Welcome

Please
• Sign in & take an Appendix
• Find a seat

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A Division of New York Department of State

January 17, 2017

9D

General Construction Principles

A Division of New York Department of State

January 17, 2017

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Course 9D

Building Systems and Equipment And Structural Requirements

January 17, 2017 4

Books for the week ....

Instructor:

January 17, 2017 5

Covered So Far

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

January 17, 2017 6
Coming Up

- 9E
  - The Residential Code of New York State
    - Plan review
- 9F
  - The Building Code of New York State
    - Plan review

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

- International Mechanical Code
- International Fuel Gas Code
- International Plumbing Code
- International Energy Code
Module One: Systems and Equipment
• AND don’t forget to apply the proper NY Supplement

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
Title 19, Chapter XXXIII
Subchapter A
Part 1223
Mechanical Code

A Division of New York Department of State

January 17, 2017

Minimum Requirements for Mechanical Systems
Lesson 1
2015 International Mechanical Code

A Division of New York Department of State

January 17, 2017

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 – NY 2016 Uniform Supplement
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 Systems
Chapter 15 – Referenced Standards

Chapter 1

101.2.4 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 ...”

2016 NY Uniform Supplement

102.8 Existing Systems

Mechanical systems LAWFULLY IN EXISTENCE at the time of adoption of this code shall be permitted to have their use and maintenance continued ... except as specifically covered in this code, the Property Maintenance Code, the Fire Code, or the Existing Building Code.

2016 NY Uniform Supplement
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 IBC 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
302.3.3 Bored Holes

- 40% of stud depth; load-bearing walls
- 60% of stud depth; nonload-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
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 required
- Minimum of 2 openings required
- Mechanical ventilation required
- Maximum 850 SF area

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
- Natural Ventilation in accordance with 402
- Mechanical Ventilation in accordance with:
  - Air changes 3/hr for dwelling units per R402.4.1.2 of the IECC follows IMC 403
  - Ambulatory care and I2 follow IMC 407

2016 NY Energy Supplement
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
- New 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

\[ V_{HR} = R_p P_z + R_a A_z \]  
(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 space or spaces in the zone.

403 Mechanical Ventilation

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>MINIMUM VENTILATION RATES</th>
<th>AREA OUTDOOR AIR RATE</th>
<th>REQUIRED AIRFLOW RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>10</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Conference room</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Auditorium</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Library</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Classroom</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Laboratory</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
<tr>
<td>Laboratory</td>
<td>1</td>
<td>0.36</td>
<td>—</td>
</tr>
</tbody>
</table>
403.3 Exhaust air overflow rates

- Must meet ASHRAE 62.2 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

<table>
<thead>
<tr>
<th>Zone To Be Exhausted</th>
<th>Exhaust Rate Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA</td>
<td>15 cfm per room</td>
</tr>
<tr>
<td>Laundry</td>
<td>15 cfm per room</td>
</tr>
<tr>
<td>Multiple use rooms</td>
<td>15 cfm per room</td>
</tr>
<tr>
<td>High traffic areas</td>
<td>15 cfm per person</td>
</tr>
</tbody>
</table>

404 Enclosed Parking Garages

- 404.1 Enclosed Parking Garages
  - With intermittently operating mechanical exhaust
    - 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
- Stationary storage battery systems
- Valve-regulated lead-acid batteries in cabinets
- 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 natural gas- and hydrogen-fueled vehicles
- 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

- Example:
- **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 supersedes

---

### 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” radius 45-degree elbow</td>
<td>3 feet 6 inches</td>
</tr>
<tr>
<td>4” radius 90-degree elbow</td>
<td>5 feet</td>
</tr>
<tr>
<td>6” radius 45-degree elbow</td>
<td>1 foot 9 inches</td>
</tr>
<tr>
<td>8” radius 45-degree elbow</td>
<td>1 foot</td>
</tr>
<tr>
<td>8” radius 90-degree elbow</td>
<td>1 foot 7 inches</td>
</tr>
<tr>
<td>10” radius 45-degree elbow</td>
<td>9 inches</td>
</tr>
<tr>
<td>10” radius 90-degree elbow</td>
<td>1 foot 6 inches</td>
</tr>
</tbody>
</table>

For S: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

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**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
505.3 Domestic Kitchen Exhaust in Multistory Buildings

- 12 items:
  1. Fire rated shaft per IBC
  2. Dampers prohibited in exhaust duct
  3. Rigid 26 ga. 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 IBC and IFC

Chapter 6 Duct Systems
601.5 Return Air Openings

- 7 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 air to crawl space
  7. No return air from toilet rooms, closets, uninhabited attics, kitchens, etc.

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

Chapter 7 Combustion air

- 701.1 Oil fire appliances
  - Shall comply with NFPA 31
  - Gas-fired shall comply with the IFGC
    - 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 IBC
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 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
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.”

903 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

• 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

NY Supplement
• **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 an *almost* "stand alone" document, and contains *almost* everything you need!

<table>
<thead>
<tr>
<th>Residential Code</th>
<th>Mechanical Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 12</td>
<td>General Requirements</td>
</tr>
<tr>
<td>Chapter 13</td>
<td>Definitions</td>
</tr>
<tr>
<td>Chapter 14</td>
<td>General Regulations</td>
</tr>
<tr>
<td>Chapter 15</td>
<td>Ventilation</td>
</tr>
<tr>
<td>Chapter 16</td>
<td>Exhaust</td>
</tr>
<tr>
<td>Chapter 17</td>
<td>Exhaust Systems</td>
</tr>
<tr>
<td>Chapter 18</td>
<td>Combustion Air</td>
</tr>
<tr>
<td>Chapter 19</td>
<td>Chimneys and Vents</td>
</tr>
<tr>
<td>Chapter 20</td>
<td>Specific Appliances</td>
</tr>
<tr>
<td>Chapter 21</td>
<td>Boilers, Water Heaters</td>
</tr>
<tr>
<td>Chapter 22</td>
<td>Heating and Cooling</td>
</tr>
<tr>
<td>Chapter 23</td>
<td>Refrigeration</td>
</tr>
<tr>
<td>Chapter 24</td>
<td>Hydronic Piping</td>
</tr>
<tr>
<td>Chapter 25</td>
<td>Special Piping (oil)</td>
</tr>
<tr>
<td>Chapter 26</td>
<td>Solar Systems</td>
</tr>
</tbody>
</table>
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 3
International Fuel gas Code

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

101.2.5 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.

2016 NYS Uniform Supplement

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

NY Uniform Supplement 101.2.5.4
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 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

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

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:

  \[
  \text{Required Volume} \geq \frac{21 \, \text{ft}^3}{\text{ACH}} \leq \frac{15 \, \text{ft}^3}{\text{ACH}}
  \]

  **Equation 3-1**

- For fan assisted appliances, use:

  \[
  \text{Required Volume} \geq \frac{15 \, \text{ft}^3}{\text{ACH}} \leq \frac{1000 \, \text{BTU}}{\text{hr}}
  \]

  **Equation 3-2**

---

**Determination of Air Infiltration Rate**

- ASHRAE - Method to estimate
  - Determine the Air Flow (CFM)
  - Convert to % of Volume of Building (ACH)
**Alternatives for 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.

---

**304.6.1 Outdoor Air**
• **305 Installation**
  - 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
- Meter pan or other entry point into building

- Stub out of solid pipe, at least 3” in length

### Typical lightning strike of CSST

- Image of a typical lightning strike on CSST.
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

402 Pipe Sizing

CSST Piping
Table 402.4(15) – 402.4(19)
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 1.50 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
    - Minimum 16 gauge thickness

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
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

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

503.6.9.3 Sizing of Plastic Vent Pipe

- Category II, III & IV Appliances
  - Sizing shall be per manufacturers instructions
Chimney Termination
Low-heat and Residential-type

503.6.4 Gas Vent Termination

Scenario
There was a vent, then a new roof......
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
- Flame safeguard required
  - 2016 NYS Uniform Supplement

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

614.5 Dryer Exhaust Power Vents

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

- 614.8.4.3 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 manufacturers specifications
- Provide appropriate clearance for use, cleanout and servicing

Hydrogen Gas Systems

- 635.1 Installation
  - Requirements are found:
    - Chapter 7 of this code
    - IFC
    - IBC
Residential Code

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", sort of

Residential Code – NY supplement

- G2411 - CSST same context as FGC 310.2
- G2431.2 - Flame Safeguard devices
- G2415.7 - Protection of piping same as FG 404.7
### 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>
</tbody>
</table>

### 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
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. Reference Standards

General Requirements

• 101.2.3 Scope
  Shall apply to installation, alteration, repair, relocation, replacement, addition to, use or maintenance of:
  plumbing systems

What about Chapters 1, 2 and 3?
Chapter 1. General Requirements
Chapter 2. Definitions
Chapter 3. General Regulations

Remember the NYS Supplement
102 Applicability

• 102.8 Existing structures
  • Lawfully in existence
  • Allowed to continue and maintain if it's not a hazard to:
    • Life
    • Health
    • Property

Definitions

• Toilet Facility
  • Space containing not less than
    • 1 water closet
    • 1 lavatory

Chapter 2: Definitions
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” – no kidding!
  - 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 – Over excavation

• 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 (51 mm) 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.

NYS Uniform Supplement

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 – Required Tests and Inspections

• 312.1 – the permit holder shall make the applicable tests….
• 312.2 – 312.9 – responsible for the following 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
  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

Example: I-2 occupancies

<table>
<thead>
<tr>
<th>Description</th>
<th>Water Closets</th>
<th>Lavatories</th>
<th>Bathrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2 employees serving food</td>
<td>1 per meal*</td>
<td>1 per 100</td>
<td></td>
</tr>
<tr>
<td>1-2 employees, other than residential</td>
<td>1 per 100</td>
<td>1 per 100</td>
<td></td>
</tr>
<tr>
<td>Visitors, other than residential</td>
<td>1 per 200</td>
<td>1 per 100</td>
<td></td>
</tr>
</tbody>
</table>

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

• 419.2 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%

**Table 403.1**

<table>
<thead>
<tr>
<th>Column 1 (CLASSIFICATION)</th>
<th>Column 2 (DESCRIPTION)</th>
<th>Column 3 (MINIMUM)</th>
<th>Column 4 (MALES)</th>
<th>Column 5 (FEMALES)</th>
<th>Column 6 (OTHERS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Urinals and toilet facilities</td>
<td>1 per 150</td>
<td>1 per 150</td>
<td>1 per 300</td>
<td>--</td>
</tr>
<tr>
<td>A-2</td>
<td>Water closets, showers, sinks, and equipment</td>
<td>1 per 60</td>
<td>1 per 60</td>
<td>1 per 75</td>
<td>--</td>
</tr>
<tr>
<td>A-3</td>
<td>Restrooms, banquet halls, and food areas</td>
<td>1 per 75</td>
<td>1 per 75</td>
<td>1 per 300</td>
<td>--</td>
</tr>
<tr>
<td>A-4</td>
<td>Restrooms, banquet halls, and food areas</td>
<td>1 per 75</td>
<td>1 per 75</td>
<td>1 per 300</td>
<td>--</td>
</tr>
</tbody>
</table>
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

403.3 Public Toilet Facilities

- In accordance with 403
- Required for all employees in all occupancies
- May be combined with public facilities
  - Exception where no public facilities required:
    - Parking garages with no attendant
    - 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 covered mall)**
  - Within one story above or below
  - Not more than 500 feet

- **403.4.1 Directional Signage**
  - Indicating route to the facilities

---

**404 Accessible Plumbing Fixture**

- **404.1** - in accordance with the Building Code.

- 1109.2 of the Building Code requires that toilet rooms and bathing facilities be accessible.

---

**403.1.2 Family / Assisted use fixtures**

- As required by 1109.2.1 of the IBC
  - 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
405.3 Settings

These are not accessibility requirements

• 405.3.4 Water Closet Compartment
• 405.3.5 Urinal partitions

Washroom and Toilet Room Requirements

• 405.3.4 Water Closet Compartment
• 405.3.5 Urinal partitions

Section 406 - 428
Specific information based on fixture or equipment

EXAMPLE
• 410 – Drinking Fountains
  – Conform to listed standards
  – Not required in restaurants if water is served
  – Bottled water 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
  - Shall be listed and labeled

- **410.2 Small Occupancies**
  - Not required with 15 or fewer occupants

- **410.3 High and low drinking fountains**
  - Electric, refrigerated drinking water coolers
  - Conform to UL 399
  - Shall be listed and labeled

### 423 Specialty Plumbing Fixtures

- **423.3 Footbath, pedicure, head shampooing**
  - Temperature shall be limited
  - 120 degrees F
  - Device conforms to:
    - ASSE 1070
    - CSA R125.3

### Chapter 5 - Water Heaters

- 502.1 - installed in accordance with manufacturers installation instructions.

  **AND**

- must also comply with:
  - MC - for oil fired units M1002
  - BC - for electric units Chapt 27
  - FGC - for gas fired units FG623
### 502.1.1 Installation
- Comply with IMC and IFGC
  - 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
Chapter 6
Water Supply and Distribution

601.5 Rehab of piping systems

• Epoxy lining systems
  • ASTM F 2831

602 Water Required

• 602.3 Individual Water Supply
  • IF potable public water supply, not available, individual water supply may be used
602.3 – Individual Water Supply

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
603.2 – Separation of Water and Sewer Piping

- <5’ separation:
  - Water min 12” above sewer

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

<table>
<thead>
<tr>
<th>PLUMBING FIXTURE OR FIXTURE FITTING</th>
<th>MAXIMUM FLOW RATE OR QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lavatory, private</td>
<td>2.2 gpm at 60 psi</td>
</tr>
<tr>
<td>Lavatory, public (residential)</td>
<td>0.5 gpm at 60 psi</td>
</tr>
<tr>
<td>Shower head*</td>
<td>2.5 gpm at 60 psi</td>
</tr>
<tr>
<td>Sink fixture</td>
<td>2.2 gpm at 60 psi</td>
</tr>
<tr>
<td>Handwash</td>
<td>1.0 gallons per flushing cycle</td>
</tr>
</tbody>
</table>

604.5 - Size of Fixture Supply

604.10 - Manifold Systems
605 Materials, Joints and Connections

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

605.2.1 Lead Content

- ≤ .25% by weighted average for drinking water
- Table 605.3, Table 605.4, section 605.16 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 2015 IECC 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 tank connected to cold water downstream of the devices

607.4 – Hot Water Supply to Fixtures
608.8 Identification of Non-potable water systems

- Specific language for marking
  - "Caution: Non-potable water – Do Not Drink"
  - Corrosion proof material
  - Minimum ¾ high letters
- Pictograph signage also required
  - Hose bibs
  - Faucets
  - Open ended pipes

NYS Supplement

- NYS Dept of Health references
  - 608.1.1 Public water supply protection
    - per Subpart 5-1.31 (10 NYCRR)
  - 608.6.1 Private water supplies
    - Prohibits cross connection public / private systems
  - 610.1 General.
    - Purging of potable water systems

NYS Supplement

608 - Protection of Potable Water Supply

- 608.13 Back flow protection
  - How to protect
- 608.15 Protection of potable water outlets
- 608.16 Connections to the potable water system
608 - Protection of Potable Water

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).

NY Supplement 602.3.1 reference

<table>
<thead>
<tr>
<th>Contaminant Source Description</th>
<th>Distance (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>and surface spreading or subsurface injection of liquid or solid manure</td>
<td>200</td>
</tr>
<tr>
<td>Storage areas for manure piles</td>
<td>200</td>
</tr>
<tr>
<td>Manure pile (following septic tank)</td>
<td>150</td>
</tr>
<tr>
<td>Septic system components (non-watertight)</td>
<td>100</td>
</tr>
</tbody>
</table>

Drain, Waste and Vent Diagram
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
**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>2(\sqrt{3}) or less</td>
<td>(\frac{1}{12})</td>
</tr>
<tr>
<td>3 to 6</td>
<td>(\frac{1}{8})</td>
</tr>
<tr>
<td>8 or larger</td>
<td>(\frac{1}{4})</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
  - Brass 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
- 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
710 Drainage System

Sizing

Confirming the Pipe Capacity

- Table 710.1(1)

- Table 710.1(2)
What is a branch interval?

712 Sumps and Ejectors

- **712.1 Building subdrains**
  - 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**

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

716 Vacuum Drainage Systems

- **716.2 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

- **716.3 Test and demonstration**
  - Minimum 19” of mercury
  - Recorded proof supplied to code official
  - Written instructions for system maintenance provided to owner
717 Replacement of Underground Pipes by Bursting Method

- **717.2 Applicability**
  - limited to gravity type systems
  - 6” and smaller

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

- **717.7 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

- **18” Minimum**

### 903 – Vent Terminals

- **2016 NY Uniform Supplement**
- **903.1 Roof Extension**
903 – Vent Terminals

- Good reason to extend vent 18" above the roof

2016 NY Uniform Supplement

903.1 Frost Closure

- Vent pipe increase in size
  - Not less that 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 Extension

- 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 ½ 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 918

904 – Outdoor Vent Extensions
Table 906.1 - maximum developed length and minimum sizing based on the (DFU)

<table>
<thead>
<tr>
<th>Size of Trap (inches)</th>
<th>Slope (inch per foot)</th>
<th>Distance from Trap (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1/2</td>
<td>1/8</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>1/4</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>1/4</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>1/4</td>
<td>16</td>
</tr>
</tbody>
</table>

909 – Fixture Vent

<table>
<thead>
<tr>
<th>Size of Trap (inches)</th>
<th>Slope (inch per foot)</th>
<th>Distance from Trap (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1/2</td>
<td>1/8</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>1/4</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>1/4</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>1/4</td>
<td>16</td>
</tr>
</tbody>
</table>
916 - Island Fixture Venting

Exercise

Determine the maximum length of the vent for the following:

1. 3" soil stack, 21 DFU, vent diameter is 2½"
   - 270'
2. 4" waste stack, 100 DFU, vent diameter is 3"
   - 200'
3. 10" soil stack, 12,000 DFU, vent diameter is 8"
   - 180'
4. 15" waste stack, 39,000 DFU, vent diameter is 5"
   - Not Possible – vent must be at least 8"
   - 24'

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
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

Individual, branch or stack type?
1002.3 – Prohibited Traps

IPC 1002.4 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

### 1003.3.6 Gravity Grease Interceptors

- New section
- No previous standards for construction of the tanks
- Interceptors must comply to IAMPO/ANSI Z1001
- Systems shall be installed to manufacturers instructions

### IPC 1003.3.7 Grease Interceptor Discharge

- 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 now 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**

  • Vertical and horizontal piping
  • Sized per flow rate, not rainfall

---

**Residential Code**

---

**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

<table>
<thead>
<tr>
<th>Leader Diameter (inches)</th>
<th>Flow Rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>2 1/4</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
</tr>
</tbody>
</table>

---

**2015 International Residential Code**
Comparison

Residential Code
Chapter 26 – General
Chapter 27 – Fixtures
Chapter 28 – Water Heaters
Chapter 29 – Water Supply
Chapter 30 – Sanitary Drainage
Chapter 31 – Vents
Chapter 32 – Traps
Chapter 33 – Storm Drainage

Plumbing Code
Chapter 3 – General
Chapter 4 – Fixtures
Chapter 5 – Water Heaters
Chapter 6 – Water Supply
Chapter 7 – Sanitary Drainage
Chapter 8 – Indirect Waste
Chapter 9 – Vents
Chapter 10 – Traps
Chapter 11 – Storm Drainage
Chapter 12 – Special Piping
Chapter 13 – Nonpotable Water Systems
Chapter 14 – Subsurface Landscape Irrigation

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
2015 New York State Energy Code

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

- Timeframe for states to review
  - 2 years
- Attestation
- 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
  - IECC Commercial
  - ASHRAE 90.1 - 2013
- Residential
  - IECC Energy Residential
- 2016 NYS Energy Supplement
- IRC Chapter 11
2015 International Energy Code
Organization
Chapter 1: Definitions
Chapter 2: General Requirements
Chapter 3: Commercial Energy Efficiency
Chapter 4: Existing Buildings
Chapter 5: Referenced Standards

2016 Supplement to the NYS Energy Code
Introduction
Part 1
Amendments to the 2015 IECC Commercial provisions
Part 2
Amendments to the ANSI/ASHRAE/IESNA 90.1-2013 Standard
Part 3
Amendments to the 2015 IECC Residential provisions

Introduction
- General overview of the application of the referenced documents in New York State
- Applicability to buildings subject to The New York City Building Codes
- Table of Contents for the amended topics in the New York State Energy Code
Chapter 4
Commercial Energy Efficiency

- Commercial Structures
  - All buildings not defined as residential
  - ASHRAE 90.1 - 2013

2016 Supplement to the NYS Energy Code

C101.5 Compliance. Residential or Commercial shall meet the proper section

C101.5.1 ComChek
ResChek
Home Energy Rating System and other energy modeling software as approved by NY Secretary of State
C103 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

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. Location of daylight zones on floor plans.
11. Air sealing details

C103.2.1 Building thermal envelope depiction.
C103.2.2 Written statement.
C103.3. Examination of documents
C103.2.1 Building thermal envelope depiction.

C103 Construction Documents

C103.3.1 Approval of Construction Documents
C103.3.2 Previous approvals.
C103.3.3 Phased approval.

C103 Construction Documents

C103.4 Amended construction documents
C103.5 Retention of construction documents
C104 Inspections
C108 Interpretation
**Definition: ABOVE-GRADE WALL.**
A wall more than 15 percent above grade and enclosing conditioned space. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

**Definition: Alteration**
“Any construction or renovation to an existing structure other than repair or addition that requires a permit. Also, a change in a mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation that requires a permit.”

**Definition: Building Commissioning**
A process that verifies and documents that the selected building systems have been designed, installed, and function according to the owner’s project requirements and construction documents, and to minimum code requirements. Required for commercial building with mechanical systems and or automatic lighting systems.
Dynamic Glazing

Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, solar heat gain coefficient (SHGC), or VT.

Definition

On-site Renewable Energy

Energy derived from solar radiation, wind, waves, tides, landfill gas, biomass, or internal heat of the earth. The energy system providing on-site renewable energy shall be located on the project site.

Definition:

C402.1.1 Low-energy buildings.

1. Those with a peak design rate of energy usage less than 3.4 Btu/h · ft² (10.7 W/m²) or 1.0 watt per square foot (10.7 W/m²) of floor area for space conditioning purposes.
2. Those that do not contain conditioned space.
Definition:

C402.1.2 Equipment buildings.
1. Are separate buildings with floor area not more than 500 square feet (50 m²).
2. Are intended to house electronic equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m²) and not intended for human occupancy.
3. Have a heating system capacity not greater than (17,000 Btu/hr) (5 kW) and a heating thermostat set point that is restricted to not more than 50°F (10°C).
4. Have an average wall and roof U-factor less than 0.200 in Climate Zones 1 through 5 and less than 0.120 in Climate Zones 6 through 8.

Visible Transmittance

The ratio of visible light entering the space through the fenestration product assembly to the incident visible light. VT includes the effects of glazing material and frame, and is expressed as a number between 0 and 1.

Definition:

Continuous Air Barrier

A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.
Definition:
Enclosed Space
A volume surrounded by solid surfaces, such as walls, floors, roofs, and openable devices, such as doors and operable windows.

Definition:
General Lighting
Lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

NYS 2016 Energy Supplement Definition
BUILDING.
Any structure used or intended for supporting or sheltering any use or occupancy or for affording shelter to persons, animals or property, together with (A) any equipment, mechanical systems, service water heating systems, and electric power and lighting systems located in such structure, and…
NYS 2016 Energy Supplement Definition

BUILDING (cont.)

(B) any mechanical systems, service water heating systems, and electric power and lighting systems located on the site where such structure is located and supporting such structure. The term “building” shall include, but shall not be limited to, factory manufactured homes (as defined in section 372(8) of the Executive Law) and mobile homes (as defined in section 372(13) of the Executive Law).

NYS 2016 Energy Supplement Definition

BUILDING SYSTEM

The term “building system” means a combination of central or terminal equipment or components or controls, accessories, interconnecting means, and terminal devices by which energy is transformed so as to perform a specific function, such as heating, ventilation and air conditioning, service water heating or illumination.

NYS 2016 Energy Supplement Definition

COMMERCIAL BUILDING

The term “commercial building” shall include all buildings not included in the definition of “residential building.”
AIR-IMPERMEABLE INSULATION.  
An insulation having an air permeance equal to, or less than 0.02 L/s-m² at 75 Pa pressure differential tested according to ASTM E 2178 or E 283.

AREA WEIGHTED AVERAGE.  
A mathematical technique for combining different amounts of various components, based on proportional relevance, into a single number. Weighted averaging may be used where there is more than one R-value for floor, wall, or ceiling insulation, or more than one U-factor for fenestration in a building. As an example, the area weighted average for window fenestration U-factors equals \(\frac{(\text{Area 1} \times \text{U-factor 1}) + (\text{Area 2} \times \text{U-factor 2}) + \ldots}{\text{Total Area}}\). This is maximum allowable fenestration U-factor.

CONDITIONED SPACE  
An area or room within a building which is within the thermal envelope of a building which is heated or cooled using fossil fuel or electricity as the energy source.
A Division of New York Department of State

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.

NYS 2016 Energy Supplement Definition

Compliance Paths
• IECC 2015
• ASHRAE 90.1-2013
• 2016 NY Energy Supplement

ASHRAE 90.1-2013.
Chapter 3 General Requirements

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

- Chapter 5 – Existing Buildings
- Chapter 6 – Reference Standards
- Index

C401 GENERAL
NYS 2016 Energy Supplement

C401.2 Application …Chapter C4 of the 2015 IECC shall be deemed to be amended ….

- The requirements of ASHRAE 90.1-2013, or
- Prescriptive. (i) The requirements of Sections C402 through C405. In addition, commercial buildings shall comply with Section C406 and tenant spaces shall comply with Section C406.1.1 Performance. or
- Performance. The requirements of Sections C402.5, C403.2, C404, C405.1, C405.3, C405.4, C405.6 and C407. The building energy cost shall be equal to or less than 85 percent of the standard reference design building
2015 IECC Commercial Provisions

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

2015 IECC Commercial Provisions

C402 Building Envelope Requirements
- Low energy buildings
- Equipment buildings
- Cold formed steel walls
- Fenestrations and daylight controls

C402.4 Fenestration (prescriptive)

C402.4.2
- Building areas greater than >2500 SF
- Not < 75% of ceiling 15’ or higher
  - Lobby
  - Atrium
  - Warehouse
  - Automotive service bays
  - Convention center
  - Etc
- Daylight zone not < ½ floor area
2015 IECC Commercial Provisions

C403 Building Mechanical Systems
- Heating
- Cooling
- Simple systems
- Complex systems
- Economizers

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: Energy 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.

2015 IECC Commercial Provisions

C403 Building Mechanical Systems

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

C403.2.4.4 Zone Isolation

- 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 zones...

- Isolation devices and controls for all air supply
C403 Building Mechanical Systems

C403.2.4.7 Economizer Fault Detection
• 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 of reporting diagnostics to operations personnel

C403 Building Mechanical Systems

C403.2.8 Kitchen Exhaust
• 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

C403 Building Mechanical Systems

C403.2.15
• Warehouse coolers & freezers
  • Larger than 3000SF
  • Not site assembled nor site constructed
• Walk-in coolers & freezers
  • Smaller than 3000SF
  • Not site assembled nor site constructed
• 11 items to comply with
2015 IECC Commercial Provisions

C403 Building Mechanical Systems

C403.2.16 Walk in cooler / freezers

- Smaller than 3000 SF
- Site assembled / constructed

- 11 items to comply with

C403.2.17 Refrigerated Display cases

Site assembled or site constructed

- Lighting controls
- Defrost termination controls
- Anti-sweat heater controls

2015 IECC Commercial Provisions

C404 Service Water Heating (Mandatory)

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

C404.5 Efficient heated water supply piping

C404.5.1 Max. allowable Pipe Length Method
C404.5.2 Max. allowable Pipe Volume Method
2015 IECC 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 systems

2015 IECC Commercial Provisions

C405  Electrical Power and Lighting Systems
  Daylight Criteria
    •  Sidelight daylight zone
    •  Toplight daylight zone
    •  Daylight-responsive controls

Definition: Daylight Zone

That portion of a building’s interior floor area that is illuminated by natural light.
  Sidelight
  Toplight
C405 Electrical Power and Lighting Systems
C405.2 Lighting Controls
- Occupant sensor controls and functions
- Time switch controls and functions
- Light Reduction Controls
- Daylight responsive controls and functions

C405.2.2 Light Reduction Controls
- Manual reduction control
  - Allows at least 50% reduction of lighting load
- Exception: where daylighting controls exist
Definition:

Lighting power density (LPD).

• LPD is the maximum watts per square foot of lighting for a general building type or a specific building space.
**2015 IECC Commercial Provisions**

**C406 Additional Efficiency Package Options**

6 options – shall comply with at least 1

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power density system 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.

**2015 IECC 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

- NYS Energy Supplement C401.2 (3)

**2015 IECC Commercial Provisions**

**C407 Total Building Performance**

Mandatory requirements-
- C402.5, C403.2, C404, C405.2, C405.3, C405.4, C405.6 and C407
- Documentation
- Compliance report

C407.6.3 Exceptional Calculation method allowed
2015 IECC Commercial Provisions

C408 System Commissioning
- Mechanical
- Hydronic
- Function testing

C408.3 Lighting System Function Testing
- C408.3.1.1 Occupant Sensor Controls
- C408.3.1.2 Time Switch Controls
- C408.3.1.3 Daylight Responsive Controls
- C408.3.2 Documentation

Chapter 5
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

2016 NYS Energy Code Supplement

Part 3 Amendments to the 2015 IECC Residential Provisions

Amends and Replaces IECC Chapter 1
- R101 Scope and General Requirements
- R102 Alternate Materials, Methods of Construction, Design...
- R103 Construction Documents
- R104 Inspections
- R105 Validity
- R106 Referenced Codes and Standards
- R107 Other Laws and Regulations
- R108 Interpretation of Energy Code Requirements
- R109 References to Chapters, Sections, Tables or Provisions
Definitions and Terminology
• Specific terminology
• In the IECC
• In the NYS 2016 Energy Code Supplement
• You need to understand the terminology to use the code.

Definition:
ABOVE-GRADE WALL.
A wall more than 50 percent above grade and enclosing conditioned space. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

Definition: Addition
“An extension or increase in the conditioned space floor area or height of a building or structure.”
Definition: Air Barrier

“Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.”

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

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”
Fenestration

“Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glass block, and combination opaque/glazed doors. Fenestration includes products with glass and non-glass glazing materials.”

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].”

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)].
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 3rd edition of the 2015 IBC 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).
“Residential Building”

NYS 2016 Energy Supplement Definition

- Building Thermal Envelope.
  The exterior walls (above and below grade), floor, roof, and any other building elements that enclose conditioned space or provides a boundary between conditioned space and exempt or unconditioned space.

Building Thermal Envelope
### Chapter 3 General Requirements

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

### Climate Zones

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A</td>
<td>Bronx, Nassau, Queens, Suffolk</td>
</tr>
<tr>
<td>5A</td>
<td>Albany, Erie, Ontario, Saratoga, Berkshire</td>
</tr>
<tr>
<td></td>
<td>Cayuga, Greene, Orange, Schenectady</td>
</tr>
<tr>
<td></td>
<td>Chenango, Livingston, Otsego, Tioga</td>
</tr>
<tr>
<td></td>
<td>Columbia, Monroe, Putnam, Washington</td>
</tr>
<tr>
<td></td>
<td>Cortland, Negaunee, Remsen, Wayne</td>
</tr>
<tr>
<td></td>
<td>Dutchess, Onondaga, Rockland, Yates</td>
</tr>
<tr>
<td>6A</td>
<td>Allegany, Franklin, Montgomery, Fulton</td>
</tr>
<tr>
<td></td>
<td>Genesee, Herkimer, Jefferson, Schuyler</td>
</tr>
<tr>
<td></td>
<td>Cattaraugus, Hamilton, Orleans, Otsego</td>
</tr>
<tr>
<td></td>
<td>Schenectady, Saratoga, Warren</td>
</tr>
<tr>
<td></td>
<td>Clinton, Oneida, Tompkins, Wyoming</td>
</tr>
<tr>
<td></td>
<td>Chenango, Herkimer, Schuyler, Warren</td>
</tr>
<tr>
<td></td>
<td>Delaware, Lewis, St. Lawrence, St. Lawrence</td>
</tr>
</tbody>
</table>

### R303 Materials, Systems and Equipment

- **R303.1 Identification**
  - Fenestration Rating, Certification and Labeling

<table>
<thead>
<tr>
<th>Rating</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td>0.51</td>
<td>0.2</td>
</tr>
<tr>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>
R303 Materials, Systems and Equipment

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

R303 Materials, Systems and Equipment

• R303.1 Identification
  – Insulated siding
    • R-value labeled on package
    • Listed on certification
    • thermal resistance (R-value) of insulated siding to be tested per ASTM C1363

R303.1.3 Fenestration Example
R303 Materials, Systems and Equipment

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

2015 IRC

Chapter 11 - Energy Efficiency

- N1101.2 Compliance
  - Chapter 5 of the *IECC*... OR
  - This Chapter ... OR
  - DOE developed software, ResCheck

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
R405 Simulated Performance Alternative
- 13 topics
  - Compliance software allowed
    - COMcheck
    - DOE approved software
  - Compliance report required, efficiency > Prescriptive
  - Electricity use 3.16 as multiplier
  - Other fuels use 1.1 as multiplier

R406 Energy Rating Index
- Rating scale of 0 – 100
  - 0 is a residential building that uses no energy
- Maximum rating
  - Climate zones 4 & 6 - 54
  - Climate zone 5 - 55

R401.3 Certificate
- Certificate posted on or near the electrical panel
  - List R-values
  - List U-factors and SHGC
  - Equipment and efficiencies
**R402 BUILDING THERMAL ENVELOPE**

- **Table 402.1.2**

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

**BUILDING THERMAL ENVELOPE**

- **Table 402.1.2**

**Choose your Zone**

- **FENESTRATION REQUIREMENTS**

**Climate Zone**

- **Fenest’ U-factor**
- **SkyLite U-factor**
- **Glazed Fenest’ SHGC**

**4 Except Marine**

- 0.35
- 0.55
- NR

**6**

- 0.32
- 0.55
- NR

**Option 1**

- 0.32
- 0.55
- NR

**Option 2**

- 0.28
- 0.55
- NR

**Solar Heat Gain – only in climate zone 4**

**Building Thermal Envelope**

- **Table R402.1.2**

<table>
<thead>
<tr>
<th>Climate Zone</th>
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<tr>
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<td>6 Option 1</td>
<td>49</td>
</tr>
<tr>
<td>6 Option 2</td>
<td>49</td>
</tr>
</tbody>
</table>

**Insulation Requirements**

**R-values are minimums**

**Building Standards and Codes**
Building Thermal Envelope

Table R402.1.2

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Wood Framed Wall R-value</th>
<th>Mass Wall R-factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 except Marine</td>
<td>20</td>
<td>8/13</td>
</tr>
<tr>
<td>5</td>
<td>20 or 13 + 6</td>
<td>13/17</td>
</tr>
<tr>
<td>6</td>
<td>13 + 10</td>
<td>15/20</td>
</tr>
<tr>
<td>Option 1</td>
<td>20 + 5 or 13 + 10</td>
<td>15/20</td>
</tr>
<tr>
<td>Option 2</td>
<td>25 cavity</td>
<td>15/20</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)

Footnote f.

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

cavity option must use R-20

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
Building Thermal Envelope

Table R402.1.2

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Floor R-value</th>
<th>Basement Wall R-value</th>
<th>Slab R-value and depth</th>
<th>Crawl Space Wall R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>30</td>
<td>15/19</td>
<td>15/20</td>
<td>15/20</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>15/19</td>
<td>15/20</td>
<td></td>
</tr>
<tr>
<td>Option 1</td>
<td>30</td>
<td>15/19</td>
<td>15/40</td>
<td></td>
</tr>
<tr>
<td>Option 2</td>
<td>30</td>
<td>15/20</td>
<td>15/40</td>
<td></td>
</tr>
</tbody>
</table>

- Continuous insulation, interior/exterier

R402.2.10 Slab Edge Insulation

- Required for air permeable insulation
- Extend over top of insulation
- Of any solid material

R402 Building Thermal Envelope

Section R402.2.3 Eave Baffle
- Required for air permeable insulation
- Extend over top of insulation
- Of any solid material
Steel Frame Conversions
Portion of Table 402.2.6

<table>
<thead>
<tr>
<th>WOOD FRAME R-VALUE REQUIREMENT</th>
<th>COLD-FORMED STEEL EQUIVALENT R-VALUE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Framed Walls</td>
<td></td>
</tr>
<tr>
<td>R-20</td>
<td>R-0 + 14 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.6 or…</td>
</tr>
<tr>
<td>R-21</td>
<td>R-0 + 14 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or…</td>
</tr>
</tbody>
</table>

a. 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
(Braced wall design)

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>Material</th>
<th>Ceiling</th>
<th>Wall</th>
<th>Door</th>
<th>Window</th>
<th>Floor</th>
<th>Basement Wall</th>
<th>Crawl Space Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine</td>
<td>0.35</td>
<td>0.55</td>
<td>0.026</td>
<td>0.060</td>
<td>0.098</td>
<td>0.047</td>
<td>0.059</td>
</tr>
<tr>
<td>4</td>
<td>0.32</td>
<td>0.55</td>
<td>0.026</td>
<td>0.045</td>
<td>0.060</td>
<td>0.033</td>
<td>0.050</td>
</tr>
<tr>
<td>5</td>
<td>0.32</td>
<td>0.55</td>
<td>0.026</td>
<td>0.045</td>
<td>0.060</td>
<td>0.033</td>
<td>0.050</td>
</tr>
<tr>
<td>6</td>
<td>0.32</td>
<td>0.55</td>
<td>0.026</td>
<td>0.045</td>
<td>0.060</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

R402 Building Thermal Envelope

Air Leakage

• R402.4.1.1 - Installation
  • Materials installed per manufacturer’s instructions
• R402.4.1.2 - Testing
  • CEO approved 3rd party testing required
  • ASTM E 779 or E 1827
  • Air changes required ≤ 3 per hour
• NYS Energy Supplement
  • 2 new exceptions based on number of units
R402 Building ThermalEnvelope

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.

Setting Up a Blower Door

R402 Building ThermalEnvelope
Air Leakage

• NYS Energy Supplement
  • 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

Air Leakage

• NYS Energy Supplement
  • 7 or more dwelling units
  • May be grouped into 7 unit sample sets
  • Must be same type units
  • Same leakage rates as 2 or more units
  • Allowances for group testing ≤ 7 per group
  • Basis comes from LEED energy efficient design

R402 Building Thermal Envelope

• Section R402.4.2 – Fireplaces
  • Wood-burning Fireplaces
  • Tight-fitting flue dampers or doors
  • Outdoor combustion air required NY 2016 Energy Supplement
  • Factory built fireplaces – listed / labeled to UL 127
  • Masonry fireplaces – listed / labeled to UL 907
  • Reminder – Residential Code Requirements
  • Fireplaces – Ventilation requirements in
    • Sections R1006

R402 Building Thermal Envelope

• 402.4.4 Rooms containing
  • 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 (Mandatory)

- 403.1 Controls.
  - 1 Programmable thermostat minimum in every dwelling unit

R403 Systems

- R403.3 Ducts and Air Handlers
  - 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

- R403.3.2 Sealing (Mandatory)
  - Shall be sealed
  - Air Handlers must meet ASHRAE 153
  - Except 2: ducts with less than 2" water column
“Only listed duct tape can be used to seal ducts”

R403 Systems

- Ducts and Air Handlers (con’t)
  - 403.3.3 Duct Testing (Mandatory)
    - Rough-in, or
    - Postconstruction
  - If all ductwork within BTE, no test required
  - Signed test required to be supplied to the CEO

R403 Systems

- Ducts and Air Handlers
  - 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

- Ducts and Air Handlers
- 403.3.5 Building Cavities (Mandatory)
  - MAY NOT be used as:
    - Ducts
    - Plenums

Duct Leakage Testing
Energy Conservation Construction Code
of New York State – 2014

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 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

- R403.5.3 Hot Water Piping Insulation (prescriptive)
- R403.6 Mechanical Ventilation (Mandatory)
  - Table R403.6.1
    | Fan Location          | Air Flow Rate Minimum (CFM) | Minimum Efficiency (CFM/Watt) | Air Flow Rate Maximum (CFM) |
    |----------------------|----------------------------|-------------------------------|-----------------------------|
    | Range Hoods          | 6.3                        | 2.8 (0.04 Watt)               | 10                          |
    | In line fan          | 6.3                        | 2.8 (0.04 Watt)               | 10                          |
    | Bathroom, utility      | 10                        | 1.4 (0.04 Watt)               | < 90                        |
    | Bathroom, utility      | 90                        | 2.8 (0.04 Watt)               | 90                          |

- R403 Systems (Mandatory)
  - 403.7 Equipment sizing.
    - 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 M1401.3 of the IRC (ACCA Manual J)
R403 Systems

• R403.8 System Serving Multiple Dwelling Units (Mandatory)
  • Shall comply with C403 and C404 of 2015 IECC

• R403.9 Snow & Ice Melt 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

Not the intended meaning
R403 Systems

- R403.10 Pool / Spas (Mandatory)
  - R403.10.3 Covers
    - Outdoor heated pools and permanent spas
      - Vapor retardant covers

R403 Systems

- R403.11 Portable Spas (Mandatory)
  - Electric powered portable spas
    - Comply with APSP – 14 2011

- R403.12 Residential Pools / Permanent Residential Spas
  - Accessory to 1/2 family res and < 3 story townhouses
    - Comply with APSP- 15a 2013

R404 Electrical Power and Lighting Systems

- 404.1 Lighting equipment (Mandatory)
  - High-eff.
  - 75 percent of permanent fixtures
  - Except low voltage lighting

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
  • fuel gas lighting system
    • no continuously burning pilot lights

R404 Electrical Power and Lighting

• Section R202 - High-Efficacy Lamps
  • Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:
    • 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.

Example - 75% High-Efficacy Lamp

- Standard Lamps
- High Efficacy Lamps

4 light fixtures but only 1 with high efficacy lamps
405 Simulated Energy Performance

- Analysis of Heating, Cooling and Service Hot Water
- MANDATORY provisions must be met
- Based on Annual Energy Cost
  - Proposed Design less than Standard Design

405 Simulated Energy Performance

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

NYS 2016 Energy Supplement

Chapter 5

- R 501.4 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
- R 501.6 Historic Buildings
  - Exempt from compliance
R502 Additions

- **R502.1.1 Prescriptive**
  - Heating & Cooling
    - Ducts extended < 40 feet in unconditioned space no testing required
  - Service Hot Water
    - Shall comply with R403.4
  - Lighting
    - Shall comply with R404.1
  - Simulated performance alternatives allowed
    - Non-conditioned to conditioned

R503 Alterations

**R503.1.1 Exceptions:** The following need not comply provided the energy use of the building is not increased

- 1. Storm windows installed over existing fenestration.
- 2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
- 3. Construction where the existing roof, wall or floor cavity is not exposed.
- 4. Roof recover.
- 5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
- 6. Surface-applied window film installed on existing single panel fenestration assemblies to reduce solar heat gain provided the code does not require the glazing or fenestration assembly to be replaced.

R502 Additions

- **R502.1 Prescriptive**
  - **R502.1.1 Building envelope**
    - Shall comply
      - Except where non-conditioned space is changed to conditioned
      - ≤ to UA for existing building
      - Section 402.1.4
R503 Alterations

- **R503.1.2**
  - Heating and cooling system compliance required
  - Duct extensions < 40 feet in unconditioned space no testing required
- **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

R504 Repairs

- **R504.1**
  - Routine maintenance exempt from permit
  - Abatement due to wear
- **R504.2 Application**
  - Glass only in existing sash and frame
  - Roof repairs
  - Bulb / ballast replacement not increasing lighting power

SUMMARY:

- **Residential Compliance**
  - IECC 2015 or Chapter 11 of the 2015 RCNY
  - Res Check
- **Commercial Compliance Methods**
  - IECC 2015 Edition and/or ASHRAE 90.1-2013
  - Com Check
- **Plus the NYS Energy supplement.**
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.
Why ask Why?

Gravity Works!

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
**Compression**

**Torsion**

**Shear**

**Tension**

**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
When Forces Go Bad

For every action there MUST be an EQUAL and OPPOSITE reaction... or a failure will result...

Forces and “Loads” 1602 (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” 1602 (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”
1602 (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
Dead loads, live loads, and other loads
Carried to the soils

Simple Vertical Load Path of a Deck
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
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: Structural 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

Minimum Design Loads

• Evaluate forces to determine these loads…
  – Rain loads - Section 1611
  – Flood loads - Section 1612
  – Earthquake loads - Section 1613
  – Atmospheric Ice Loads – Section 1614
  – Structural Integrity – Section 1615

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

Table 1607.1
Minimum Uniformly Distributed and Minimum Concentrated 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 theaters</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>50</td>
<td></td>
</tr>
<tr>
<td>Lobbies</td>
<td>100-</td>
<td>---</td>
</tr>
</tbody>
</table>

Loads 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>
Section 1608
Snow Loads

- Design snow loads
  - Determined from Chapter 7 of ASCE 7(2010)
- Figure 1608.2 of the 2015 IBC
- Ground snow loads
  - Used to determine design snow load
  - 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; or
  - Alternative All-Heights Method
    - Section 1609.6 of IBC
    - 6 exceptions
      - compliance alternatives
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 and IV Buildings
    - Figure 1609.3(3) – 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 & IV 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></td>
<td></td>
<td>Active pressure</td>
</tr>
<tr>
<td>Well-graded, clean gravels, gravel-sand mixes</td>
<td>GW</td>
<td>30</td>
</tr>
<tr>
<td>Poorly graded clean gravels, gravel-sand mixes</td>
<td>GP</td>
<td>30</td>
</tr>
<tr>
<td>Silty gravels, poorly graded gravel-sand mixes</td>
<td>GM</td>
<td>40</td>
</tr>
<tr>
<td>Clayey gravels, poorly graded gravel-clay mixes</td>
<td>GC</td>
<td>45</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
- 2015 IBC Section 1612.3
- **NY Code Supplement 1612.3**
  - For design and construction within flood hazard areas
  - Flood hazard areas are established
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 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 9/13/16

From the USGS Website for the year 2014.

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 1613.3.1 (1) (page 389) and 1613.3.1 (2) (page 391)
- Maps developed based on information from USGS National Seismic Hazard Mapping Project
- Basic Formulas
- Tables 1613.3.5 (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 1613.3.1(1) and (2) provide “contours” for NY
Numbers are PERCENT values, calculations are done with DECIMAL (.20)
Based on history, experience and scientific assumptions
Ss – acceleration at short periods (JOLT)
S1 – acceleration at 1 second (SHAKE)
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

**ASSUME Site Class (soils type) D without professional determination**
- Site Class E – Soft clay soil
- Site Class F – Soils requiring site response analysis in accordance with Chapter 20 (ASCE 7)

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
Remember...

The building is assigned the MOST SEVERE Seismic Design Category

Remember...

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 $S_l$ for your area
- Reading Tables and performing calculations

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
Wind Loads versus Seismic Loads

- 1604.10 Wind and seismic detailing

Lateral-force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7, excluding Chapter 14 and Appendix 11A, even when wind load effects are greater than seismic load effects.

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