Residential Code Requirements
Exhaust, Ventilation & Duct Systems

December 2011

Office of Education and Data Management
Department of Construction Services

Residential Code Requirements
Exhaust, Ventilation &
Duct Systems
Moving from 2003 IRC to 2009 IRC

Presented by
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Assistant Director
December 2011

Based Upon

• 2003 IRC
  – Sections in reference to:
    • Ventilation
    • Exhaust
    • Duct Systems
  – As amended by the 2005 Amendment to the Connecticut Supplement

Based Upon

• 2009 IRC
  – Sections in reference to:
    • Ventilation
    • Exhaust
    • Duct Systems
  – As amended by the pending 2011 Amendment to the Connecticut Supplement

Please turn down cell phones and put pagers on vibrate.

Thank you
Course Objectives

• Construction Changes that effects ventilation, exhaust and ducts.
• Review of Code Definitions
• What Are The Residential Code Requirements For
  – Ventilation
  – Exhaust
  – Duct Systems
• How Does 2009 IRC requirements differ from 2003 IRC requirements

Course Objectives

Ventilation, Exhaust, Duct Systems

• How Do Each Of These Systems
  – Interact with each other
    • As directed by the 2009 IRC compared to 2003
    • In overall
      – Operation
      – Comfort
      – Indoor Air Quality

Ventilation

• What Is It?
  – According to Chapter 2, Section R202 definitions
    • VENTILATION:
      – The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space

Natural Ventilation

• When Can We Use Natural Ventilation?
  – Section R303.1
    • Minimum open able area to the outdoors
      – 4% of the floor area being ventilated
Residential Code Requirements
Exhaust, Ventilation & Duct Systems

4% Example #1

- Applying R303.1
  - 20' x 30' = 600 sq ft
  - 4% Of Floor Area
    - Minimum open able area equals
      - .04 x 600 = 24 sq ft
    - 32 sq ft open able area (vs.) minimum of 24 sq ft
- Windows Meet Code Requirements

4% Example #2

- Applying R303.1
  - 20' x 30' = 600 sq ft
  - 4% Of Floor Area
    - Minimal open able area equals
      - 600 x .04 = 24 sq ft
    - 12 sq ft operable area (vs.) minimum of 24 sq ft
- Window Does Not Meet Code Requirement

Adjoining Spaces

- An Adjoining Room
  - Section R303.2
    - When ½ or greater of the common wall is open and unobstructed
    - Opening not less than 1/10 of the floor area
      - Of the interior room
      - Not less than 25 square feet

Adjoining Spaces #1

- Required Opening
  - Total of both rooms
    - 50' x 20' = 1200 sq ft
    - 4% of area = 1200 x .04 = 48 sq ft
- Open Able Area
  - Door = 4' x 7' = 28 sq ft
    - 28 sq ft per door X 2 doors = 56 sq ft
    - 56 Actual (vs.) 48 required
      - Code Requirement is Met

Adjoining Spaces #2

- Required Opening
  - Total of both rooms
    - 50' x 20' = 1200 sq ft
    - 4% of area = 1200 x .04 = 48 sq ft
- Open Able Area
  - Door = 4' x 7' = 28 sq ft
    - 28 sq ft per door X 2 doors = 56 sq ft
    - 56 Actual (vs.) 48 required
      - Code Requirement is Met
## Residential Code Requirements

### Exhaust, Ventilation & Duct Systems

#### Adjoining Spaces #2

- **Required Opening**
  - Total of both rooms
    - 60’ X 20’ = 1200 sq ft
    - 4% of area = 1200 X .04 = 48 sq ft

- **Open Able Area**
  - Door = 3’ X 7’ = 21 sq ft
  - 21 sq ft per door X 2 doors = 42 sq ft
  - 42 Actual (vs.) 48 required
    - Code Requirement is NOT Met

- 60’ X 20’ = 1200 sq ft
- 4% of area = 1200 X .04 = 48 sq ft

#### Bathroom Ventilation

- **Section R303.3 Bathrooms**
  - Aggregate Glazing Area
    - Of not less than 3 sq ft, in windows
      - ½ of which must be open able

- 42 Actual (vs.) 48 required

#### Crawl Space Ventilation

- **Where Required**
  - **Section R408.1 Ventilation**
    - Under-floor space between the
      - Bottom of the floor joists and the earth
      - Shall be provided with ventilation openings
  - **Minimum net area of ventilation openings**
    - Not to be less than
      - 1 square foot for every 150 square feet
  - **One opening to be**
    - Within 3 feet of each corner

- Where Required (New for 2009 IRC)
  - **Section R408.1 Ventilation**
    - When the Ground surface is covered by Class 1 Vapor Retarder Material (0.1 perm or less)
  - **Minimum net area of ventilation openings**
    - Not to be less than
      - 1 square foot for each 1,500 square feet
  - **One opening to be**
    - Within 3 feet of each corner
Crawl Space Ventilation

Ventilation Opening Shall Be Within 3 Feet Of Each Corner Of The Building

Ventilation Openings

• Openings To Be Covered For
  – Height & width
  – Section R408.2
    • Materials
      – Perforated sheet metal plates
      – Expanded sheet metal plates
      – Cast iron grills
      – Extruded load bearing brick vents
      – Hardware Cloth
      – Corrosion resistant wire mesh

Opening Exceptions

• Natural Ventilation
  – Climatic conditions
  – Opening reduction
  • With approved vapor barrier
  • Cross ventilation provided
  – Space used as supply plenum
  • For heating or cooling
  – Mechanical ventilation
  • Rate of 1.0 cfm / 50 sq ft
  – No ventilation openings
  • Approved vapor retarder
  • Space is supplied with conditioned air

Exception #5

• No Openings Required When
  – Ground is covered with an approved vapor retarder
  • Perimeter walls are insulated
  – Refers over to
    • Section N1102.1.7 Crawl Space Walls
      – Insulation requirements per Table 1102.1
      – Exposed earth
        • Continuous vapor retarder
        • Maximum permeance of 1.0
### 2003 Table Is Set Up By Climate Zones

**CT Uses Zones 12, 13, 14**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>U-factor</th>
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<th>Glazed Fenestration U-factor</th>
<th>Shgc</th>
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### 2009 Table Is Set Up By Climate Zones

**CT Uses Zone 5**

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### Attic / Roof Ventilation

**Ventilation Required – Section R806.1**

(As per 2005 Amendments to CT Supplement)

- Cross ventilation necessary
  - Ventilation to be from openings protected from the elements
    - With corrosion resistant wire mesh
    - 1/8 to ¼ inch maximum openings

**Minimum Area - Section R806.2**

- Not less than 1 to 150 of the area
  - Reduction to 1 to 300
    - With ventilators providing 50 to 80%
    - Of required ventilation

### Vent Clearance

**Installation Of Eave Or Cornice Vents**

- Insulation is not to block the free flow of air
  - Minimum space of 1 inch
    - To be provided between insulation and roof sheathing
**Necessity Of Mechanical Ventilation & Exhaust Systems**

- **Our Areas Of Discussion On Natural Ventilation**
  - Have shown that when the code requirements for Natural Ventilation cannot be met
    - Mechanical Ventilation is necessary
- **Reference To:**
  - R303 Light Ventilation & Heating
  - R408 Under Floor space

**Definitions Relating To Mechanical Ventilation & Exhaust**

- **How Does The Code Look At Mechanical Systems?**
  - **Mechanical Exhaust System**
    - A system for removing air from a room or space by mechanical means
  - **Mechanical System**
    - A system specifically addressed and regulated in this code and composed of components, devices, appliances and equipment

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**Definitions Relating To Mechanical Ventilation & Exhaust**

- **Continuation**
  - **Ventilation**
    - The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space
      - (This is the same definition we looked at previously)
  - **NOTE:**
    - Ventilation and venting are two separate processes
      - Venting is the removal of combustion products to the outdoors

**Mechanical Ventilation For Habitable Rooms**

- **When Natural Ventilation Does Not Meet The Requirements Of R303.1**
  - **Exception #1**
    - Applies for the use of Mechanical Ventilation
      - It can be broken down into two parts
  - **Part 1**
    - An approved mechanical ventilation system
      - Capable of 0.35 air changes/ hour
      - Within the room
Example For Part 1

- **Application:**
  - Room is:
    - 12'w X 20'l X 8'h = 1920 cu ft
    - 0.35 air change / hour = 35%
      - .35 X 1920 cf = 672 cfm
      - 672 cfm / 60 min = 11.2 cfm

Second Portion Of Exception

- **Part 2**
  - When a whole house mechanical ventilation system is used
    - It is to be capable of supplying outdoor ventilation at
      - 15 cubic feet per minute / occupant
    - Computation base
      - 2 occupants for first bedroom
      - 1 occupant for each additional bedroom

Example For Part 2

- **5 Bedroom Home**
  - Master = 2 occupants
  - #2 = 1 occupant
  - #3 = 1 occupant
  - #4 = 1 occupant
  - #5 = 1 occupant
  - Total occupant load = 6 X 15 cfm = 90 cfm
    - 90 cfm whole house mechanical ventilation is necessary

Mechanical Ventilation For Bathrooms

- **Section R303.3 Bathrooms**
  - When the natural ventilation requirements for bathrooms cannot be met
    - The Exception would apply for mechanical ventilation
    - Minimum ventilation rates of
      - 50 cfm intermittent
      - 20 cfm continuous
    - All exhausting must be to the exterior of the building
Additional Code Sections

• Section M1506 Mechanical Ventilation
  – Sets up overlapping sections with R303.3
    • First
      – Exhaust air from bathrooms and toilet rooms shall not be recirculated within a residence or to another dwelling
    • Second
      – Exhaust systems shall have the capacity to exhaust the minimum air flow rate
        » As per Table M1506.3

Referenced Table

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Opening Locations

• Intake Openings R303.4.1
  – Minimum requirements for intake openings of natural and mechanical
    • 10 feet from hazardous or noxious contaminant
    • If within 10 feet of a source
      – Locate opening a minimum of 2 feet below the contaminant source
  – Dwelling unit exhaust, Bathroom exhaust and Kitchen exhaust
    • Are not considered to be hazardous or noxious

Figure R303.4.1

From 2003 IRC Commentary
**Exhaust Location**

- **Exhaust Openings R303.4.2**
  - Location of exhaust openings not to create a nuisance
    - What Does The Code Consider To Be A Nuisance
      - Dangerous to human life
      - Detrimental to health
      - Worse than bothersome
    - No direction of exhaust air to walkways

**Opening Protection**

- **Outside Opening Protection R303.5**
  - To be provided with corrosion resistant
    - Screens, Louvers or Grills
  - Minimum opening
    - Of \( \frac{1}{4} \) inch
  - Maximum opening
    - Of \( \frac{1}{2} \) inch

**Underfloor Mechanical Ventilation**

- **Exception #4**
  - Of Section R408.2
    - Allows for mechanical ventilation
  - With continuous mechanical ventilation
    - At a rate of 1.0 cfm
      - For each 50 sq ft of underfloor space
    - Ground surface to be covered with an approved vapor retarder material

**What Is The Difference**

- **Vapor Permeable Membrane:**
  - A material of covering having a permeance rating of \( 5 \) perms or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E96.
    - A vapor permeable material permits the passage of moisture vapor

- **Vapor Retarder:**
  - A vapor resistant material, membrane or covering such as foil, plastic sheeting, or insulation facing having a permeance rating of \( 1 \) perm or less, when tested in accordance with the desiccant method using Procedure A of ASTM E96.
    - Vapor retarders limit the amount of moisture vapor that passes through a material or wall assembly
Example

Crawl Space

- Crawl Space = 50' long x 30' wide =
  - 1500 Square Ft
    - 1500 sq ft / 50 sq ft = 30
    - 30 x 1.0 cfm = 30 cfm
  - Answer:
    - 30 cfm of Mechanical Ventilation is needed

Exception #4 Continued

- When Exception #4 Is Used
  - You must also comply with the code requirements of
    - Section N1102.7 Crawl Space Walls
      - “... Insulation shall be installed on crawl space walls when the crawl space is not vented to the outside air. The required R-value in Table N1102.1 shall be applied…”

Hydrogen Generation & Refueling Operations

- Natural Ventilation
  - Section M1307.4.1
    - For indoor operations
      - Minimum opening size of 3 inches
- Two Openings Required
  - Section M1307.4.2
    - One entirely within 12” of the ceiling
    - One entirely within 12” of the floor

Ventilation Openings

- Each Opening Must Go
  - Directly to the outdoors
    - Horizontally
    - ½ sq ft / 1000 cu ft of garage volume
- Louvers & Grills
  - M1307.4.1.2
    - Opening based on net free area
    - Less
      - 25% for metal louvers
      - 75% for wood louvers
Example #1

- **Garage Area**
  - 1. 20’w × 30’l × 8’h = 4800 cu ft
  - 2. 4800 cu ft / 1000 = 4.8
    - Since ½ square foot = 72 square inches
      - 4.8 × 72 = 345.6 sq in.
      - 345.6 / 144 = 2.4 sq ft
  - 3. 2.4 sq ft of minimum free area required

Mechanical Ventilation For Hydrogen Operations

- **Indoor Locations For Hydrogen Generating Or Refueling Operations**
  - To be mechanically ventilated as per Section 502.16 of the 2003 IMC
  - Ventilation rate of 1 cu ft / min (for each) 12 cu ft of room volume
  - Mechanical operation to be continuous
    - Unless interlocked with gas detection system

Engineered Installations

- **Section M1307.4.3**
  - Specially Engineered Installations
    - It sets up the supply of ventilation air
      - By use of an approved engineered system
  - It sets up a performance code
    - For new system development

Exhaust Systems

2009 IRC - Section M1501

- Section 1501.1 Outdoor discharge
  - Air removed by every mechanical exhaust system shall be discharged to the outdoors
    - Air shall not be exhausted into an attic, soffit, ridge vent or crawl space.
      - Exception: Whole house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics shall be permitted.
**Clothes Dryer Exhaust**

2009 IRC Section M1502

Formerly Section M1501 - 2003 IRC

- **Section M1502.1 General**
  - Exhausted according to Manufacturer’s Instructions
- **Section M1502.2 Independent exhaust systems**
  - Exhaust is to be independent and terminate outdoors
- **Section M1502.3 Duct Termination**
  - Duct termination is to
    - Terminate not less than 3 feet in any directions from openings
    - Be equipped with a backdraft damper
    - No screens in duct termination

**Dryer Exhaust Ducts**

2009 IRC

Section M1502.4 Dryer Exhaust Ducts

- **M1502.4.1 Material and size**
  - Smooth interior finish
  - Minimum of 0.016” thick rigid metal
  - 4 inches nominal diameter
- **M1502.4.2 Duct installation**
  - Supported at 4 foot intervals and secured in place
  - Joints to run in the direction of air flow
  - No fasteners to extend into duct
- **M1502.4.3 Transition duct**
- **M1502.4.4 Duct length**
- **M1502.4.5 Length identification**

**M1502.4.6 Exhaust ducts required**

- Where space for clothes dryer is provided.
- Exception
  - Does not apply to condensing (ductless) dryers

**M1502.4.3 Transition duct**

- Limited to a single length
  - Not to exceed 8 feet
- To be listed and labeled UL 2158A
- Not to be concealed

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**Exhaust Duct**

M1502.4.4 Duct length (2009 IRC)

- **M1501.4.4.1 Specified Length**
  - Not to exceed 25 feet in length
  - Reduced in accordance to Table M1502.4.4.1
- **M1501.4.4.2 Manufacturer’s instructions**
  - Size and Length as per MFG installation instruction

Length Limitation 2003 IRC

- **Section M1501.3**
  - Not to exceed 25 feet in length
  - Does not include the transition
  - Restriction reductions
    - 45 degree = 2.5 feet
    - 90 degree = 5 feet
**Dryer Exhaust Ducts**

- **M1502.4.5 Length identification**
  - Where concealed within building construction
    - Exhaust duct shall be identified on permanent label or tag
    - Label or tag shall be located within 6 feet of duct connection.

- **M 1502.5 Protection Required**
  - Protective shield plates shall be placed where nails or screws likely to penetrate
    - Less than 1.25 inches (between duct & finish surface)
    - Minimum thickness 0.062 inch steel
    - Extend 2 inches above sole plate and below top plate

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**Range Hoods**

- **2009 IRC Section M1503**

- **General** Section M1503.1
  - All ducted range hoods are to discharge to the outdoors, through a single wall duct
    - No termination in Attic, Crawl Space, Inside of Building
    - Wall duct
      - Smooth interior finish
      - Air tight
      - Equipped with backdraft damper

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**Exception**

- Range hood discharge
  - Listed & Labeled Ductless (Recirculating) Range Hoods
    - Are not required to exhaust outdoors
    - When
      - Installed as per MFG Installation Instructions
      - Mechanical or Natural ventilation is provided

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**Range Hood Duct Materials**

- **Section M1503.2 Duct Material**
  - Single wall ducts for range hoods are to be constructed of
    - Galvanized steel, Stainless steel, Copper
  - Exception
    - Downdraft exhaust systems using
      - Schedule 40 PVC
**Downdraft Exception**

Exception to M1503.2

- **When Schedule 40 PVC Is Used**
  - Installation must meet all of the requirements
    - Duct to be installed under a concrete slab poured on grade
    - Trench to be backfilled with sand or gravel
    - Duct extension above indoor concrete floor
      - Maximum of 1 inch
    - Duct extension above outdoor grade
      - Maximum of 1 inch
    - Ducts are to be solvent cemented

**Range Hoods**

- **M 1503.3 Kitchen exhaust rates**
  - Fans shall be sized in accordance to M1507.3
- **M 1503.4 Makeup air required**
  - Exhaust hood systems exhausting in excess of 400 cubic feet per minute
    - Shall be provided with makeup at +/- equal rate
    - Makeup air systems equipped with means of closure and automatic controls to start and operate simultaneously with exhaust system

**Microwave Oven Installation**

- **Installation Of Microwave Oven Over A Cooking Appliance**
  - Section M1504.1
    - Unit is to be listed and labeled
    - Installation to be in conformance with
      - Listing and labeling
      - Manufacturers Installation Instructions

**Overhead Exhaust Hoods**

- **Section M1505.1**
  - Domestic open-top broiler units
    - To be provided with a metal exhaust hood
      - Minimum of 28 gage
    - 0.25 inch clearance to combustible materials
    - Minimum clearance from cooking surface of
      - 24 inches
Minimum Dimensions

• **Besides The 24” Minimum Clearance**
  -- To the cooktop surface
• **Unit is to be**
  -- As wide as the cook-top
  -- Extend over the cook-top
• **System Must Meet Requirements For**
  -- Outside termination
  -- Backdraft damper
  • For control of infiltration & exfiltration

Mechanical Ventilation
2009 IRC Section M1507

• **M 1507.2 Recirculation of Air:**
  • Exhaust Air from toilet rooms and bathrooms shall not be recirculated
  • Exhaust Air from toilet rooms and bathrooms shall not discharge into attic, crawl space or other airs inside building

• **M 1507.3 Ventilation Rate:** Table M1507.3

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Short Break

Chapter 16
Duct Systems

• **Terms And Definitions**
  – **Duct System**
    • A continuous passageway for the transmission of air which, in addition to duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.
  – **Plenum**
    • A chamber that forms apart of an air-circulation system other than the occupied space being exhausted.
**Duct Construction**

- **Duct Design Section M1601.1**
  - When serving heating, cooling & ventilation equipment
  - Fabrication to follow
    - This chapter's provisions &
    - ACCA Manual D
      - Or other approved methods

**Type Of Duct Systems**

- **The Chapter Breaks Them Down Into**
  - Above ground duct systems
    - Section M1601.1.1
  - Underground duct systems
    - Section M1601.1.2

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**Above Ground Duct Systems**

- **Seven Code Requirements**
  - Discharge Air Temperature
    - Limited to 250 degrees F.
  - Factory Made Duct Material
    - To be Class 0 or Class 1 materials

<table>
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<tr>
<th>DUCT CLASS</th>
<th>MAXIMUM FLAME-SPREAD RATING</th>
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<tr>
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- **What Are These Ratings?**
  - Flame Spread
    - The propagation of flame over a surface
  - Flame Spread Index
    - The numerical value assigned to a material tested in accordance with ASTM E84

- **An Additional Area Of Reference**
  - NFPA 255
    - Standard method of test of surface burning characteristics of building materials
Above Ground Duct

- Fibrous duct is to conform to
  - SMACNA or NAIMA standards
- Minimum thickness of metal duct
  - As per Table M1601.1(2)

From: 2003 IRC

Above Ground Duct

- Gypsum products may only be used for construction of return ducts and plenums
  - Air temp not to exceed 125 degrees F
  - Exposed surface not to be subject to condensation
- Duct system construction materials flame spread index
  - Not to be greater than 200
- Stud wall cavities & floor joist spaces to be used as return air plenums
  - Must meet four criteria

Wall Cavities & Joist Spaces Criteria

- All Of The Following Must Be Met
  - May not be used for supply air
  - May not be part of a required fire resistance rated assembly
  - Wall cavity use not to convey air from more than one floor level
  - Space isolation from adjacent concealed spaces
  - Using tight fitting fire block
    - As per Section R602.8

Acceptable Installation

- Wall Studs
- Fireblocking
- Grill Open To Wall Cavity
- Gypsum Nailed Over Both Sides Of Studs
- Joint Space Plenum
- Bottom Plate Cutaway Opening Sealed In Flooring
Residential Code Requirements
Exhaust, Ventilation & Duct Systems

December 2011

Unacceptable

Underground Duct Systems
M1601.1.2

• Construction Materials
  • Concrete, Clay, Metal, Plastic

• Maximum Temperature
  • 150 degrees F. for plastic duct

• Metal duct to be protected from corrosion
  • In an approved manner
  • Or encased in 2" of concrete, minimum

• Installation of non-metallic duct
  • Follow MFG installation instructions

Manufactured Duct

• Factory-Made Ducts – Section M1601.2
  • Listed – labeled, approved for their intended use
  • Installation per MFG installation instructions

Flexible Air Duct Label Representation
Flexible Air Connector Label Representation
Residential Code Requirements
Exhaust, Ventilation & Duct Systems

December 2011

Flex Duct MFG Installation Instructions

SEE THE NEXT PAGE OF YOUR HANDOUT FOR COMPLETE SHEET

Factory Made Duct Insulation

• Duct Insulation Materials
  Section M 1603.3
  – Formerly M1601.2.1(2003 IRC)
  – All materials must conform to:
    • Flame spread index & smoke developed index
      – Flame spread not greater than 25
      – Smoke developed index not greater than 50
      – Exception 2009 IRC sprayed applied polyurethane foam to exteriors of ducts in attics & crawl spaces 25/450
  • Coverings and linings
    – Shall not
      » Glow, Flame, Smolder or Smoke
      » As per ASTM C 411 testing

Duct Insulation To Conform To

• Insulation Conformance Factors
  – External insulation & flex duct identification
    • Legible markings
      – Every 36 inches or less
      – To include
        » Manufacturer
        » R-value
        » Flame spread index
        » Smoke developed index

External Insulation & Flex Duct

• Installed Thickness R-Value
  – Duct board, liner & factory rigid duct
    • Use nominal insulation thickness
  – Duct wrap
    • Installed thickness
      – 76% of nominal thickness
  – Factory flexible ducts
    • Installed thickness
      – Difference between outside dia & inside diameter
        » Divided by 2
**Vibration Isolators**

- **Section M1601.2.1** (Formerly M1601.2.2 (2003 IRC))
  - When prefabricated from approved material
    - May not exceed 10” in length

**Installation Of Ductwork**

- **Joints & Seams – Section M1601.4.1** (Formerly M1601.3.1 in 2003 IRC)
  - Joints are to be substantially air tight
    - Joint & Seam sealing
      - Tapes, Mastics, Gasketing & other approved means
      - All methods to comply with their UL rating

**Examples**

- **Rigid Fibrous Glass Duct**
  - Meets UL 181A
    - UL 181 A-P = Pressure Sensitive Tape
    - UL 181 A-M = Mastic
    - UL 181 A-H = Heat Sensitive Tape

- **Flexible Air Ducts & Connectors**
  - Meets UL 181B
    - UL 181 B-FX = Pressure Sensitive Tape
    - UL 181 B-M = Mastic

**Connections**

- **Flange Connections**
  - Duct to flange connections are to be mechanically fastened

- **Crimp Joints For Round Ducts**
  - Should have a 1.5 inch contact lap
  - Must be mechanically connected
    - Minimum fastening of
      - 3 sheet metal screws or rivets, equally spaced
**Duct Support**

- **Support:** Section M 1601.4.3 (2003 IRC Section M1601.3.2)
  - **Metal Duct support**
    - 0.5 inch wide number 18 gage metal strap
    - (or) 12 gage galvanized wire
    - At intervals of
      - Not exceeding 10 feet
  - **Non-metallic ducts**
    - To be supported as per MFG installation instructions
- **Duct Separation:** Section M1601.4.7 (2003 IRC Section M1601.3.6)
  - Minimum of 4” from earth

**Do I Need To Fireblock?**

- **Fireblocking - Section M1601.4.4**
  - Formerly M1601.3.3 in 2003 IRC
  - Fireblock as per Section R602.8/R302.11
    - As per number 4
      - At openings around vents, pipes, ducts, cables and wires at ceiling and floor level, with an approved material to resist the free passage of flame and products of combustion

**Insulation Installation**

- **Duct Insulation**
  - Section M1601.4.5 (Formerly M1601.3.4 of 2003 IRC)
    - It shall be installed in accordance with three separate requirements
  - **Requirements**
    - **Vapor Retarder**
      - Maximum permeance of 0.05 perm
    - **Aluminum Foil**
      - Minimum thickness of 2 mils
    - **Both to be installed on the exterior of insulation**
      - On cooling supply ducts
      - Passing through unconditioned space
      - Exception spray polyurethane foam with water vapor 3 perm/ft² at installed thickness

- **When Wall Or Floor Is Fireblocked**
  - Duct coverings are not to penetrate the wall or floor

- **Exterior Duct System**
  - To be protected against the elements

**Would This System Meet Code??**
**Insulation Thickness**

- When Chapter 11 Of The 2009 IRC Is Used
  - For Energy Efficiency
    - Section N1103.2 Ducts -
      - Supply Ducts in Attics shall be insulated to a minimum of R-8
      - All other ducts shall be insulated to a minimum of R-6
    - Exception:
      - Ducts or portions thereof located completely inside the building envelope.

**Ducts In Garages**

- Supply Ducts in Garages
  - Ducts A - Ducts in Openings into Garage
  - Duct B - Any Duct Approved by the IRC

**Under Floor Plenums**

- Section M1601.5 (Formerly M1601.4 in 2003 IRC)
  - Underfloor space used as a supply plenum
    - Downflow / Counterflow furnace

**Return Air**

- Return Air May Be Taken From
  - Inside the dwelling
    - Outside dilution air may be added
  - Prohibited Sources – Section M1602.2
    - Outdoor and return air may not be taken from any of five locations
    - With some exceptions
Prohibited Sources
- **No Air To Be Taken From**
  - Within 10 foot minimum from
    - Appliance vent, Plumbing vent, Exhaust discharge
      - Unless outlet is 3 feet above the air inlet
  - **When Flammable Vapors Are Present**
    - May not be less than
      - 10 feet above a public way, or driveway
    - Nor less than 10 feet on grade location from
      - Sidewalk, street, alley or driveway

Prohibitions Continued
- **If Room Or Space**
  - Is less than 25% of the entire volume served
    - As per Manual D for room connections
      - Adjoining rooms or spaces may be considered as a single room
  - **Exception**
    - The 25% does not apply
      - If the return air is less than or = to the amount of supply air to the room or space

Prohibitions Continued
- **No Return Air May Be Taken From**
  - Closet
  - Bathroom
  - Kitchen
  - Garage
  - Mechanical Room
  - Furnace Room
    - Or another dwelling

Prohibited Sources
- **Any Room Or Space With Fuel Burning Units**
  - When the room serves as the sole source of return Air
- **Exception**
  - Direct vent or non-vented unit
  - Space volume exceeds
    - 1 cubic foot for each 10 Btu/h of total input
    - Discharge air is = to supply air
    - Return air inlet not within 10 feet of firebox or draft hood
  - Solid fuel burning with return air inlet
    - Greater than 10 feet from firebox or draft hood
Combustion Air

Major Change in 2009 IRC from 2003 IRC
- Section M1701.1 Scope.
  - Solid-fuel burning appliances
    - Shall be provided with combustion air in accordance with the manufacturer's installation instructions.
  - Oil-Fired appliances
    - Shall be provided with combustion air in accordance with NFPA 31 - 2006
  - Methods of providing combustion air in this chapter do not apply to fireplaces, fireplace stoves, and direct-vent appliances
  - Gas-fired appliances shall be in accordance with Chapter 24 – Fuel Gas

Combustion Air - 2003 IRC
- Air Supply Section M1701.1
  - The section deals with liquid and solid fuel systems
    - It does not deal with gas units
  - Buildings Of Unusually Tight Construction
    - Combustion air is to be gotten from outside the sealed envelope
  - Ordinary Tightness Is Based Upon
    - 50 cu ft of air per 1000 Btu/h of total input

What Is
- Unusually Tight Construction
  - Construction meeting these requirements
    - Thermal envelope walls
      - With a vapor retarder rating of 1 perm or less with gasketed or sealed openings
    - Doors & openable windows meeting air leakage
      - Requirements of IECC 502.14.1
    - Applied caulking and sealants for joints, windows, door frames, plates
      - Mechanical, electrical & plumbing penetrations and other openings

Combustion Air (2003 IRC)
- Prohibited Sources Section M1701.4
  - Areas where a fan may cause adverse conditions
  - Areas with flammable vapors
  - Fuel fired systems may not get air from
    - Sleeping rooms
    - Bathrooms
    - Toilet Rooms
  - Exceptions
    - If solid fuel, provided it is not a conditioned space
    - If all air is from outdoors and enclosure uses
      - Solid weather stripped door with self closure
**All Air From Inside The Building (2003 IRC)**

**Required Volume**
- This method may be used if the following are met
  - Volumetric space is greater than 50 cu ft per 1000 Btu/h of total input
  - Building is of Ordinary Tightness
- Communicating rooms may be used
  - If they communicate directly through openings
  - With no doors

**Confined Space (2003 IRC)**

- **Section M1702.2**
  - Opening dimensions for each opening
    - 1 sq in / 1000 Btu/h of total input
      - Minimum of 100 sq in per opening

**Outdoor Air (2003 IRC)**

- **All Air From Outdoors M1703**
  - Two openings or ducts - Section M1703.2
    - Location
      - Within 12" of the top
      - Within 12" of the bottom
    - May be direct connections to
      - Outdoors, Ventilated Attic, Ventilated Crawl Space
    - Opening size
      - Vertical Ducts = 1 sq in per 4000 Btu/h total input
      - Horizontal Ducts = 1 sq in per 2000 Btu/h total input
      - Minimum cross sectional dimension of rectangular duct to = 3 inches

**Diagram Example #1**

**DIRECT OPENINGS (100% Outside Air)**

2 Permanent Openings Each Sized (1Sq. In. / 4,000 Btu/hr Input)
- Top Or Outlet Opening
  - Located Within 12 Inches Of Ceiling
- Bottom Or Inlet Opening
  - Located Within 12 Inches Of Floor
Residential Code Requirements
Exhaust, Ventilation & Duct Systems

Diagram Example # 2
Vertical Ducts

Diagram Example # 3
Through Horizontal Ducts

Outdoor Air From Indirect Areas (2003 IRC)

- Attic Combustion Air - Section M1703.3
  - Ventilation to be sufficient for
    - Attic needs & combustion air needs
  - Metal sleeve to extend
    - 6 inches above joists & insulation
  - Inlet within outlet may be used
    - Inlet duct to be 12” above outlet duct

- Underfloor Combustion Air – Section M1703.4
  - Ventilation openings to outside
    - To be a minimum of
      - 2 times the required combustion air opening

Diagram Example # 1
Combustion Air From Attic Space
2009 IRC - NFPA 31- 2006 Chapter 5
Air for Combustion and Ventilation

• Section 5.2 Basic Requirements
  – Appliances located not to interfere with supply of air within space
  – Outside air shall be introduced where tight buildings' normal infiltration does not provide sufficient combustion air
  – Ducts from outdoors same cross-sectional area as free area of openings to which they connect
  – Smallest dimension of rectangular air ducts not less than 3 in.
  – Residential requirements of 5.2.1 permitted to be met by either Section 5.3 or 5.4

2009 IRC - NFPA 31- 2006 Chapter 5
Air for Combustion and Ventilation

• Section 5.3 Appliances Located in Unconfined Spaces
  – Section 5.3.1: In unconfined spaces in buildings of conventional frame, brick or stone construction
    • Air for combustion and ventilation shall be permitted to be supplied by normal infiltration
  – Section 5.3.2: If Normal Infiltration is not sufficient because of TIGHT Construction
    • Air for combustion and ventilation shall be obtained directly from outdoors
    • Or from spaces that freely communicate with outdoors by means of permanent opening or openings having a total free area not less than 1 in² per 5000 Btu/hr based on input rating of all appliances in space
2009 IRC - NFPA 31- 2006 Chapter 5
Air for Combustion and Ventilation

• Section 5.4 Appliances Located in Confined Spaces
  – Section 5.4.1: All Air Taken from Inside the Building
    • The confined space shall be provided with 2 openings see figure 5.4.1.1, one near top of space and one near bottom
  – Section 5.4.2: All Air Taken from Outdoors
    • The confined space shall be provided with 2 openings, one near top of space and one in or near bottom
    • The openings shall communicate directly or by means of ducts with the outdoors or to spaces such as attics or crawl space that freely communicate with outdoors
  – Section 5.4.3: Air Taken from Inside the Building – Combustion Air Taken from Outdoors
    • The confined space shall be provided with 2 openings ...

NFPA 31- 2006
Section 5.4.1
All Air Taken from Inside the Building

NFPA 31- 2006
Section 5.4.2
All Air Taken from Outdoors
Combustion Air For Gas

- **Chapter 24 Fuel Gas**
  - Uses the same methods as chapter 17 (2003 IRC)
  - With a few additions

- **Combining Spaces In Different Stories**
  - Section G2407.5.3.2
  - Allows for the use of a second story for combustion air under ordinary tightness
  - 1 or more openings in
    - Doors and floors
    - Total free area of 2 sq in per 1000 Btu/h total input

One Opening For Outside Air

- **One Permanent Opening Method - Section G2407.6.2**
  - Allows for one opening
    - Within 12" of the top of the enclosure
    - Opening size of
      - 1 sq inch per 3000 Btu/h of total input
  - Equipment within enclosure minimum clearances of
    - 1" sides and back
    - 8" in front
**Residential Code Requirements**

**Exhaust, Ventilation & Duct Systems**

**December 2011**

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### One Opening Placement

- **A** = Direct Opening To Outside Within 12 Inches Of Ceiling
- **B** = Horizontal Duct To Outside Within 12 Inches Of Ceiling
- **C** = Vertical Duct To Attic Space Within 12 Inches Of Ceiling

Terminates Minimum Of 6 Inches Above Attic Floor And Insulation

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### Enclosure Clearances

- **SINGLE OPENING TO OUTDOOR AIR**
- **FRONT**
- **6 INCH MINIMUM**

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### Use Of Indoor & Outdoor Air

- **Outdoor Opening Calculation** – Section G2407.7.3
  - **Calculation of opening size**
    - Interior ratio shall be
      - Available volume / Required volume
    - Outdoor size reduction factor
      - 1 minus ratio of interior space
    - Minimum outdoor opening size
      - Size as determined by section G2407.6
      - Times the reduction factor
    - **NOTE:** Minimum dimension not to be less than 3 inches

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### Example Problem

![Example Problem Diagram]

20' x 20'

20,000 Btu/hr Furnace

50,000 Btu/hr Water Heater

2 Openings 10" x 20"

2 - 3" Dia. Openings

NOTE: Ceiling 8'

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Office of Education and Data Management
**Do The Openings To The Outdoors, Combined With The Volumes Of A & B Meet Combustion Air Demand?**

- **Volume Of “A”:**
  - 4800 Cubic Feet
- **Volume Of “B”:**
  - 4800 Cubic Feet
- **Area Of The 3” Diameter Opening:**
  - 7.07 Square Inches
- **Area Of Each Opening Between A & B:**
  - 200 Square Inches

**Problem Continued**

- **TOTAL INPUT:**
  - 200,000 Btu/hr
- **Question**
  - Do “A” & “B” meet the volumetric requirements of G2407.5?
    - **Required Volume =**
      - 10,000 Cu.Ft.
    - **Available Volume =**
      - 9,600 Cu. Ft.
    - **NO**

**Problem Continued**

- **Do openings between “A” & “B” meet requirements of G2407.5.3**
  - **Required Area =**
    - 200 Square Inches
  - **Actual Area =**
    - 200 Square Inches
  - **YES**

**Problem Continued**

- **Determine The Required Area Of Each Outdoor Opening?**
  - **Required Area =**
    - $(200,000 / 4000) \times 1 \text{sq in} = 50 \text{ sq in}$
  - **Determine If The 3 Inch Diameter Openings Along With The Interior Openings Comply?**
    - $[(1) - 9600 / 10000] \times 50 = 0.04 \times 50 = 2 \text{ sq in.}$
      - **OK**
How Does All This Fit In With

Tying The Ends Together

- Single Code Requirements
  - Will not stop Indoor Air Quality problems
- All Code Requirements Together
  - Ventilation, Exhaust, Proper Duct Design
    - Will keep the Residential Building free of
      - Contaminants
      - Moisture
      - Mold
      - Hazardous Products
- Promoting a healthy and safe environment

What Does The Future Hold

- ASHRAE Standards Are In The Lead
  - ASHRAE Standard 62.2 – 2003
    - Ventilation & Acceptable Indoor Air Quality for Low-Rise Residential Buildings
      - Leads the way in Residential IAQ through
        • Ventilation, Exhaust & Ducting
      - Maine is in the process of adopting this standard for their new Building Code
      - Newer codes will be using this standard
        • In its complete or a partial form

Questions??

CT Department of Public Safety
Division of Fire, Emergency and Building Services

- Office of the State Building Inspector
  (860) 685 - 8310
- Office of the State Fire Marshal
  (860) 685 - 8350
- Office of Education and Data Management
  (860) 685 – 8330

http://www.ct.gov/dps/

Thank-you!