2015 CRCA Tradeshow & Seminars
January 23, 2015

Ventilation for low- and steep-slope roofs

presented by

Mark S. Graham
Associate Executive Director, Technical Services
National Roofing Contractors Association

Historic philosophy

- 1:150 ratio
- 1:300 ratio exception

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Code requirements

Residential vs. Commercial

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International Building Code, 2012 Edition

Chapter 12-Interior Environment; Section 1203-Ventilation

1203.2 Attic spaces. Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof framing members shall have cross ventilation for each separate space by ventilation openings protected against the entrance of rain and snow. Blocking and bridging shall be arranged so as not to interfere with the movement of air. An airspace of not less than 1 inch (25 mm) shall be provided between the insulation and the roof sheathing. The net free ventilating area shall not be less than 1/150th of the area of the space ventilated.

Exceptions:

[continued…]

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Exceptions:

1. The net free cross-ventilation area shall be permitted to be reduced to 1/300 provided that not less than 50 percent and not more than 80 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents.
2. The net free cross-ventilation area shall be permitted to be reduced to 1/300 where a Class I or II vapor barrier is installed on the warm-in-winter side of the ceiling.
3. Attic ventilation shall not be required when determined not necessary by the building official due to atmospheric or climatic conditions.

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International Residential Code, 2012 Edition

Chapter 8-Roof-Ceiling Construction; Section R806-Roof Ventilation

R806.1 Ventilation required. Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilation openings shall have a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum. Ventilation openings having a least dimension larger than 1/4 inch (6.4 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, or similar material with openings having a least dimension of 1/16 inch (1.6 mm) minimum and 1/4 inch (6.4 mm) maximum.

Openings in roof framing members shall conform to the requirements of Section R802.7. Required ventilation openings shall open directly to the outside air.

Exception: Attic ventilation shall not be required when determined not necessary by the code official due to atmospheric or climatic conditions.

[continued…]

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R806.2 Minimum vent area. The minimum net free ventilating area shall be 1/150 of the area of the vented space.

Exception: The minimum net free ventilation area shall be 1/300 of the vented space provided one or more of the following conditions are met:

1. In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.
2. At least 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located no more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically, with the balance of the required ventilation provided by eave or cornice vents. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

R806.3 Vent and insulation clearance. Where eave or cornice vents are installed, insulation shall not block the free flow of air. A minimum of a 1-inch (25 mm) space shall be provided between the insulation and the roof sheathing and at the location of the vent.

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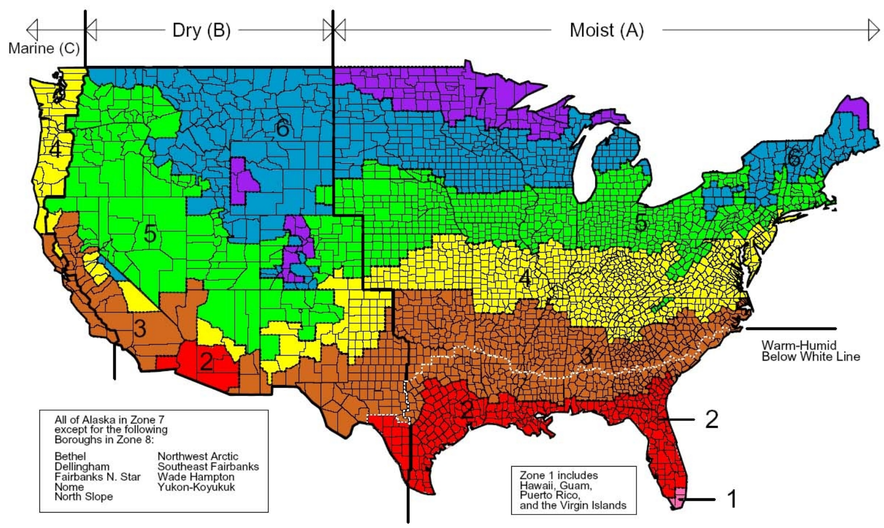
Climate zones

IECC 2012, Section C301 and Sec. R301—Climate Zones



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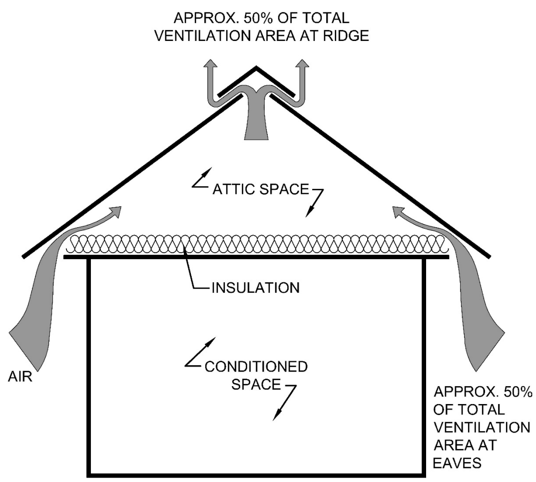
"Balanced" ventilation



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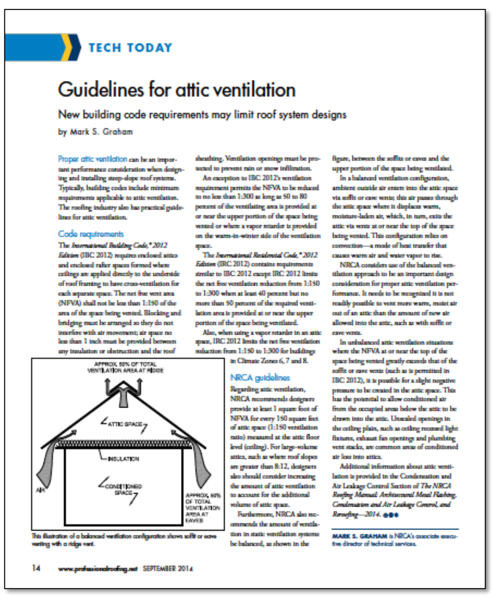

TECH TODAY

Guidelines for attic ventilation

New building code requirements may limit roof system designs

by Mark S. Graham

Proper attic ventilation can be an important performance consideration when designing and installing steep-slope roof systems. Typically, building codes include minimum requirements applicable to attic ventilation. The roofing industry also has practical guidelines for attic ventilation.

Code requirements

The *International Building Code,® 2012 Edition* (IBC 2012) requires enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof framing to have cross-ventilation for each separate space. The net free vent area (NFVA) shall not be less than 1:150 of the area of the space being vented. Blocking and bridging must be arranged so they do not interfere with air movement; air space no less than 1 inch must be provided between any insulation or obstruction and the roof sheathing. Ventilation openings must be protected to prevent rain or snow infiltration.

An exception to IBC 2012's ventilation requirement permits the NFVA to be reduced to no less than 1:300 as long as 50 to 80 percent of the ventilating area is provided at or near the upper portion of the space being vented or where a vapor retarder is provided on the warm-in-winter side of the ventilation space.

The *International Residential Code,® 2012 Edition* (IRC 2012) contains requirements similar to IBC 2012 except IRC 2012 limits the net free ventilation reduction from 1:150 to 1:300 when at least 40 percent but no more than 50 percent of the required ventilation area is provided at or near the upper portion of the space being ventilated.

Also, when using a vapor retarder in an attic space, IRC 2012 limits the net free ventilation reduction from 1:150 to 1:300 for buildings in Climate Zones 6, 7 and 8.

NRCA guidelines

Regarding attic ventilation, NRCA recommends designers provide at least 1 square foot of NFVA for every 150 square feet of attic space (1:150 ventilation ratio) measured at the attic floor level (ceiling). For large-volume attics, such as where roof slopes are greater than 8:12, designers also should consider increasing the amount of attic ventilation to account for the additional volume of attic space.

Furthermore, NRCA also recommends the amount of ventilation in static ventilation systems be balanced, as shown in the figure, between the soffits or eaves and the upper portion of the space being ventilated.

In a balanced ventilation configuration, ambient outside air enters into the attic space via soffit or eave vents; this air passes through the attic space where it displaces warm, moisture-laden air, which, in turn, exits the attic via vents at or near the top of the space being vented. This configuration relies on convection—a mode of heat transfer that causes warm air and water vapor to rise.

NRCA considers use of the balanced ventilation approach to be an important design consideration for proper attic ventilation performance. It needs to be recognized it is not readily possible to vent more warm, moist air out of an attic than the amount of new air allowed into the attic, such as with soffit or eave vents.

In unbalanced attic ventilation situations where the NFVA at or near the top of the space being vented greatly exceeds that of the soffit or eave vents (such as is permitted in IBC 2012), it is possible for a slight negative pressure to be created in the attic space. This has the potential to allow conditioned air from the occupied areas below the attic to be drawn into the attic. Unsealed openings in the ceiling plain, such as ceiling recessed light fixtures, exhaust fan openings and plumbing vent stacks, are common areas of conditioned air loss into attics.

Additional information about attic ventilation is provided in the Condensation and Air Leakage Control Section of *The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing—2014.* ●●●

MARK S. GRAHAM is NRCA's associate executive director of technical services.

APPROX. 50% OF TOTAL VENTILATION AREA AT RIDGE / ATTIC SPACE / INSULATION / CONDITIONED SPACE / AIR / APPROX. 50% OF TOTAL VENTILATION AREA AT EAVES

This illustration of a balanced ventilation configuration shows soffit or eave venting with a ridge vent.

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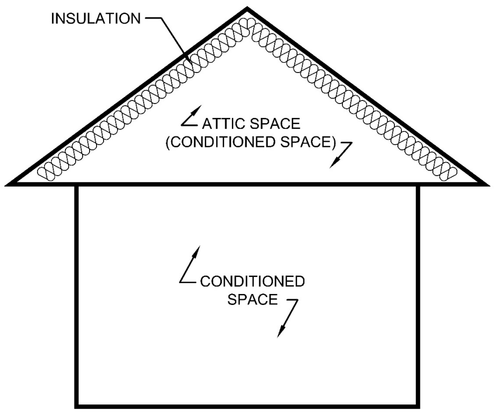
Unvented, conditioned attics



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International Residential Code, 2012 Edition

Chapter 8-Roof-Ceiling Construction; Section R806-Roof Ventilation

R806.5 Unvented attic and unvented enclosed rafter assemblies. Unvented attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) and unvented enclosed rafter assemblies (spaces between ceilings that are applied directly to the underside of roof framing members/rafters and the structural roof sheathing at the top of the roof framing members/rafters) shall be permitted if all the following conditions are met:

1. The unvented attic space is completely contained within the building thermal envelope.
2. No interior Class I vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly or on the ceiling side of the unvented enclosed rafter assembly.
3. Where wood shingles or shakes are used, a minimum 1/4- inch (6 mm) vented air space separates the shingles or shakes and the roofing underlayment above the structural sheathing.

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4. In Climate Zones 5, 6, 7 and 8, any air-impermeable insulation shall be a Class II vapor retarder, or shall have a Class III vapor retarder coating or covering in direct contact with the underside of the insulation.
5. Either Items 5.1, 5.2 or 5.3 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
   - 5.1 Air-impermeable insulation only. Insulation shall be applied in direct contact with the underside of the structural roof sheathing.
   - 5.2 Air-permeable insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing as specified in Table R806.5 for condensation control.
   - 5.3 Air-impermeable and air-permeable insulation. The air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing as specified in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the air-impermeable insulation.

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5.4. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

TABLE R806.5
INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPERMEABLE INSULATION R-VALUE[a]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

[a] Contributes to but does not supersede the requirements in Section N1103.2.1.

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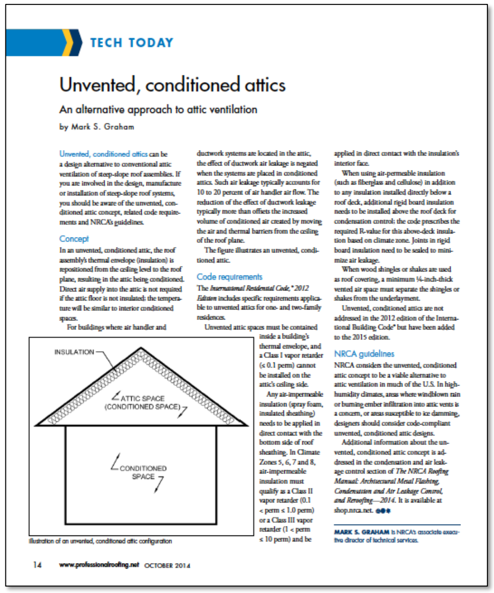

TECH TODAY

Unvented, conditioned attics

An alternative approach to attic ventilation

by Mark S. Graham

Unvented, conditioned attics can be a design alternative to conventional attic ventilation of steep-slope roof assemblies. If you are involved in the design, manufacture or installation of steep-slope roof systems, you should be aware of the unvented, conditioned attic concept, related code requirements and NRCA's guidelines.

Concept

In an unvented, conditioned attic, the roof assembly's thermal envelope (insulation) is repositioned from the ceiling level to the roof plane, resulting in the attic being conditioned. Direct air supply into the attic is not required if the attic floor is not insulated; the temperature will be similar to interior conditioned spaces.

For buildings where air handler and ductwork systems are located in the attic, the effect of ductwork air leakage is negated when the systems are placed in conditioned attics. Such air leakage typically accounts for 10 to 20 percent of air handler air flow. The reduction of the effect of ductwork leakage typically more than offsets the increased volume of conditioned air created by moving the air and thermal barriers from the ceiling of the roof plane.

The figure illustrates an unvented, conditioned attic.

Code requirements

The *International Residential Code,® 2012 Edition* includes specific requirements applicable to unvented attics for one- and two-family residences.

Unvented attic spaces must be contained inside a building's thermal envelope, and a Class I vapor retarder (≤ 0.1 perm) cannot be installed on the attic's ceiling side.

Any air-impermeable insulation (spray foam, insulated sheathing) needs to be applied in direct contact with the bottom side of roof sheathing. In Climate Zones 5, 6, 7 and 8, air-impermeable insulation must qualify as a Class II vapor retarder (0.1 < perm ≤ 1.0 perm) or a Class III vapor retarder (1 < perm ≤ 10 perm) and be applied in direct contact with the insulation's interior face.

When using air-permeable insulation (such as fiberglass and cellulose) in addition to any insulation installed directly below a roof deck, additional rigid board insulation needs to be installed above the roof deck for condensation control; the code prescribes the required R-value for this above-deck insulation based on climate zone. Joints in rigid board insulation need to be sealed to minimize air leakage.

When wood shingles or shakes are used as roof covering, a minimum ¼-inch-thick vented air space must separate the shingles or shakes from the underlayment.

Unvented, conditioned attics are not addressed in the 2012 edition of the International Building Code® but have been added to the 2015 edition.

NRCA guidelines

NRCA considers the unvented, conditioned attic concept to be a viable alternative to attic ventilation in much of the U.S. In high-humidity climates, areas where windblown rain or burning ember infiltration into attic vents is a concern, or areas susceptible to ice damming, designers should consider code-compliant unvented, conditioned attic designs.

Additional information about the unvented, conditioned attic concept is addressed in the condensation and air leakage control section of *The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing—2014*. It is available at shop.nrca.net.

MARK S. GRAHAM is NRCA's associate executive director of technical services.

Illustration of an unvented, conditioned attic configuration

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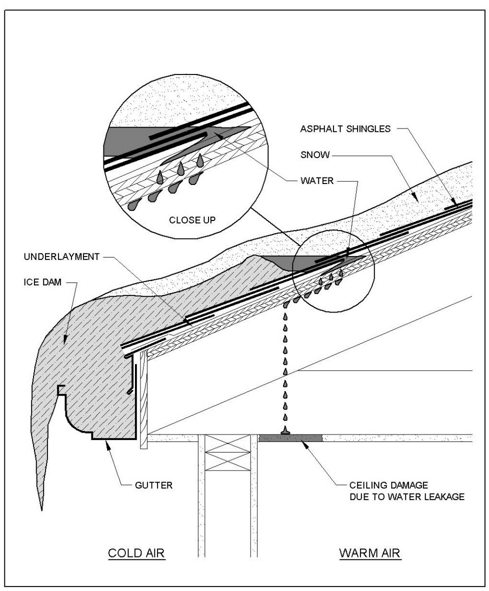
Ice damming



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Ice damming

Code requirements

IBC 2012:

- For asphalt shingles, roll roofing, slate, metal shingles, and wood shakes and shingles
- "…history of ice forming along eaves…"
- 24 inches inside exterior wall line

IRC 2012:

- Similar to IBC 2012 except…
- Instead of "…history…", see IRC 2012, Table R301.2(1)—Climate and Geographic Design Criteria

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Ice damming

The NRCA Roofing Manual

NRCA guidelines:

- For all steep-slope water-shedding roof systems (including tile and architectural metal panels)
- Include anytime "…the January mean temperature is 30 F or less…."
- ASTM D1970 self-adhering underlayment
- Extending upslope a minimum of 24 inches—measured in the horizontal plane—from the inside of a building's exterior wall line

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The NRCA Roofing Manual

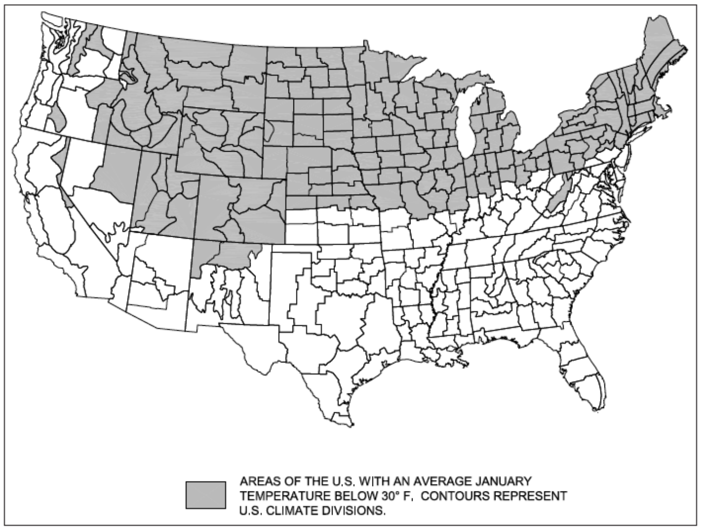

Figure 2-3: Areas of the U.S. with an average January temperature below 30 F, composite 1981-2012 data. Map is based on data provided by NOAA/ESRL Physical Sciences Division, Boulder, Colo., from its website, www.cdc.noaa.gov. Contours represent U.S. Climate Divisions.

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November 2014

TECH TODAY

Ice damming season

Proper roof system design can prevent leakage following freeze-thaw cycles

by Mark S. Graham

Moisture infiltration resulting from ice damming can be a problematic occurrence with steep-slope, water-shedding roof systems. You should be aware of the cause of ice damming-related leakage, as well as code provisions and NRCA's recommendations for implementing design considerations to prevent such leakage.

Ice dam formation

Ice damming can be experienced during the winter months in the northern- and mixed-climate U.S. regions during periods of snow and ice accumulation and melting.

Ice dams form when accumulated snow melts from the warmer upper portions of steep-slope roofs and refreezes over the relatively colder lower portions of a roof. The resulting ice formations act like dams and cause melting snow to back up beneath the primary roof covering, likely leaking into the building's interior.

An illustration of ice damming is provided in the figure.

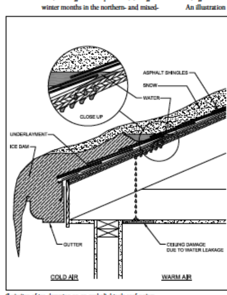

Illustration of ice damming on an asphalt shingle roof system

Code requirements

The *International Building Code,® 2012 Edition* (IBC 2012) requires the installation of an "ice barrier" within asphalt shingle, metal shingle, mineral-surfaced roll roofing, slate, and wood shake and shingle roof systems for buildings "… where there has been a history of ice forming along the eaves causing a backup of water … ."

The code stipulates the ice barrier shall consist of at least two layers of underlayment cemented together or a self-adhering polymer-modified bitumen sheet. The ice barrier shall extend from the eave edges to at least 24 inches inside a building's exterior wall line.

The code indicates an ice barrier is not required for detached buildings that contain no conditioned floor area (unheated utility buildings).

The *International Residential Code,® 2012 Edition* (IRC 2012) includes similar requirements to those in IBC 2012 except whether an ice barrier is required as indicated in IRC 2012's Table R301.2(1)—Climate and Geographic Design Criteria. When adopting IRC 2012, the adopting jurisdiction is intended to specifically indicate in the table whether an ice barrier is required.

NRCA's recommendations

NRCA recommends water and ice-dam protection membranes be used in locations where the average January temperature is 30 F or less.

A water and ice-dam protection membrane preferably is a single-layer application of self-adhering polymer-modified bitumen sheet; NRCA recommends sheets complying with ASTM D1970, "Standard Specification for Self Adhering Polymer Modified Sheet Materials Used as Steep Slope Roofing Underlayment for Ice Dam Protection."

Furthermore, NRCA recommends an ice dam-protection membrane be applied starting at the eaves and extending upslope to a point 24 inches—measured in the horizontal plane—from the inside of a building's exterior wall line.

Additional information regarding ice damming, preventing ice dam-related leakage and a U.S. map indicating where the average January mean temperature is below 30 F is provided in *The NRCA Roofing Manual: Steep-slope Roof Systems—2013.*

MARK S. GRAHAM is NRCA's associate executive director of technical services.

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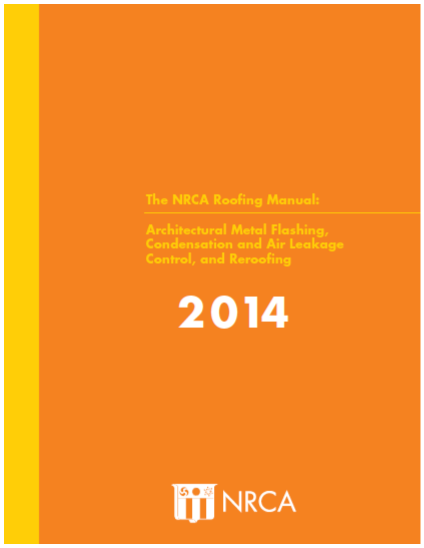
Vaulted (cathedral) ceilings



Wayne Tobiasson/CRREL research:

- Ventilation has a role in reducing ice-dam and icicle formation
- When it is warmer than 22 F, melted water seldom refreezes at eaves.
- Size ventilation to keep the bottomside of the roof deck below freezing when it is 22 F outside.
- When it is colder than 22 F, it is easier to ventilate with outside air

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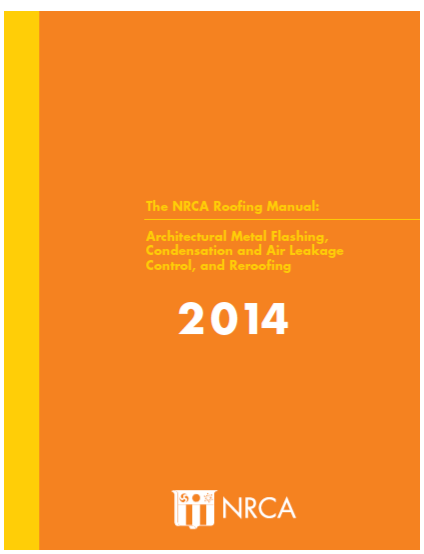
Vaulted (cathedral) ceilings



Pages 220-223:

- Further explanation of concept
- Graphs/curves:
  - Roof slope
  - Roof system R-value
  - Airway height (air space)
  - Inlet area (in^2)
  - Airway length (rafter length)

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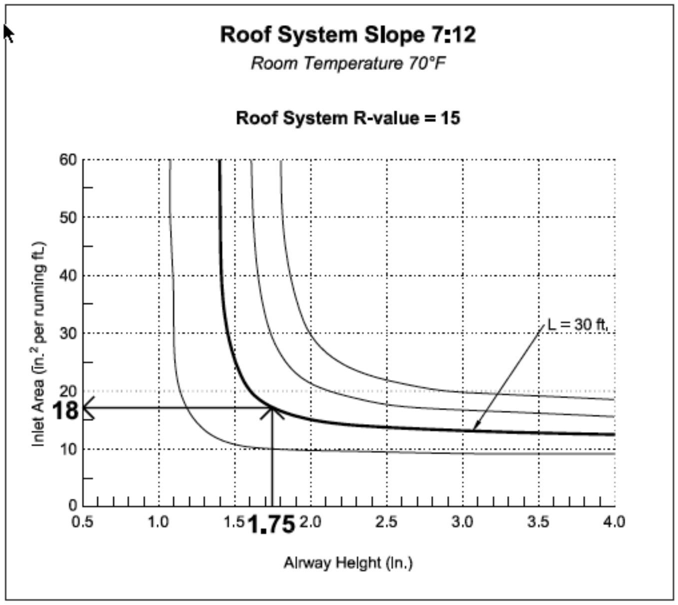

Figure 14: Example calculation for airways 1.75 inches in height with a rafter length of 30 feet and an R-value of 15, slope of 7:12

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Questions

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Mark S. Graham
Associate Executive Director, Technical Services
National Roofing Contractors Association
10255 West Higgins Road, 600
Rosemont, Illinois 60018-5607

(847) 299-9070
mgraham@nrca.net
www.nrca.net

Twitter: @MarkGrahamNRCA
Personal website: www.MarkGrahamNRCA.com

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