 0.0062&quot; (0.16)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>0.6 mm minimum 0.0024&quot; (0.10)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td>Max fastening at truss or rafters</td>
<td>2.5 mm minimum 0.010&quot; (0.25)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>1.6 mm minimum 0.0062&quot; (0.16)</td>
<td>Each end, nailable</td>
</tr>
<tr>
<td></td>
<td>0.6 mm minimum 0.0024&quot; (0.10)</td>
<td>Each end, nailable</td>
</tr>
</tbody>
</table>

2308

Conventional Light-frame Construction

The Prescriptive Method in the Building Code

2308.2 Limitations:

Maximum Building Size

- 3 stories above grade
- 11’ 7” floor to floor height
  - 10’ Max bearing wall stud height
- 40’ truss or rafter span
2308.2.1 Stories

<table>
<thead>
<tr>
<th>SEISMIC DESIGN CATEGORY</th>
<th>ALLOWABLE STORY HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and B</td>
<td>Three stories</td>
</tr>
<tr>
<td>C</td>
<td>Two stories</td>
</tr>
<tr>
<td>D and E⁺</td>
<td>One story</td>
</tr>
</tbody>
</table>

2308.2.3 Allowable loads

- Average dead load 15 psf
  - Roofs, Exterior walls, Floors and Partitions
- Floor live load 40 psf
  - Table 1607.1
- Ground snow load 50 psf
  - Figure 1608.2

2308.2.4 Basic wind speed

- $V_{ul}$ shall not exceed 130 mph
  - Exception: up to 140 mph allowed
    - Exposure Category B, not in hurricane prone region
- $V_{ul}$ exceeds 130 mph, allowed to use:
  - NFRC WFCM (Wood Frame Construction Manual)
  - ICC 600
2308.2.6 Risk category limitations

Seismic

- Prescriptive method NOT permitted in:
  - Seismic Design Categories B, C, D, or F when Risk Category IV (critical facilities)

2308.2 Limitations

Additional Seismic Conditions

- 2308.2.6 not allowed for Risk category IV in Seismic design categories B, C, D and F
- 2308.3.2 Braced wall line sill plate anchorage
- 2308.4.4.1 Openings in floor diaphragms
- 2308.4.4.2 Vertical offsets in floor diaphragms
- 2308.4.10 Anchorage Exterior of means of egress components
- 2308.6.6 Cripple wall bracing

Use of Span Tables is Based on

- Spacing
- Species and Grade
- Live Loads and Dead Loads
- Lumber size
- Maximum spans
Spacing

- Spacing is the distance from centerline to centerline of the members.

Live and Dead Loads

- Live Load + Dead Load ≤ Strength
- When proposed live and/or dead load exceed the Tables?
  - Other methods per 2301.2
  - OR engineered

Lumber Sizes

<table>
<thead>
<tr>
<th>Nominal Size</th>
<th>Actual Surfaced Dry Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 4</td>
<td>1½ x 3½</td>
</tr>
<tr>
<td>2 x 6</td>
<td>1½ x 5½</td>
</tr>
<tr>
<td>2 x 8</td>
<td>1½ x 7¼</td>
</tr>
<tr>
<td>2 x 10</td>
<td>1½ x 9¼</td>
</tr>
<tr>
<td>2 x 12</td>
<td>1½ x 11¼</td>
</tr>
</tbody>
</table>
Span

• The distance from face to face of the support

Safety in Construction

• 2308.4.2.4 Notches and holes.
  – Just a reminder
  – Same information as in MC, PC, FGC
    • Location & size of holes
    • Location & size of notches

2308.7.2 Rafter Span

• The horizontal distance from inside surface of supporting wall to inside surface of ridge board
Span Table Exercise
Appendix page 17

Given the following information, determine the applicable tables to use.

### Span Table Exercise

#### Member, Location and/or Load

<table>
<thead>
<tr>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Bearing Header</td>
</tr>
<tr>
<td>Floor joists - living areas, 40 PSF live load</td>
</tr>
<tr>
<td>Wall studs - exterior bearing - attic, limited storage, 20 PSF live load</td>
</tr>
<tr>
<td>Exterior Bearing Girder</td>
</tr>
<tr>
<td>Floor joists - living areas, 40 PSF live load</td>
</tr>
<tr>
<td>Floor joists - living areas, 40 PSF ground snow load</td>
</tr>
<tr>
<td>Wall studs - exterior bearing - attic, limited storage, 20 PSF live load</td>
</tr>
</tbody>
</table>
Wood Framing and Lateral Loads

Review:
Lateral Loads and Load Path

- Wind and Earthquake forces are lateral loads
- These loads must be transferred FROM the point of origin TO the resisting element
- Resisting elements together MUST complete the LOAD PATH

Key Elements in Lateral Force Resisting Systems for Wood Framing

- Horizontal diaphragms
  - Roofs and Floors
- Shear Walls (engineered)
- Braced Walls (prescriptive)
Why Bracing?

- Prevent racking or lateral movement
- Diagonal Braces or Sheathing Panel attached to framing prevents wall distortion

Definitions

Braced Walls Lines

“A straight line through a building plan that represents the location of the lateral resistance provided by the wall bracing”

Braced Wall Panel
### Table 2308.6.1a

**First Column: Force acting on the Building**

- **The anticipated LATERAL LOAD**
- **Seismic Design Categories A through E**

<table>
<thead>
<tr>
<th>Seismic Design Category</th>
<th>Column 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>D &amp; E</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2308.6.1b

- Specific force acting conditions and requirements for various design categories.

**Figure:**
- Diagram illustrating the force acting on the building with respective force acting categories.
### Reading Table 2308.6.1a

**Second Column: Story Conditions**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Distance between Bracing Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and B</td>
<td>89 - 90</td>
</tr>
<tr>
<td>C</td>
<td>90 - 91</td>
</tr>
</tbody>
</table>

Where is the bracing located.

### Reading Table 2308.6.1a

**Distance between Bracing Lines**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>89</td>
</tr>
<tr>
<td>B</td>
<td>90</td>
</tr>
<tr>
<td>C</td>
<td>91</td>
</tr>
</tbody>
</table>
Reading Table 2308.6.1a
Max distance for braced panels from end

- How far from the ends of the braced wall line can the panels be

Table 2308.6.1a
Braced Panel location

<table>
<thead>
<tr>
<th>Location</th>
<th>Max distance from wall line</th>
</tr>
</thead>
<tbody>
<tr>
<td>12'-6&quot;</td>
<td>20'-0&quot;</td>
</tr>
<tr>
<td>12'-0&quot;</td>
<td>20'-0&quot;</td>
</tr>
<tr>
<td>12'-0&quot;</td>
<td>20'-0&quot;</td>
</tr>
<tr>
<td>12'-0&quot;</td>
<td>20'-0&quot;</td>
</tr>
</tbody>
</table>

Alternative Braced Panel

- May replace any of the 8 methods
  - Min 2'-8" wide
  - 10' max height
  - 2 anchor bolts per panel
  - Tie downs for end studs
Portal Frame w/ hold downs

2308.6.5.2

- Minimum 16” each panel one story
- 24” if two story

Continuous Bracing

- RCNYS
  - Tables R602.10.4 & R602.10.5
  - Similar terminology
  - Many more methods

Three Methods of ENGINEERED Shear Wall Analysis

- PERFORATED
- SEGMENTED
- PORTAL FRAME

* ANCHOR BOLTS FOR TRACTION (SHEAR)
Basic Concept: Diaphragms

Wind pushes against this wall. Floor and Roof Systems hold the top and bottom of the wall.

Panels hold the floor and transfer the load.

---

Basic Concept:

As the Building gets taller

More panel width needed on lower stories.

---

Wall Bracing

2308.6

“Buildings shall be provided with exterior and interior braced wall lines…”

- As DESCRIBED in 2308.6.1
  - Along each story
  - Longitudinal and transverse directions
Wall Bracing

2308.6

2308.6.1 Braced wall panels

- 10 possible methods

1. 1 x 4 diagonal let-in brace
2. Diagonal Wood boards
3. Wood structural panels
4. Fiberboard sheathing
5. Gypsum sheathing
6. Particle board sheathing
7. Portland cement plaster
8. Hardboard panel siding
9. Alternate braced wall
10. Portal frame with hold-downs

Bracing Example

WSP

- WSP specific:
  - Minimum 3/8” sheathing where studs 16” o.c.
  - 2308.6.4
    - Minimum 48” panel length
    - Cover 3 stud spaces
- Table 2308.6.1 requirements
  - Panel at each end
  - Max. ≤ 25’ o.c.
  - Max length of, spacing and % based on SDC

Wall Bracing

• General Rules: 2308.6
  - In BOTH Directions
Braced Wall Lines

2308.6.1

• General Rules:
  – Lines spaced no more than 35’ o.c.

Table 2308.6.1 Spacing...

BRACED WALL LINES shall not exceed 35 FEET O.C. ...

Max 35’ O.C.

Table 2308.6.1... wall panels shall start “X” feet from each end of a braced wall line, depending on Seismic design
2308.6.2 ... are in line or offset ... by not more than 4 feet.

If the offset is greater than 4', this shall be treated as a separate Braced Wall Line as long as there is a panel at each end.

A + B = Required %

Table 2308.6.1

2308.6.2 ... braced wall panels that meet the amount of bracing as specified in Table 2308.6.1 and figure as specified in Table 2308.6.3(1)
2308.6.3 ... braced wall panels that meet the minimum panel length as specified in 2308.6.4 and 2308.6.5

Summary

• When Wood can be used, engineered or prescriptive
• Prescriptive Framing
• Conventional Light-frame Construction
• Trusses