Residential Energy Code
Combustion Air and Make-Up Air

Presenters
Don Sivigny
Don.sivigny@state.mn.us
6651-284-5874
&
Scott Nelson
Scott.nelson@state.mn.us
651-284-5850

CCLD /DOLI

History of the Energy Code

History

- First Energy Code Became effective on January 30, 1976

History

- First Energy Code Became effective on January 30, 1976
- Model Energy Code Phase
  - 1982-1992

History

- First Energy Code Became effective on January 30, 1976
- Model Energy Code Phase
  – 1982-1992
- Chapter 7670
  – June 16, 1994

History

- First Energy Code Became effective on January 30, 1976
- Model Energy Code Phase
  - 1982-1992
- Chapter 7670
  - June 16, 1994
- Chapter 7672
  - April 15, 2000

History

- First Energy Code Became effective on January 30, 1976
- Model Energy Code Phase
  - 1982-1992
- Chapter 7670
  - June 16, 1994
- Chapter 7672
  - April 15, 2000
- Mn. Rule 1322
  - June 1 2009

Minnesota's Residential Energy Code What's Changing

Minnesota Rules Chapter 1322

The New Residential Energy Code,

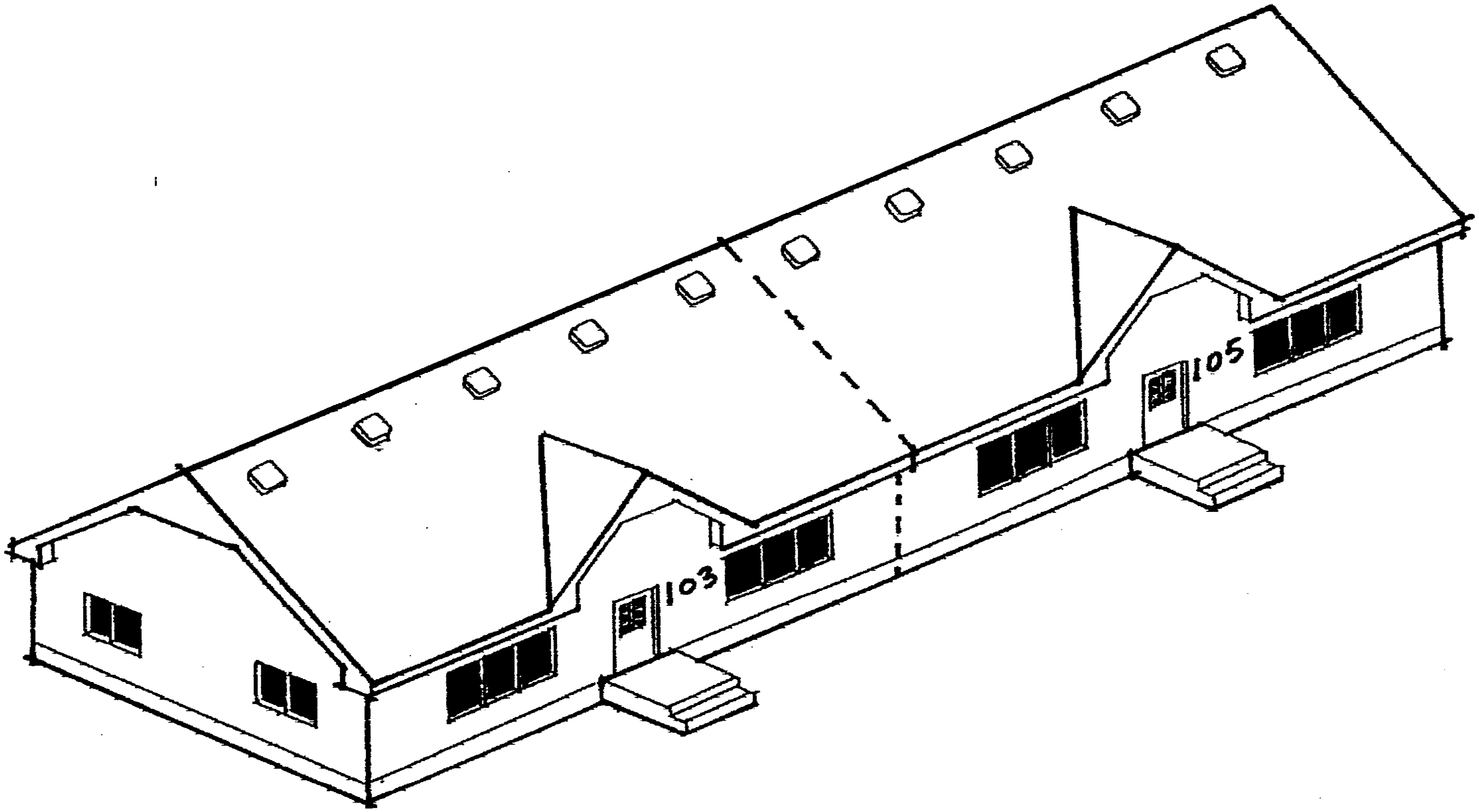
Incorporates Provisions for Radon Control however we are not discussing them today

N1101.1 Scope

This chapter regulates the energy efficiency for the design and construction of buildings regulated by the International Residential Code (IRC) as adopted and amended by the State of Minnesota.

Single Family Dwellings

- Two Family Dwellings



Townhouses

N1101.1 Scope

This chapter shall also be used to meet the energy efficiency for the design and construction of new multi-family residential buildings regulated by the International Building Code (IBC) as adopted and amended by the State of Minnesota, that:

Scope

(1) are not more than three stories in height;

These would be under the Residential Energy Code

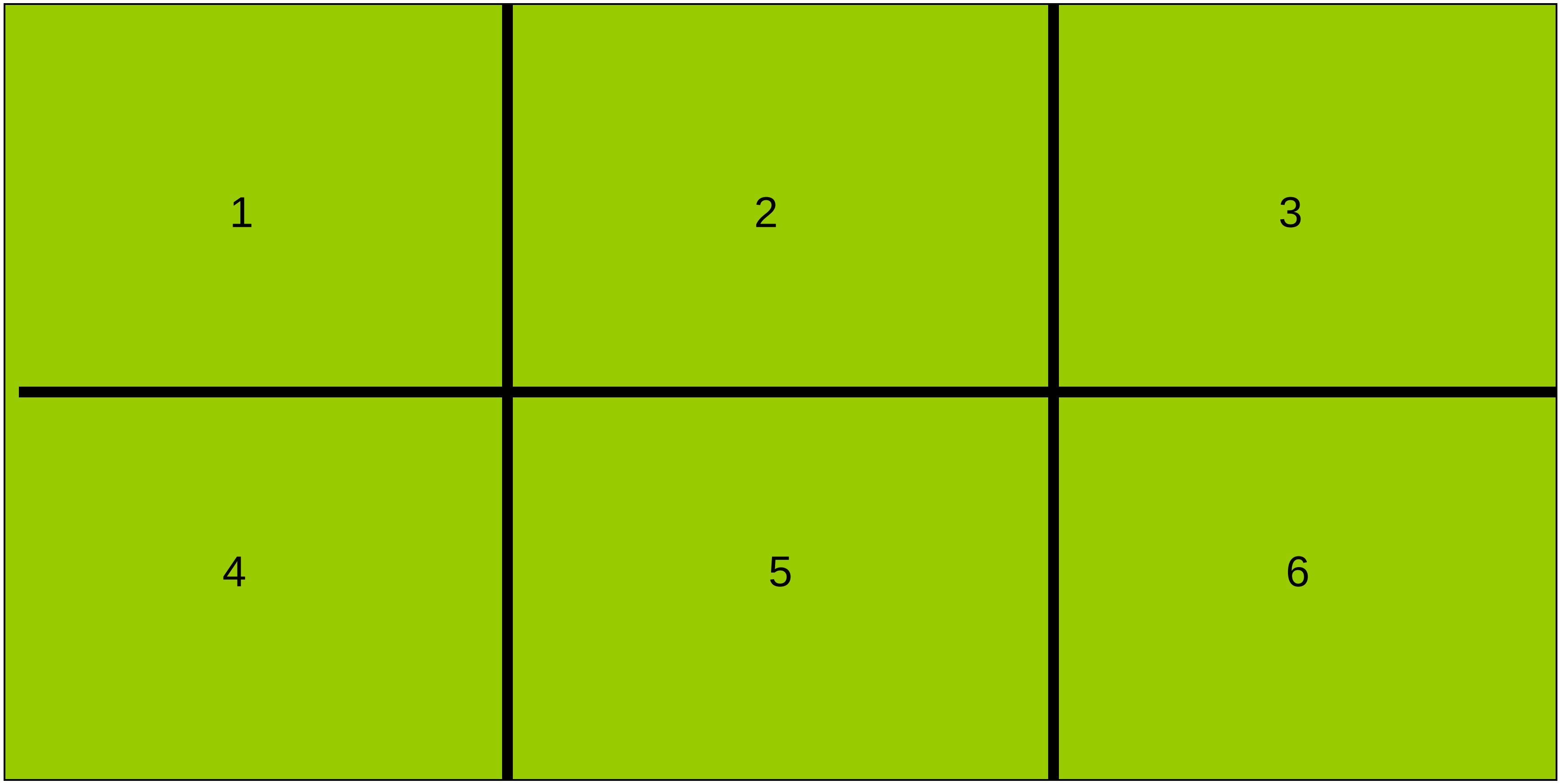
This Building would be built to the Commercial Energy Code

Scope

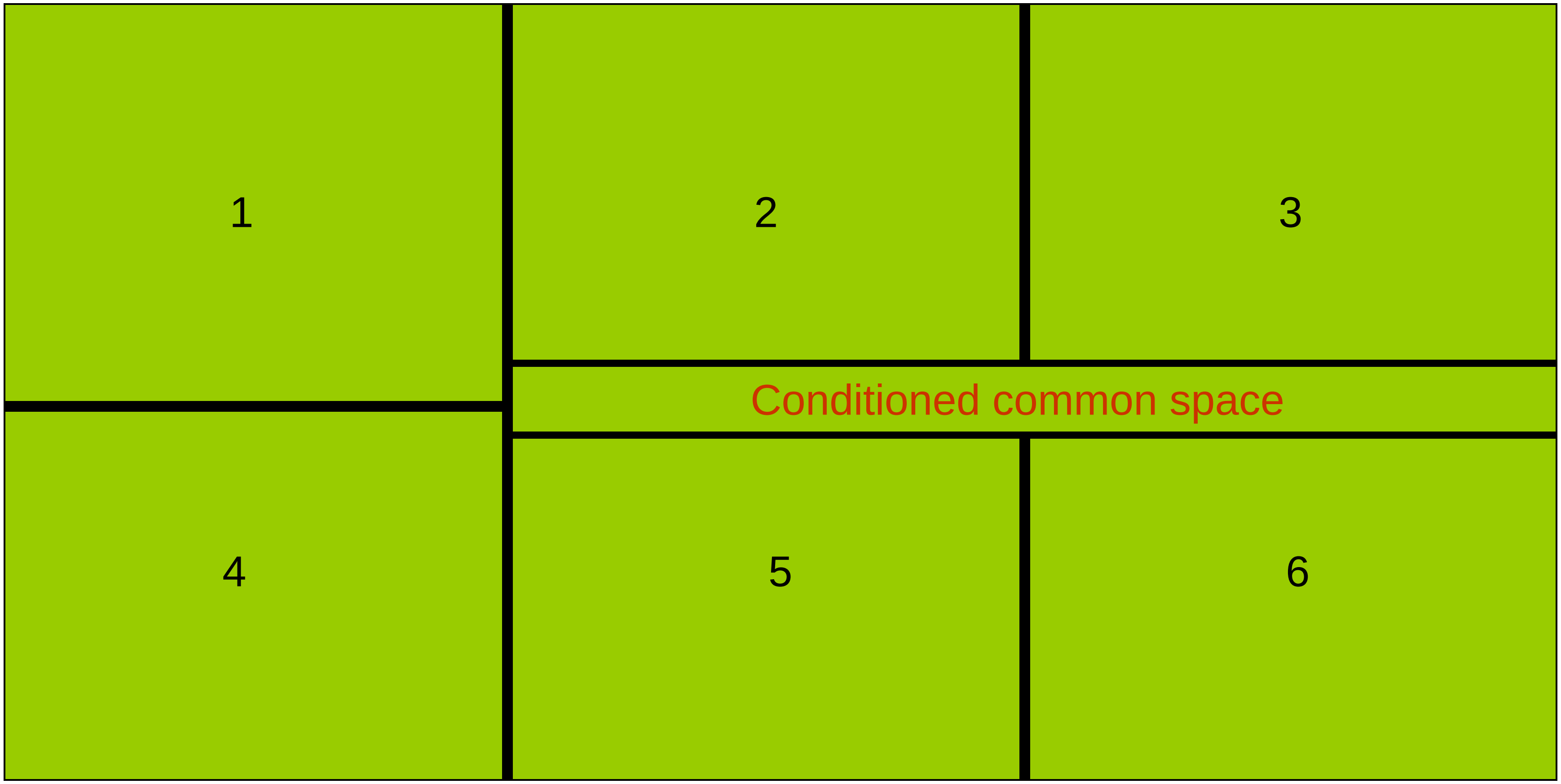
(1) are not more than three stories in height;

(2) contain no conditioned common space that is shared between dwellings;

This Building **would** Meet the Scoping Provisions



This Building **would not** Meet the Scoping Provisions



Scope

(1) are not more than three stories in height;

(2) contain no conditioned common space that is shared between dwellings;

(3) each dwelling unit contains a separate means of egress.

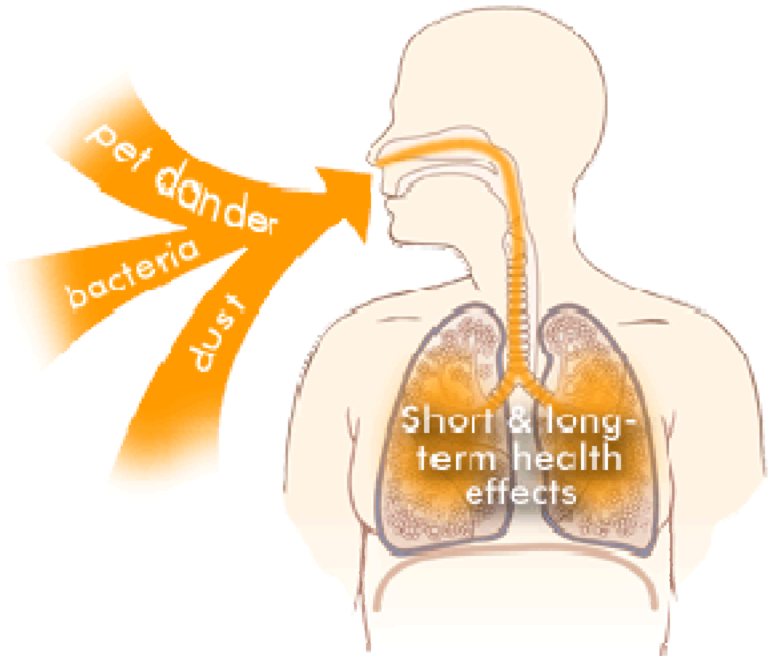
Scope

The intent of these criteria is to provide a means for furnishing

Scope

The intent of these criteria is to provide a means for furnishing

1. quality indoor air



© AirAdvice, Inc., www.airadvice.com

Scope

The intent of these criteria is to provide a means for furnishing

1. **quality indoor air**
2. **assuring building durability**

What is meant by durable buildings?

What is meant by durable buildings?

- Insurance company point of view

What is meant by durable buildings?

- Insurance company point of view
- Mortgage company point of view

What is meant by durable buildings?

- Insurance company point of view
- Mortgage company point of view
- Contractor point of view

What is meant by durable buildings?

- Insurance company point of view
- Mortgage company point of view
- Contractor point of view
- Code/Building Inspector point of view

What is meant by durable buildings?

- Insurance company point of view
- Mortgage company point of view
- Contractor point of view
- Code/Building Inspector point of view
- Owner/occupant point of view

What is meant by durable buildings?

- Insurance company point of view
- Mortgage company point of view
- Contractor point of view
- Code/Building Inspector point of view
- Owner/occupant point of view
- Other points of view

Why and where do the codes address durability?

- Energy code

Why and where do the codes address durability

- Energy code
  - Required by the legislature to address it.

Why and where do the codes address durability

- Energy code
  - Required by the legislature to address it.
  - Should it be only a BTU code?

Vapor Retarders/Wall Durability

Vapor Retarders/Wall Durability

- Durability and moisture control are directly related

Vapor Retarders/Wall Durability

- Durability and moisture control are directly related
- Controlling moisture means controlling wetting and drying

Vapor Retarders/Wall Durability

- Durability and moisture control are directly related
- Controlling moisture means controlling wetting and drying
- Wetting is primarily controlled by air barriers, flashing and drainage plane improvements

Vapor Retarders/Wall Durability

- Durability and moisture control are directly related
- Controlling moisture means controlling wetting and drying
- Wetting is primarily controlled by air barriers, flashing and drainage plane improvements
- Drying is primarily controlled by air barriers and vapor retarders

Vapor Retarders/Wall Durability

- Durability and moisture control are directly related
- Controlling moisture means controlling wetting and drying
- Wetting is primarily controlled by air barriers, flashing and drainage plane improvements
- Drying is primarily controlled by air barriers and vapor retarders
- This is true on both the cold and warm sides of the wall

Why and where do the codes address durability

- What about the building codes

Why and where do the codes address durability

- What about the building codes
  - Flashings

Why and where do the codes address durability

- What about the building codes
  - Flashings
  - Weather resistive barriers

Why and where do the codes address durability

- What about the building codes
  - Flashings
  - Weather resistive barriers
  - Drainage – (above and below grade)

Why and where do the codes address durability

- What about the building codes
  - Flashings
  - Weather rssistive barriers
  - Drainage– (above and below grade)
  - Ventilation

Why and where do the codes address durability

- What about the building codes
  - Flashings
  - Weather resistive barriers
  - Drainage
  - Ventilation
  - Others?

Water/Moisture/Bulk/Diffusion

Water/Moisture/Bulk/Diffusion

- When the rate of wetting exceeds the rate of drying accumulation occurs

Water/Moisture/Bulk/Diffusion

- When the rate of wetting exceeds the rate of drying accumulation occurs
- The drying potential of an assembly decreases with the thickness of the insulation and increases with the rate of air flow

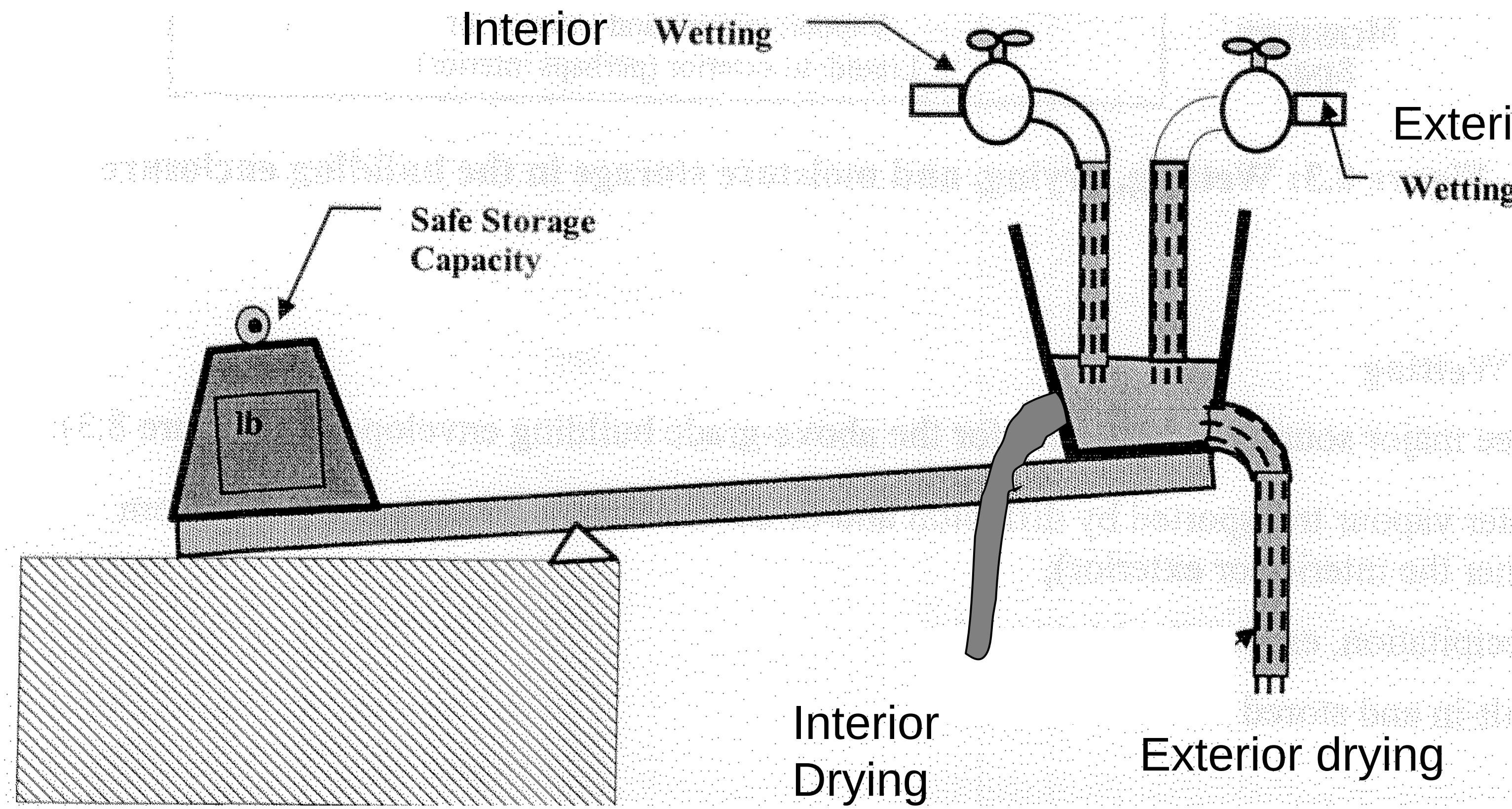
Water/Moisture/Bulk/Diffusion

- When the rate of wetting exceeds the rate of drying accumulation occurs
- The drying potential of an assembly decreases with the thickness of the insulation and increases with the rate of air flow
- Energy conservation increases the thickness of the insulation and decreases the air flow

Water/Moisture/Bulk/Diffusion

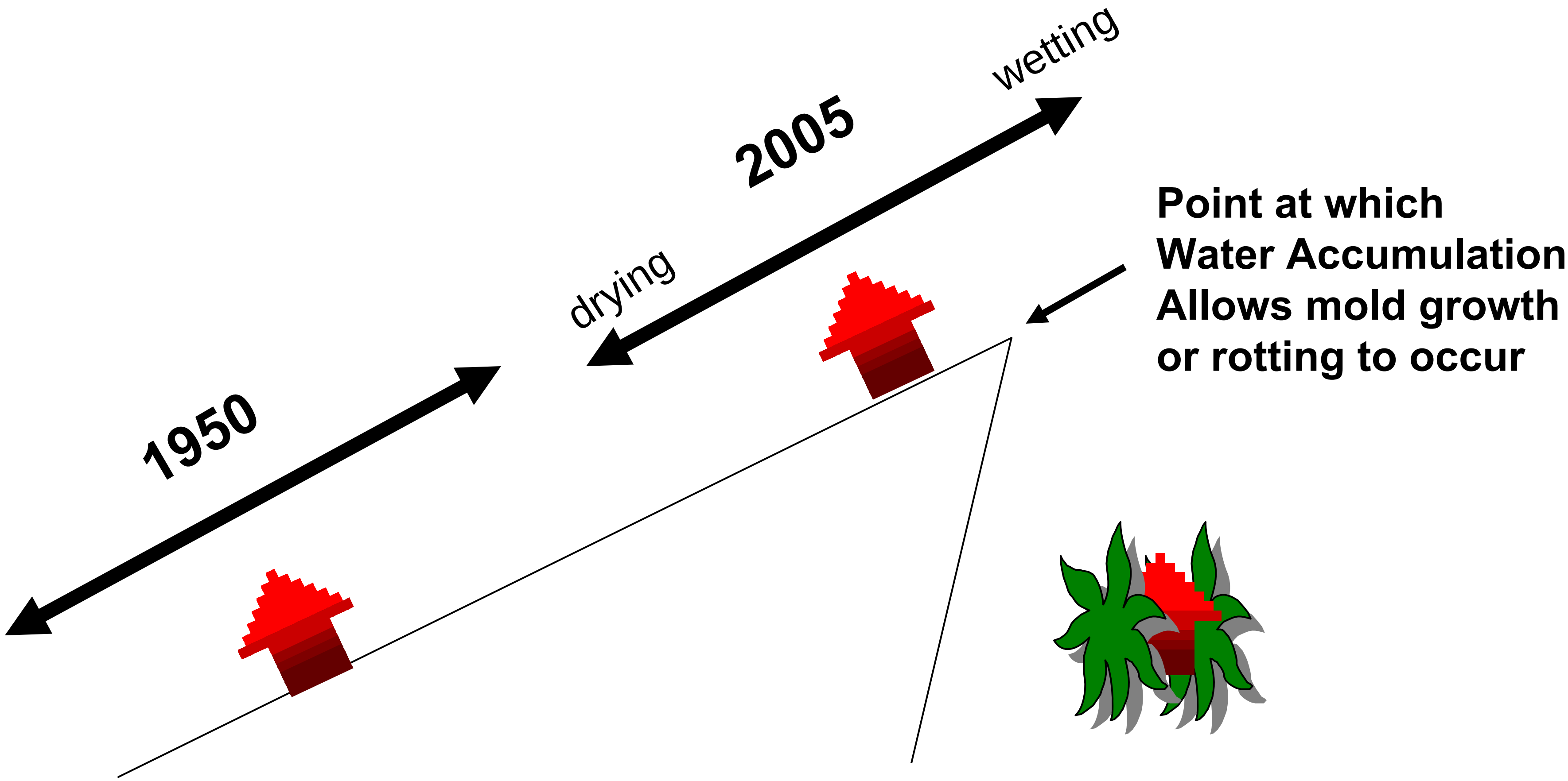
- When the rate of wetting exceeds the rate of drying accumulation occurs
- The drying potential of an assembly decreases with the thickness of the insulation and increases with the rate of air flow
- Energy conservation increases the thickness of the insulation and decreases the air flow
- Energy conservation has a potential to increase moisture wall problems

Moisture Balances Occurring In the Exterior Wall



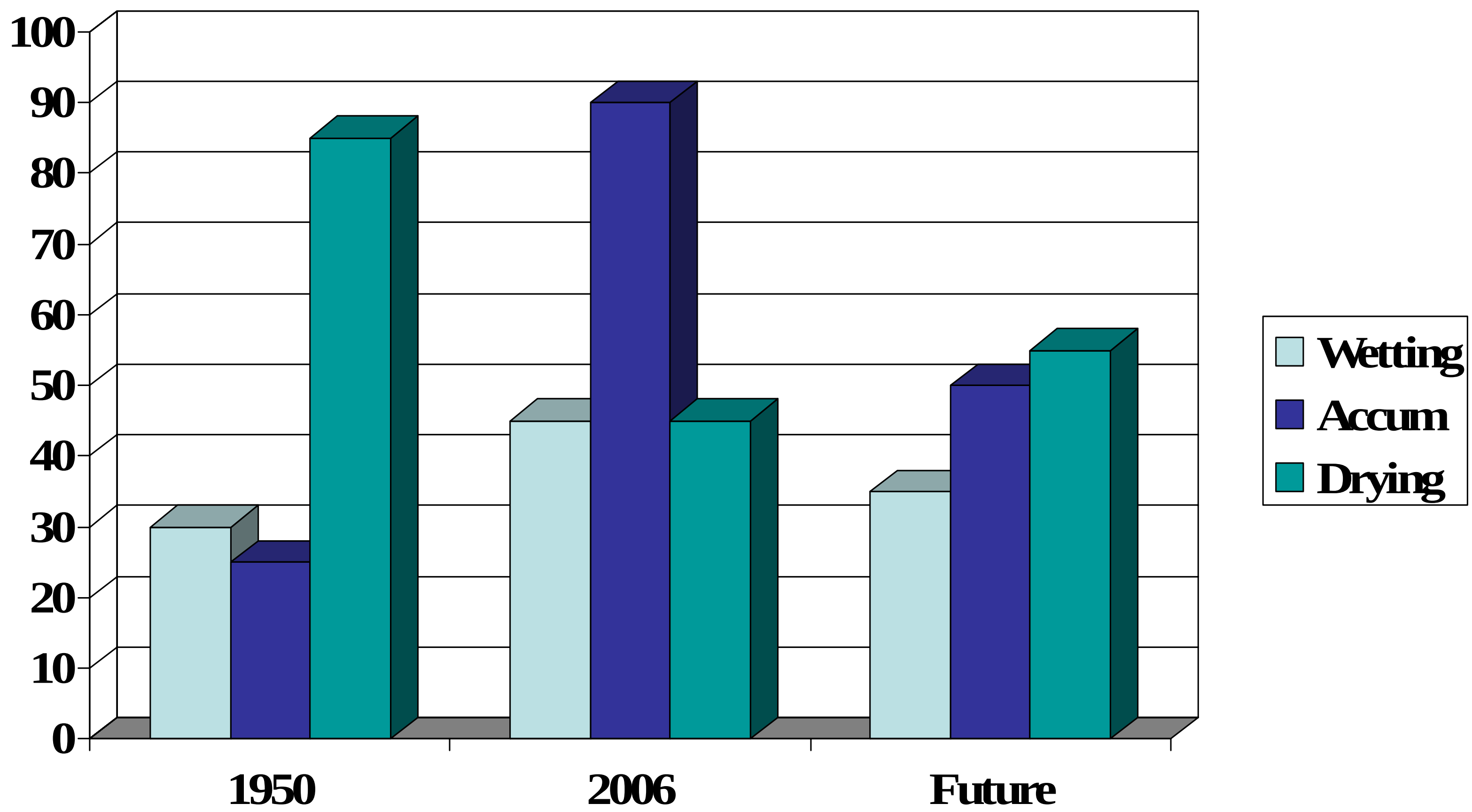
A typical house can have 10,000 pounds of studs and sheathing
10% moisture is 1,000 pounds or 125 gallons of water capacity

Building’s Today are too close to the Edge of the Cliff



National Experts have stated that moldy buildings today likely make up 5-10% of all housing.
Before 1990 the failure rate was less than 0.1%

Moisture Balance in Walls



Scope

The intent of these criteria is to provide a means for furnishing

1. **quality indoor air**
2. **assuring building durability**
3. **permitting energy efficient operation**

Scope

Exceptions: **There are several exceptions to the scoping provisions of this document and have been placed there by the committee to clarify its intent for construction and enforcement.**

Scope

- **Portions of the building envelope that do not enclose conditioned space, including garages.**

Scope

- **Insulation R-values, air barrier and vapor retarder requirements are not required for existing foundations, crawl space walls, and basements in existing dwellings or existing dwelling units whose alterations or repair require a permit, if the original dwelling's permit was issued prior to the effective date of this chapter.**

Scope

- **Additions to existing dwellings or dwelling units may be made without making the entire dwelling or dwelling unit comply, provided that the addition complies with all the requirements of this chapter.**

Scope

- Alterations and repairs to existing dwellings or dwelling units may be made without making the entire dwelling or dwelling unit comply.

Scope

- Buildings that have been specifically designated as historically significant by the state or local governing body or, listed or, determined to be eligible for listing in the National Register of Historical Places.

Scope

- If a building houses more than one occupancy, each portion of the building must conform to the requirements for the occupancy housed in that portion.

Scope

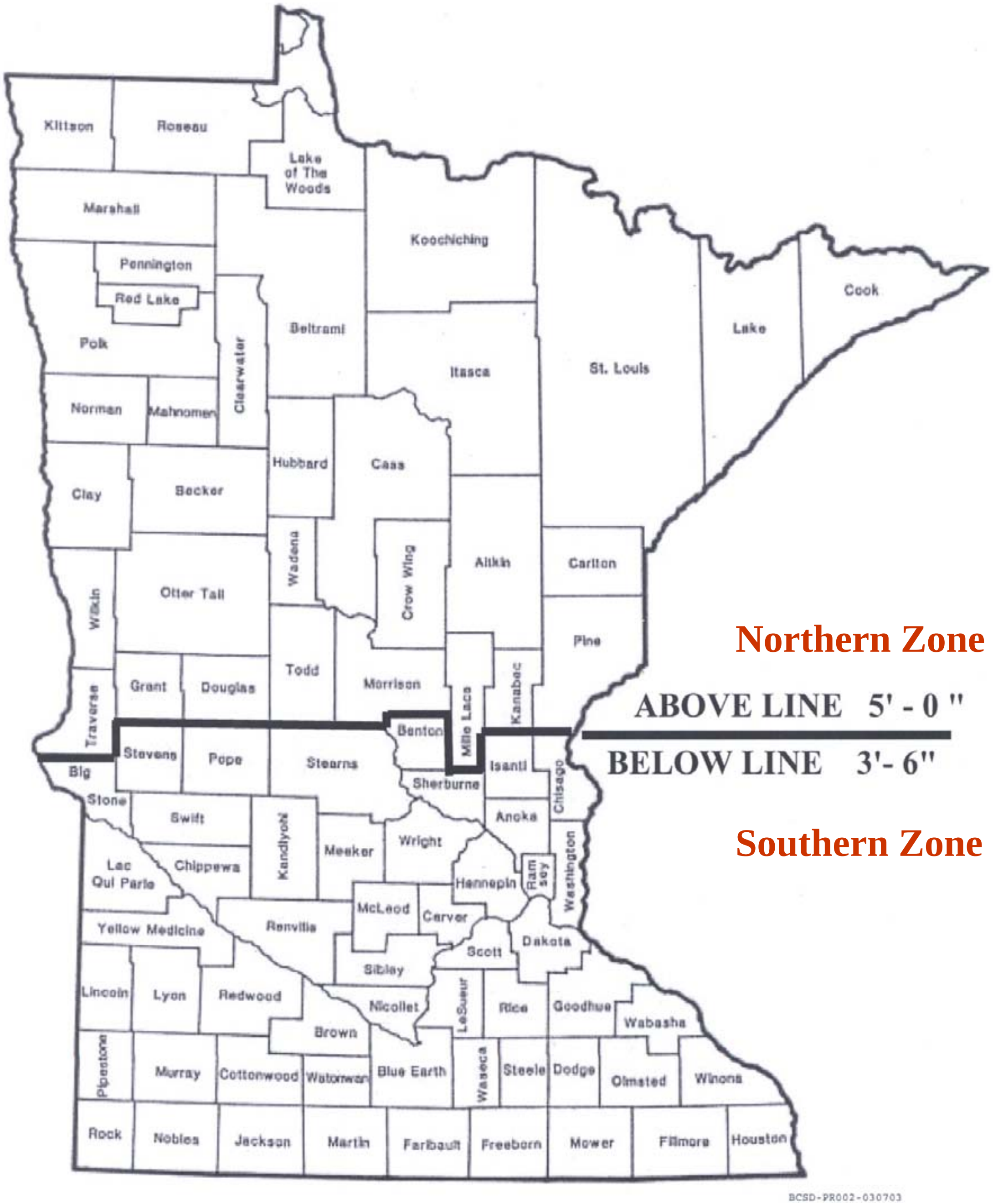
- This chapter does not cover buildings, structures, or portions of such buildings whose peak design energy rate usage is less than 3.4 Btu per hour per square foot or 1.0 Watt per square foot of floor area for all purposes.

Compliance
Climate Zones

Climate zones from Table N1101.2 or Figure 1101.2 shall be used in determining the applicable requirements from this chapter.

Please note: These are different than what is in the national document. We are adopting the state map for frost and snow load but it is not consistent with the wind load chart that the structural committee adopted.

Climate Zones

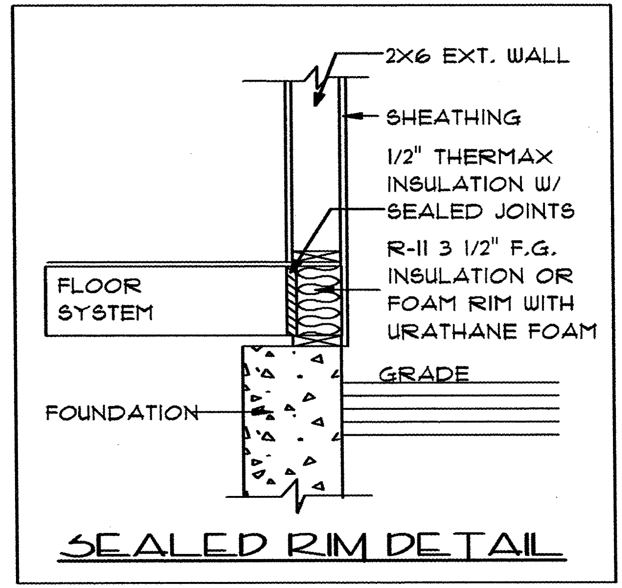


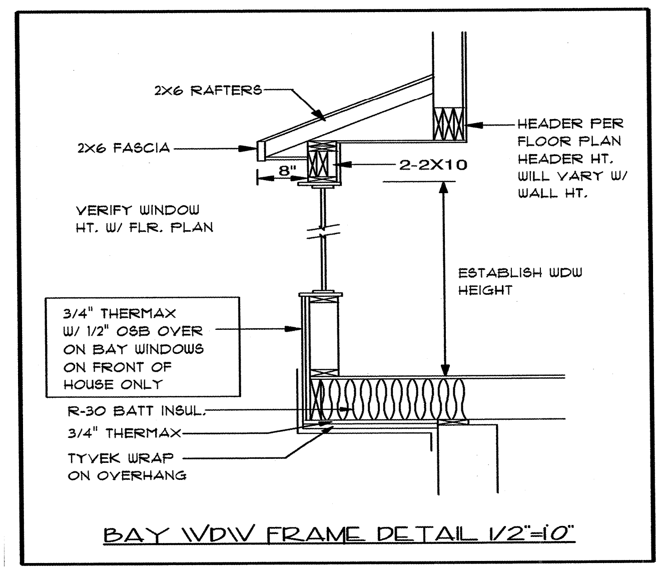
Identification/Insulation Mark

- Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this chapter.

Plans & Specs

- Plans and specifications shall show in sufficient detail, pertinent data and features, of the building, the equipment, and the systems as herein governed, including, but not limited to:





Building Thermal Insulation.

- All thermal_insulation must conform to Minnesota Rules Chapter 7640, "Minnesota Thermal Insulation Standards" adopted by the Department of Commerce.
- For Foam Insulation we need to know and use the aged R-value

Building Thermal Insulation.

- Insulation shall be manufactured for its intended use, and installed according to the manufacturer's specifications.

- Insulation materials used on the exterior for the purpose of insulating foundation walls shall be a water resistant material and shall comply with ASTM C578, C612 or other approved standards.

Attic thickness markers.

- The thickness of blown or sprayed roof and/or ceiling insulation shall be written in inches on markers that are installed at least one for every 100 ft^2 (9.3 m^2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness, with numbers a minimum of 1 inch (25 mm) in height. Each marker shall face the attic access opening.

Attic insulation card.

- A signed and dated insulation receipt attic card must be attached to the framing near the access opening, in a clearly visible place and posted with the certificate required by N1101.8. The attic card must identify the type of insulation installed, the manufacturer, the installer, the R-value per inch, the designed settled thickness, the square footage of attic coverage area, and the number of bags installed.

Table

Component	Certificate requirements
Date certificate is installed	Posted date
Dwelling or dwelling unit location	Mailing address and city
Residential Contractor	Name of licensed residential contractor
Insulation installed in or on ceiling/roof, walls, slab-on-grade and floor	Type and installed R-value
Rim joist and foundation wall insulation	Installed R-value, type and whether the insulation is exterior, integral or interior
Fenestration	Average U-factor and SHGC (solar heat gain coefficient)
Ducts outside conditioned spaces	Installed R-value
Mechanical ventilation system	Type, location and design continuous & total ventilation rates
Make-up air & combustion air systems (if installed)	Type, location and size
Heating system	Type, input rating, AFUE or HSPF, manufacturer, model and the structures calculated heat loss
Domestic water heater	Type, size, manufacturer and model
Cooling system (if installed)	Type, output rating, SEER, manufacturer, model, the structures calculated cooling load and heat gain
Radon Control System	Passive or active

Fenestration Products

- **Fenestration product rating. U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100,and air leakage by NFRC 400, by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled U-factor, shall be assigned a default U-factor from Table N1101.6.**

Default Glazed Fenestration U-Factor Table

- Frame Type	Single Pane	Double Pane	Skylight	
			Single pane	Double pane
Metal **Metal w/thermal break**	1.20 **1.10**	0.80 **0.65**	1.60 **1.90**	1.05 **1.10**
Non-Metal or metal clad	- 0.95	- 0.55	- 1.25	- 0.80
Glazed Block	0.60			

Table N1101.5(2)

Default Door U-Factors

Uninsulated metal	1.2
Insulated Metal	0.6
Wood	0.5
Insulated non-metal edge, Max 45% glazing, Any glazing double pane	0.35

Installation of Materials

- **Installation. All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and the conditions of any listing or required certifications.**

Building Certificate

- **A certificate shall be posted in a permanently visible location inside the building. The certificate shall list information and the values of components listed in Table 1101.8.**

Table

Component	Certificate requirements
Date certificate is installed	Posted date
Dwelling or dwelling unit location	Mailing address and city
Residential Contractor	Name of licensed residential contractor
Insulation installed in or on ceiling/roof, walls, slab-on-grade and floor	Type and installed R-value
Rim joist and foundation wall insulation	Installed R-value, type and whether the insulation is exterior, integral or interior
Fenestration	Average U-factor and SHGC (solar heat gain coefficient)
Ducts outside conditioned spaces	Installed R-value
Mechanical ventilation system	Type, location and design continuous & total ventilation rates
Make-up air & combustion air systems (if installed)	Type, location and size
Heating system	Type, input rating, AFUE or HSPF, manufacturer, model and the structures calculated heat loss
Domestic water heater	Type, size, manufacturer and model
Cooling system (if installed)	Type, output rating, SEER, manufacturer, model, the structures calculated cooling load and heat gain
Radon Control System	Passive or active

Building Thermal Envelope Requirements

- **Based on the climate zone specified in Table N1101.2, the building thermal envelope shall meet the requirements of Table N1102.1(1) or Table N1102.1(2).**

Table 1102.1(1) Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration[b] U-Factor	Skylight U-Factor	Glazed Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value (f)	Floor over unconditioned space R-Value	Basement[f] Wall R-Value	Slab[c] R-Value & Depth	Crawl Space Wall R-Value	Rim Joist R-value
Southern	0.35	0.60	NR	38	19 or 13+5[e]	15	30[d]	5/10	10, 3.5 ft	10	10
Northern	0.35	0.60	NR	44	19	15	30[d]	10	10, 5 ft	10	10

(a) R-values are minimums. U-factors are maximums. R-19 shall be permitted to be compressed into a 2x6 cavity.
(b) The fenestration U-factor column excludes skylights.
(c) R-5 shall be added to the required slab edge R-values for heated slabs.
(d) Or insulation sufficient to fill the framing cavity, R-19 minimum.
(e) "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, R-5 sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
(f) When using Log Type construction for Thermal Mass Walls the following shall apply;
1. A minimum of a 7Inch diameter log shall be used
2. The U-value of fenestration products shall be 0.31 overall on average or better

Table 1102.1(2) Equivalent U-Factors[a]

Climate Zone	Fenestration U-Factor	Skylight U-Factor	Ceiling U-Factor	Frame Wall U-Factor	Mass Wall U-Factor	Floor U-Factor	Basement Wall U-Factor	Crawl Space Wall U-Factor
South	0.35	0.60	0.026	0.060	0.077	0.033	0.10	0.10
North	0.35	0.60	0.023	0.060	0.077	0.033	0.10	0.10

(a) Non-fenestration U-factors shall be obtained from measurement, calculation or an approved source.

Mass walls.

- Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth), and solid timber/logs.

- Mass walls shall comply with Section N1102.1.

Table 1102.1(1) Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration[b] U-Factor	Skylight U-Factor	Glazed Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value (f)	Floor over unconditioned space R-Value	Basement[f] Wall R-Value	Slab[c] R-Value & Depth	Crawl Space Wall R-Value	Rim Joist R-value
Southern	0.35	0.60	NR	38	19 or 13+5[e]	15	30[d]	5/10	10, 3.5 ft	10	10
Northern	0.35	0.60	NR	44	19	15	30[d]	10	10, 5 ft	10	10

(a) R-values are minimums. U-factors are maximums. R-19 shall be permitted to be compressed into a 2x6 cavity.
(b) The fenestration U-factor column excludes skylights.
(c) R-5 shall be added to the required slab edge R-values for heated slabs.
(d) Or insulation sufficient to fill the framing cavity, R-19 minimum.
(e) "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, R-5 sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
(f) When using Log Type construction for Thermal Mass Walls the following shall apply;
1. A minimum of a 7Inch diameter log shall be used
2. The U-value of fenestration products shall be 0.31 overall on average or better

Steel-frame ceilings, walls and floors

- Shall meet the insulation requirements of Table N1102.2.3 or shall meet the U-factor requirements in Table N1102.1(2).

- The calculation of the U-factor for a steel-frame wall shall use a series-parallel path calculation method.

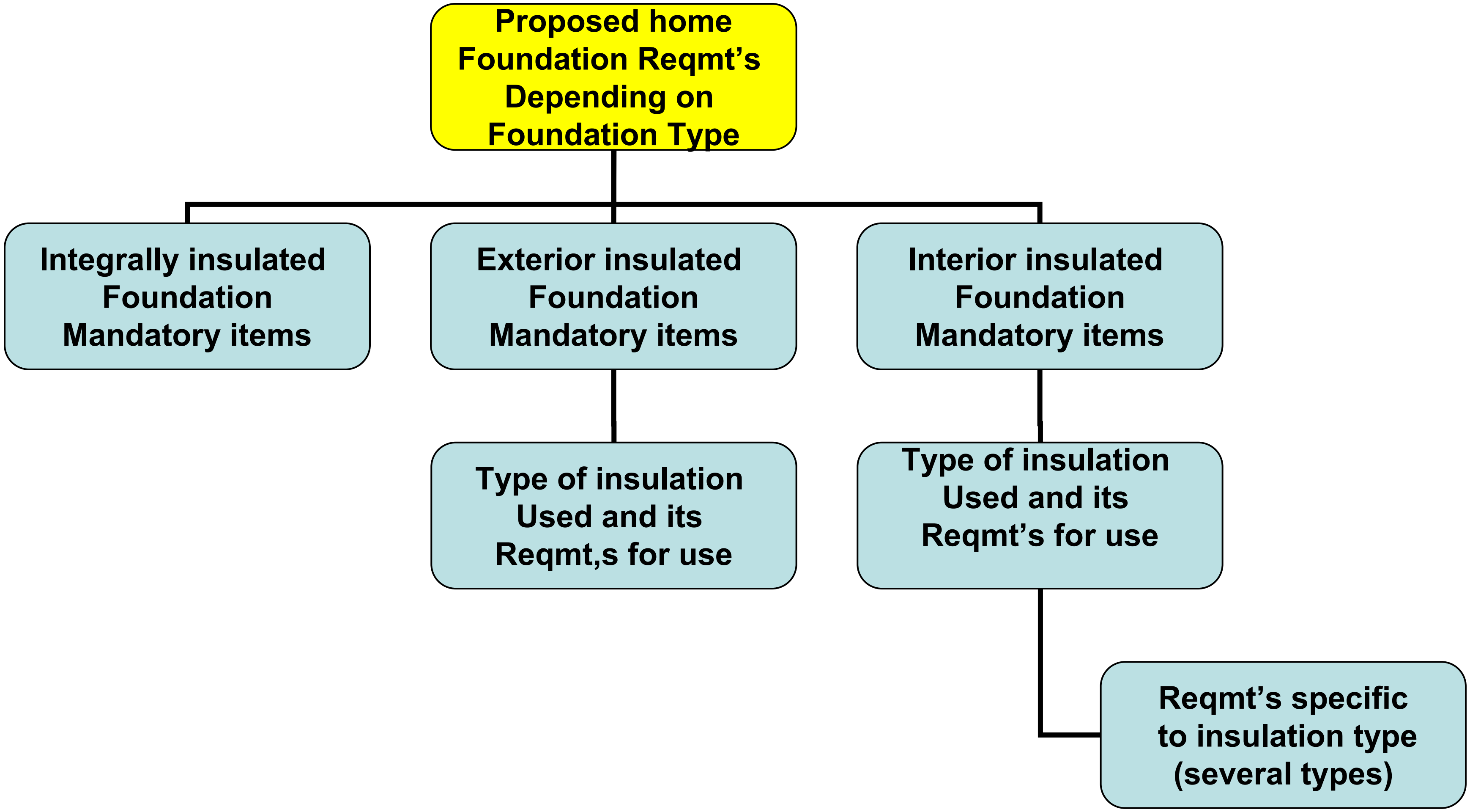
Table 1102.2.3 Steel frame Ceiling, Wall and Floor Insulation (R-value)

Wood Frame R-Value Requirement	Cold-Formed Steel Equivalent R –Value[1]
Steel Truss Ceilings[2]	
R-38	R-49 or R-38+3
R-44	R-38+5
Steel Joist Ceilings[2]	
R-30	R-21 + R-6 in 2 x 6, R-21 + R-12 in 2 x 8 or 2 x 10
R-38	R-49 in 2x4 or 2x6 or 2x8 or 2x10
Steel Framed Wall	
R-19	R-13+9 or R-19+8 or R-25+7
Steel Joist Floor	
R-30	R-21+R-6 in 2x6 R-21+R-12 in 2x8 or 2x10

Footnotes:
1. Cavity insulation R-value is listed first, followed by a "+" and the continuous insulation R-value, if applicable.
2. Insulation exceeding the height of the framing shall cover the framing.

Foundations

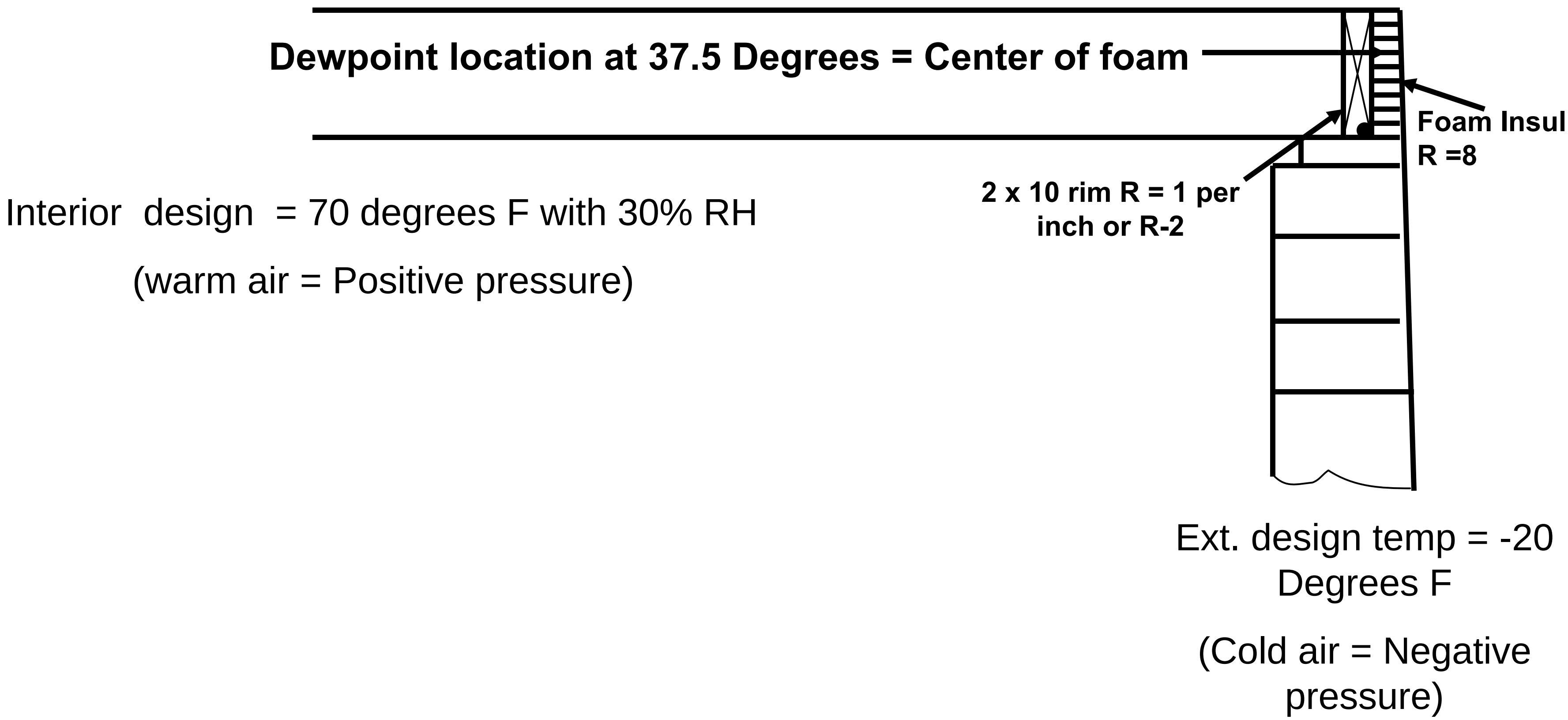
Decision Tree for foundation Insulation in the Residential Energy Code



Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

Foundation Wall Performance
Prescriptive Option

- **Foundation insulation** Foundation insulation of basement and crawl space walls and the perimeter of slab-on grade floors must comply with this section. Insulation materials shall be installed according to manufacturer's installation specifications and any additional requirements of sections N1102.2.6.1 through N1102.2.6.11. Adding additional insulation to increase R-values or adding an additional vapor retarder to foundation wall assemblies, other than those required in this section, is prohibited.



Total R Value = 10 **Delta T = 90** **See Dew Point Calculations Below**

R-8 (Foam insulation) Divided by 10 (Total R Value) Multiplied by 90 (Delta T) = Temperature change from one side of foam to other side of foam. Ex. (8/10 x 90 = 72 Degrees temperature Change) The temperature between the foam insulation and the 2 x 10 rim is now at 52 Degrees. (-20 + 72 = 52)

The dew point temperature for a building with a interior temp of 70 degrees F and a interior RH of 30% is 37.5 degrees. (see Psychrometric Chart) This is the condensation point in this assembly. If moisture condenses there how will it get out or dry out. Remember it will condensate to the first plane or surface to the cold side. Heat and moisture always flow from warm to cold.

Exceptions:

- 1. Foundation walls enclosing unconditioned spaces shall meet this requirement unless the floor overhead is insulated in accordance with Section N1102.1.
- 2. Permanent wood foundations shall meet the requirements of R401.1.
- 3. Frost protected shallow foundations shall meet the requirements of R403.3
- 4. Insulating concrete form materials shall meet the requirements of Section R611.

Basement foundation and crawl space walls.

- Basement foundation and crawl space walls shall be insulated from the top of the foundation wall down to the top of the footing or from the top edge of the interior wall to the top of the slab if insulation is on the interior.

Slab-on-grade and basement walkout foundation walls.

Slab-on-grade and basement walkout foundation walls.

- Insulation shall extend to the design frost line or top of footing whichever is less.
-

Slab-on-grade and basement walkout foundation walls.

- Insulation shall extend to the design frost line or top of footing whichever is less.
- The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree angle away from the exterior wall.

Slab-on-grade and basement walkout foundation walls.

- Insulation shall extend to the design frost line or top of footing whichever is less.
- The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree angle away from the exterior wall.
- Slab-edge insulation is not required in jurisdictions designated by the code official as having termite infestation.

Foundation wall and rim joist area thermal insulation requirements.

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

Exception

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

In the Southern Zone, the foundation and rim joist area insulation may be reduced to a minimum of an R-5 if

Exception

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

In the Southern Zone, the foundation and rim joist area insulation may be reduced to a minimum of an R-5 if

- 1. The insulation is located on the exterior or is integral to the foundation wall; and

Exception

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

In the Southern Zone, the foundation and rim joist area insulation may be reduced to a minimum of an R-5 if

- 1. The insulation is located on the exterior or is integral to the foundation wall; and
- 2. An additional R-5 insulation is added to the minimum attic R-value level; and

Exception

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

In the Southern Zone, the foundation and rim joist area insulation may be reduced to a minimum of an R-5 if

- 1. The insulation is located on the exterior or is integral to the foundation wall; and
- 2. An additional R-5 insulation is added to the minimum attic R-value level; and.
- 3. The heating system meets the minimum efficiency ratings in Table N1102.2.6.4; and

Table 1102.2.5 HVAC System Minimum Efficiency Requirement to Qualify for R-5 Exterior Insulation in the Southern Zone

Heating System Type	Minimum Efficiency Rating	
	AFUE	HSPF
Furnace, Gas or Oil Fired	90%	N/A
Boiler, Gas or Oil Fired	85%	N/A
Heat Pump, Split Systems	N/A	8.0
Heat Pump, Single Package or Equipment (including gas/electric package units)	N/A	7.6

Exception

- The foundation wall system and rim joist area shall have an insulating layer with minimum thermal properties as required in this section. The insulation layer must be a minimum R-10 in accordance with Table N1102.1.

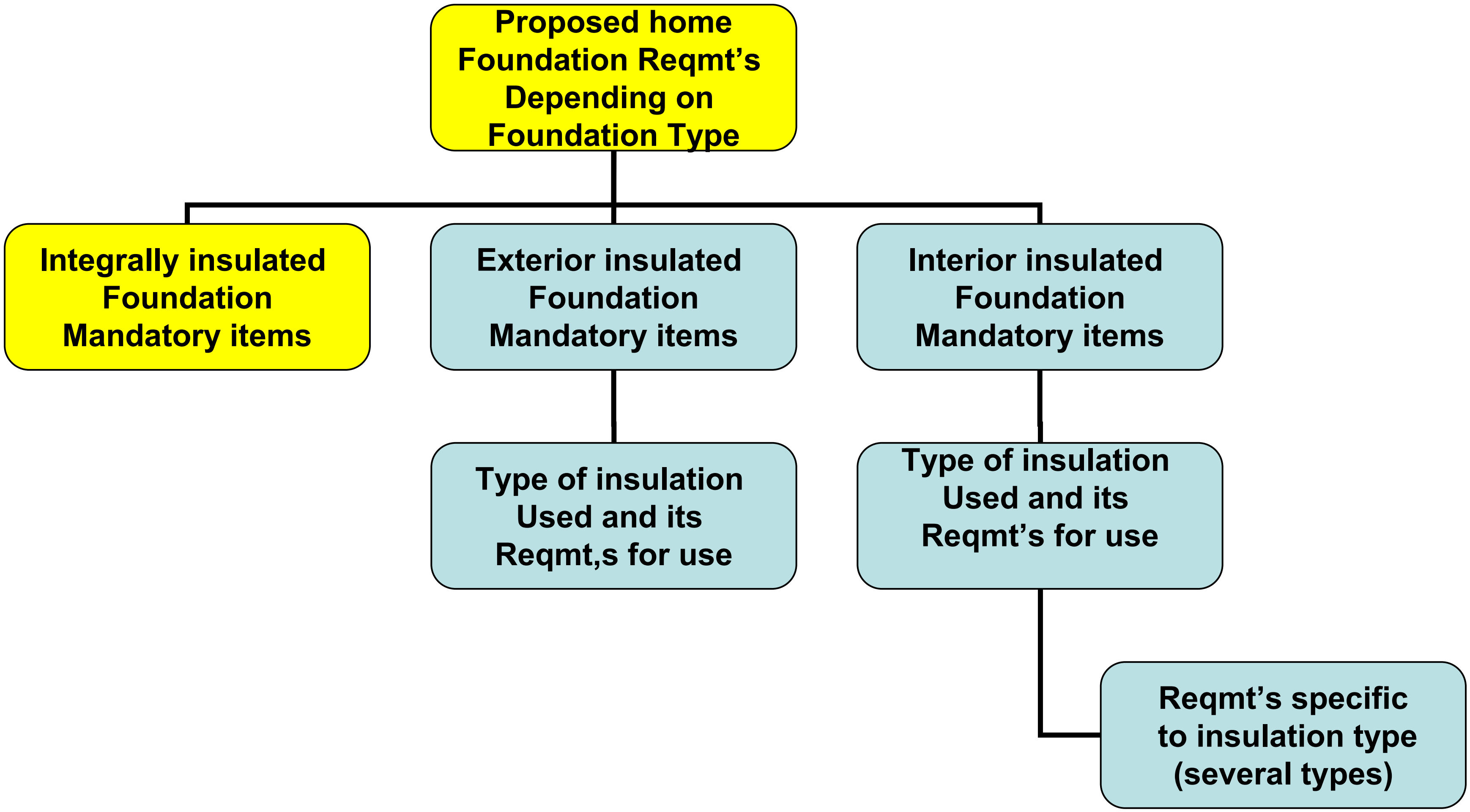
In the Southern Zone, the foundation and rim joist area insulation may be reduced to a minimum of an R-5 if

- 1. The insulation is located on the exterior or is integral to the foundation wall; and
- 2. An additional R-5 insulation is added to the minimum attic R-value level; and
- 3. The heating system meets the minimum efficiency ratings in Table N1102.2.6.4; and
- 4. A minimum of a 6 inch energy heel is used for the roof framing and/or truss system.

Requirements for Integral foundation insulation systems

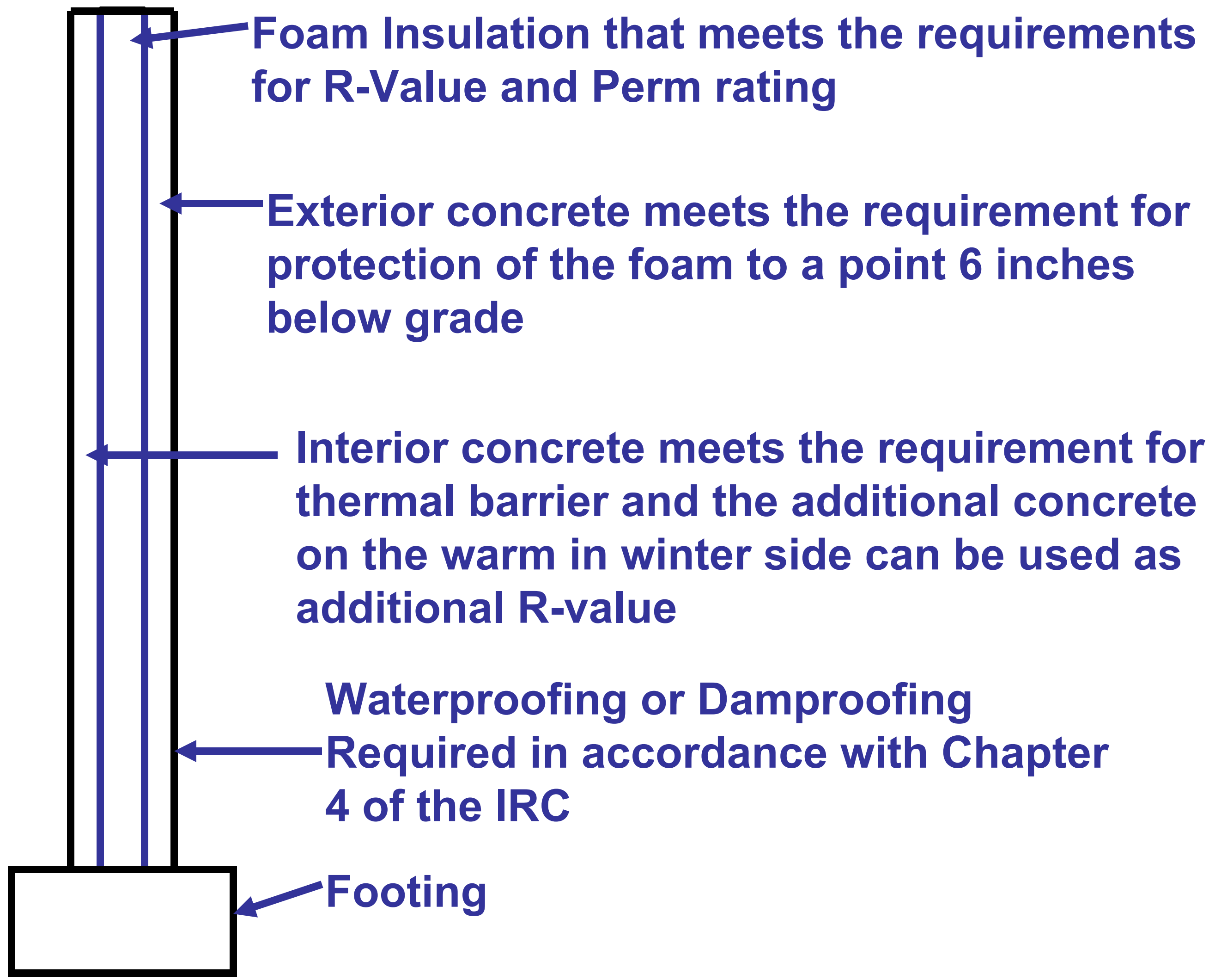
- An insulation assembly installed integral to the foundation walls shall be manufactured for its intended use and installed according to the manufacturer's specifications.

Decision Tree for foundation Insulation in the Residential Energy Code



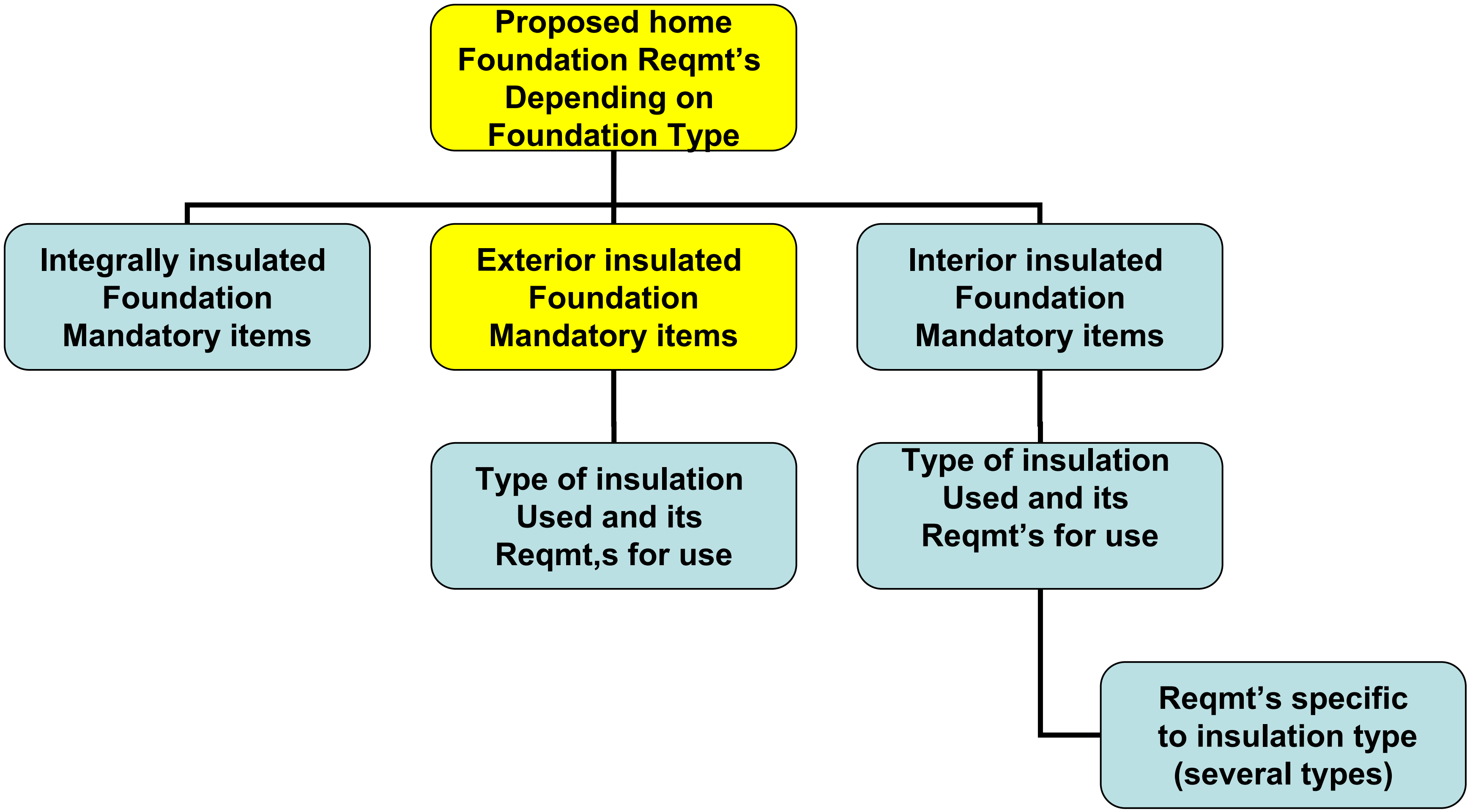
Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…


Styrofoam
Insulated Concrete Wall Systems


Foam Insulation that meets the requirements for R-Value and Perm rating
Exterior concrete meets the requirement for protection of the foam to a point 6 inches below grade
Interior concrete meets the requirement for thermal barrier and the additional concrete on the warm in winter side can be used as additional R-value
Waterproofing or Dampproofing Required in accordance with Chapter 4 of the IRC
Footing

Requirements for Exterior foundation insulation requirements

Decision Tree for foundation Insulation in the Residential Energy Code



Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

- 1. Shall be of water resistant materials manufactured for its intended use;

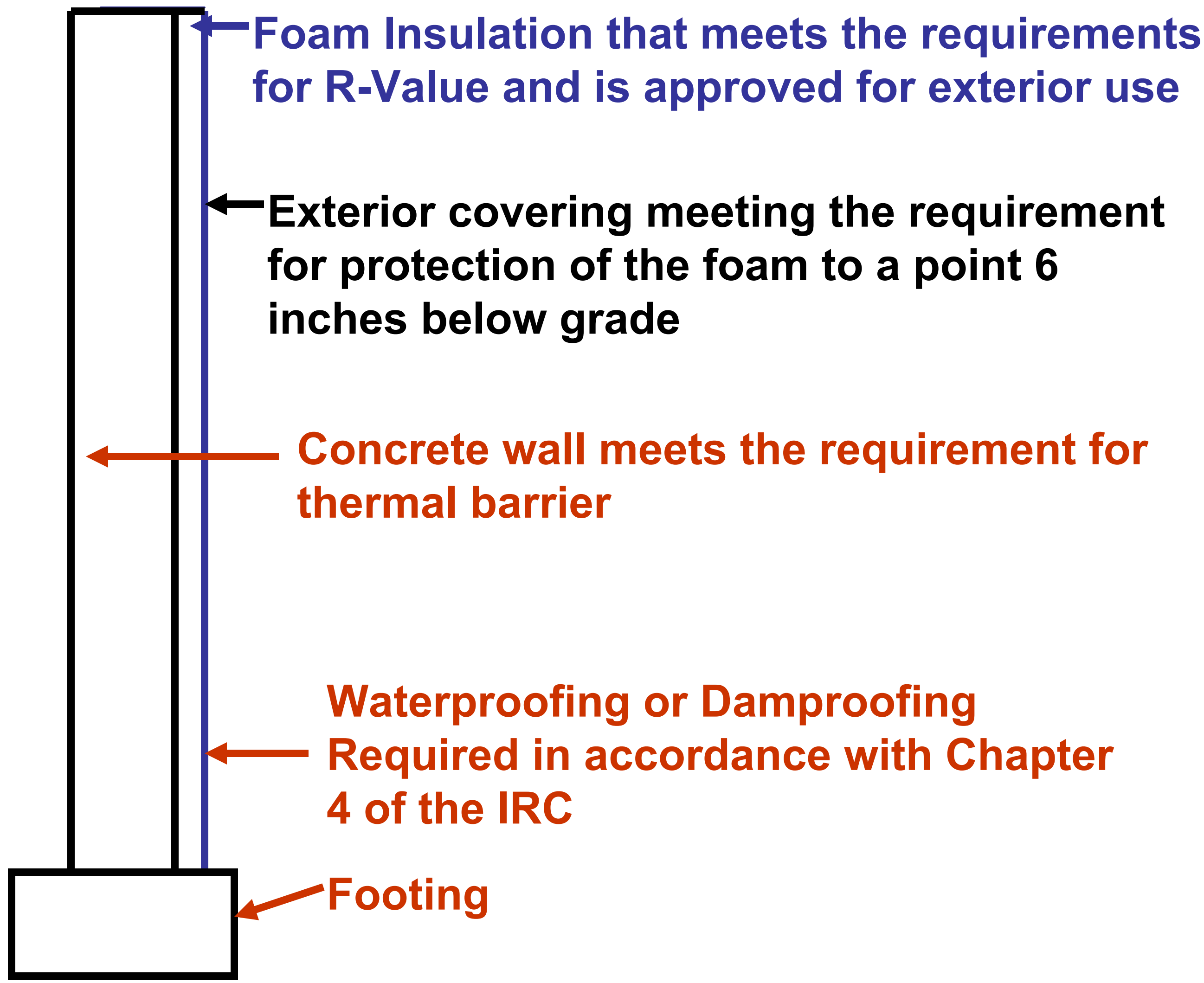
- 1. Shall be of water resistant materials manufactured for its intended use;
- 2. Installed according to the manufacturer's specifications;

- 1. Shall be of water resistant materials manufactured for its intended use;
- 2. Installed according to the manufacturer's specifications;
- 3. Shall comply with either ASTM C578, C612 or C1029 as applicable and;

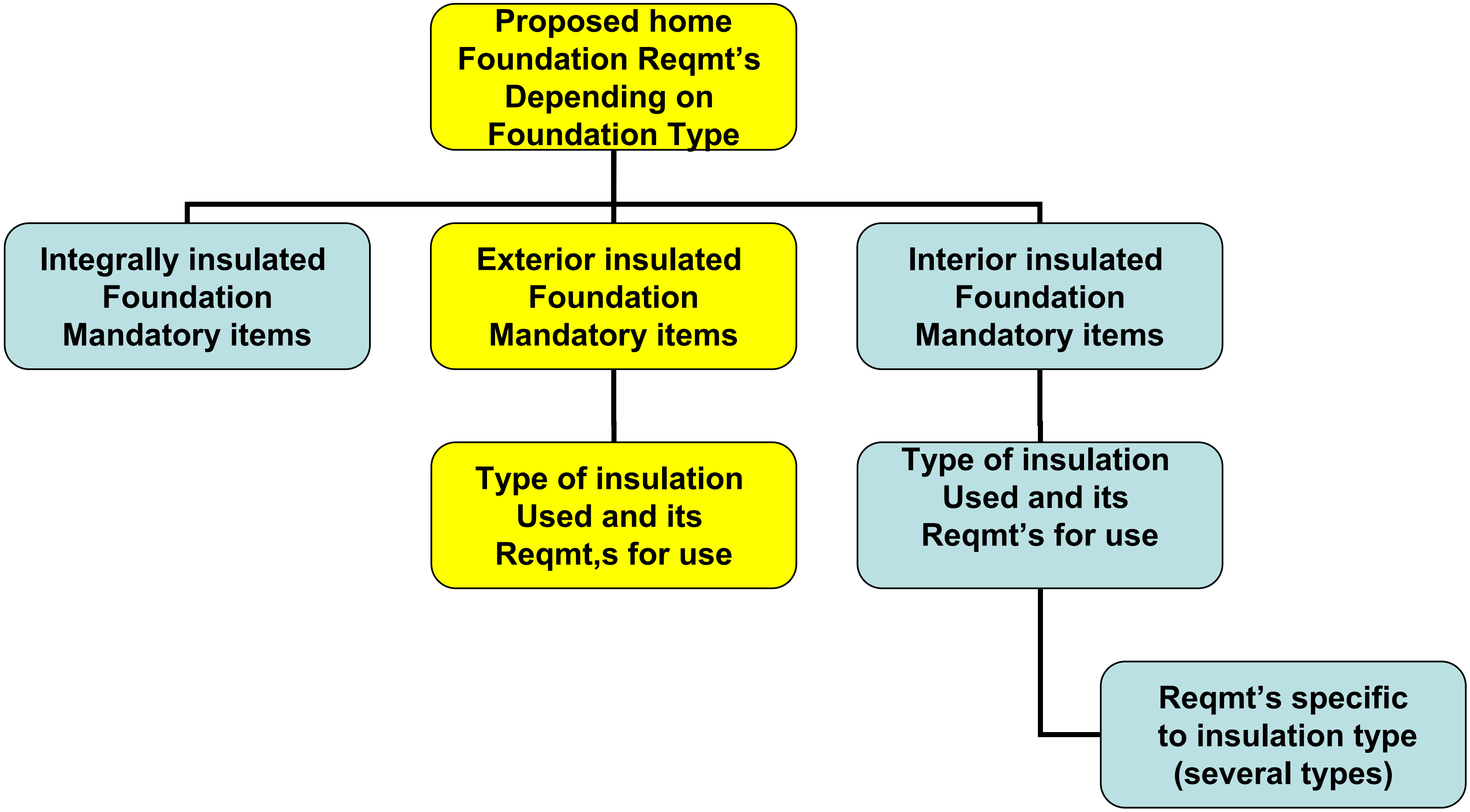
Exterior foundation insulation

- 1. Shall be of water resistant materials manufactured for its intended use;
- 2. Installed according to the manufacturer's specifications;
- 3. Shall comply with either ASTM C578, C612 or C1029 as applicable and;
- 4. Shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation’s thermal performance. The protective covering shall cover the exposed exterior insulation and extend a minimum of 6 inches (152 mm) below grade. The insulation and protective covering system shall be flashed in accordance with the IRC Section R703.8.

Exterior Foundation Insulation



Decision Tree for foundation Insulation in the Residential Energy Code

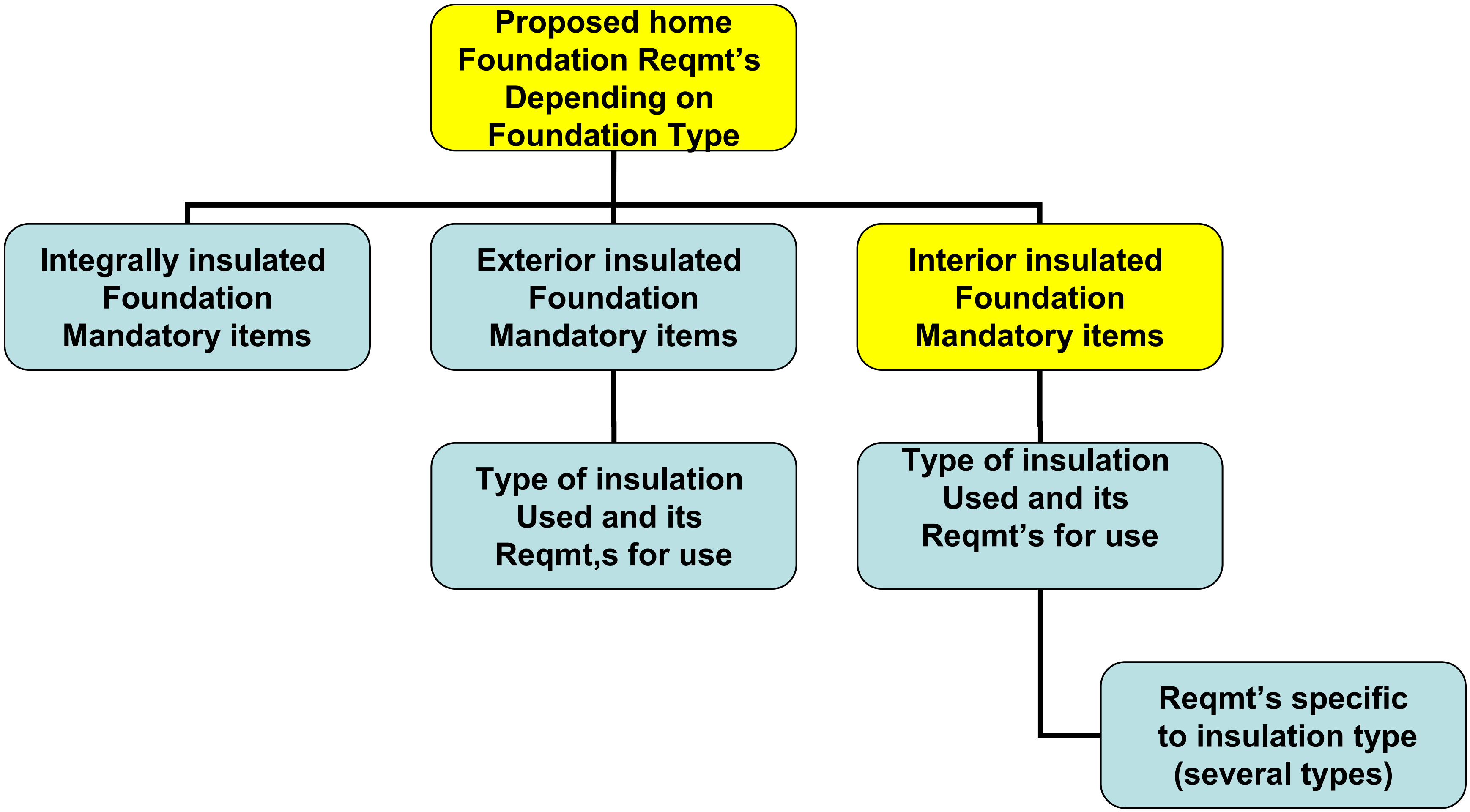


Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…


DOW
Styrofoam
TG

Requirements for Interior foundation insulation

Decision Tree for foundation Insulation in the Residential Energy Code

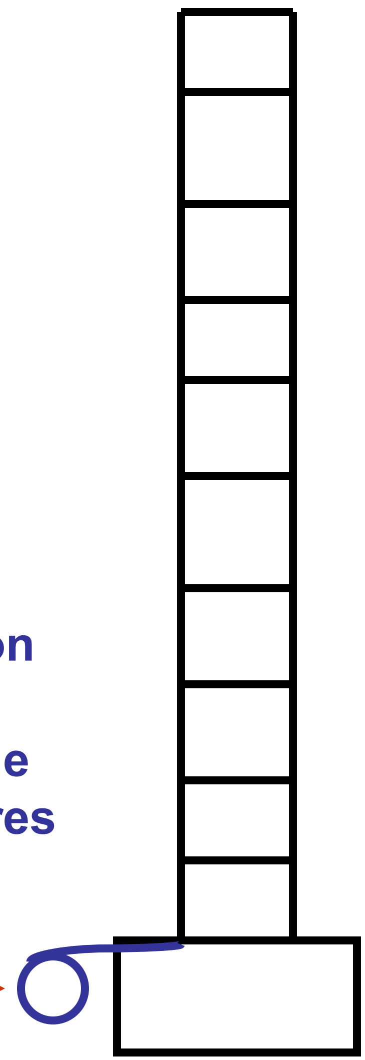


Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

Interior foundation insulation

- 1. Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.

Interior Foundation Insulation

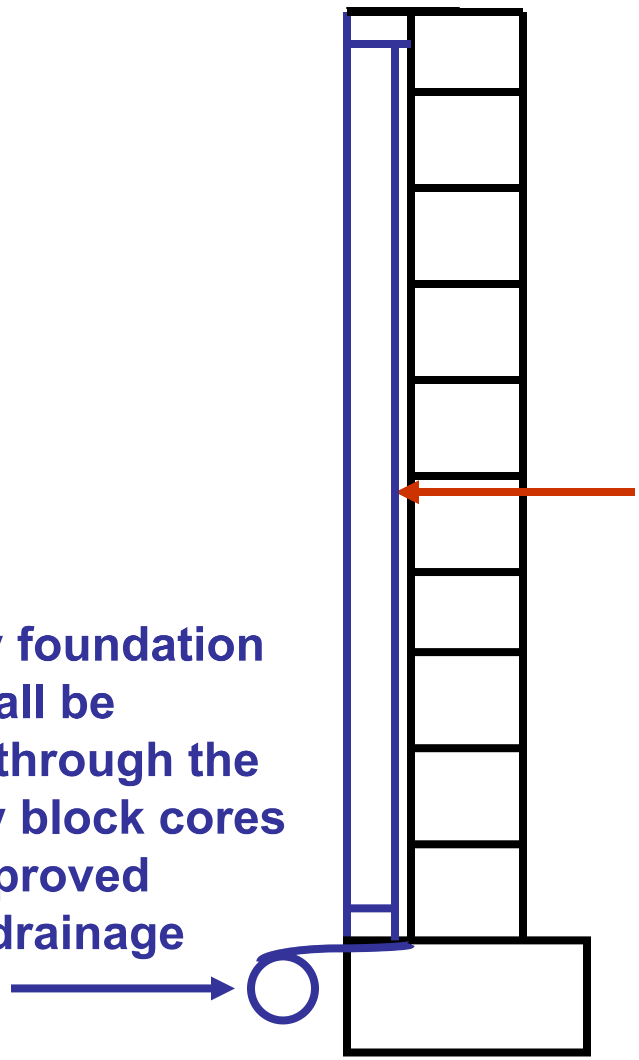


Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.

Interior foundation insulation

- 1. Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.
- 2. If a frame wall is installed it shall not be in direct contact with the foundation wall, unless that interior side of the foundation wall has been waterproofed.

Interior Foundation Insulation



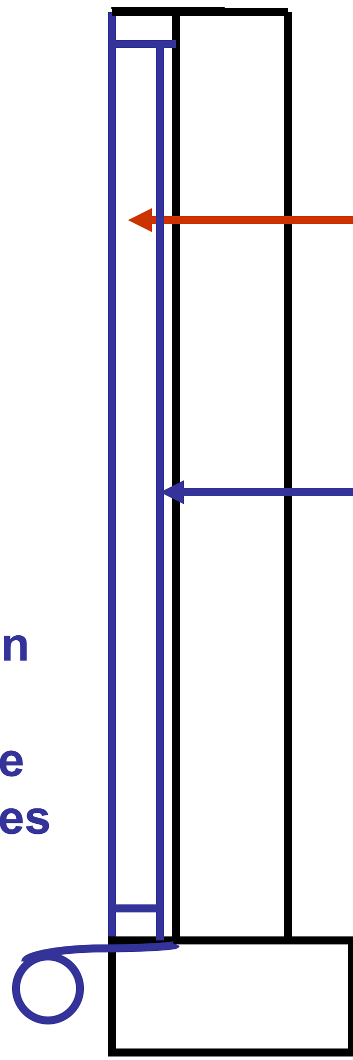
If a frame wall is installed it shall not be in direct contact with the foundation wall, unless that interior side of the foundation wall has been waterproofed.

Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.

Interior foundation insulation

- 1. Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.
- 2. If a frame wall is installed it shall not be in direct contact with the foundation wall, unless that interior side of the foundation wall has been waterproofed.
- 3. Comply with the interior air barrier requirements in N1102.4.1

Interior Foundation Insulation

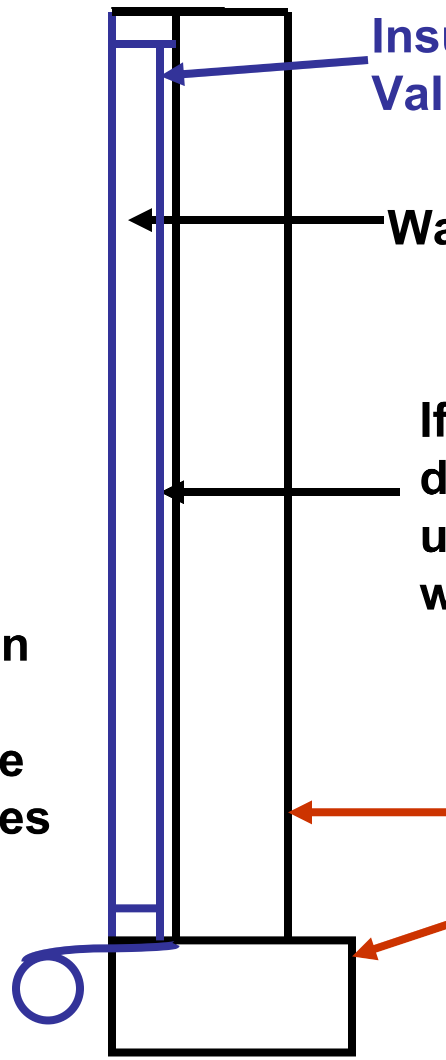


Warm Side Vapor and Air barrier

If a frame wall is installed it shall not be in direct contact with the foundation wall, unless that interior side of the foundation wall has been waterproofed.

Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.

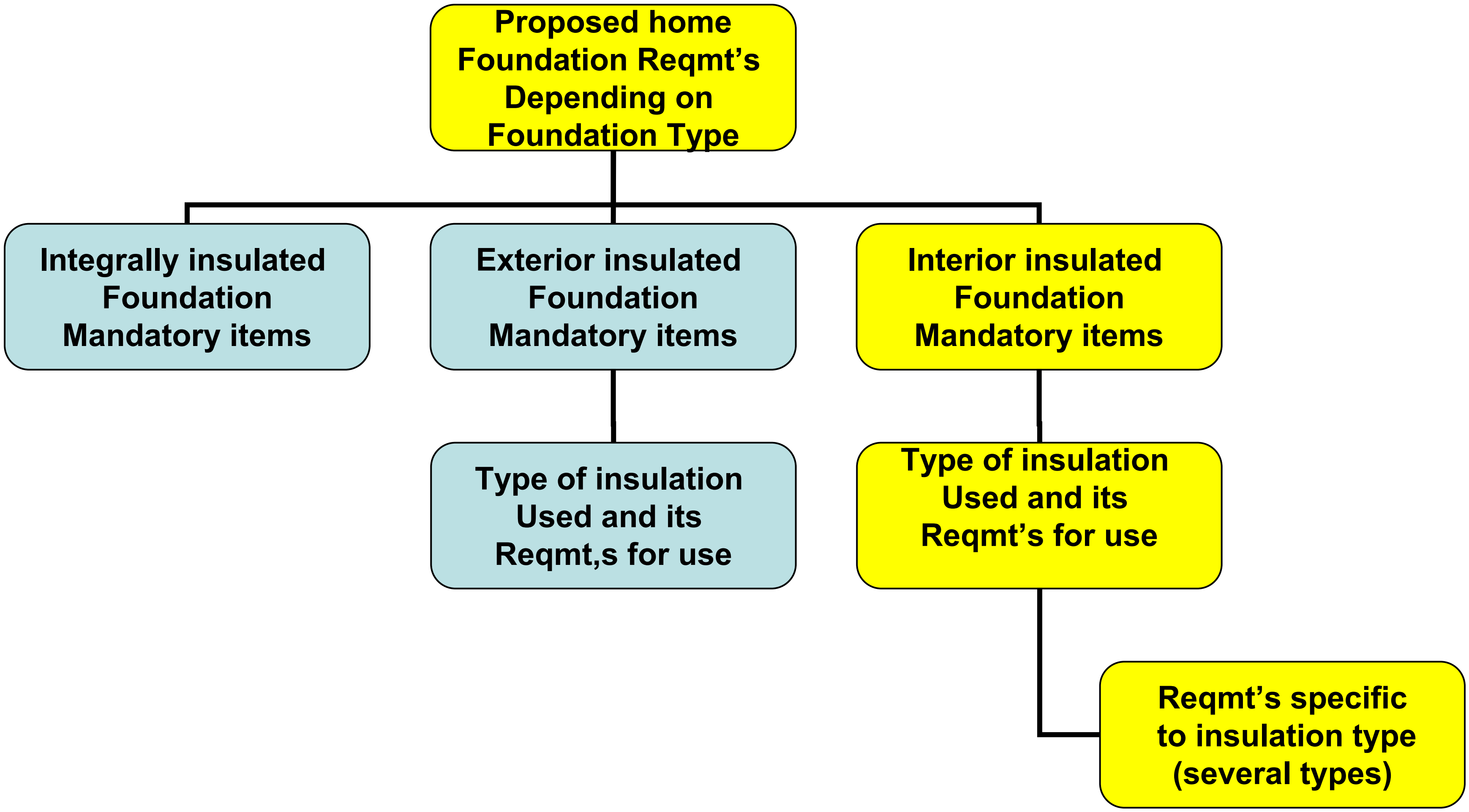
Interior Foundation Insulation



Interior foundation insulation requirements

- 1. Masonry foundation walls shall be drained through the masonry block cores to an approved interior drainage system.
- 2. If a frame wall is installed it shall not be in direct contact with the foundation wall, unless that interior side of the foundation wall has been waterproofed.
- 3. Comply with the interior air barrier requirements in N1102.4.1
- 4. Comply with section N1102.2.6.8, N1104.2.2.6.9, N1102.2.6.10, or N1102.2.6.11.

Decision Tree for foundation Insulation in the Residential Energy Code



Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

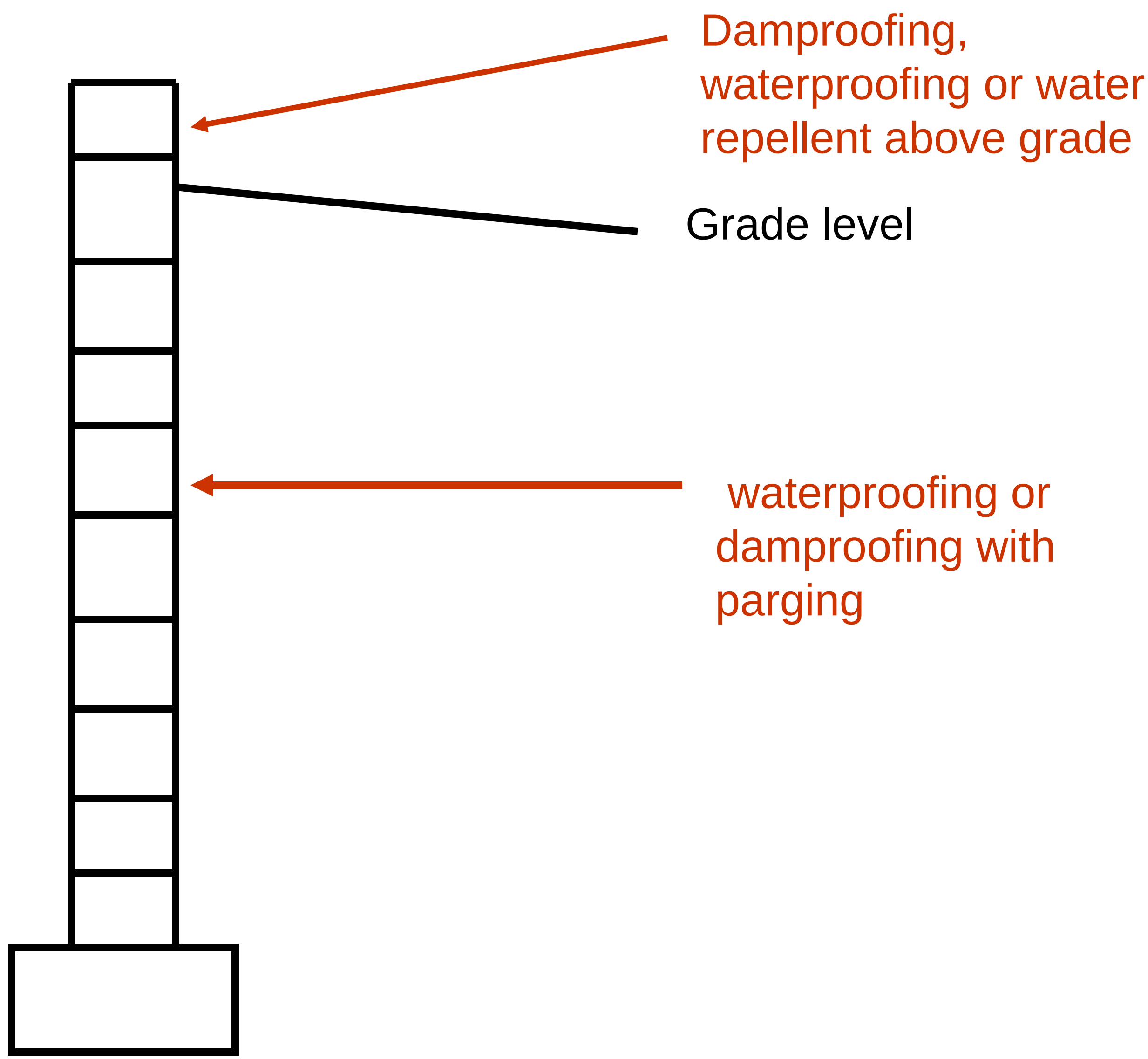
Rigid interior insulation N1102.2.6.8

- 1. Either ASTM C 578 or ASTM C 1289.

Rigid interior insulation N1102.2.6.8

- 1. Either ASTM C 578 or ASTM C 1289.
- 2. Dampproofing, waterproofing, or a water **repellant shall** be applied to the exposed above grade foundation walls or a layer of dampproofing or waterproofing shall be installed on the entire inside surface of the foundation wall. Water repellant materials shall comply with ASTM E 514 with 90% or greater reduction in water permeance when compared to an untreated sample.

Rigid Interior Foundation Insulation N1102.2.6.8



Rigid Interior Foundation Insulation N1102.2.6.8

Installation requirements

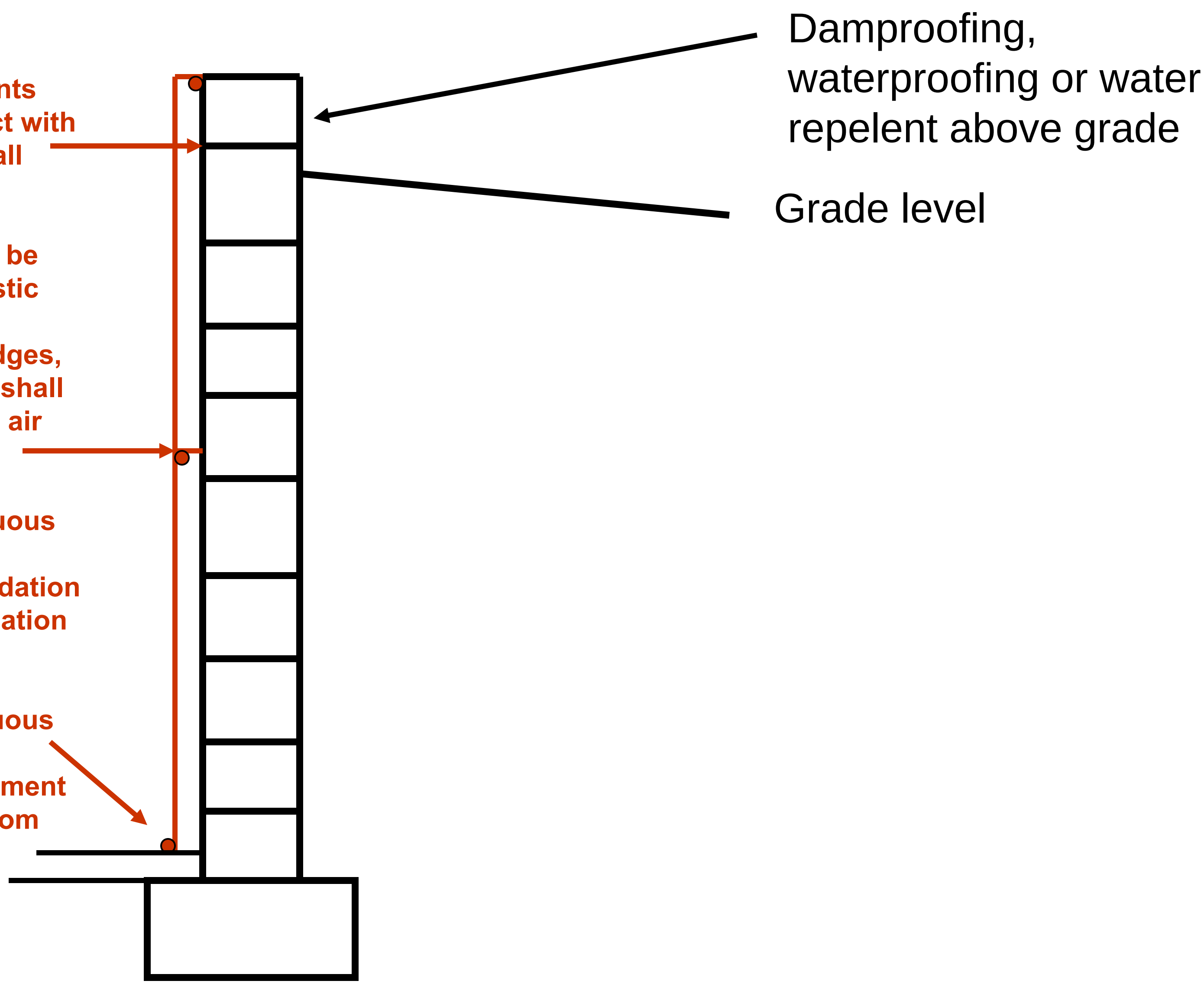
a. Must be in contact with the foundation wall surface

b. Vertical edges shall be sealed with acoustic sealant

c. All interior joints, edges, and penetrations shall be sealed against air and water vapor penetration.

d. Horizontally continuous acoustic sealant between the foundation wall and the insulation at the top of the foundation wall.

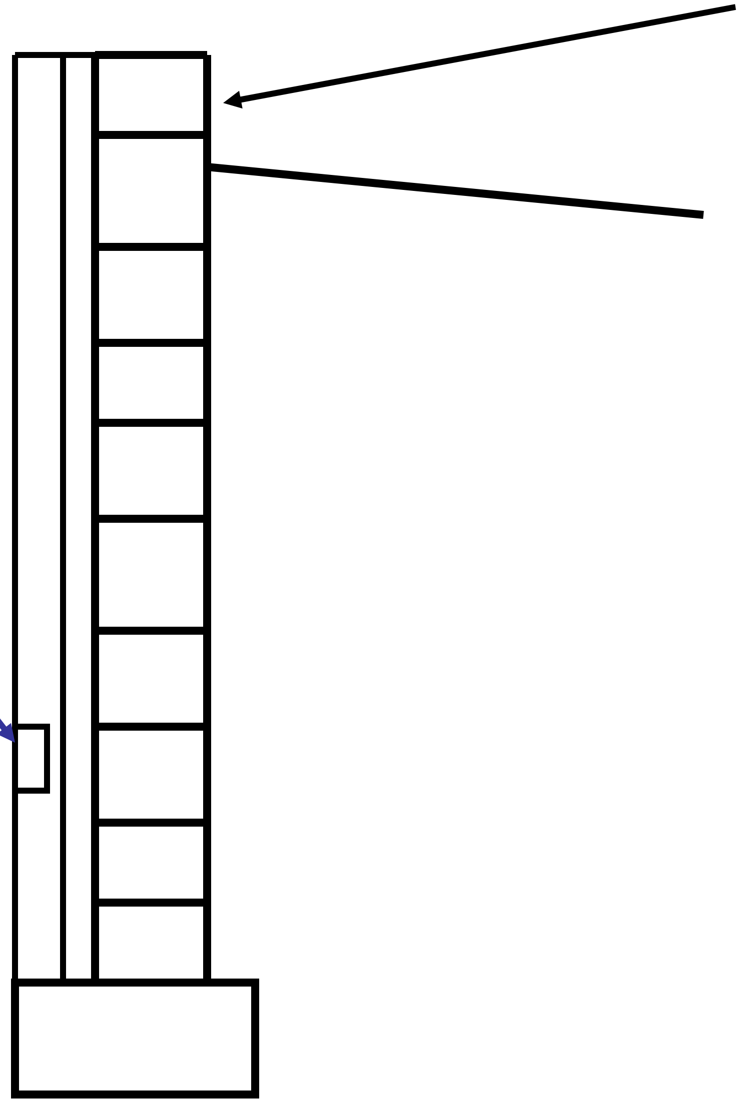
e. Horizontally continuous acoustic sealant between the basement floor and the bottom insulation edge.



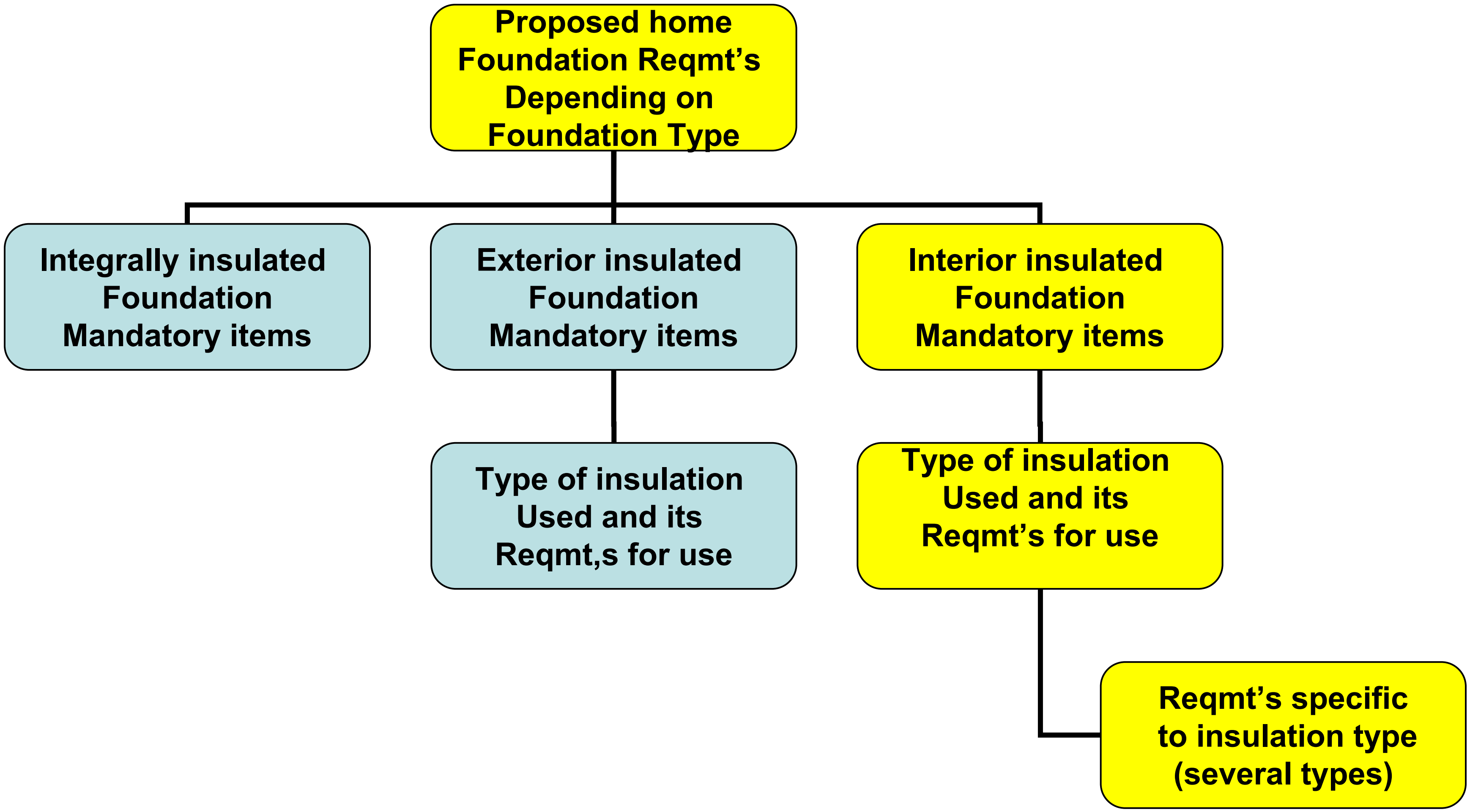
Rigid Interior Foundation Insulation N1102.2.6.8

Installation requirements

The insulation shall not be penetrated by the placement of utilities or by fasteners or connectors used to install a frame wall.



Decision Tree for foundation Insulation in the Residential Energy Code



Note: **This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…**

Spray applied interior insulation N1102.2.6.9

- 1. Closed cell polyurethane
-

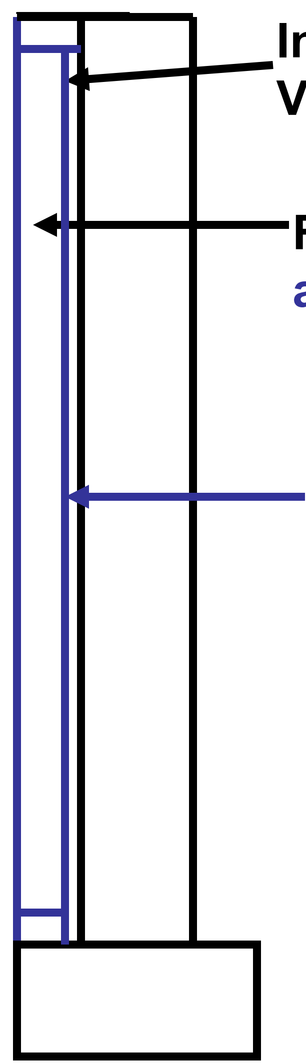
Spray applied interior insulation N1102.2.6.9

- 1. Closed cell polyurethane
- a. ASTM C 1029 compliant with a permeance not greater than 1 in accordance with ASTM E 96 procedure A.

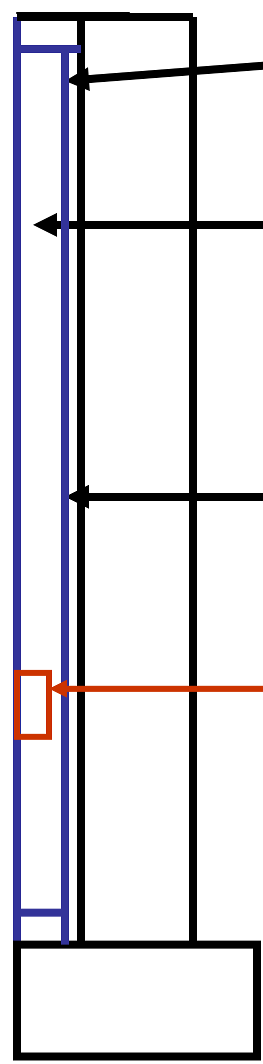
Spray applied interior insulation N1102.2.6.9

- 1. Closed cell polyurethane
- a. ASTM C 1029 compliant with a permeance not greater than 1 in accordance with ASTM E 96 procedure A.
- b. Sprayed directly onto the foundation wall surface. There must be a 1” minimum gap between the foundation wall surface and any framing.

Interior Spray applied interior insulation N1102.2.6.9



Interior Spray applied interior insulation N1102.2.6.9



Insulation that meets the requirements for R-Value

Foam may become the Warm Side vapor and Air barrier

If a frame wall is installed it shall not be in direct contact with the foundation wall

The insulation shall not be penetrated by the placement of utilities.

Through penetrations shall be sealed

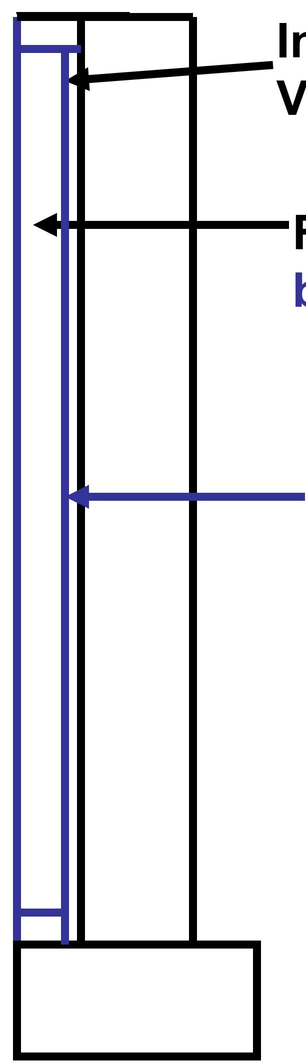
Spray applied interior insulation N1102.2.6.9

- 2. ½ pound free rise open cell foam

Spray applied interior insulation N1102.2.6.9

- 2. ½ pound free rise open cell foam
- a. Sprayed directly onto the foundation wall surface. There must be a 1” minimum gap between the foundation wall surface and any framing.

Interior Spray applied interior insulation N1102.2.6.9

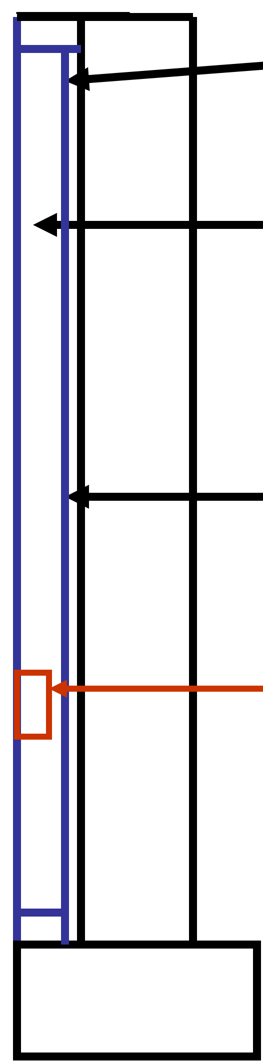


Insulation that meets the requirements for R-Value

Foam may become the Warm Side Air barrier

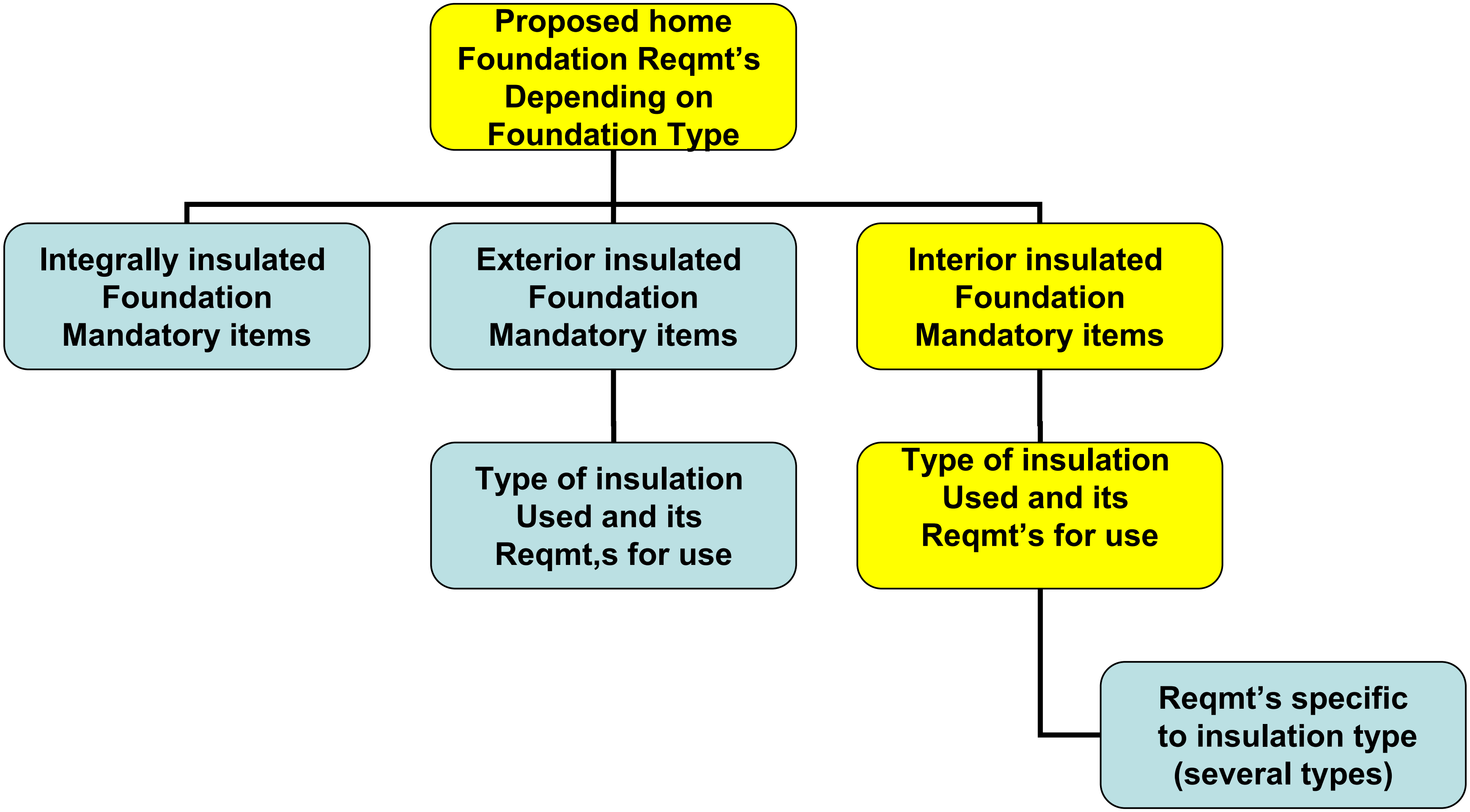
If a frame wall is installed it shall not be in direct contact with the foundation wall

Interior Spray applied interior insulation N1102.2.6.9



Semi-rigid interior insulation N1102.2.6.10

Decision Tree for foundation Insulation in the Residential Energy Code



Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

Semi-rigid interior insulation N1102.2.6.10

- 1. ASTM C1621 with a maximum permeance of 1.1 per inch.

Semi-rigid interior insulation N1102.2.6.10

- 1. ASTM C1621 with a maximum permeance of 1.1 per inch.
- 2. Must have a minimum density of 1.3 pcf and have a fungal resistance per ASTM C1338.

Semi-Rigid Interior Foundation Insulation N1102.2.6.8

Installation requirements

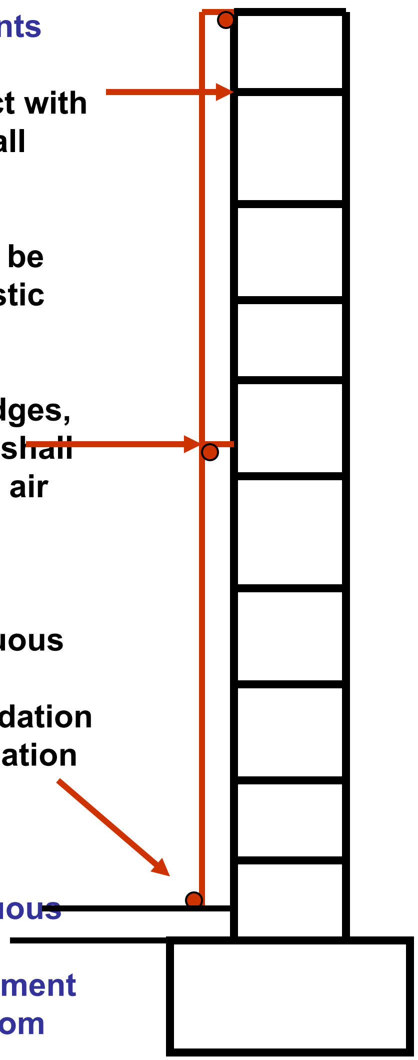
a. Must be in contact with the foundation wall surface

b. Vertical edges shall be sealed with acoustic sealant

c. All interior joints, edges, and penetrations shall be sealed against air and water vapor penetration.

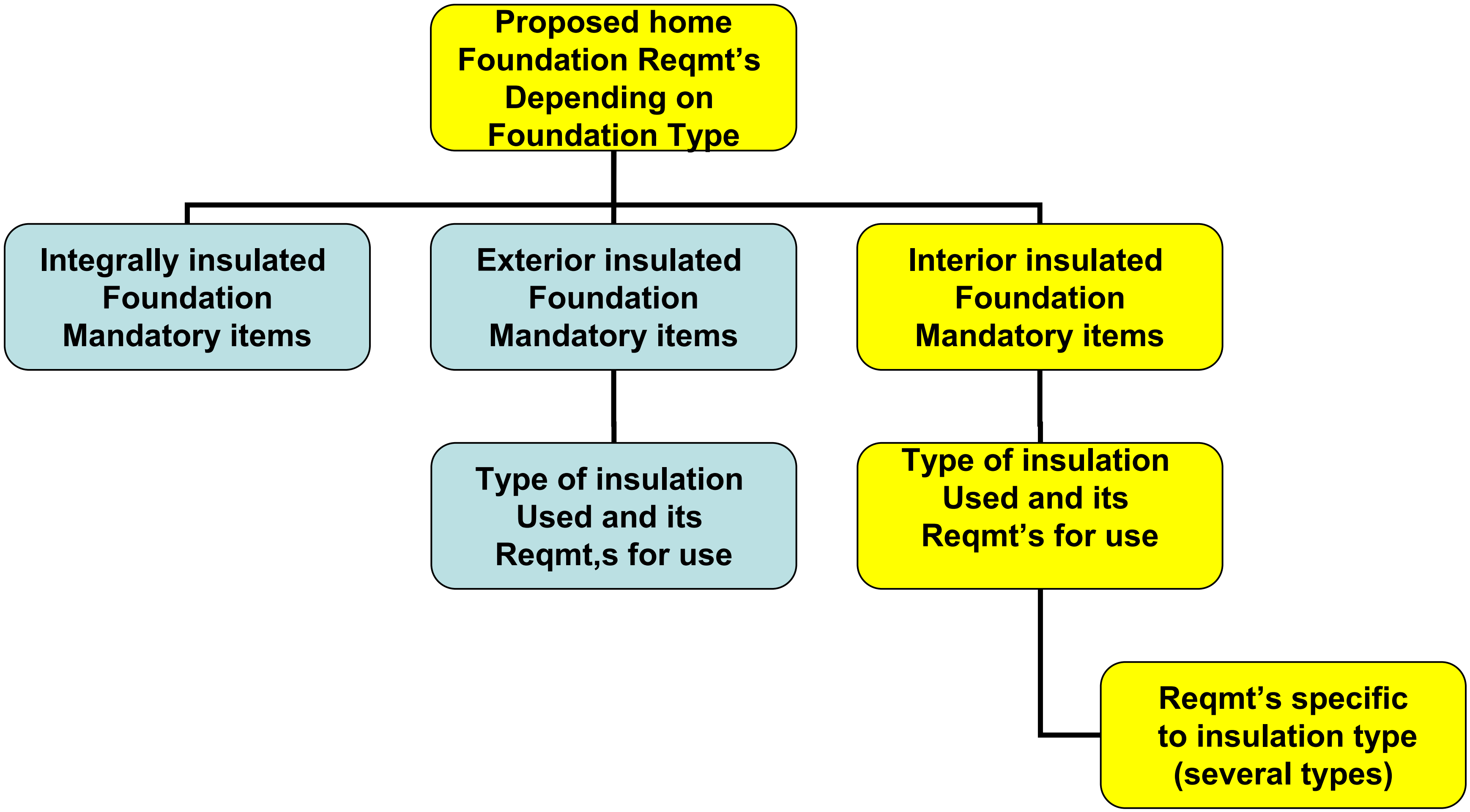
d. Horizontally continuous acoustic sealant between the foundation wall and the insulation at the top of the foundation wall.

e. Horizontally continuous acoustic sealant between the basement floor and the bottom insulation edge.



Unfaced fiberglass batt interior insulation

Decision Tree for foundation Insulation in the Residential Energy Code

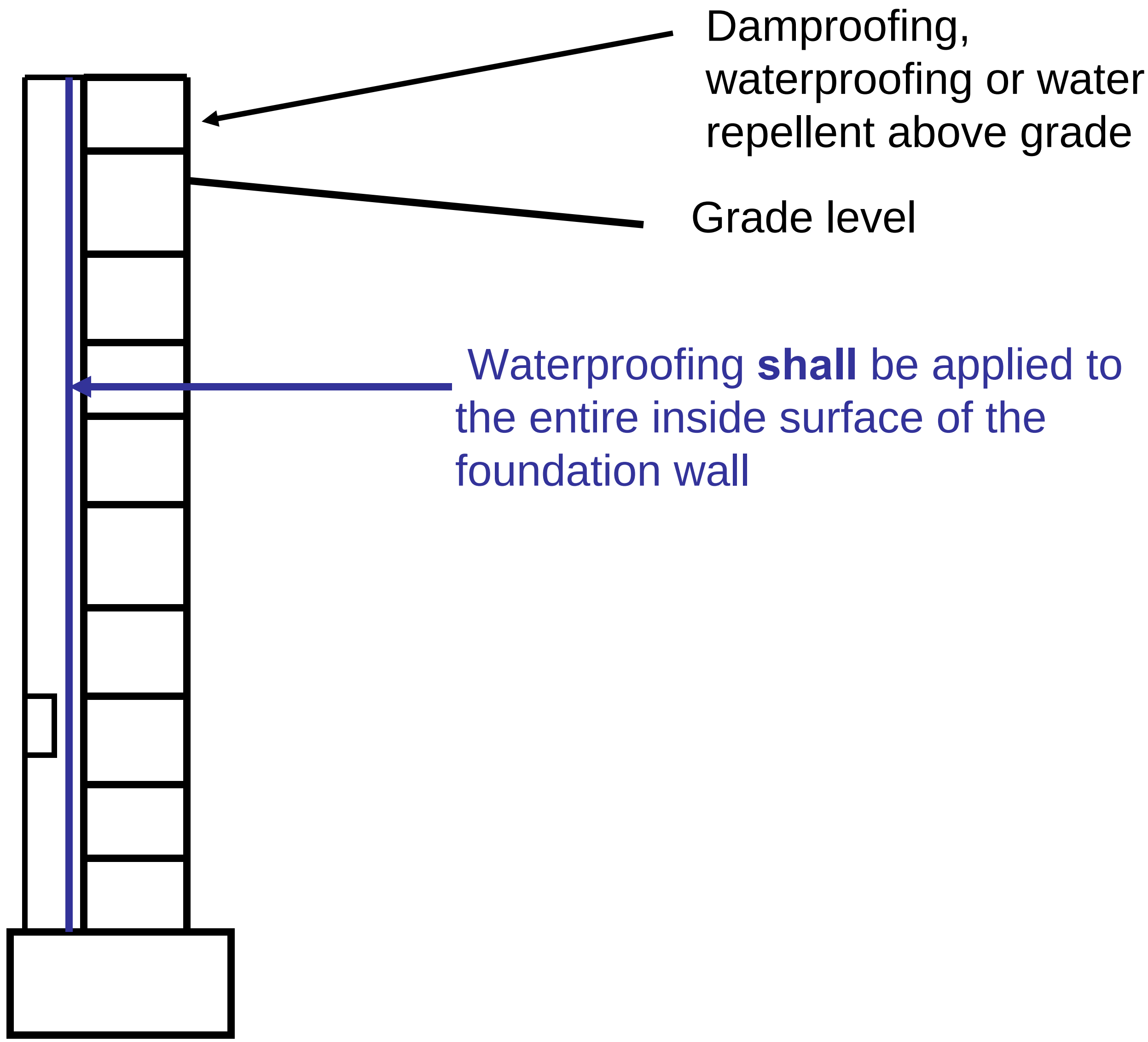


Note: This is not a complicated process. It is very prescriptive. The builder shall decide where they want to insulate the foundation and what product they are going to use and follow the code, including code sections, ASTM Standards etc…

Unfaced fiberglass batt interior insulation

- 1. Waterproofing shall be applied to the entire inside surface of the foundation wall.

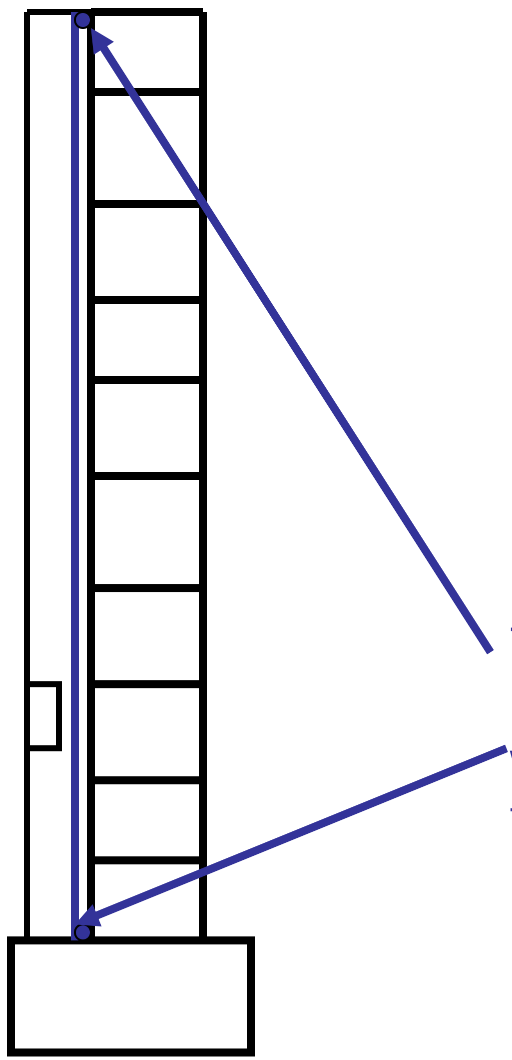
Unfaced fiberglass Interior Foundation Insulation N1102.2.6.8



Unfaced fiberglass batt interior insulation

- 1. Waterproofing shall be applied to the entire inside surface of the foundation wall.
- 2. The top and bottom plates must be air sealed to the foundation wall surface and the basement floor.

Unfaced fiberglass Foundation Insulation N1102.2.6.8



The top and bottom plates must be air sealed to the foundation wall surface and the basement floor.

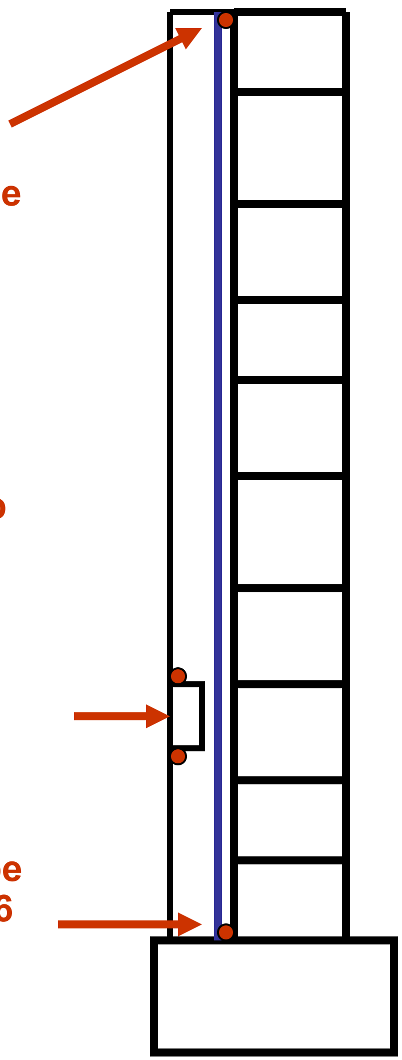
Unfaced fiberglass Foundation Insulation N1102.2.6.8

In addition an air barrier material and vapor retarder material with a minimum a permeance of at least 1 in accordance with ASTM E 96 procedure A.

a. Air sealed to the framing with construction adhesive or equivalent at the top and bottom plates and where the adjacent wall is insulated, and

b. Air sealed utility boxes and other penetrations, and

•c. All seams shall be overlapped at least 6 inches and sealed with compatible sealing tape or equivalent.



Waterproofing **shall** be applied to the entire inside surface of the foundation wall

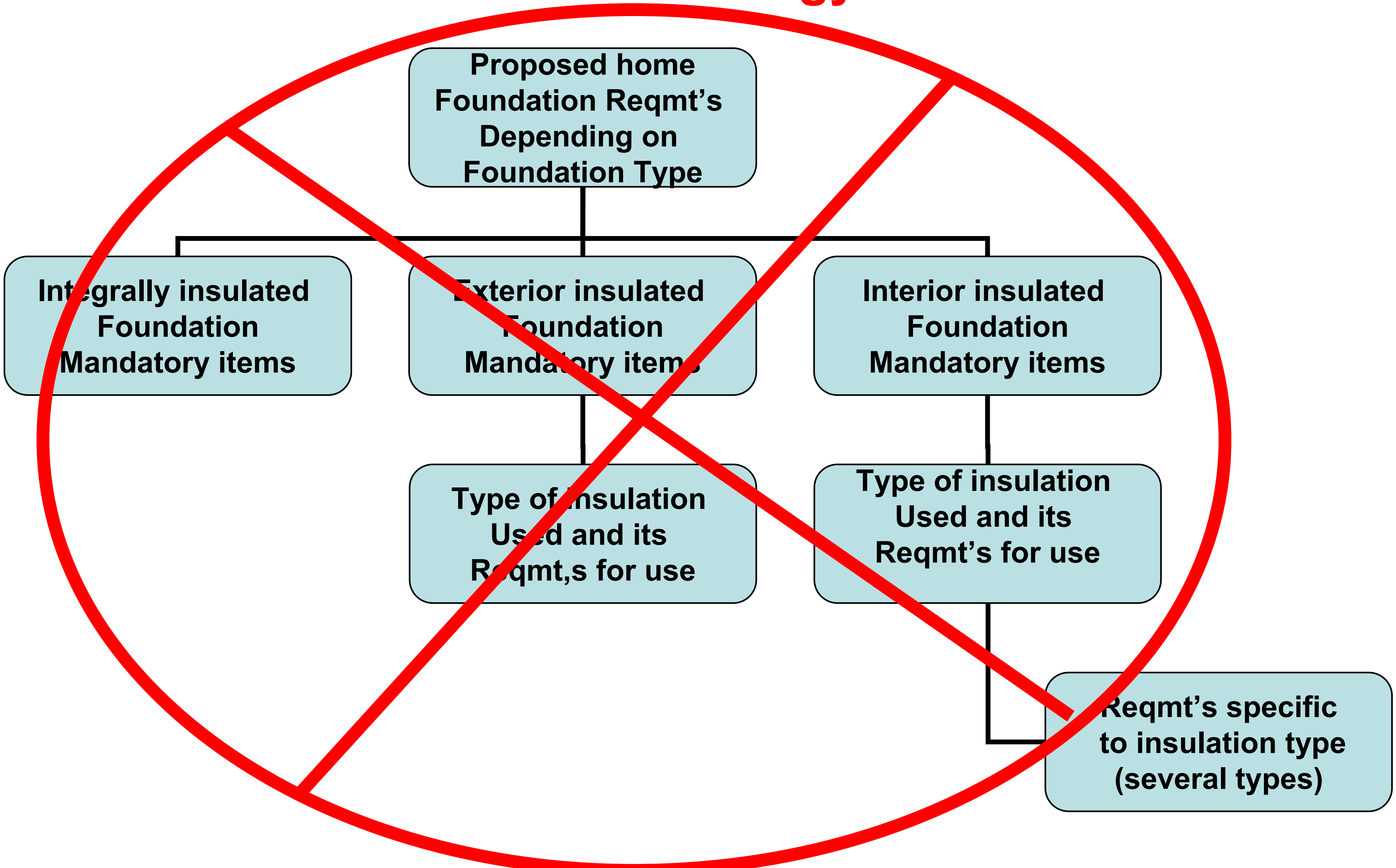
The top and bottom plates must be air sealed to the foundation wall surface and the basement floor.

Unfaced fiberglass batt interior insulation

- 1. Waterproofing shall be applied to the entire inside surface of the foundation wall.
- 2. The top and bottom plates must be air sealed to the foundation wall surface and the basement floor.
- 3. In addition an air barrier material and vapor retarder material with a minimum a permeance of at least 1 in accordance with ASTM E 96 procedure A.
- a. Air sealed to the framing with construction adhesive or equivalent at the top and bottom plates and where the adjacent wall is insulated, and
- b. Air sealed utility boxes and other penetrations, and
- c. All seams shall be overlapped at least 6 inches and sealed with compatible sealing tape or equivalent.
- d. Up to R-13 batts are allowed.

Foundation Wall Insulation Performance Option

Decision Tree for foundation Insulation in the Residential Energy Code



Note: This is not a complicated process, for the builder. However for someone else it may be

Foundation Wall Insulation Performance Option

- Insulated foundation systems designed and installed under the performance option shall meet the requirements of this section.

Water separation plane

- The foundation shall be designed and built to have a continuous water separation plane between the interior and exterior. The interior side of the water separation plane must:

Water separation plane

- 1. Have a stable annual wetting/drying cycle whereby foundation wall system water (solid, liquid and vapor) transport processes produce no net accumulation of ice or water over a full calendar year and the foundation wall system is free of adsorbed water for at least 4 months over a full calendar year;

Water separation plane

- 1. Have a stable annual wetting/drying cycle whereby foundation wall system water (solid, liquid and vapor) transport processes produce no net accumulation of ice or water over a full calendar year and the foundation wall system is free of adsorbed water for at least 4 months over a full calendar year;
- 2.Prevent conditions of moisture and temperature to prevail for a time period favorable to mold growth for the materials used; and

Water separation plane

- 1. Have a stable annual wetting/drying cycle whereby foundation wall system water (solid, liquid and vapor) transport processes produce no net accumulation of ice or water over a full calendar year and the foundation wall system is free of adsorbed water for at least 4 months over a full calendar year;
- 2.Prevent conditions of moisture and temperature to prevail for a time period favorable to mold growth for the materials used; and
- 3.Prevent liquid water from the foundation wall system reaching the foundation floor system at any time during a full calendar year.

Documentation

- The foundation insulation system designer shall provide documentation certified by a professional engineer registered in Minnesota demonstrating how the requirements of this section are fulfilled. The foundation insulation system designer shall also specify the design conditions for the wall and the design conditions for the interior space for which the water separation plane will meet the requirements of this section. The foundation insulation system designer shall provide a label disclosing these design conditions and the label shall be posted in accordance with N1101.8.

Installation

- The *water separation plane* shall be designed and installed to prevent external liquid or capillary water flow across it after the foundation is backfilled.

Foundation air barrier.

- **The foundation insulation system shall be designed and installed to have a foundation air barrier system between the interior and the exterior.**

Foundation air barrier.

- The foundation insulation system shall be designed and installed to have a foundation air barrier system between the interior and the exterior.
- The foundation air barrier system must be a material or combination of materials that is continuous with all joints sealed and is durable for the intended application.

Foundation air barrier.

- The foundation insulation system shall be designed and installed to have a foundation air barrier system between the interior and the exterior.
- The foundation air barrier system must be a material or combination of materials that is continuous with all joints sealed and is durable for the intended application.
- Material used for the foundation air barrier system must have an air permeability not to exceed 0.004 ft3/min.ft2 under a pressure differential of 0.3 in. water (1.57psf) (0.02 L/s.m2 at 75Pa) as determined by either commonly accepted engineering tables or by being labeled by the manufacturer as having these values when tested in accordance with ASTM E2178.

FENESTRATION.

Glazed fenestration exemption

- Up to 15 ft^2 of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor requirements in Section N1102.1.

Opaque door exemption

- One opaque door assembly is exempted from the U-factor requirements in Section N1102.1

Thermally isolated sunroom U-factor

- New windows and doors separating the sunroom from conditioned space shall meet the building thermal envelope requirements.

Replacement Fenestration

- Where some or all of an existing fenestration unit is replaced with a new fenestration product, including frame, sash, and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factors found in Tables N1102.1, unless exempt under Section 1102.3.1.

Ventilation

Ventilation
Minnesota Rules, Chapter 1322, Residential Energy Code

1. Ventilation Overview
   - -What is ventilation
   - -Why ventilate
   - -How much should we ventilate

2. Mechanical Ventilation Systems
   - -Total and continuous ventilation rates
   - -Ventilation System Requirements (3 types)
     - Exhaust only
     - Balanced
     - Other methods

3. Air distribution/circulation

4. Insulation, labeling, documentation

Ventilation Systems-Overview

- Goals of Mechanical Ventilation
  - To maintain good indoor air quality
  - To control indoor moisture

Ventilation Systems-Overview

- **ASHRAE 62.1-2004**
  - **“Acceptable indoor air quality: air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.”**

Ventilation Systems

- When to Ventilate?
  - Primarily when the home is occupied
  - May need to continue after or purge before

Ventilation Systems

- When to Ventilate?
  - Primarily when the home is occupied
  - May need to continue after or purge before
- Where to Ventilate?
  - Ideally where the pollutants are concentrated
  - Remove point source pollutants immediately
  - Use general ventilation for disperse pollutants

Overview- What is Ventilation?

"The process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space."

Overview- Ventilation Systems

- **Why** Ventilate?
  - People pollutants
    - human respiration, body odors
    - water vapor
  - Building pollutants
    - VOCs, Combustion gases, radon
    - water vapor
  - Activity pollutants
    - VOCs, odors
    - water vapor

Overview-Ventilation Systems

- Types of Air Exchange in Houses
  - Infiltration/Exfiltration
  - Natural ventilation
  - Chimneys
  - Exhaust devices
  - Mechanical ventilation

Why Ventilate?

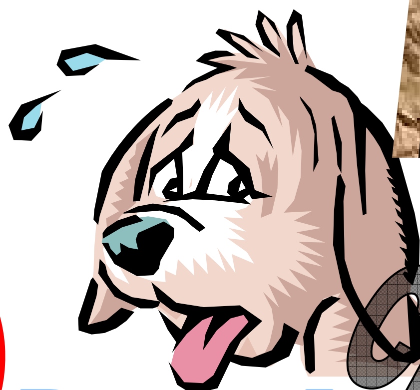
Athletic equipment

Mold

Bathroom exhaust

Diapers

Smoke

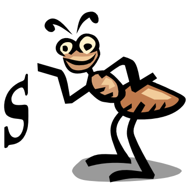


Pet odors

Cleaning supplies

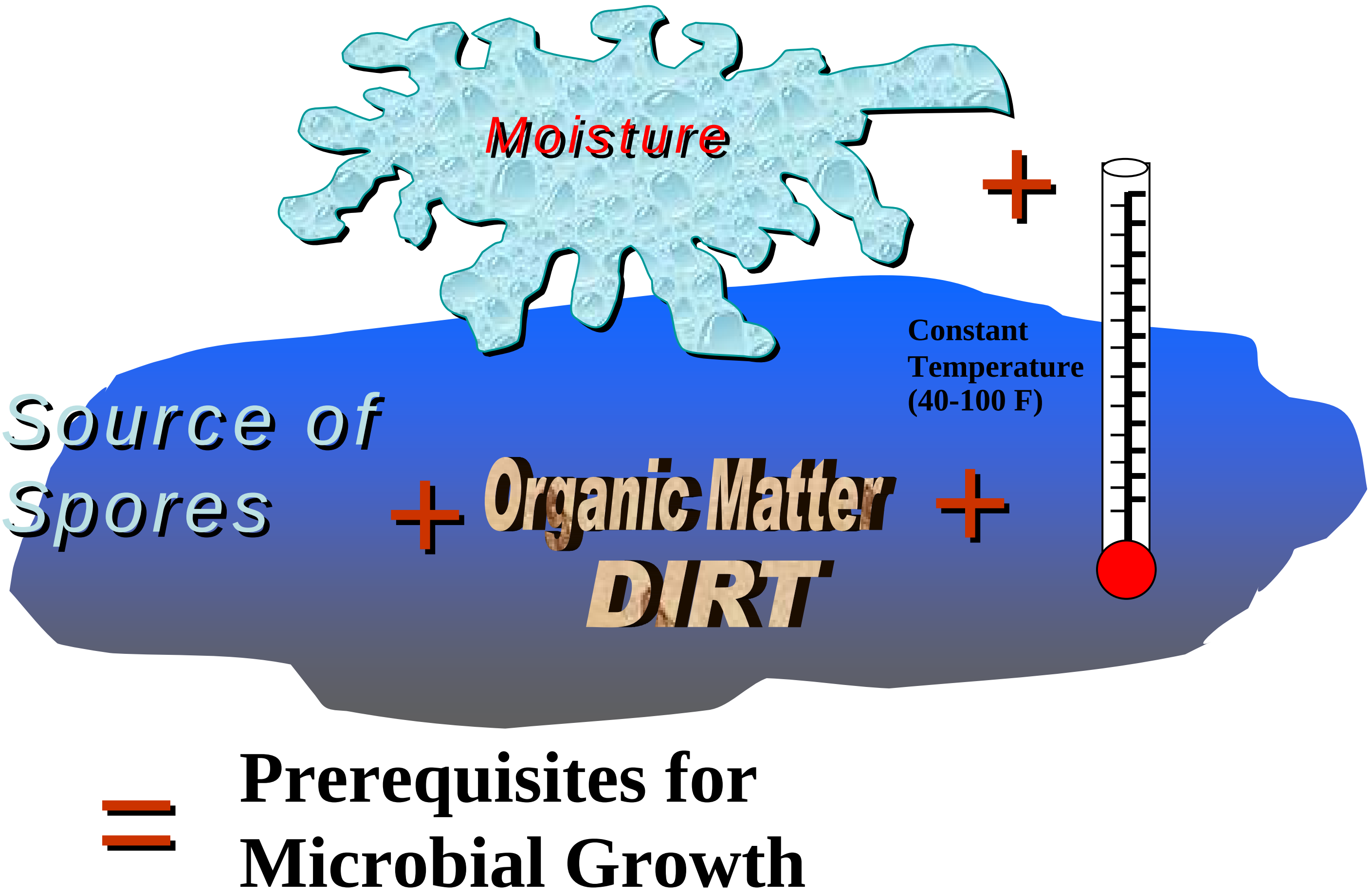
Window condensation

Dust Mites

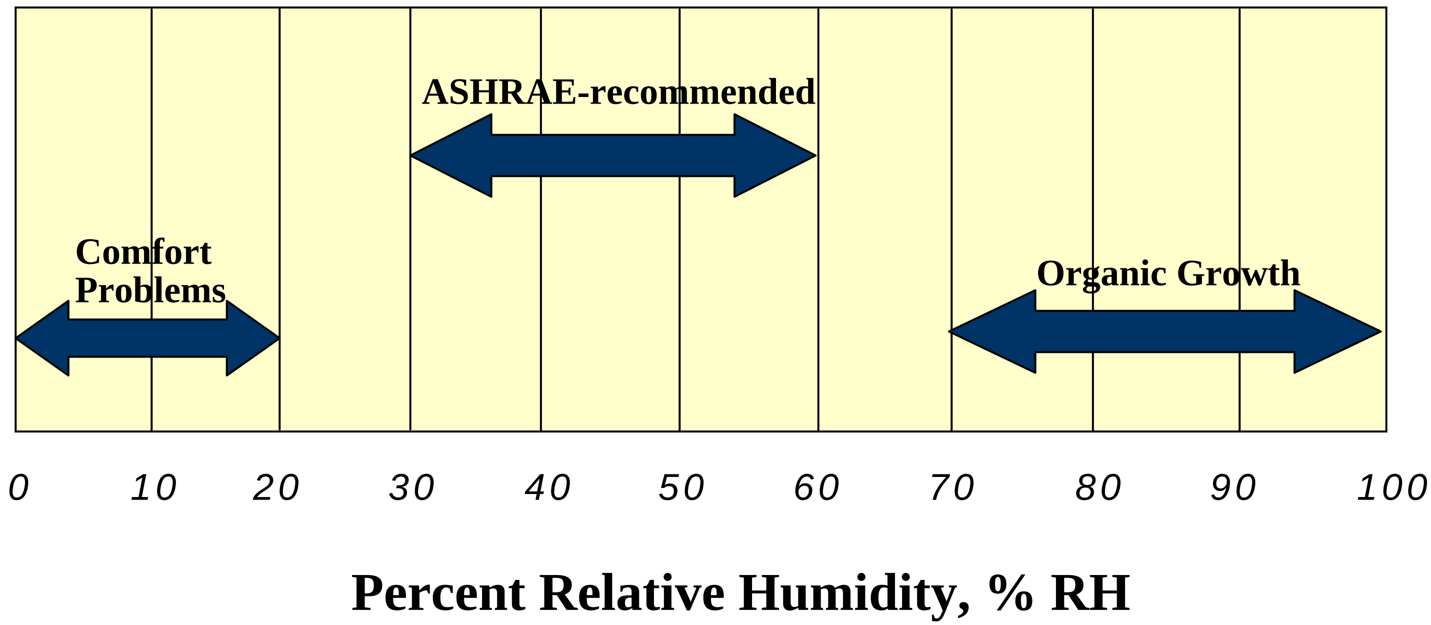


IAQ Solutions - HUMIDITY CONTROL

Why Manage Humidity?



OVERVIEW- HUMIDITY CONTROL



Overview- Ventilation Systems

- **How Much** to Ventilate, considering:?
  - Moisture generation rates
    - people
    - building
  - Other pollutants
    - type of pollutant
    - source strength
  - Occupant sensitivity
  - Continuous ventilation

Overview-Ventilation Systems

- **How Much** to Ventilate?
- Chapter 1322: Total ventilation rate: "…shall provide sufficient outdoor air = total ventilation rate average, for each one hour period in accordance with Table N1104.2, or equation 11-1.
- Equation 11-1
  - Total ventilation rate (CFM) = (0.02 x square feet of conditioned space) + (15 x (number of bedrooms +1)).
  - Includes the basement but excludes conditioned crawl spaces.

Overview-Ventilation Systems

- **Equation 11-1**
  - **Total ventilation rate (CFM) = (0.02 x square feet of conditioned space) + (15 x (number of bedrooms +1)).**
  - Example 1:
    - 2300 square feet of conditioned space house
      - Conditioned space = “An area, room or space being heated or cooled by any equipment or appliance.”
    - 3 bedrooms
    - .02 x square feet of conditioned space = .02 x 2300 = 46 CFM
    - Number of bedrooms (3) + 1 = 4
    - 15 x 4 = 60 CFM
    - Total ventilation rate (CFM) = 46 CFM + 60 CFM = 106 CFM

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

Conditioned space[1] (in sq. ft.)	Number of Bedrooms: 1 — Total/ Continuous	2 — Total/ Continuous	3 — Total/ Continuous	4 — Total/ Continuous	5 — Total/ Continuous	6[2] — Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Overview-Ventilation Systems

- Continuous Ventilation:
  - N1104.2.1: "… a minimum of 50% of the total ventilation rate, but not less than 40 CFM, on a continuous rate average for each one hour period in accordance with Table N1104.2 or Equation 11-2.
  - Equation 11-2: Continuous ventilation (CFM)= total ventilation rate /2.
  -

Table N1104.2 Total and continuous ventilation rates (in CFM)

Conditioned space[1] (in sq. ft.)	Number of Bedrooms					
	1	2	3	4	5	6[2]
	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Overview-Ventilation Systems

- Total Ventilation : equation 11-1 total ventilation rate = 106 CFM and Table N1104.2 total ventilation rate = 110 CFM.

- Continuous ventilation rate = 53 CFM (if equation 11-2 is used) or 55 CFM = 55 CFM if table N1104.2 is used.

Supplemental Ventilation

- Kitchen Exhaust
- Bathroom Exhaust
- ETC.

Ventilation Systems
Required ventilation rate
Example 2

(.02 x square feet of conditioned space + (15x (number of bedrooms +1)) = **Total Ventilation Rate**

Example: 4 bedroom, 2 bathroom, 2,000 sq.ft. house

(4 Bedrooms + 1) X 15 (cfm)	5 X 15 =75
+ (0.02 (cfm) X 2000 sq.ft.)	+ 40
115 cfm	**115 cfm**

Continuous Ventilation Rate

- 50% of **Total Ventilation Rate**

- Example:

  115 cfm ÷ 2 = 57.5 cfm > **60 cfm**

Draft rule Chapter 1322
N1104.2.1

Table N1104.2 Total and continuous ventilation rates (in CFM)

Conditioned space[1] (in sq. ft.)	Number of Bedrooms					
	1	2	3	4	5	6[2]
	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

Conditioned space[1] (in sq. ft.)	Number of Bedrooms					
	1	2	3	4	5	6[2]
	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Ventilation Systems
Required ventilation rate
Example 3

(.02 x square feet of conditioned space) + (15 x (number of bedrooms +1)) **= Total Ventilation Rate**

6 bedroom, 3 bathroom, 5,000 sq.ft. house

(6 Bedrooms + 1) X 15 (cfm)	7 X 15 =105
+ (0.02 (cfm) X 5000 sq.ft.)	= 100
205	**205**

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
$\boxed{4501 – 5000}$	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Ventilation Systems
Required ventilation rate
Example 4

(.02 X square feet of conditioned space) + (15 x (number of bedrooms +1))**= Total Ventilation Rate**

Example: 6 bedroom, 3 bathroom, 7,000 sq.ft. house

(6 Bedrooms + 1) X 15 (cfm)
+ (0.02 (cfm) X 7000 sq.ft.)

7 X 15 =105
+ 140
245 cfm

Table N1104.2 Total and continuous ventilation rates (in CFM)

	Number of Bedrooms					
	1	2	3	4	5	6[2]
Conditioned space[1] (in sq. ft.)	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous	Total/ Continuous
1000 – 1500	60/40	75/40	90/45	105/53	120/60	135/68
1501 – 2000	70/40	85/43	100/50	115/58	130/65	145/73
2001 – 2500	80/40	95/48	110/55	125/63	140/70	155/78
2501 – 3000	90/45	105/53	120/60	135/68	150/75	165/83
3001 – 3500	100/50	115/58	130/65	145/73	160/80	175/88
3501 – 4000	110/55	125/63	140/70	155/78	170/85	185/93
4001 – 4500	120/60	135/68	150/75	165/83	180/90	195/98
4501 – 5000	130/65	145/73	160/80	175/88	190/95	205/103
5001 – 5500	140/70	155/78	170/85	185/93	200/100	215/108
5501 – 6000[2]	150/75	165/83	180/90	195/98	210/105	225/113

Sub-script 2 to the table

- If conditioned space exceeds 6000 sq. ft. or there are more than 6 bedrooms, use Equation 11-1 from section N1104.2 to calculate total ventilation rate.

Ventilation Systems

- Framework for Mechanical Ventilation
  - Quantity and location of exhaust (stale, moist) air
  - Quantity and location of supply (fresh, outdoor) air
  - Pressure imbalances (unbalanced exhaust & supply)
  - Internal distribution/circulation patterns
  - Controls

Overview-Ventilation Systems

N1104.3 Ventilation system requirements. The mechanical ventilation system shall be one of 3 types:

1. Exhaust in accordance with N1104.2.1 (Continuous ventilation section).
2. Balanced, and HRV/ERV in accordance with N1104.3.2
3. Other method in accordance with N1104.3.3

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:
  1. Meet minimum continuous rate in N1104.2.1

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:
  1. Meet minimum continuous rate in N1104.2.1
  2. Designed and certified by equipment manufacturer as capable of continuous operation at rated CFM

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:

1. Meet minimum continuous rate in N1104.2.1
2. Designed and certified by equipment manufacturer as capable of continuous operation at rated CFM
3. Have a 1.0 sone maximum per HVI Standard 915 for surface mounted fans

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:

1. Meet minimum continuous rate in N1104.2.1
2. Designed and certified by equipment manufacturer as capable of continuous operation at rated CFM
3. Have a 1.0 sone maximum per HBI Standard 915 for surface mounted fans
4. Be permitted to use a required overcurrent protection device as a disconnect per the NEC.

Overview-Ventilation Systems

- N1104.3.1 Exhaust Systems. Fans used to comply with the **continuous ventilation part** of the mechanical ventilation system shall:

1. Meet minimum continuous rate in N1104.2.1
2. Designed and certified by equipment manufacturer as capable of continuous operation at rated CFM
3. Have a 1.0 sone maximum per HBI Standard 915 for surface mounted fans
4. Be permitted to use a required overcurrent protection device as a disconnect per the NEC.
5. Comply with the MN Mechanical Code 1346 which may require additional makeup air.

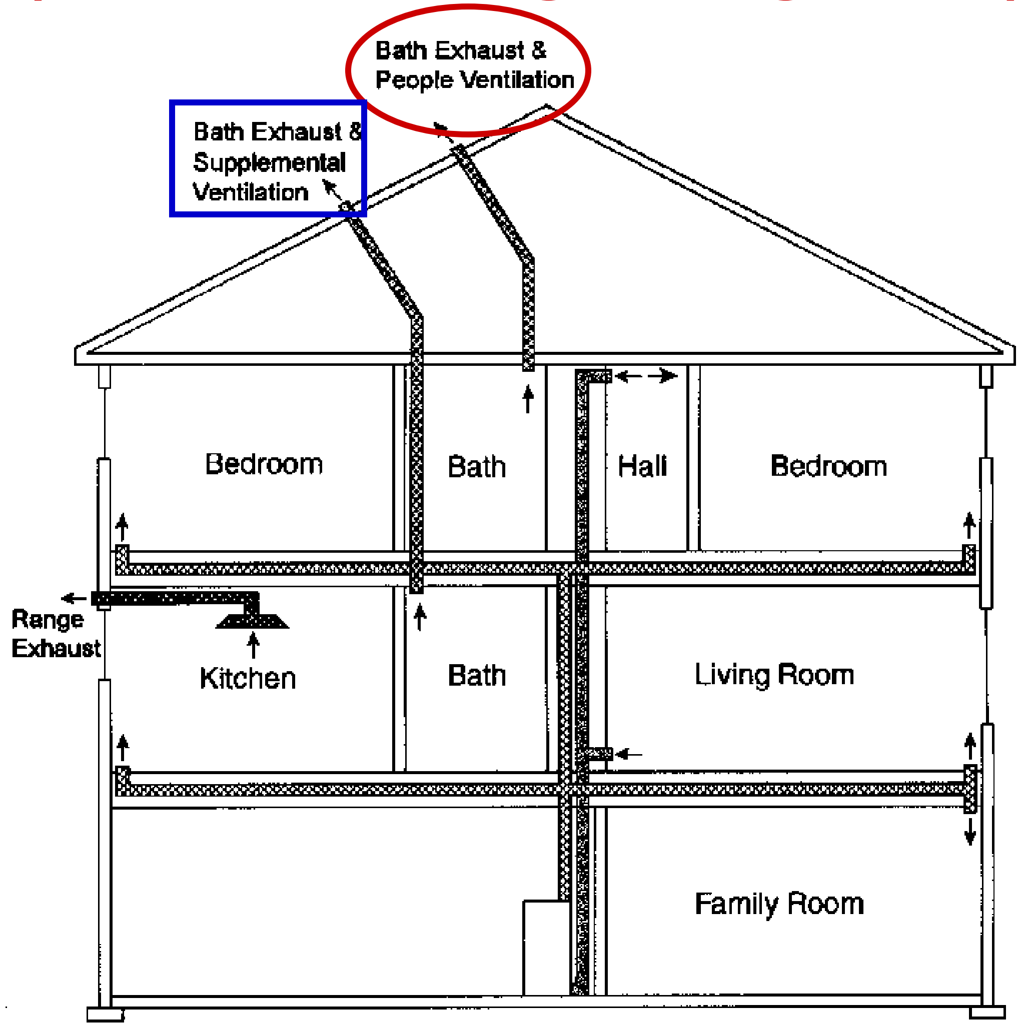
Ventilation System Requirements

- Exhaust Systems
  - Exhaust Fans operating @ the Continuous Ventilation Rate
  - Plus “supplemental/intermittent ventilation” system
  - ***Make up air into home?***
- Note:
  - Surface mounted fan runs continuously at
    - **1 sone fan**
  - In-line fan (outside conditioned space) and intermittent fans run continuously at
    - **2.5 sone fan**

- Exhaust-only systems
  1. Decentralized fans in baths, kitchen, laundry, etc.
  2. Centralized exhaust system
     - with or without heat recovery

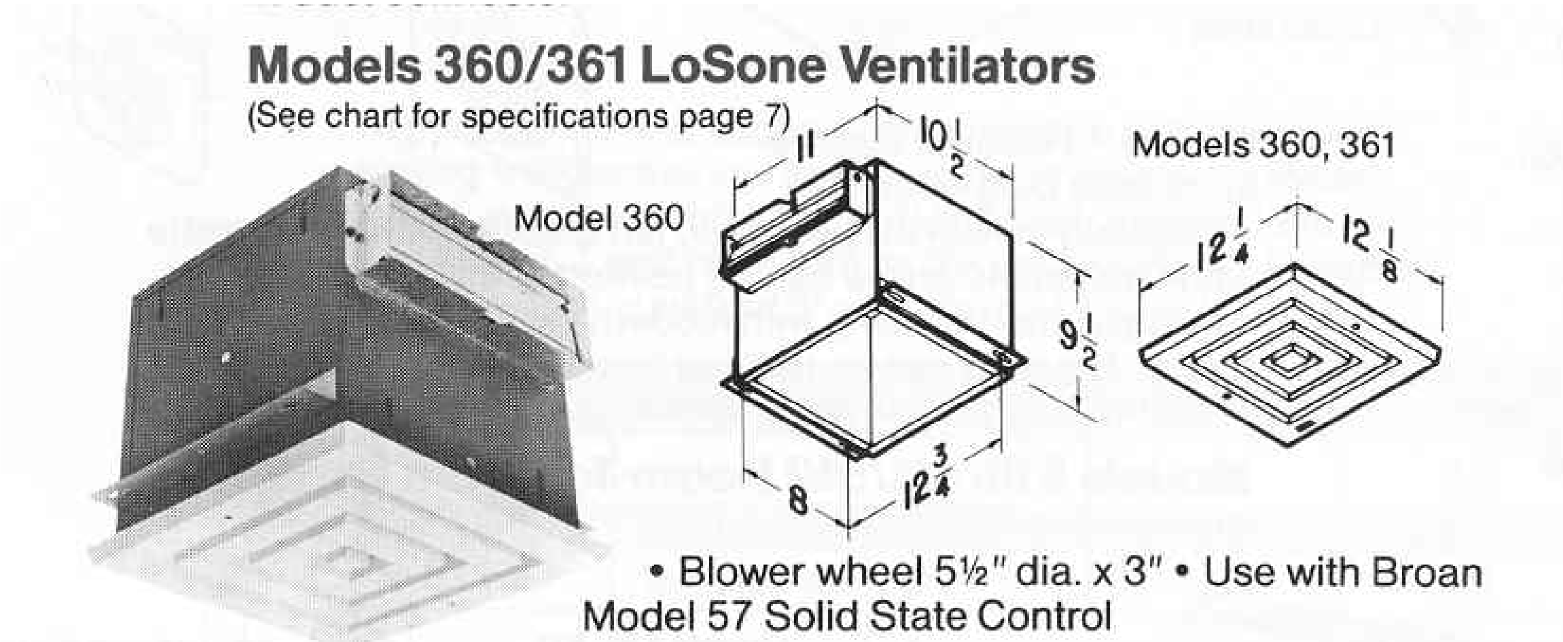
Decentralized Exhaust-Only

Point Source Approach
(Example using a single fan)



Decentralized Exhaust-Only

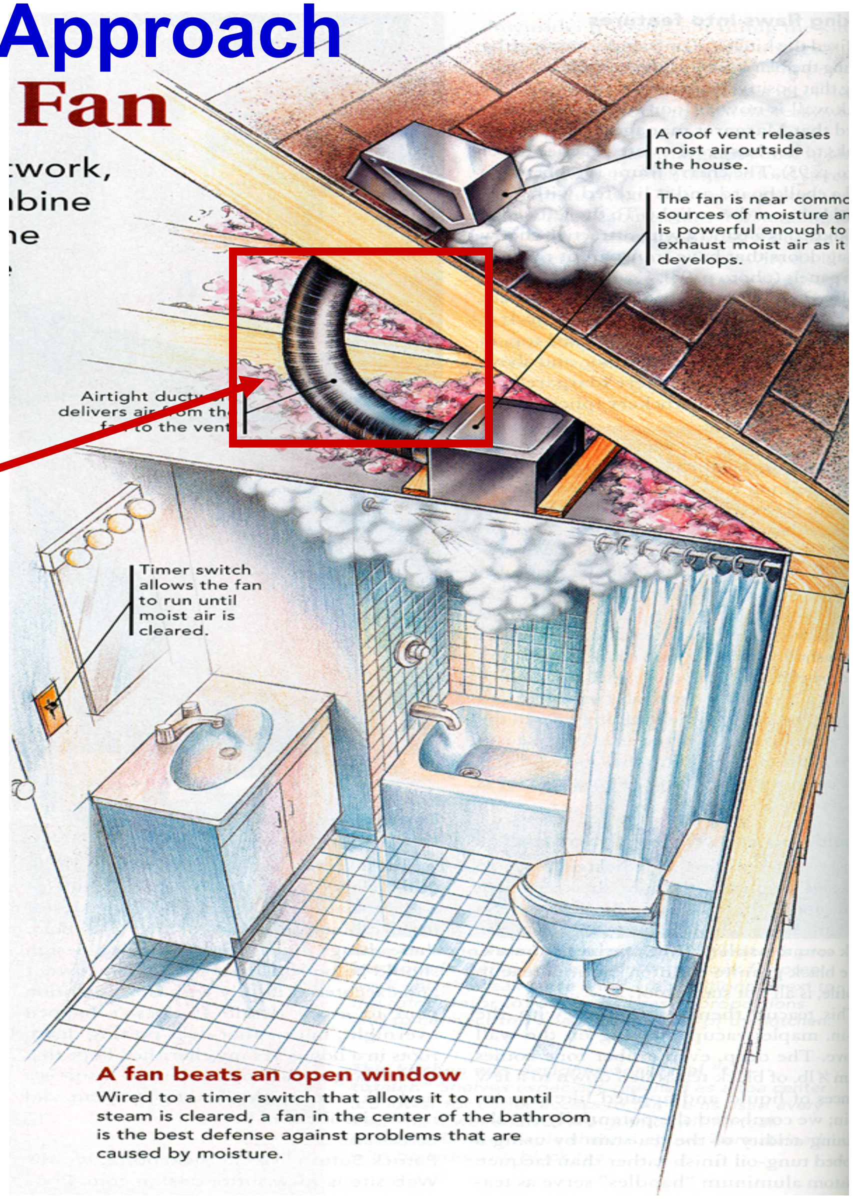
Point Source Approach



Decentralized Exhaust-Only

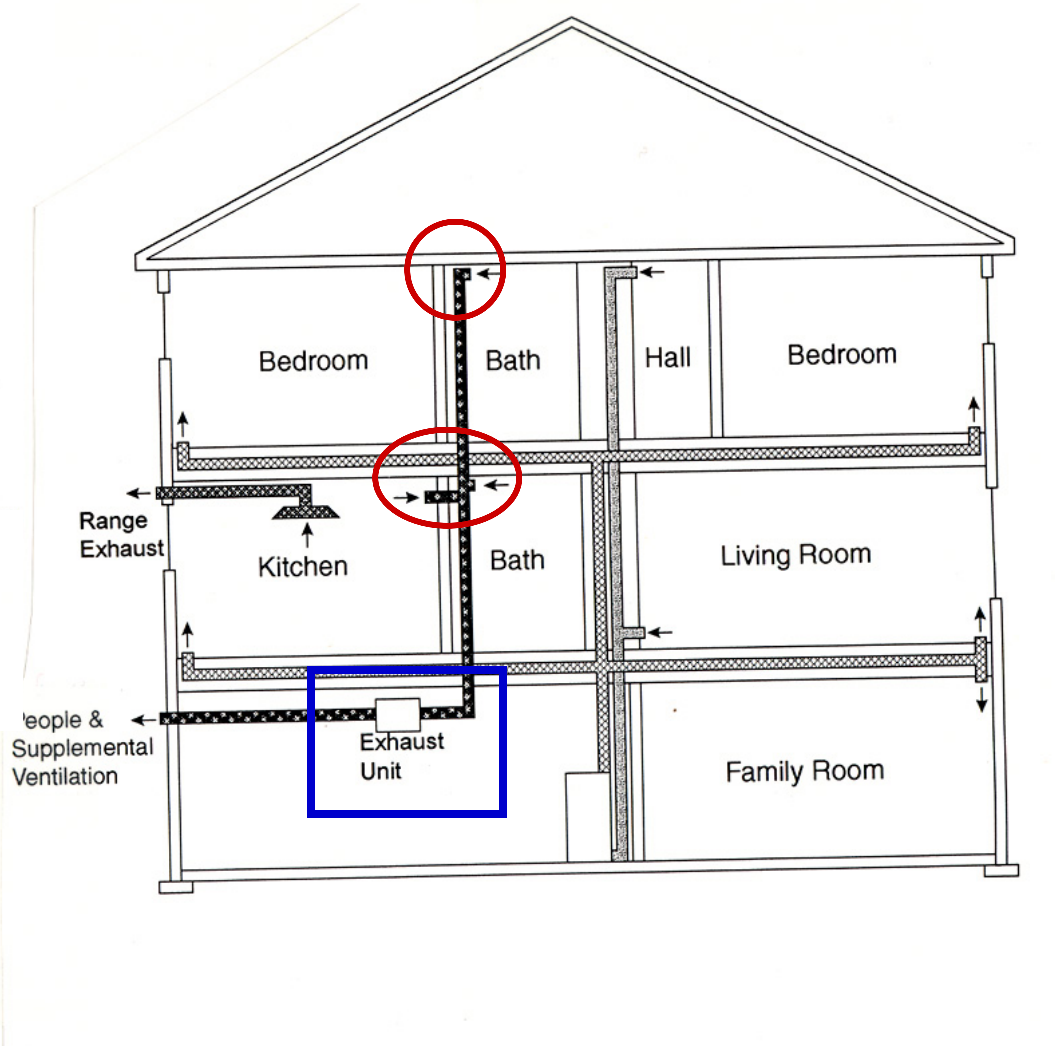
Point Source Approach

Flex Duct installations shall be stretched tight with no sags and excess duct cut off to allow for less static pressure loss and a more effective system.



Centralized Exhaust-Only

Point Source Approach
(Example using a dedicated exhaust Unit)



Centralized Exhaust-Only

Point Source Approach

Ventilation Systems

- **Balanced systems**
  - **integrated supply and exhaust system**
    - HRV/ERV most common system

Ventilation Systems

- Balanced systems
  - integrated supply and exhaust system
  - **separate supply and exhaust fans**

- Mechanical ventilation is required:
  - "Balanced ventilation systems"
    - Energy Recovery Ventilator (ERV)
    - Heat Recovery Ventilator (HRV)
    - Fans

N1104.3.2 Balanced, and HRV/ERV Systems.

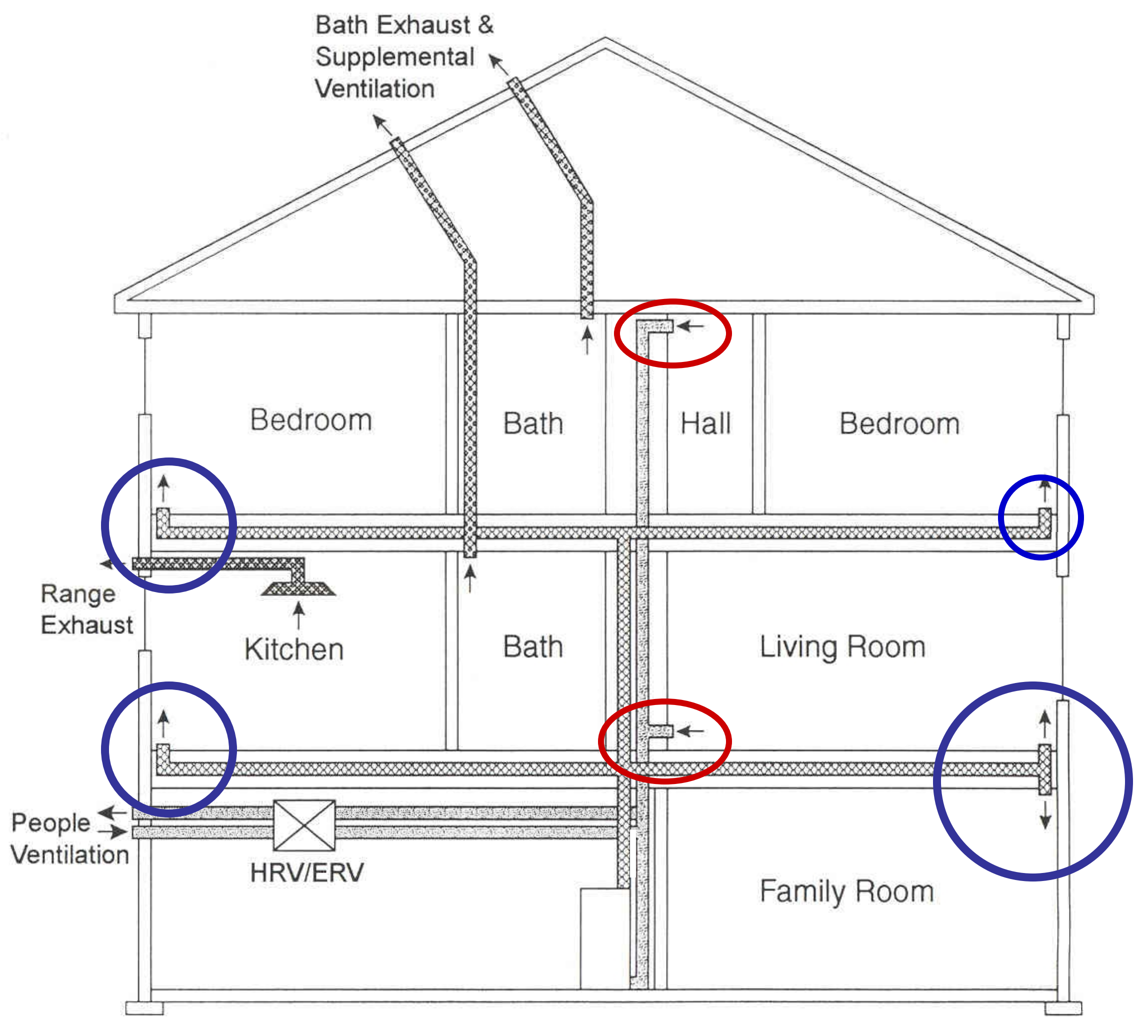
Shall meet either:

1. The requirements of HVI Standard 920, 72 hour minus 13 F cold weather test, or

2. Certified by a licensed professional engineer and installed per manufacturers installation instructions.

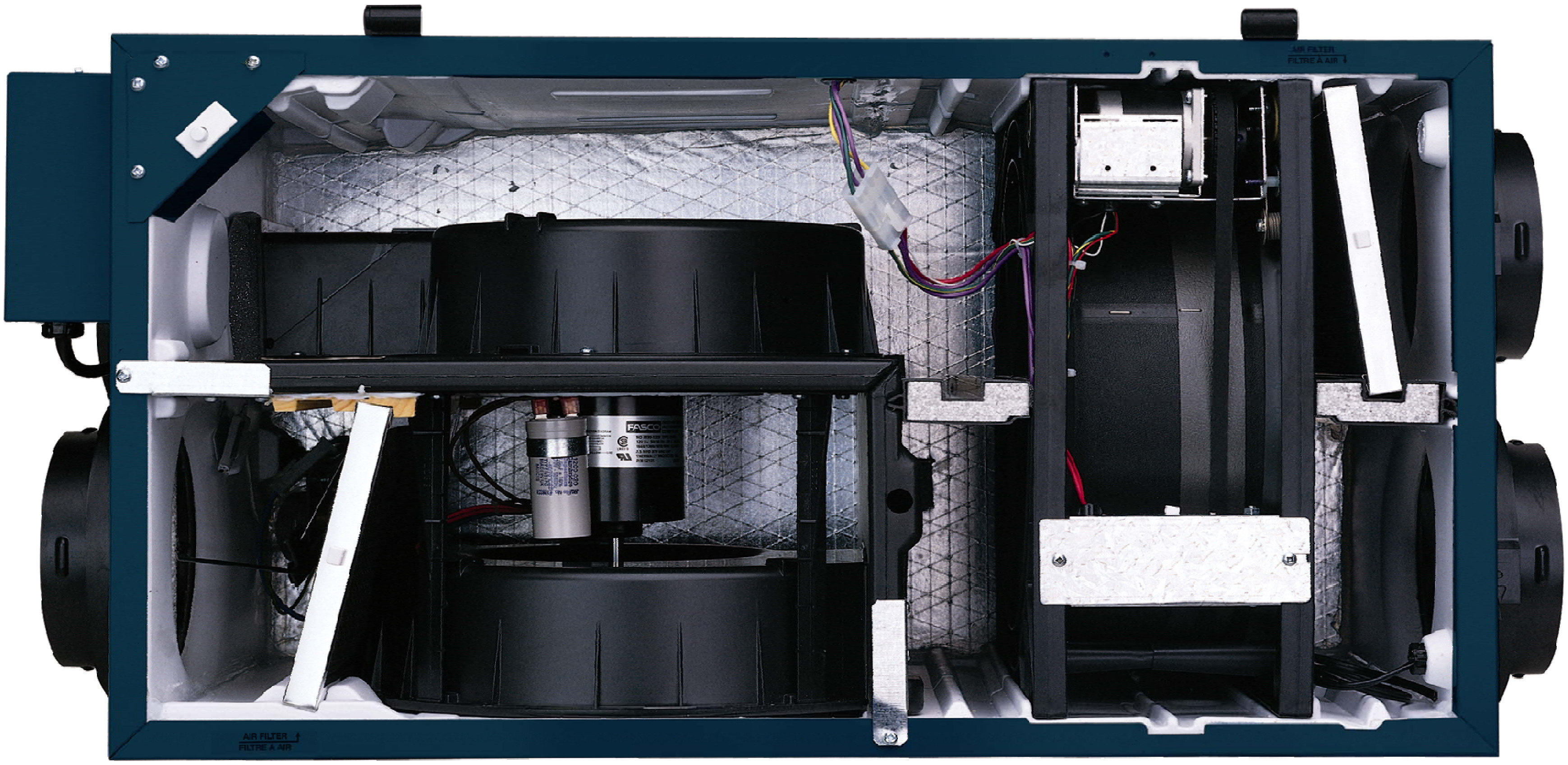
Balanced Ventilation

Volume Source Approach



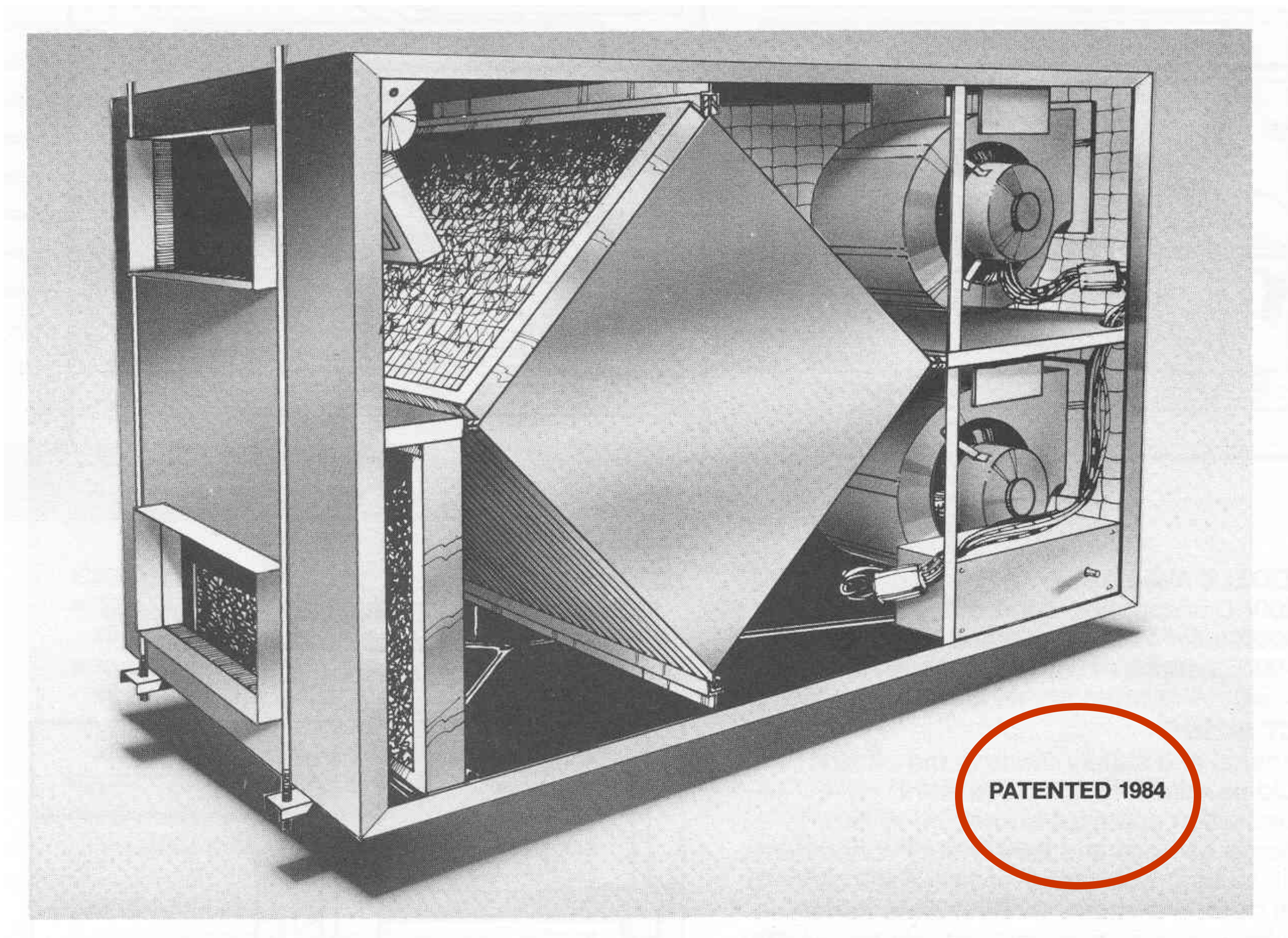
Balanced Ventilation

Energy Recovery Ventilator



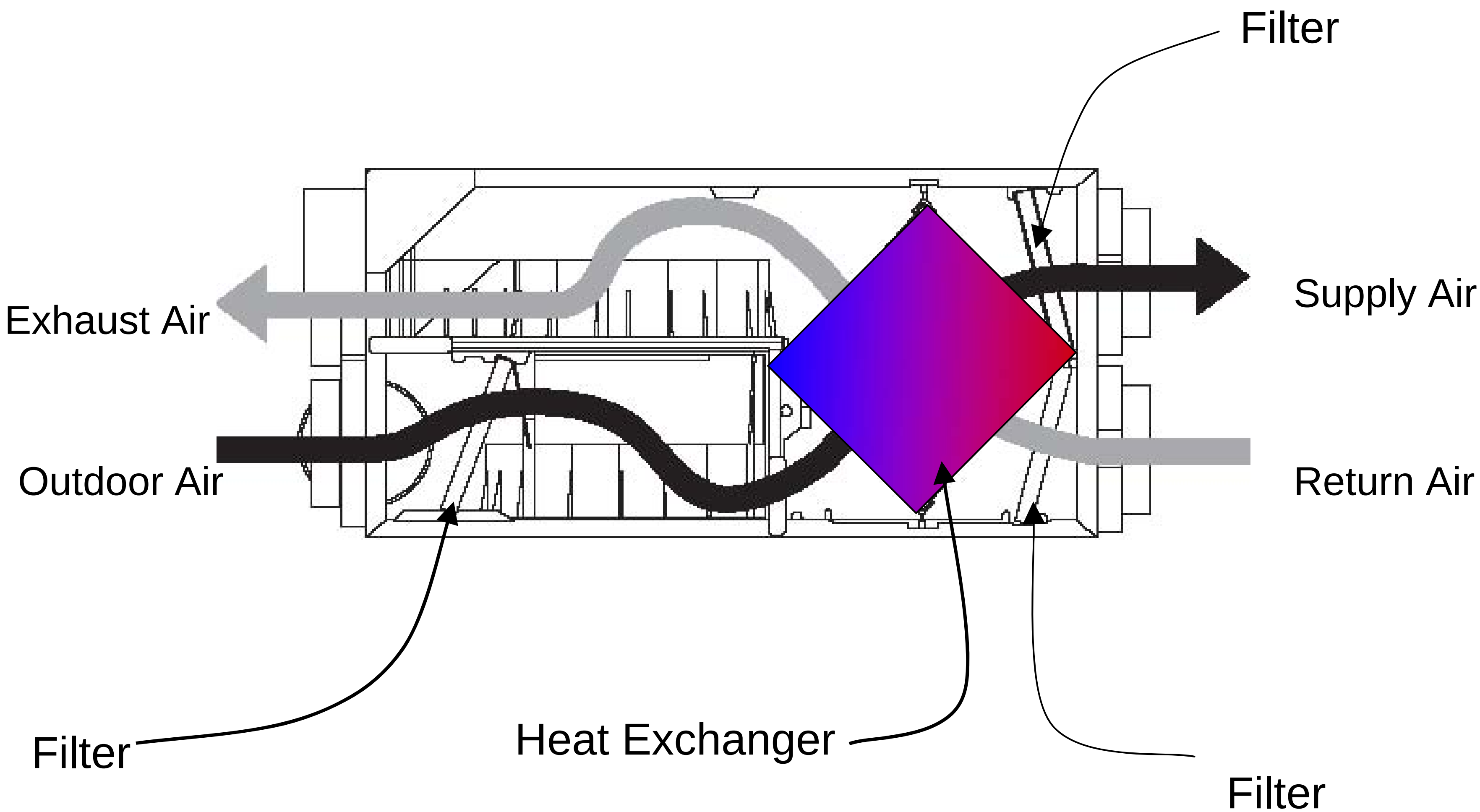
Balanced Ventilation

Heat Recovery Ventilator

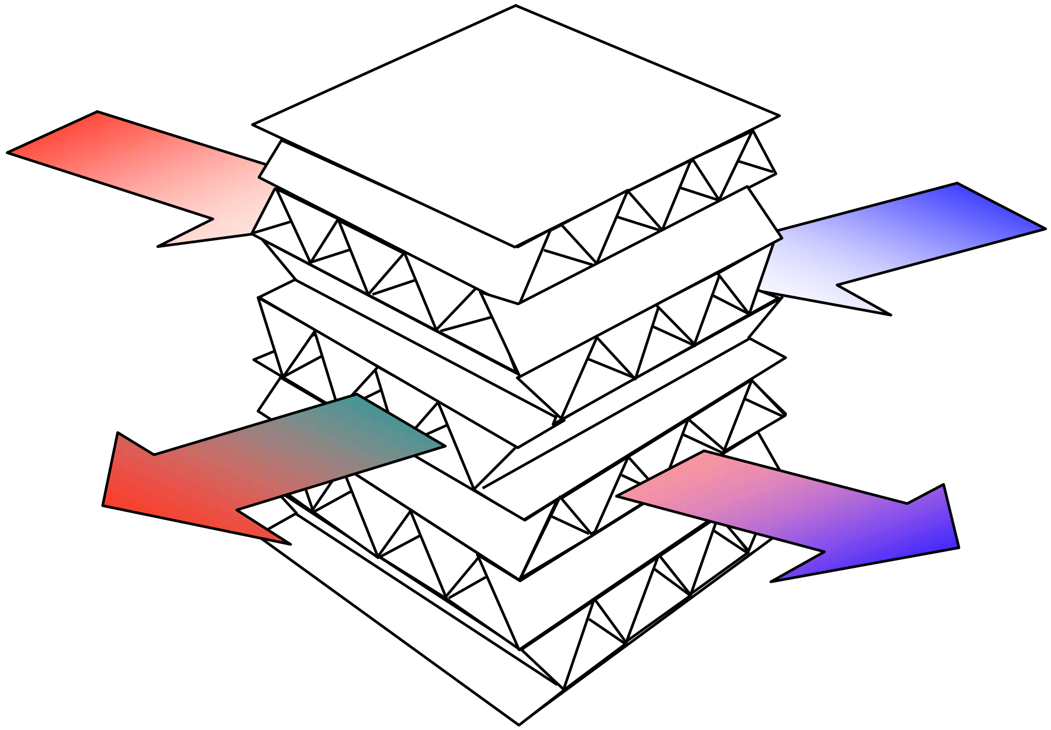


Heat Recovery Ventilator

Heat Recovery Ventilator

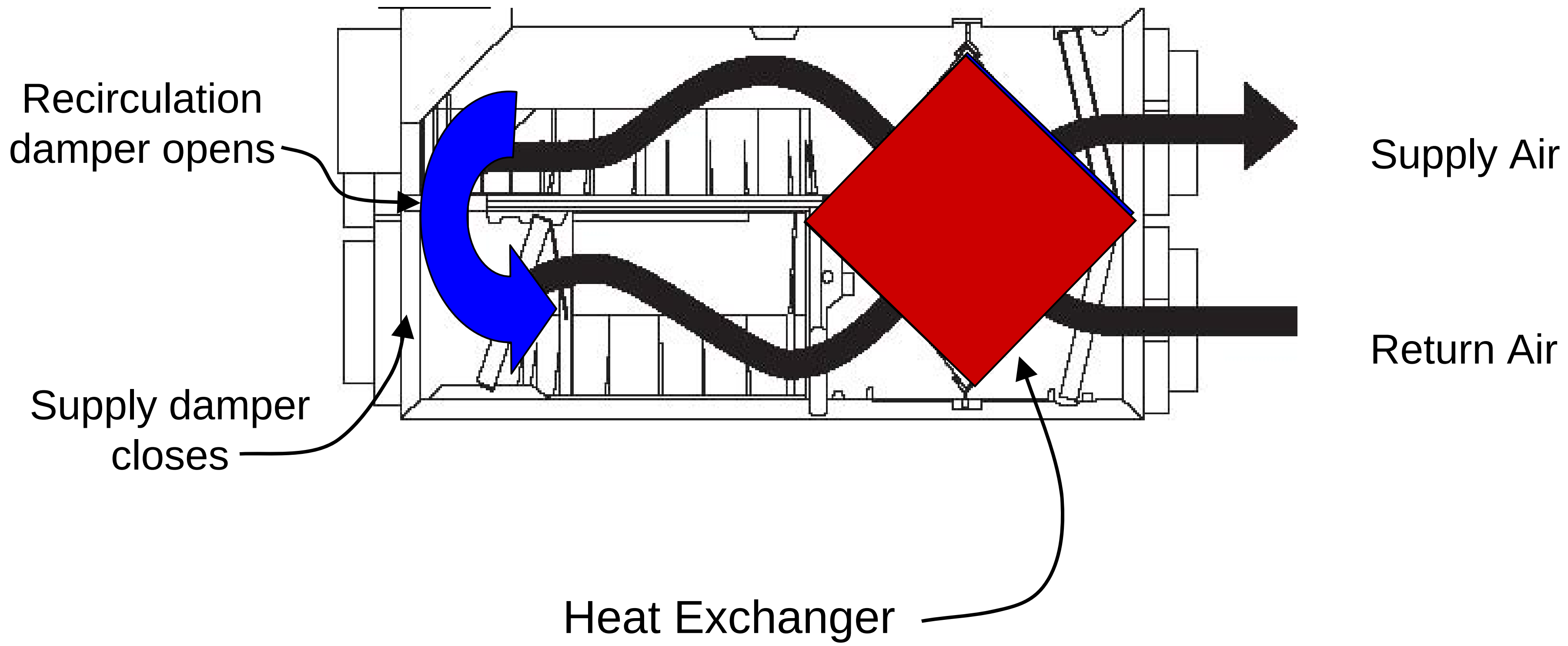


Heat Recovery Ventilator

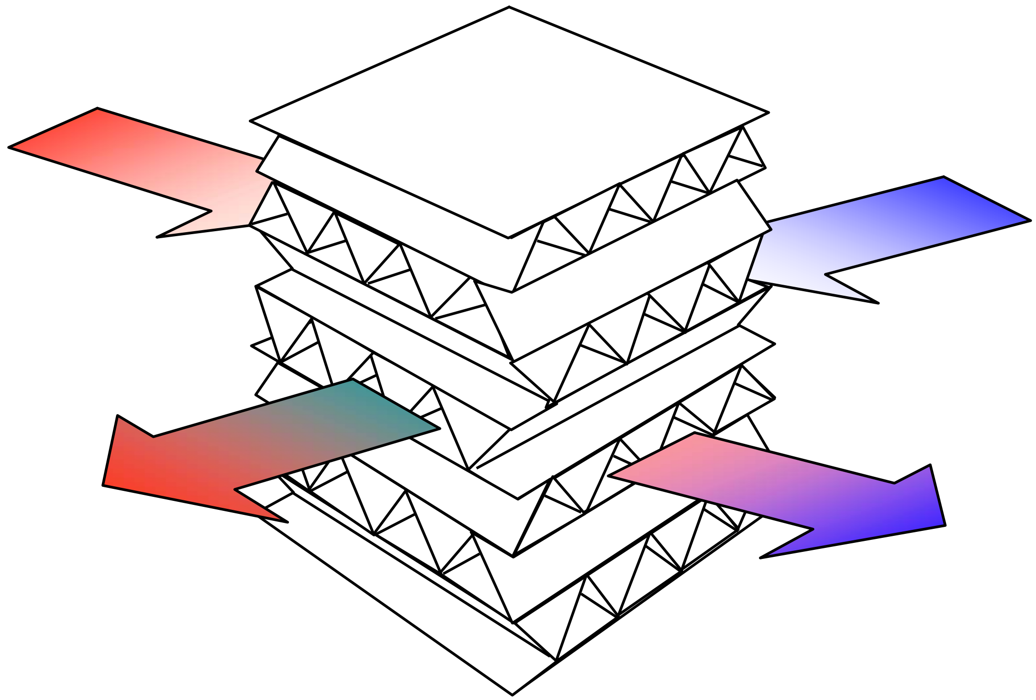


1. Transfers heat by conduction

HRV Defrost Operation



Energy Recovery Ventilator



1. Transfers heat by conduction

2. Transfers humidity using *hygroscopic* resin

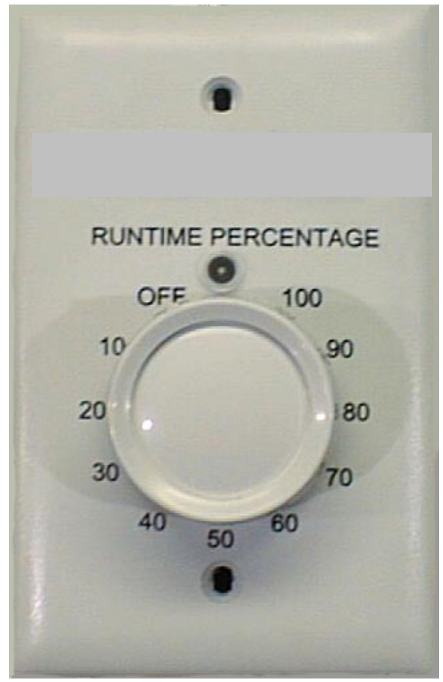
Ventilation System Requirements (Example)

- “Balanced Systems” (HRV or ERV)
  - – Provides an “average” of 60 cfm
    - **Provide (60 cfm X 60 min) = 3,600 cfh**

Ventilation System Requirements

- Exhaust Systems
- "Balanced Systems" (ERV)
  - Provides an "average" of 60 cfm
    - Provide (60 cfm X 60 min) = 3,600 cfh
      - 120 cfm for 30 minutes (120 X 30 = 3,600)
      - 180 cfm for 20 minutes (180 X 20 = 3,600)
      - 240 cfm for 15 minutes (240 X 15 = 3,600)

Proportional Timer



Turns unit on and off a percentage of each hour

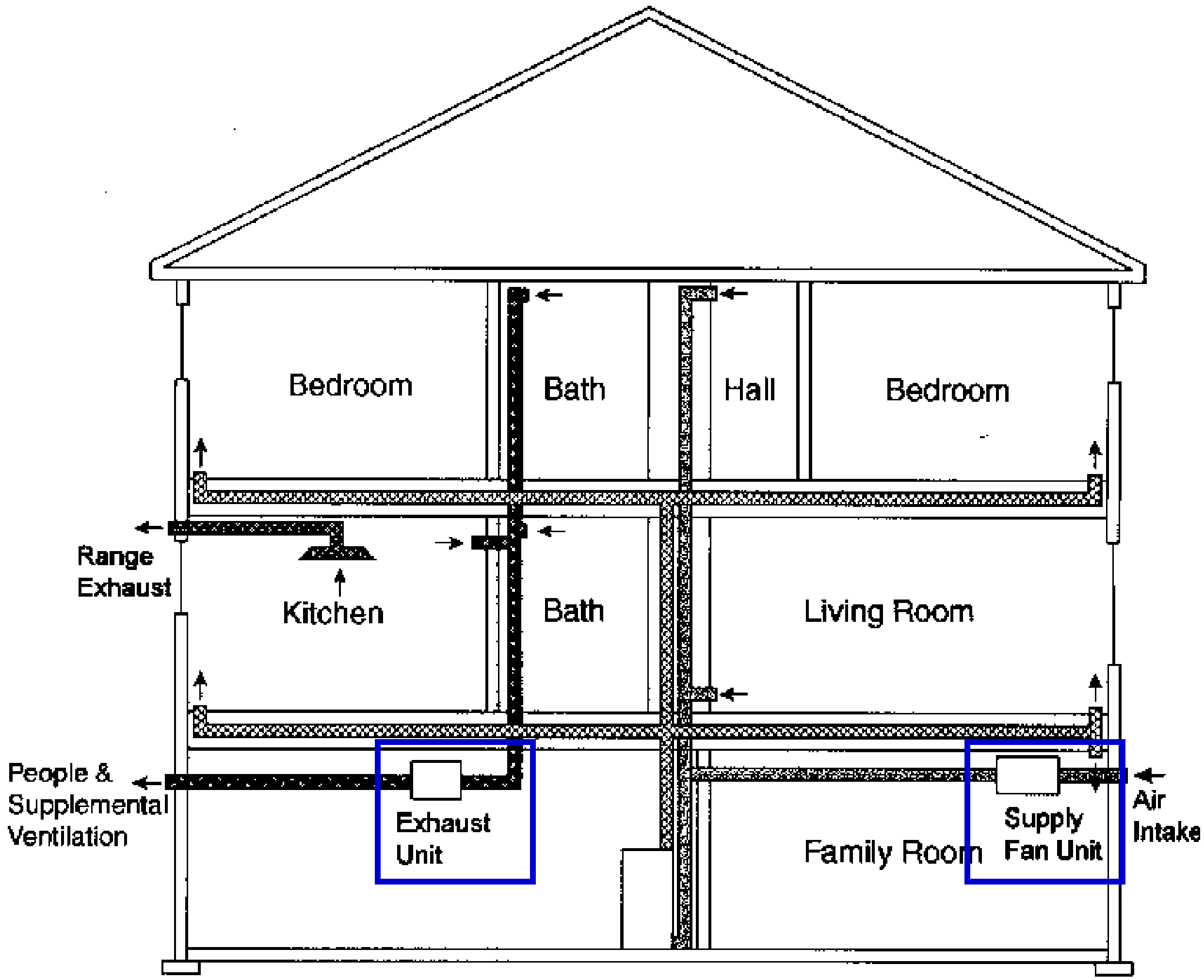
Overview-Ventilation Systems

N1104.3.3 Other methods.

– Any mechanical ventilation system consisting of exhaust fans, supply fans or combination of both (that comply with N1104) shall be allowed.

Other Methods-complies with N1104

Separate Exhaust and Supply



Installation Requirements

- Installed in accordance with MN Rule 1346

Air distribution/circulation
4 conditions

- Outdoor air shall be delivered to each habitable space by:

1. A forced air circulation system (Furnace)

Air distribution/circulation
4 conditions

- Outdoor air shall be delivered to each habitable space by:

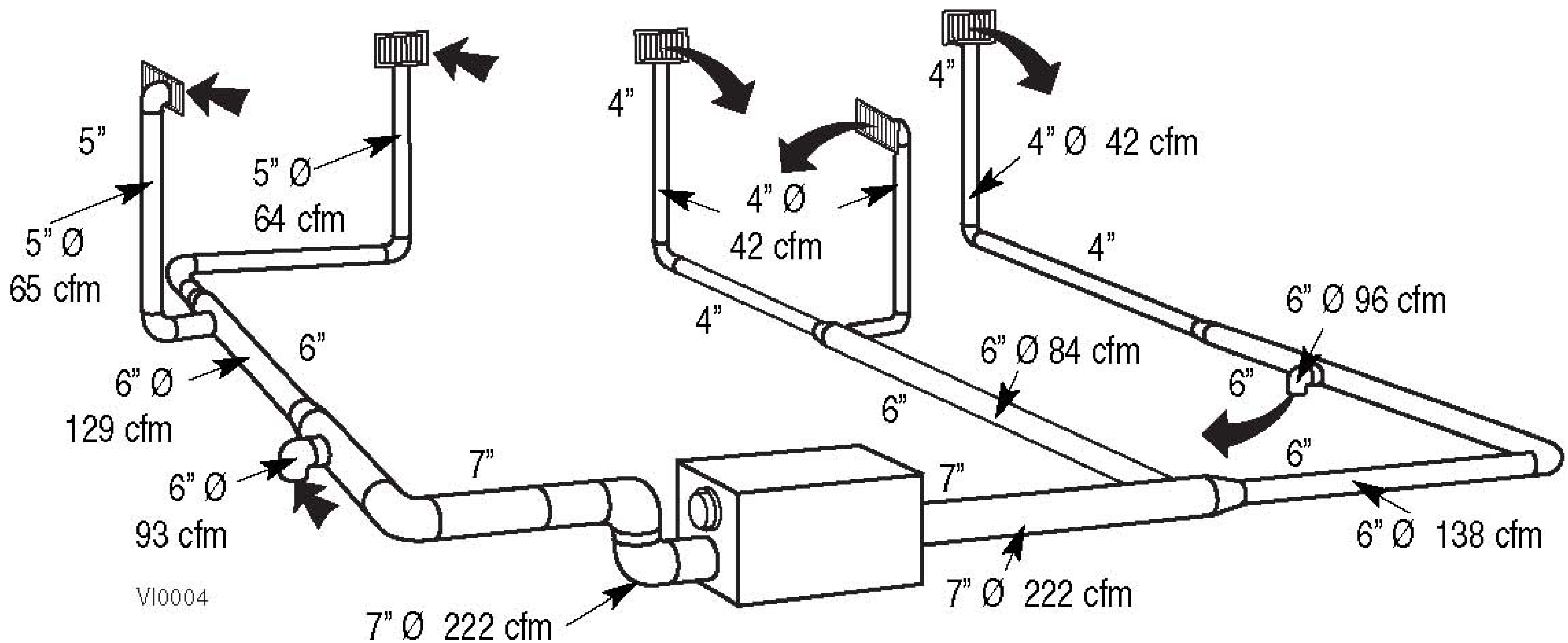
1. A forced air circulation system (Furnace)
2. Separate duct system

Air distribution/circulation
4 conditions

- Outdoor air shall be delivered to each habitable space by:

1. A forced air circulation system (Furnace)
2. Separate duct system
3. Individual inlets

“Not ducted” through Furnace



Air distribution/circulation
4 conditions

- Outdoor air shall be delivered to each habitable space by:
  1. A forced air circulation system (Furnace)
  2. Separate duct system
  3. Individual inlets
  4. Passive opening

Air distribution/circulation

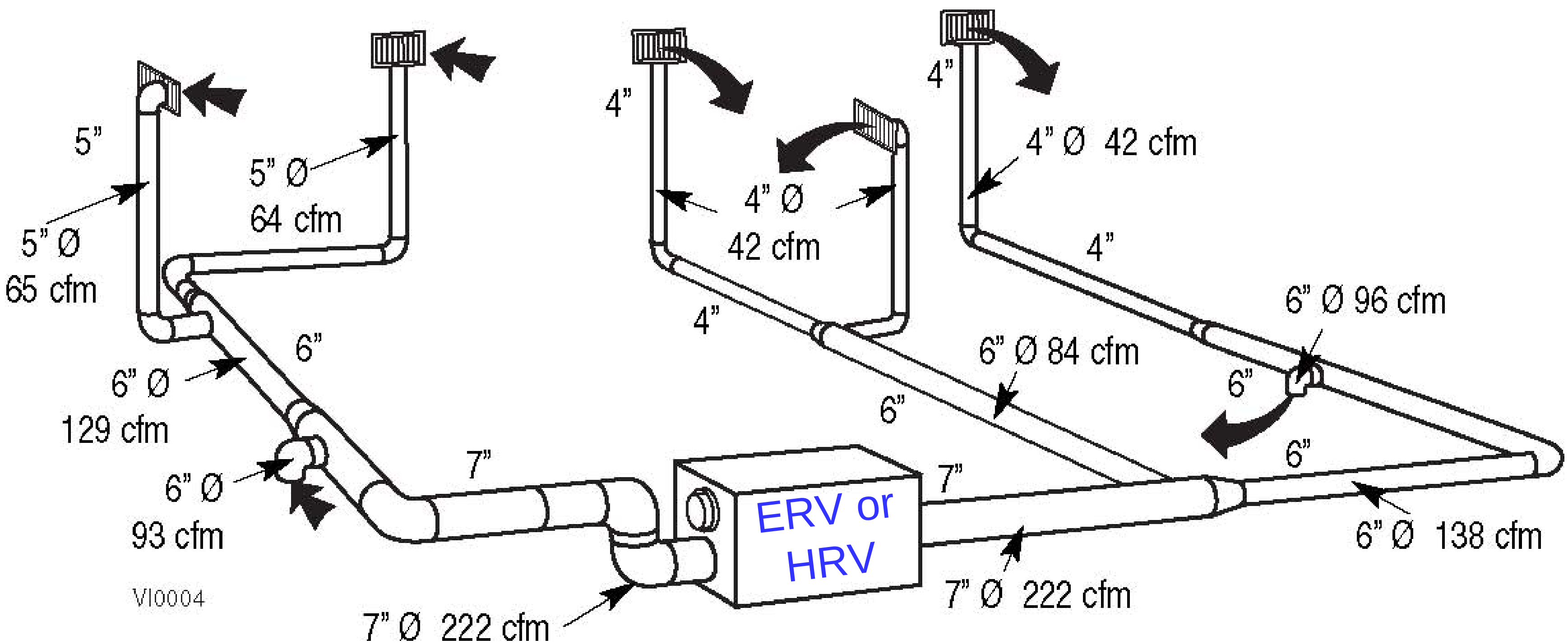
First condition: using forced air circulation system

- Outdoor air shall be delivered to each habitable space by:
  1. A forced air circulation system (Furnace)
     - Outdoor air in NOT ducted to the forced air system
     - Outdoor air IS ducted to the forced air system

Air distribution/circulation

- Outdoor air shall be delivered to each habitable space by:
  1. A forced air circulation system (Furnace)
     - (a) When an outdoor air supply is ***not ducted*** to the forced air system, controls shall be installed to allow the forced air system to provide an average circulation flow rate each hour, of not less than **0.15 cfm/sq.ft**. of the conditioned floor area.

“Not ducted” through Furnace



Air distribution/circulation

- Outdoor air shall be delivered to each habitable space by:

1. A forced air circulation system (Furnace)
    - (b) When an outdoor air supply IS ducted to the forced air system, it shall be tempered so that the mixed air temperature shall be no less than 60 degrees Fahrenheit or the heating equipment manufacturers installation instruction, and controls shall be installed………not less than 0.075 cfm / ft ^2 of conditioned floor area.

Intake openings

- Exterior air intake openings shall be located in accordance Minnesota Rules Chapter 1346.

Filtration

- All mechanically supplied outdoor air shall have a filter with a designated minimum efficiency of MERV 4 (i.e. good furnace filter) The filter shall be located on the inlet of the appliance and shall be installed to be readily accessible and facilitate regular service.

Controls.

Mechanical ventilation system controls shall be provided in accordance with the following:

1. **If required by the equipment (i.e. HRV or ERV) manufacturer's installation instructions, controls shall be installed to ensure that the forced air circulation system is operating whenever the mechanical ventilation system is operating.**

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

2. Controls shall be installed to **ensure** that whenever the mechanical ventilation system is operating, the forced air circulation system **provides indirect circulation of 0.15 cfm** per square foot of conditioned floor area or **direct distribution of 0.075 cfm** per square foot of conditioned floor area.

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

3. If the mechanical **ventilation system is not designed** to operate whenever the forced air circulation system is operating, the mechanical ventilation system shall **incorporate an accessible backflow damper** to prevent flow from the outside when the mechanical ventilation system is off.

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

4. Controls shall be compatible with the mechanical ventilation system.

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

5. Controls shall be installed to operate the mechanical ventilation system as designed.

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

6. Controls shall be **readily accessible** to occupants and shall be labeled to indicate their function.

Controls.

Mechanical ventilation system controls (N1104.4.10) shall be provided in accordance with the following:

7. If a switch is used to control the continuous ventilation system, it can be centrally or remotely located. If remotely located, it shall NOT be in a bath or toilet room. If centrally located, it shall be properly labeled and lighted when the system is on. If remotely located, there shall be a lighted status indicator in a central location that will be lighted when the system is on.

Push Button "Switch"

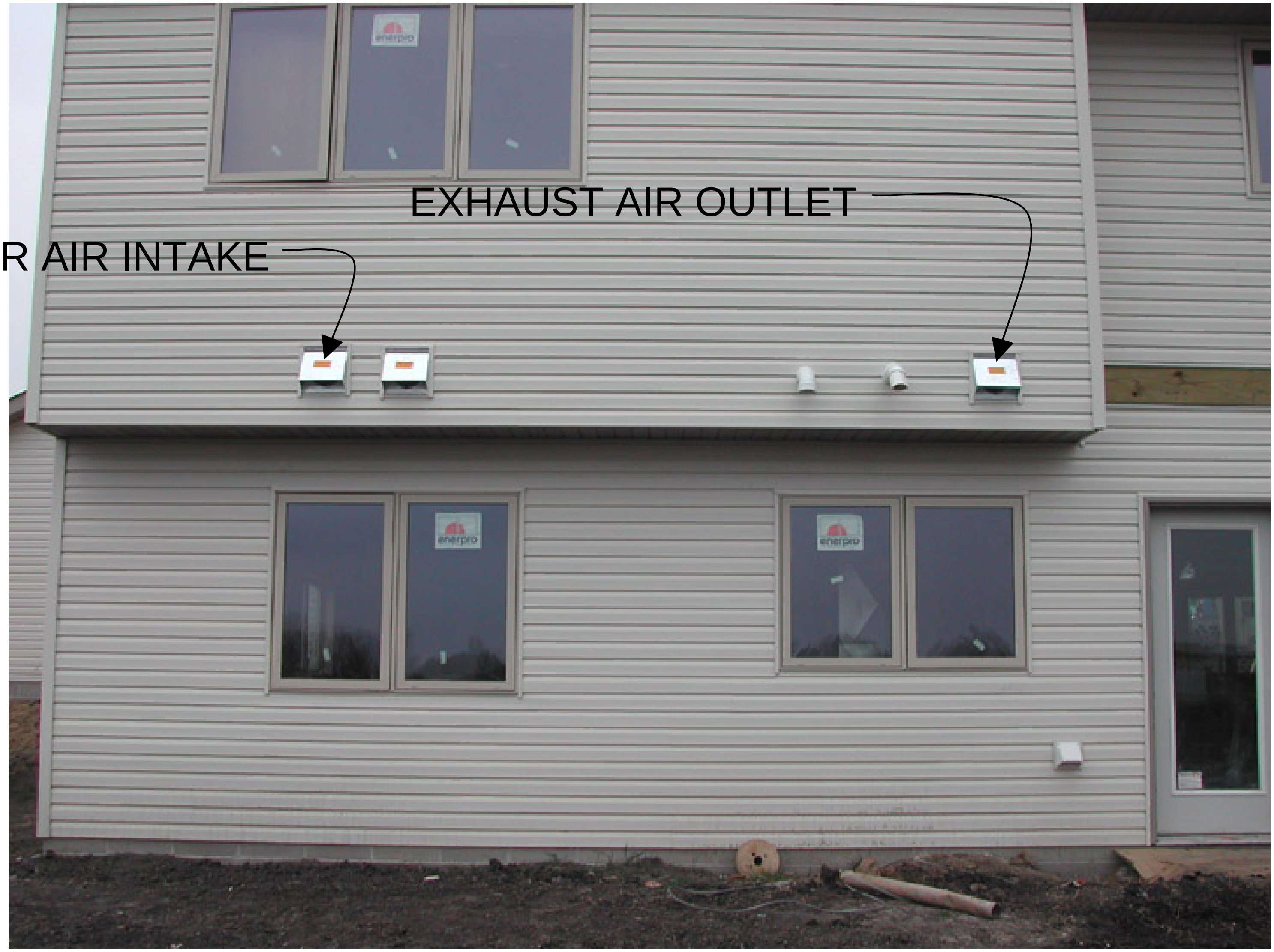
Labeling

- The outdoor air intake and exhaust air outlet shall include a permanent, weather resistant identification label stating:
  - “OUTDOOR AIR INTAKE” or
  - “EXHAUST AIR OUTLET”.

Labeling

- The outdoor air intake and exhaust air outlet shall include a permanent, weather resistant identification label stating:
  - Controls provided for continuous and intermittent ventilation shall be provided with a label stating “VENTILATION SYSTEM” or “VENTILATION FAN” or “INTERMITTENT FAN” or ventilation symbols, as appropriate.

Labeling



Documentation

- *(ALL)* Mechanical ventilation systems shall be provided with documentation that includes proper operation and maintenance instructions and a warning regarding potential problems if the system is not operated and maintained.
  - Bathroom fans
  - ERV’s & HRV’s
  - Furnaces
  - “Other equipment”

Documentation

- A permanent warning label shall be affixed to mechanical ventilation systems if it is readily accessible. If the mechanical ventilation system is not readily accessible, the documentation shall be in a conspicuous readily accessible location. (i.e. on the furnace or ERV)

Changing Design Conditions

City	Summer Db/Wb ºF 1999	Summer Db/Wb ºF 2006	Winter Db ºF 1999	Winter Db ºF 2006
Albert Lea	87/72	**85/72**	-17	**-15**
Alexandria	88/72	**86/70**	-22	**-21**
Bemidji	85/69	**84/68**	-31	**-24**
Brainerd	87/71	**86/71**	-20	**-20**
Duluth	82/68	**81/67**	-21	**-20**
Faribault	88/72	**86/73**	-17	**-16**
Fergus Falls	88/72	**86/71**	-21	**-21**
Virginia	83/72		-25	
International Falls	83/68	**83/67**	-29	**-28**
Mankato	88/72	**86/72**	-17	**-15**
Minneapolis/St. Paul	89/73	**88/72**	-16	**-15**
Rochester	87/72	**85/72**	-17	**-17**
St. Cloud	88/72	**86/71**	-15	**-20**
Willmar	88/72	**85/71**	-15	**-20**
Winona	88/73	**88/74**	-14	**-13**

Changing Design Conditions

	Summer Db/Wb ºF		Winter Db ºF	
City	1999	2006	1999	2006
Aitkin		82/72		-24
Cloquet		82/68		-20
Crookston		84/70		-27
Ely		82/68		-29
Eveleth		82/68		-26
Hibbing		82/68		-19
Montevideo		86/72		-17
Mora		84/70		-21
Morris		84/72		-21
New Ulm		87/73		-15
Owatonna		86/73		-16
Pequot Lake		84/68		-23
Pipestone		85/73		-15
Redwood Falls		89/73		-17
Roseau		82/70		-29
Thief River		82/68		-25
Tofte		75/61		-14
Warroad		83/67		-29
Wheaton		84/71		-20
Worthington		84/71		-14

Residential Thermostats

- At least one thermostat shall be provided for each separate heating and cooling system
  - Does not require a programmable ‘stat!

Duct Insulation

- Ducts shall be insulated in accordance with Minnesota Rule Chapter 1346

Residential Duct Insulation

Minimum Required Duct Insulation (see notes for explanations)	
Duct Location	**Requirements**
Attics, garages, and ventilated crawl spaces	R-8 and V
Exterior of building	R-8, V and W
Inside of building and in unconditioned spaces TD less than or equal to 15°F	None required
TD greater than 15°F and less than or equal to 40°F	R-3.3 and V
TD greater than 40°F	R-5 and V
Within conditioned spaces, in basements with insulated walls, and in plenums within conditioned spaces	None required
Intake and exhaust ducts within conditioned spaces*	R-3.3 and V
Within cement slab or within ground (also see IMC Section 603.7)	R-3.5

Notes:

* Insulation required for a distance of 3 feet (914 mm) from the exterior.

TD = Design temperature differential between the air in the duct and the ambient temperature outside of the duct.

V = Vapor retarder required in accordance with the IMC Section 604.11. When a vapor retarder is required, duct insulation required by this section shall be installed without respect to other building envelope insulation.

W = Approved weatherproof barrier.

Duct Sealing

Location	Design Static Pressure	Minimum Required Sealing
All locations	Greater than 3.0 inches (750 Pa) water gauge	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Ductwork shall be equal to or less than Leakage Class 6 as defined in Section 4.1 of the *SMACNA HVAC Duct Leakage Test Manual**.
Portions of ducts not completely inside the vapor retarder/air barrier enclosing conditioned space	3.0 inches(750 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
Portions of return air ducts in the same space as an atmospherically vented or fan-assisted appliance.	3.0 inches(750 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
All locations	Greater than 0.50 to 3.0 inches (125 to 750 Pa) water gauge	All transverse joints and duct wall penetrations shall be sealed.
All locations	0.50 inches (125 Pa) water gauge and less	All transverse joints, longitudinal seams, and duct wall penetrations shall have no visible gaps and shall be sufficiently airtight in accordance with Section 1.7 of the *SMACNA HVAC Duct Construction Standards - Metal & Flexible*.

No Change!

Supply Ducts

- Supply ducts shall be continuously ducted from the point of origin to the point of discharge . . . ***building framing cavities and building components shall not be used as supply ducts***.

Domestic Water Piping Insulation

A. **Cold Water:** No insulation required.

Exception:

1. Piping within 6 inches of any heating pipes, . . .

   and underground piping, . . . minimum of 1” insulation with . . . vapor jacket.

Domestic Water Piping Insulation

B. **Hot Water**: No insulation required.

Exceptions:

1. All recirculating systems . . . 0.5” . . . on the entire loop with vapor jacket.
2. Underground piping, underground piping, . . . minimum of 1” insulation with . . . vapor jacket.

HVAC Piping Insulation

Hydronic, steam, and condensate piping . . . insulated in accordance with Minnesota Chapter Rule 1346 and shall have vapor appropriate jacket.

HVAC Piping Insulation

Hydronic, steam, and condensate piping . .

Exceptions:

1. Piping installed ***within*** HVAC equipment; or
2. Piping installed in basements, crawl spaces, and cellars.

No Change!

Insulation Thickness for Nominal Pipe Diameters

Fluid Temperature Range °F	Runouts (See item C)	1 inch (25.4 mm and less)	1.25 to 2" (31.7 to 50.8 mm)	2.5 to 4" (63.5 to 101.6 mm)	5 to 6" (127 to 152 mm)	8" (203 mm) and Larger
Piping System Type - Heating						
Above 350	1.5	2.5	2.5	3.0	3.5	3.5
251-350	1.5	2.0	2.5	2.5	3.5	3.5
201-250	1.0	1.5	1.5	2.0	[illegible]	3.5
141-200	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.5	1.0	1.0	[illegible]	1.5	1.5
Piping System Type - Cooling						
40-55	0.5	0.5	.75	1	1	1
Below 40 (see item D)	1	1	1.5	1.5	1.5	1.5

A. Insulaton thickness in this section assumes a k-value of 0.27. If the k-value of a product is less than 0.22, then the thickness must be adjusted to have an equivalent R-value.

B. For piping exposed to outdoor air, insulation thickness must be 0.5 inch (12.7 mm) greater than required in the table.

C. This column applies only to runouts (branches) 2 inches (50.8 mm) in diameter and less, not exceeding 12 feet (3658 mm) in length, to individual terminal units. All other runouts shall meet the requirements given in other columns in the table, as appropriate.

D. For applications with fluid temperatures of 32°F (0°C) and below, a vapor retarder shall be installed in accordance with IMC Section 604.11.

Circulating hot water systems

Include controls that turn the circulating pump off when the system is not in use or when the circulating loop temperature is satisfied.

Equipment sizing

Heating and cooling equipment shall be sized per Minnesota Mechanical codes

and an approved equivalent (method such as **ACCA Manual J**)

Draft rule Chapter 1346.0312

Minnesota Rules Chapter 1346

2006 International Mechanical Code

2006 International Fuel Gas Code

MN amendments

MN Mechanical Code (MN Rule 1346) 1346.0501and 1346.5304

Agenda

1. Review Makeup Air Tables in the MN Mechanical Code as they apply to new and existing dwellings (See MN Rule 1309). Review examples.
2. Review Combustion Air requirements with an example.

Minnesota Mechanical Code

- *Residential Makeup Air/Combustion Air Software:*

  – Makeup air is determined according to amended IMC Section 501.3 (2006 IMC)

  – Combustion air is determined according to amended IFGC Section 304 (2006 IFGC)

  – Ventilation air is determined according to the Minnesota Energy Code

Exhaust Systems
MN Mechanical Code 1346.0501

501.3.1:Makeup Air in new dwellings shall be determined by using table 501.3.1 and shall be supplied in accordance with IMC section 501.3.2

Use the Appropriate Column to Estimate House Infiltration				
	One or Multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel appliance[C]	Mulltiple atmospheric vented gas or oil appliance or solid ve fuel appliance[D]
1 a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf) (including unfinished basements)				
Estimated House Infiltration (cfm): [1a x 1b]				
2 Exhaust Capacity a) continuous exhaust only ventilation system (not applicable to balanced ventilation systems such as HRV)				
b) clothes dryer	135	135	135	135
c) 80% of largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
d) 80% of next largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	not applicable			
Total Exhaust Capacity (cfm): [2a+2b+2c+2d]				
3 Makeup Air Requirement a) Total Exhaust Capacity (from Above)				
b) Estimated House Infiltration (from Above)				
Makeup Air quanity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)				
4 For Makeup Air Opening Sizing, refer to Table 501.3.2				

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances ar solid fuel appliances.

Makeup Air Opening Sizing Table for New and Existing Dwellings					
	One or Multiple power vent or direct vent appliances or no combustion	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel	Mulltiple atmospherically vented gas or oil appliance or solid	Passive makeup air opening duct diameter E,F & G
Type of opening or system	(cfm)	(cfm)	(cfm)	(cfm)	(inches)
Passive Opening	1 - 36	1 - 22	1 - 15	1 - 9	3
Passive Opening	37 - 66	23 - 41	16 - 28	10 - 17	4
Passive Opening	67 - 109	42 - 66	29 - 46	18 - 28	5
Passive Opening	110 - 163	67 - 100	47 - 69	29 - 42	6
Passive Opening	164 - 232	101 - 143	70 - 99	43 - 61	7
Passive Opening	233 - 317	144 - 195	100 - 135	62 - 83	8
Passive Opening	318 - 419	196 - 258	136 - 179	84 - 110	9
Passive Opening	420 - 539	259 - 332	180 - 230	111 - 142	10
Passive Opening with Motorized Damper	540 - 679	333 - 419	231 - 290	143 - 179	11
Powered Makeup Air[H]	> 679	> 419	> 290	> 179	Not applicable

A Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliance(s).

E An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and ten feet for each 90-degree elbow to determine the remaining length of straight duct allowable.

F If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.

G Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.

H Powered makeup air shall be electrically interlocked with the largest exhaust system.

Exhaust Systems
MN Mechanical Code 1346.0501

- That's for new buildings but….

- How about an existing building that's altered?
  - Year built
  - Exhaust CFM
  - Solid fuel burning appliance

Exhaust Systems
MN Mechanical Code 1346.0501

- 501.3.3 Additions, alterations, or installations of mechanical systems in EXISTING dwellings. Makeup air shall be supplied to existing dwellings when any of the following conditions occur (**6 conditions**):

1. If a dwelling was constructed after 2003 using makeup air provisions of IMC Section 501.3.2, makeup air quantity shall be determined by using Table 501.3.1 and shall be supplied according to IMC Section 501.3.2 when any of the following conditions occur:
   - A vented combustion appliance is installed/replaced
   - An exhaust system is installed or replaced (exception)

Exhaust Systems
MN Mechanical Code 1346.0501

501.3.3 Additions, alterations, or installations of mechanical systems in EXISTING dwellings. Makeup air shall be determined to existing dwellings when any of the following conditions occur(6 conditions):

2. If a dwelling was constructed after 1999 using provisions of the Minnesota Energy Code (MN Rules 7672) makeup air shall be

   determined by using 501.3.1

   supplied in accordance with IMC Section 501.3.2

3. When a solid fuel burning appliance is installed in a dwelling constructed during or after 1994 under the MN Energy code (MN Rules 7670) makeup air shall be

   determined by using 501.3.1

   supplied in accordance with IMC Section 501.3.2

Procedure to Determine Makeup Air Quantity
for Exhaust Equipment in Dwellings Built after 1999 using Chapter 7672
Use the Appropriate Column to Estimate House Infiltration

		One or Multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel appliance[C]	Mulltiple atmospherically vented gas or oil appliance or solid vent fuel appliance[D]
1	a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
	b) conditioned floor area (sf) (including unfinished basements)				
	Estimated House Infiltration (cfm): [1a x 1b]				
2	Exhaust Capacity				
	a) continuous exhaust only ventilation system (not applicable to balanced ventilation systems such as HRV)				
	b) clothes dryer	135	135	135	135
	c) 80% of largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
	d) 80% of next largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	not applicable			
	Total Exhaust Capacity (cfm): [2a+2b+2c+2d]				
3	Makeup Air Requirement				
	a) Total Exhaust Capacity (from Above)				
	b) Estimated House Infiltration (from Above)				
	Makeup Air quanity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)				
4	For Makeup Air Opening Sizing, refer to Table				

Exhaust Systems
MN Mechanical Code 1346.0501

501.3.3 Additions, alterations, or installations of mechanical systems in EXISTING dwellings. Makeup air shall be determined to existing dwellings when any of the following conditions occur (6 conditions):

4. Dwelling constructed during or after 1994 and an exhaust system with a rated capacity > 300 CFM makeup air shall:
   - -be determined by using IMC table 501.3.3(1)
   - -supplied according to 501.3.2

Procedure to Determine Makeup Air Quantity
for Exhaust Equipment in Existing Dwellings Built Between 1994 and 1999 With an exhaust rate greater than 300 cfm
(Refer to Item 4 in section 501.4.3 to determine applicability of this table)
Use the Appropriate Column to Estimate House Infiltration

	One or Multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel appliance[C]	Mulltiple atmospherically vented gas or oil appliance or solid vent fuel appliance[D]
1 a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf)	1500			
Estimated House Infiltration (cfm): [1a x 1b]	225			
2 Exhaust Capacity				
80% of largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
d) 80% of next largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
3 Makeup Air Requirement a) Total Exhaust Capacity (from Above)	0			
b) Estimated House Infiltration (from Above)	225			
Makeup Air quanity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)	-225			
4 For Makeup Air Opening Sizing, refer to Table 501.3.2	No Makeup air required			

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliances.

Exhaust Systems
MN Mechanical Code 1346.0501

501.4.3 Additions, alterations, or installations of mechanical systems in EXISTING dwellings. Makeup air shall be determined to existing dwellings when any of the following conditions occur (6 conditions):

5. Dwelling constructed prior to 1994 with an exhaust > 300 CFM makeup air shall be;

- -determined by using IMC Table 501.3.3(2)
- -supplied according IMC Section 501.3.2

Procedure to Determine Makeup Air Quantity
for Exhaust Equipment in Dwellings Built Before 1994 With an Exhaust Rate Greater Than 300 cfm
(Refer to Item 5 in section 501.4.3 to determine applicability of this table)
Use the Appropriate Column to Estimate House Infiltration

	One or Multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel appliance[C]	Multiple atmospherically vented gas or oil appliance or solid vent fuel appliance[D]
1 a) pressure factor (cfm/sf)	0.25	0.15	0.10	0.05
b) conditioned floor area (sf) (including unfinished basements)				
Estimated House Infiltration (cfm): [1a x 1b]				
or Alternate Calculation (by using blower door test)[E] c) conversion factor	0.75	0.45	0.30	0.15
d) CFM50 value (from blower door test)				
Estimated House Infiltration (cfm) 1c x1d)				
2 Exhaust Capacity 80% of largest exhaust rating (cfm)= Exhaust capacity (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
3 Makeup Air Requirement a) Total Exhaust Capacity (from Above)				
b) Estimated House Infiltration (from Above)				
Makeup Air quanity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)				
4 For Makeup Air Opening Sizing, refer to Table 501.3.2				

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.
B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.
C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.
D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliances.
E As an alternative, the Estimated House Infiltration may be calculated by performing a blower door test and multiplying the conversion factor by the CFM50 value.

Exhaust Systems
MN Mechanical Code 1346.0501

501.4.3 Additions, alterations, or installations of mechanical systems in EXISTING dwellings. Makeup air shall be determined to existing dwellings when any of the following conditions occur (6 conditions):

6. Dwelling constructed prior to 1994 and a solid fuel appliance is installed makeup air shall be:

-determined by IMC Table 501.3.3(3)

-supplied according to IMC Section 501.3.2

Table 501.4.3(3)

Procedure to Determine Makeup Air Quantity

for Exhaust Equipment in Existing Dwellings Built Before 1994 With a Solid Fuel Burning Appliance

(Refer to Item 6 in section 501.4.3 to determine applicability of this table)

Use the Appropriate Column to Estimate House Infiltration

			One or Multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct appliances[B]	One atmospherically vented gas or oil appliance or one solid vent fuel appliance[C]	Mulltiple atmospherically vented gas or oil appliance or solid vent fuel appliance[D]
1	a)	pressure factor (cfm/sf)	0.25	0.15	0.10	0.05
	b)	conditioned floor area (sf) (including unfinished basements)				
		Estimated House Infiltration (cfm): [1a x 1b]				
	or Alternate Calculation (by using blower door test)[E]					
	c)	conversion factor	0.75	0.45	0.3	0.15
	d)	CFM50 value (from blower door test)				
		Estimated House Infiltration (cfm) 1c x1d)				
2	Exhaust Capacity					
	a)	continuous exhaust only ventilation system (not applicable to balanced ventilation systems such as HRV)				
	b)	clothes dryer	135	135	135	135
	c)	80% of largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)				
	d)	80% of next largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	not applicable			
		Total Exhaust Capacity (cfm): [2a+2b+2c+2d]				
3		Makeup Air Requirement				
	a)	Total Exhaust Capacity (from Above)				
	b)	Estimated House Infiltration (from Above)				

Examples of Footnotes

- A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances <u>or</u> if there are no combustion appliances.
- B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.
- C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system <u>or</u> one solid fuel appliance.
- D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent <u>or</u> if there are atmospherically vented gas or oil appliances <u>and</u> solid fuel appliance's).

MN Mechanical Code: *Determine Makeup Air Requirements for the following:*

Size of new house:	2,000 sq. ft. (including basement)
Average ceiling height:	8 ft.
Number of bedrooms:	3
Ventilation type:	Heat recovery ventilator (HRV)
Type of gas water heater:	40,000 Btu/hr power vent
Type of gas furnace:	60,000 Btu/hr direct vent
Type of gas fireplace:	30,000 Btu/hr direct vent
Kitchen exhaust fan:	250 cfm (exhausts to the outside)
Next largest exhaust fan:	70 cfm
Combustion air space:	10 ft. x 10 ft. x 8 ft.

Minnesota Mechanical Code

It's NEW, so…. The makeup air shall be

- *Step 1: Makeup Air Requirements shall be determined using Table 501.3.1 and…*

- *Step 2: Supplied in accordance with Table 501.3.2*

Minnesota Mechanical Code

Make up Air

Examples

MN Mechanical Code: *Determine Makeup Air Requirements for the following:*

Size of new house:	2,000 sq. ft. (including basement)
Average ceiling height:	8 ft.
Number of bedrooms:	3
Ventilation type:	Heat recovery ventilator (HRV)
Type of gas water heater:	40,000 Btu/hr power vent
Type of gas furnace:	60,000 Btu/hr direct vent
Type of gas fireplace:	30,000 Btu/hr direct vent
Kitchen exhaust fan:	250 cfm (exhausts to the outside)
Next largest exhaust fan:	70 cfm
Combustion air space:	10 ft. x 10 ft. x 8 ft.

Procedure to Determine Makeup Air Quantity for Exhaust Equipment in Dwellings

	One or multiple power vent or direct vent appliances <u>or</u> no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct vent appliances[B]	One atmospherically vented gas or oil appliance or one solid fuel appliance[C]	Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D]
1. Use the Appropriate Column to Estimate House Infiltration				
a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf) (including unfinished basements)	2,000			
Estimated House Infiltration (cfm): [1a x 1b]	300			
2. Exhaust Capacity				
a) continuous exhaust-only ventilation system (cfm) (not applicable to balanced ventilation systems such as HRV)	0			
b) clothes dryer (cfm)	135	135	135	135
c) 80% of largest exhaust rating (cfm) (not applicable if recirculating system <u>or</u> if powered makeup air is electrically interlocked and matched to exhaust)	200			
d) 80% of next largest exhaust rating (cfm) (not applicable if recirculating system <u>or</u> if powered makeup air is electrically interlocked and matched to exhaust)	Not Applicable			
Total Exhaust Capacity (cfm): [2a + 2b + 2c + 2d]	335			
3. Makeup Air Requirement				
a) Total Exhaust Capacity (from above)	335			
b) Estimated House Infiltration (from above)	300			
Makeup Air Quantity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)	35			

4. For Makeup Air Opening Sizing, refer to Table → **M501.3.2**

Table 501.3.2

Makeup Air Opening Sizing Table for New and Existing Dwellings

Type of opening or system	One or multiple power vent or direct vent appliances or no combustion appliances[A] (cfm)	One or multiple fan-assisted appliances and power vent or direct vent appliances[B] (cfm)	One atmospherically vented gas or oil appliance or one solid fuel appliance[C] (cfm)	Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D] (cfm)	Passive makeup air opening duct diameter[E,F,G] (inches)
Passive Opening	1-36	1-22	1-15	1-9	3
Passive Opening	37-66	23-41	16-28	10-17	4
Passive Opening	67-109	42-66	29-46	18-28	5
Passive Opening	110-163	67-100	47-69	29-42	6
Passive Opening	164-232	101-143	70-99	43-61	7
Passive Opening	233-317	144-195	100-135	62-83	8
Passive Opening with Motorized Damper	318-419	196-258	136-179	84-110	9
Passive Opening with Motorized Damper	420-539	259-332	180-230	111-142	10
Passive Opening with Motorized Damper	540-679	333-419	231-290	143-179	11
Powered Makeup Air[H]	>679	>419	>290	>179	Not Applicable

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliance(s).

E. An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and 10 feet for each 90 degree elbow to determine the remaining length of straight duct allowable.

F. If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.

G. Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.

H. Powered makeup air shall be electrically interlocked with the largest exhaust system.

MN Mechanical Code:

Determine Makeup and Combustion Air Requirements for the following:

Size of new house (modified 2 story):

- basement: 1175 square feet
- first floor: 1194 square feet
- second floor: 760 square feet

TOTAL : 3129 square feet

average ceiling height:	8 ft.
Number of bedrooms:	3
Ventilation type:	Heat recovery ventilator (HRV)
Type of gas water heater:	40,000 Btu/hr power vent
Type of gas furnace:	67,000 Btu/hr direct vent
Type of gas fireplace:	none
Kitchen exhaust fan:	none that exhausts outside
Next largest exhaust fan:	2 baths at 50 cfm, 1 bath at 70 cfm
Combustion air space:	mechanical room area = open basement

Procedure to Determine Makeup Air Quantity for Exhaust Equipment in Dwellings

	One or multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct vent appliances[B]	One atmospherically vented gas or oil appliance or one solid fuel appliance[C]	Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D]
1. Use the Appropriate Column to Estimate House Infiltration				
a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf) (including unfinished basements)	3129			
Estimated House Infiltration (cfm): [1a x 1b]	469			
2. Exhaust Capacity				
a) continuous exhaust-only ventilation system (cfm) (not applicable to balanced ventilation systems such as HRV)	0			
b) clothes dryer (cfm)	135	135	135	135
c) 80% of largest exhaust rating (cfm) (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	56			
d) 80% of next largest exhaust rating (cfm) (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	Not Applicable			
Total Exhaust Capacity (cfm): [2a + 2b + 2c + 2d]	191			
3. Makeup Air Requirement				
a) Total Exhaust Capacity (from above)	191			
b) Estimated House Infiltration (from above)	469			
Makeup Air Quantity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)	0			

4. For Makeup Air Opening Sizing, refer to Table → 501.3.2

MN Mechanical Code:

Determine Makeup Air Requirements for the following:

Size of new house (Rambler with full basement):

basement: 1352 square feet

first floor: 1496 square feet

TOTAL : 2848 square feet

average ceiling height: 8 ft.

Number of bedrooms: 2

Ventilation type: Heat recovery ventilator (HRV)

Type of gas water heater: 2 @ 40,000 Btu/hr power vent

Type of gas furnace: 67,000 Btu/hr power vent

Type of gas fireplace: 2 power vent gas fireplaces and 1 solid fuel

Kitchen exhaust fan: none that exhausts outside

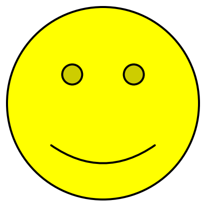
Next largest exhaust fan: 1 baths at 50 cfm, 1 bath at 70 cfm

Combustion air space: 5 x 12 x 8 = Mechanical room volume (480)

Procedure to Determine Makeup Air Quantity for Exhaust Equipment in Dwellings

	One or multiple power vent or direct vent appliances or no combustion appliances[A]	One or multiple fan-assisted appliances and power vent or direct vent appliances[B]	One atmospherically vented gas or oil appliance or one solid fuel appliance[C]	Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D]
1. Use the Appropriate Column to Estimate House Infiltration				
a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf) (including unfinished basements)			2848	
Estimated House Infiltration (cfm): [1a x 1b]			171	
2. Exhaust Capacity				
a) continuous exhaust-only ventilation system (cfm) (not applicable to balanced ventilation systems such as HRV)			0	
b) clothes dryer (cfm)	135	135	135	135
c) 80% of largest exhaust rating (cfm) (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)			56	
d) 80% of next largest exhaust rating (cfm) (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	Not Applicable		40	
Total Exhaust Capacity (cfm): [2a + 2b + 2c + 2d]			231	
3. Makeup Air Requirement				
a) Total Exhaust Capacity (from above)			231	
b) Estimated House Infiltration (from above)			171	
Makeup Air Quantity (cfm): [3a - 3b] (if value is negative, no makeup air is needed)			60	

4. For Makeup Air Opening Sizing, refer to Table 501.3.2



See Correction

Makeup Air Opening Sizing Table for New and Existing Dwellings

Type of opening or system	One or multiple power vent or direct vent appliances **or** no combustion appliances[A] (cfm)	One or multiple fan-assisted appliances **and** power vent or direct vent appliances[B] (cfm)	One atmospherically vented gas or oil appliance **or** one solid fuel appliance[C] (cfm)	Multiple atmospherically vented gas or oil appliances **or** solid fuel appliances[D] (cfm)	Passive makeup air opening duct diameter[E,F,G] (inches)
Passive Opening	1-36	1-22	1-15	1-9	3
Passive Opening	37-66	23-41	16-28	10-17	4
Passive Opening	67-109	42-66	29-46	18-28	5
Passive Opening	110-163	67-100	47-69	29-42	6
Passive Opening	164-232	101-143	70-99	43-61	7
Passive Opening	233-317	144-195	100-135	62-83	8
Passive Opening with Motorized Damper	318-419	196-258	136-179	84-110	9
Passive Opening with Motorized Damper	420-539	259-332	180-230	111-142	10
Passive Opening with Motorized Damper	540-679	333-419	231-290	143-179	11
Powered Makeup Air[H]	>679	>419	>290	>179	Not Applicable

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliance(s).

E. An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and 10 feet for each 90 degree elbow to determine the remaining length of straight duct allowable.

F. If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.

G. Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.

H. Powered makeup air shall be electrically interlocked with the largest exhaust system.

IFGC Section 304- Combustion, Ventilation, and Dilution Air

- Air for combustion, ventilation, and dilution of flue gases….shall be obtained by:

1. 304.2 “Indoor combustion air
2. 304.3 “Outdoor combustion air
3. 304.4 “Combination indoor and outdoor combustion air”
4. 304.5 “Engineered solutions” OR
5. 304.6 “Mechanical combustion air supply

IFGC Section 304- Combustion, Ventilation, and Dilution Air

- Air for combustion, ventilation, and dilution of flue gases….shall be obtained by 304.2 through 304.6 with exceptions:

1. Direct vent appliances
2. Type 1 clothes dryers that are provided with makeup air
3. Replacement of fuel gas utilization equipment with 3 conditions:
   - < 30% original rating
   - Combustion air provisions meet original installation
   - Must be safe, nonhazardous, and not overloaded

IFGC Section 304- Combustion, Ventilation, and Dilution Air

– For Residential purposes:

- **Main Entry: res·i·dence**
- **Pronunciation: \□re-zə-dən(t)s, □rez-dən(t)s, □re-zə-□den(t)s**
- **Function:** ***noun***
- **Date: 14th century**
- **1 a : the act** or **fact** of dwelling in a place for **some time b :** the act or fact of living or regularly staying at or in some place for the discharge of a duty or the enjoyment of a benefit
  2 a (1) **:** the place where one actually lives as distinguished from one's domicile or a place of temporary sojourn *(2)* **:** domicile 2a **b :** the place where a **corporation** is actually or officially established **c :** the status of a legal resident
  3 a : a building used as a home **:** dwelling **b :** housing or a unit of housing provided for students
  4 a : the period or duration of abode in a place **b :** a period of active and especially full-time study, research, or teaching at a **college or university**
- — **in residence :** engaged to live and work at a particular place often for a specified time **<poet *in residence* at a university>**

– See amended IRC 1309 for dwelling definition

IFGC Section 304- Combustion, Ventilation, and Dilution Air

- For Residential purposes:

- Appendix E : Worksheet E-1 and Table E-1

100,000

30,000

IFGC Appendix E, Worksheet E-1

Residential Combustion Air Calculation Method
(for Furnace, Boiler, and/or Water Heater in the Same Space)

Step 1: Complete vented combustion appliance information.

Furnace/Boiler:

__ Draft Hood (Not fan assisted)	__ Fan Assisted & Power Vent	__ Direct Vent	Input: _______Btu/hr

Water Heater:

__ Draft Hood (Not fan assisted)	__ Fan Assisted & Power Vent	__ Direct Vent	Input: _______Btu/hr

Step 2: Calculate the volume of the Combustion Appliance Space (CAS) containing combustion appliances.

The CAS includes all spaces connected to one another by code compliant openings. CAS volume:_______ft3

Step 3: Determine Air Changes per Hour (ACH)[1]

Default ACH values have been incorporated into Table E-1 for use with Method 4b (KAIR Method).
If the year of construction or ACH is not known, use method 4a (Standard Method).

Step 4: Determine Required Volume for Combustion Air.

4a. Standard Method

Total Btu/hr input of all combustion appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input:_______Btu/hr

Use Standard Method column in Table E-1 to find Total Required Volume (TRV) TRV:_______ft3

If CAS Volume (from Step 2) **is greater than** TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) **is less than** TRV then go to **STEP 5.**

4b. Known Air Infiltration Rate (KAIR) Method

Total Btu/hr input of all fan-assisted and power vent appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input:_______Btu/hr

Use Fan-Assisted Appliances column in Table E-1 to find Required Volume Fan Assisted (RVFA) RVFA:_______ft3

Total But/hr input of all non-fan-assisted appliances Input:_______Btu/hr

Use Non-Fan-Assisted Appliances column in Table E-1 to find Required Volume Non-Fan-Assisted (RVNFA) RVNFA:_______ft3

Total Required Volume (TRV) = RVFA + RVNFA RV = _______ + _______ = _______ft3

If CAS Volume (from Step 2) **is greater than** TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) **is less than** TRV then go to **STEP 5.**

Step 5: Calculate the ratio of available interior volume to the total required volume.

Ratio = CAS Volume (from Step 2) **divided by** TRV (from Step 4a or Step 4b) Ratio = _______ / _______ = _______

Step 6: Calculate Reduction Factor (RF).

RF = 1 **minus** Ratio RF = 1 - _______ = _______

Step 7: Calculate single outdoor opening as if all combustion air is from outside.

Total Btu/hr input of all Combustion Appliances in the same CAS (EXCEPT DIRECT VENT) Input:_______Btu/hr

Combustion Air Opening Area (CAOA):
Total Btu/hr **divided by** 3000 Btu/hr per in^2 CAOA = ____ / 3000 Btu/hr per in^2 = ____in^2

Step 8: Calculate Minimum CAOA.

Minimum CAOA = CAOA **multiplied by** RF Minimum CAOA = _____ x ____ = _____in^2

Step 9: Calculate Combustion Air Opening Diameter (CAOD)

CAOD = 1.13 **multiplied by the square root of** Minimum CAOA CAOD = 1.13 x $\sqrt{\text{(Minimum CAOA)}}$ = ____in

[1] If desired, ACH can be determined using ASHRAE calculation or blower door test. Follow procedures in Section G304.

Minnesota Mechanical Code

- Combustion Air Handout example…..

Minnesota Mechanical Code

- ***Determine Makeup Air Requirements for the following:***

Size of new house:	**2,000 sq. ft. (including basement)**
Average ceiling height:	**8 ft.**
Number of bedrooms:	**3**
Ventilation type:	**Heat recovery ventilator (HRV)**
Type of gas water heater:	**40,000 Btu/hr power vent**
Type of gas furnace:	**60,000 Btu/hr direct vent**
Type of gas fireplace:	**30,000 Btu/hr direct vent**
Kitchen exhaust fan:	**250 cfm (exhausts to the outside)**
Next largest exhaust fan:	**70 cfm**
Combustion air space:	**10 ft. x 10 ft. x 8 ft.**

Minnesota Mechanical Code

- *Determine Combustion Air Requirements using Worksheet E-1 and Table E-1*

IFGC Appendix E, Worksheet E-1

• New Home

• Step 1:	Furnace = Direct Vent	60,000 Btu/hr
•	Water heater = Power Vent	40,000 Btu/hr
• Step 2:	Combustion Appliance Space (CAS) = 10 x 10 x 8 =	800 cu. ft.
• Step 3:	Determine Air Changes per Hour (ACH)	
•	New construction, so use Method 4b (KAIR Method)	
• Step 4b:	From Table E-1, Required Volume Fan-Assisted (RVFA) =	3,000 cu. ft.
•	Required Volume Non-Fan-Assisted (RVNFA) =	0 cu. ft.
•	Total required volume (TRV) =	3,000 cu. ft.
•	CAS is less than TRV, so go to step 5	
• Step 5:	Ratio = CAS/TRV = 800/3,000 =	0.27
• Step 6:	Reduction Factor (RF) = 1-Ratio = 1-0.27 =	0.73
• Step 7:	Combustion Air Opening Area (CAOA) =	
•	Total Btu/hr / 3,000 Btu/hr per sq. inch = 40,000/3,000 =	13.3 sq. in.
• Step 8:	Minimum CAOA = CAOA x RF = 13.3 x 0.73 =	9.71 sq. in.
• Step 9:	Combustion Air Opening Diameter (CAOD) =	
•	1.13 x square root of Minimum CAOA =	
•	1.13 x square root of 9.71 =	**3.52 inch = <u>4 inch</u>**

•

Exhaust Systems
MN Mechanical Code 1346.0501

- Thank you!