Maryland Association of Home Inspectors

Third Annual Education Conference -- January 18, 2014
Linthicum Heights, MD

Roofing issues home inspectors should be aware of

presented by

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

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Topics

- Building codes and standards
- Roof decks
- Underlayment
- Asphalt shingles
- Flashing details
- Attic ventilation
- Other roof system types
- Questions

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Building codes

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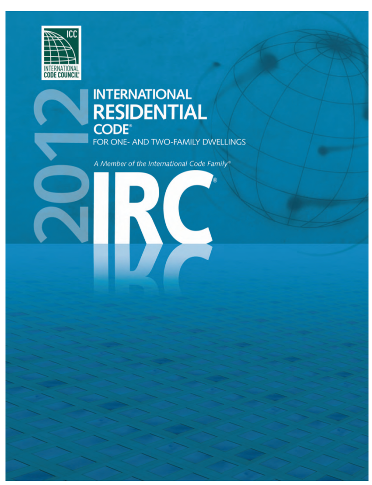
International Residential Code, 2012 Edition (IRC 2012)



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International Residential Code, 2012 Edition

- Chapter 9-Roof Assemblies
- Similar to IBC 2012, Chapter 15
- Reroofing
- Fire resistance
- Wind resistance
- Prescriptive-based language

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Building Codes Manual (2012 Codes)

- Based on 2012 I-codes:
  - IBC 2012
  - IRC 2012
  - IECC 2012
  - IPC 2012
  - IFC 2012
- Includes roofing-related code text and NRCA commentary on each section
- Co-branded with ICC; NRCA promotes to industry and ICC promotes to code officials

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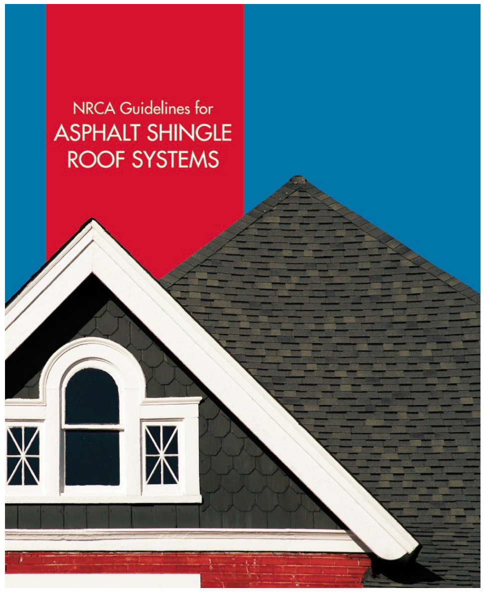
Asphalt shingles



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Chapter 1—Roof Decks

A roof deck is the structural substrate to which an asphalt shingle roof system is applied. A roof deck must be capable of safely supporting dead loads, including the weight of an asphalt shingle roof system, and design live loads, including any additional loads that may be required by the applicable building code. A roof deck also must be able to provide adequate withdrawal resistance for fasteners used to attach a roof system. Geographical location and climatic conditions can influence the type of roof deck, rafter spacing, deck slope and other structural characteristics that are appropriate for a roof deck. A roof deck material of long-term expected service life is an important design consideration.

Asphalt shingle roof systems may be applied directly to the following roof deck substrates:

- Wood panels (plywood, oriented strand board)
- Wood planks and wood boards

The proper thickness and species of a wood panel, wood plank or wood board roof deck required for a specific roof assembly should be determined by the design loads, including wind uplift, anticipated for the roof system and the distance (span) between the supporting members. End joints of each adjacent piece of decking should be staggered. The end joints should also be centered over the supporting members, except for matched ends (e.g., tongue-and-groove).

In some instances, roof deck types other than wood panels, wood planks or wood boards may be encountered. For example, in some situations, metal, concrete, gypsum, cementitious wood fiber, other nonwood or fabricated wood materials are used as structural decks for steep-slope roof systems. In these instances, NRCA recommends a nailable substrate consisting of appropriately designed wood panels, wood planks or wood boards be installed over the structural deck to provide an adequate substrate for an asphalt shingle roof system.

Asphalt shingle roof systems should be applied only over continuous wood panels or closely spaced wood planks or wood boards. Spaced, or "skipped," wood planks or wood boards are not considered adequate substrates for asphalt shingle roof systems.

The bottom, leading or eave edge of a roof deck should be flush or extend out from the outer edge of a fascia board or crown molding without gaps to provide for a continuous surface to properly terminate an asphalt shingle roof system.

NRCA recommends designers specify roof deck slopes intended for the application of asphalt shingle roof systems at 4:12 or greater.

1.1 Wood Panels

Wood-panel roof decks can be subdivided into two general types: plywood roof decks and oriented strand board (OSB) roof decks.

Plywood panels are composed of thin wood layers called veneers that are peeled from logs. The veneers are laid at right angles to one another then glued together under heat and pressure. This cross-lamination orientation adds strength and stability to the panels. Panels consist of a number of cross-laminated layers that vary in number according to a panel's thickness.

OSB panels are composed of layers of compressed, glued wood strands. These strand layers are oriented at right angles to one another before being glued under heat and pressure and formed into panels. OSB panel performance can be affected by the type of wood (i.e., hardwood or softwood) used in its manufacture.

All plywood and wood-based panels used to support asphalt shingle roof systems should be rated for structural use as roof sheathing. Most building codes require a label on plywood or wood-based panels, ensuring the plywood or wood-based panel complies with the criteria set forth in one of the following standards:

- U.S. Product Standards (PS) PS 1, "Construction and Industrial Plywood," for all-veneer plywood
- PS 2, "Performance Standard for Wood-Based Structural-Use Panels"
- APA—The Engineered Wood Association (APA) Standard PRP-108, "Performance Standards and Policies for Structural-Use Panels," for structural-use panels (all-veneer plywood and OSB)

Performance standards PS 1 and PS 2, which were initiated by APA, have been developed under the "Procedures for the Development of Voluntary Product Standards" of the U.S. Department of Commerce. Performance standard PRP-108 was developed by APA.

Adherence to PS 1, PS 2 and PRP-108 standards is voluntary by wood panel producers; they are not required to meet these standards to sell their products.

NRCA recommends plywood or wood-based panels intended for use as roof sheathing meet or exceed the requirements set forth by PS 1, PS 2 or PRP-108.

When plywood is used as a roof deck material, NRCA recommends the use of a minimum of four-ply, 15⁄32-inch-thick plywood for 16-inch rafter spacings, and four-ply, 5⁄8-inch-thick plywood for 24-inch rafter spacings. These minimum thicknesses are intended to provide adequate support for an asphalt shingle roof system and adequate pull-out resistance for the fasteners used to attach asphalt shingles to plywood panels. In some instances, thicker plywood panels may be necessary to accommodate specific design loads anticipated for the roof assembly and the distance between the supporting members.

When OSB is used as a roof deck material, a minimum of 15⁄32-inch-thick OSB is recommended for 16-inch rafter spacings and 5⁄8-inch-thickness OSB for 24-inch rafter spacings. These minimum thicknesses are intended to provide adequate support for an asphalt shingle roof system and adequate pull-out resistance for the fasteners used to attach asphalt shingles to OSB panels. In some instances, thicker OSB panels may be necessary to accommodate specific design loads anticipated for the roof assembly and the distance between the supporting members.

NRCA has concerns about the long-term performance of OSB panels, including those addressed by PS 2 and PRP-108, used as substrates for asphalt shingle roof systems. Although NRCA acknowledges the widespread use of OSB panels for constructing roof deck substrates, experience has shown that OSB panels are subject to dimensional changes, ridging and fastener backout resulting from changing moisture conditions the roof decks normally encounter. If given a choice between an OSB panel roof deck substrate or a plywood roof deck substrate, NRCA has a preference for roof deck substrates constructed of plywood panels complying with PS 1.

Plywood and OSB sheathing panels should be installed with about 1⁄8-inch minimum gaps at panel edges to allow for expansion of the panels. Panel edge clips, often called H-clips, are sometimes used to provide this gap and also provide additional support of panel edges between widely spaced framing members.

End joints of wood sheathing panels that do not occur over supporting members should be supported to provide adequate bearing for the sheathing panel ends.

Preservative-treated Panels: Caution should be taken when wood panel roof decks are constructed of wood that has been treated with an oil-borne preservative. Many roofing material manufacturers recommend wood roof decks be constructed with wood that has been treated with a non-oil preservative pressure treatment or with nontreated air- or kiln-dried lumber. When preservative-treated wood panels are used, the roofing material manufacturer can be consulted for its specific recommendations for roofing material application on preservative-treated wood panel roof decks.

For additional information regarding preservative wood treatment, the American Wood Preservers Association can be consulted.

Fire-retardant-treated Panels: Because of the deterioration of some fire-retardant-treated (FRT) wood panels caused by premature, heat-induced activation of the intended chemical reaction, special care should be taken to analyze and investigate the complete building envelope when considering the use of FRT wood panel decks in the design of a steep-slope roof assembly. NRCA does not recommend using FRT wood as a roof deck material.

1.2 Wood Planks and Wood Boards

Wood plank and wood board roof decks are composed of solid-sawn dimensional lumber. They are normally supported by wood beams, often glue-laminated timber (gluelams), and/or solid lumber joists or purlins.

The terms wood "plank" and wood "board" generally are differentiated by thickness and width.

Wood planks are long, relatively thick pieces of lumber. Specifications sometimes vary in thickness from 2 inches up to 5 inches with the width dimension in the plane of the roof deck. Wood planks may be single or double tongue-and-groove, straight-edge, ship-lapped or grooved for splines on longitudinal edges.

Wood boards are pieces of lumber that are less than 2 inches thick with square edges. Board widths are typically between 4 inches and 12 inches wide and are laid with their width dimensions in the horizontal plane of a roof deck. Boards less than 4 inches wide are sometimes classified as strips. Use of nominal 6-inch-wide wood boards is suggested for roof decks to prevent excessive movement and splitting. Boards that are thinner than nominal 1 inch are not considered strong enough to support roof loads.

The proper thickness and species of wood plank and wood board deck required for a specific roof assembly should be determined by the design loads, including wind uplift, anticipated for the roof system and the distance (span) between the supporting members. End joints of each adjacent piece of decking should be staggered. The end joints should also be centered over the supporting members, except for matched ends (e.g., tongue-and-groove).

Preservative-treated Wood: Since Jan. 1, 2004, preservative-treated lumber produced for consumer use is no longer treated with chromated copper arsenate (CCA). Some commercial uses of CCA are still available. The new treatment processes use alkaline copper quat (ACQ), copper azole (CBA), sodium borates (SBX), ammoniacal copper zinc arsenate (ACZA) or variations of these compounds. Most, except SBX, are more corrosive than CCA and require fasteners, anchors and connectors of specific composition to resist corrosion from the wood treatment.

NRCA suggests the following guidelines when encountering the current generation of treated wood:

- Carbon steel, aluminum and electroplated galvanized steel fasteners and connectors should not be used in contact with treated wood. Hot-dipped galvanized fasteners complying with ASTM A153 and connectors complying with ASTM A653, Class G185, generally are acceptable. Type 304 or Type 316 stainless-steel fasteners and connectors are recommended for maximum corrosion resistance.
- Fasteners with proprietary anti-corrosion coatings may be acceptable for use with treated wood. When considering the use of such proprietary coated fasteners and connectors, fastener manufacturers can be consulted for specific information regarding the performance of their products in treated wood and any precautions or special instructions that may be applicable.
- Aluminum fasteners, flashings and accessory products should not be used in direct contact with any treated wood. ACQ-treated wood is not compatible with aluminum.
- Uncoated metal and painted metal flashings and accessories, except for 300-series stainless steel, should not be used in direct contact with treated wood. Metal products, except stainless steel, may be used if separated from treated wood by a spacer or barrier, such as a single-ply membrane or self-adhering polymer-modified bitumen membrane.

NRCA is of the opinion that the corrosion-related concerns regarding the use of the current generation of treated wood possibly outweigh the benefits that treated wood provides as a component in roof assemblies. In many instances, nontreated, construction-grade wood is suitable for use in roof assemblies as blocking or nailers provided reasonable measures are taken to ensure the nontreated wood remains reasonably dry when in service. Where a specific design provides for a secondary means of waterproofing, NRCA now considers the use of nontreated, construction-grade wood to be an acceptable substitute for treated wood.

1.3 Other Deck Types

NRCA recognizes other types of structural decks are sometimes used in constructing asphalt shingle roof assemblies, particularly in nonresidential construction. NRCA recommends asphalt shingle roof systems be attached directly only to structural wood panel, wood plank or wood board roof decks. NRCA does not recommend the direct attachment of shingles to gypsum, concrete plank, cementitious wood fiber or similar nonwood or fabricated wood materials.

In some situations, metal, concrete, gypsum, cementitious wood fiber, other nonwood or fabricated wood materials are used as structural decks for steep-slope roof systems. In these instances, NRCA recommends a nailable substrate consisting of appropriately designed wood panels, wood planks or wood boards be installed over the structural deck to provide an adequate substrate for an asphalt shingle roof system.

For ventilation purposes, if necessary, and to allow acceptable clearance for proper fastener penetration of a wood panel nailing substrate, NRCA suggests the use of wood battens or metal channels attached over a structural deck to raise and separate the wood panels from the deck surface below. The design, placement, spacing, height and attachment of wood battens or metal channels are the responsibility of the designer. A complete roof assembly,

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2.2 Underlayment Design and Installation

Asphalt shingles are designed for use as multilayered, water-shedding roof components that rely on the slope of a roof substrate to effectively shed water. Depending on a roof substrate's slope and exposure conditions of an asphalt shingle roof system, different underlayment materials and configurations will be appropriate.

Roof Slope: NRCA recommends designers specify substrates for asphalt shingle roof systems have slopes of 4:12 or more. For roof substrates having slopes of 4:12 or more, NRCA recommends a minimum single-layer underlayment be specified and applied horizontally in shingle fashion.

For roof substrates having slopes of 3:12 up to 4:12, a single layer of self-adhering polymer-modified bitumen underlayment or a minimum double-layer underlayment should be specified. When a double-layer underlayment is specified, it should be applied horizontally in shingle fashion, with half the roll width minus 1-inch exposure and half the roll width plus 1-inch underlap.

Also, for asphalt shingle roof systems on slopes less than 4:12, NRCA recommends designers consider the following:

- More stringent underlayment specification, such as a layer of self-adhering underlayment with laps and joints sealed
- Roof layout and valley/plane intersection details
- Careful consideration of anticipated climate conditions

These factors also necessitate careful selection of the type of asphalt shingle (e.g., interlocking, laminated, no-cutout) proposed.

Some asphalt shingle manufacturers and some building codes allow for the application of asphalt shingles on lesser slopes down to 2:12.

Underlayment Configurations: There are different underlayment configurations that can be used for asphalt shingle roof systems. Generally, these configurations can be categorized as follows:

- Single layer of underlayment
- Single layer of self-adhering underlayment
- Double layer of underlayment

Single Layer of Underlayment: This configuration consists of one layer of underlayment fastened to a deck before application of a roof covering. For single-layer applications, the underlayment should be applied horizontally in shingle fashion and side lapped a minimum of 2 inches over the preceding sheet. End laps should be a minimum of 4 inches. Vertical end laps for alternate courses should be offset a minimum of 3 feet. Underlayment should be fastened with nails or staples only as necessary to hold the material in place before and during the installation of a primary roof covering. See Figure 1.

Some building codes may require specific fastener types and patterns for underlayment in high-wind regions in an attempt to hold the underlayment in place in the event of wind blow-off of the primary roof covering.

Installing nonadhered underlayment in vertical runs, referred to as "strapping," is considered by NRCA to be acceptable for steeply sloped asphalt shingle roof systems. If the strapping method is used, NRCA recommends the underlayment sheets be offset at a slight angle to promote drainage overlap and the side-lap and end-lap coverage be increased. Strapping should be limited to steeper slopes that are more difficult to cover with horizontal runs.

Single-layer of Self-adhering Underlayment: This configuration consists of one layer of self-adhering polymer-modified bitumen sheet membrane applied over a roof deck. This type of membrane is designed to be used as a water and ice-dam protection membrane. Side laps and end laps should be adhered and the membrane sheet adhered to the substrate. Designers should note that these types of membranes, when installed over an entire roof area, act as air and vapor retarders. Potential problems with ventilation,

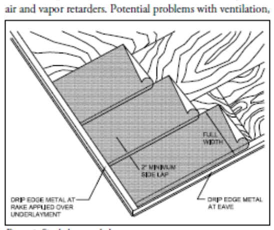

Figure 1: Single-layer underlayment

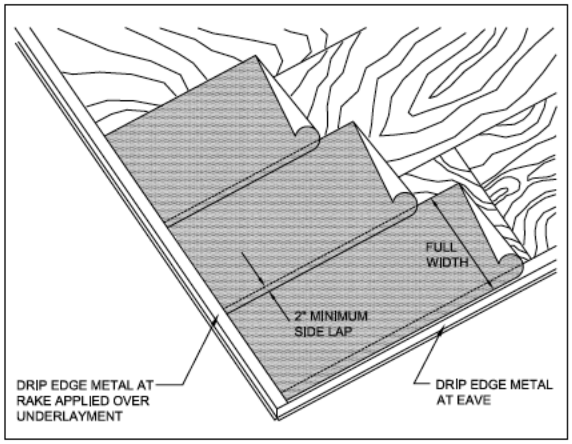

Figure 1: Single-layer underlayment

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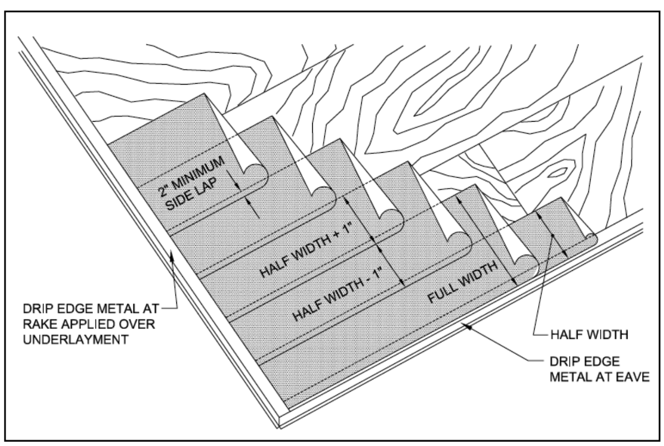

Figure 3: Double-layer underlayment

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moisture control and vapor retarder placement should be considered during the design phase. See Figure 2.

During reroofing, self-adhering polymer-modified bitumen sheet underlayment may not be able to be removed completely from the existing roof deck without damaging the roof deck.

Double-layer of Underlayment: This configuration consists of two layers of underlayment fastened to a roof deck before application of asphalt shingles. When a double-layer underlayment is required, the material should be applied horizontally in shingle fashion. For double-layer applications, all underlayments should be lapped a minimum of one-half the roll width plus 2 inches over the preceding sheet. End laps should be a minimum of 4 inches. An underlayment should be fastened appropriately for the slope of the roof to hold the material in place prior to the installation of a primary roof covering material. See Figures 3 and 4.

When a double-layer underlayment configuration is used and underlayment layers are identical materials, they are commonly installed in shingle fashion. However, if one layer is used to "dry in" the building temporarily or underlayments of two different compositions are used, each layer may be applied in a single-layer configuration.

Water and Ice-dam Protection Membrane Underlayment: Regardless of the type of underlayment required or roof slope, in locations where the average temperature for January is 30 F or less, NRCA recommends installation of a water and ice-dam protection membrane. See Figure 5.

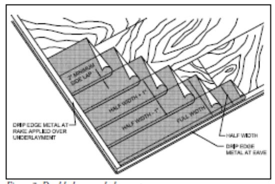

Figure 3: Double-layer underlayment

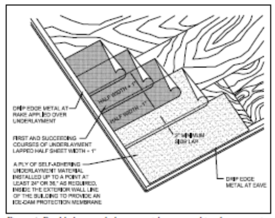

Figure 4: Double-layer underlayment with water and ice-dam protection membrane

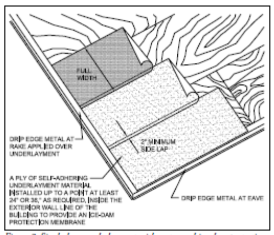

Figure 2: Single-layer underlayment with water and ice-dam protection membrane

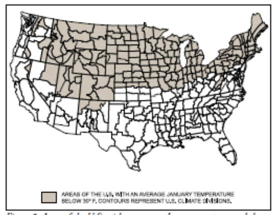

Figure 5: Areas of the U.S. with an average January temperature below 30 F, composite 1983-2007 data. Map is based on data provided by NOAA/ESRL Physical Sciences Division, Boulder, Colo., from its website, www.cdc.noaa.gov. Contours represent U.S. Climate Divisions.

Some building codes require the use of water and ice-dam protection membranes in areas where the mean January temperature is 25 F or less. Designers and contractors are urged to consult the applicable building code.

A water and ice-dam protection membrane generally is a self-adhering polymer-modified bitumen membrane. NRCA recommends these types of self-adhering membranes comply with ASTM D1970, which should be designated on the packaging.

Water and ice-dam protection membrane should be applied starting at a roof system's eaves and extend upslope a minimum of 24 inches from inside the exterior wall line of a building. For slopes less than 4:12 and in heavy snowfall regions, NRCA recommends water and ice-dam protection membranes be applied starting at the eaves and extending a minimum of 36 inches upslope from inside the exterior wall line of a building. The membrane should extend up the adjoining walls and beyond the 36 inch line at the downslope end of a valley. See Figures 6A and 6B.

Water and ice-dam protection membrane for downslope perimeters, transitions, valleys and around penetrations is recommended in cold regions. In climates where ice damming can be severe, consideration should be given to extending the ice-dam protection membrane farther up the slope.

Water and ice-dam protection membranes should not be relied on to prevent leaks from occurring. Careful consideration of roof ventilation, insulation and project-specific detailing for particular climatic conditions is vital. Also, self-adhering polymer-modified bitumen underlayments should not be left exposed for long periods of time. Self-adhering polymer-modified bitumen underlayments should be covered with primary roofing material as soon as practical to prevent degradation. Self-adhering material is temperature-sensitive and in cool or cold climates may need the application of heated air to assist sealing at side laps and end laps. Manufacturers' individual product requirements can be consulted for additional information.

Designers should note that these types of membranes, when used as underlayments over entire roof areas, also function as vapor retarders. Potential issues with ventilation, moisture control and vapor-retarder placement should be considered during the design phase.

Water and ice-dam protection membranes do not need to be covered by additional underlayment material.

Drip Edge Metal: The use of drip edge metal at eaves and rakes provides a means of terminating the underlayment and asphalt shingles and provides for efficient water shedding. Most building codes require the use of drip edge metal for asphalt shingle roof systems at eaves and rakes.

Drip edge metal is most common for asphalt shingle roof systems. Drip edge metal is typically fabricated in two configurations, L-type or T-type. See Figure 7.

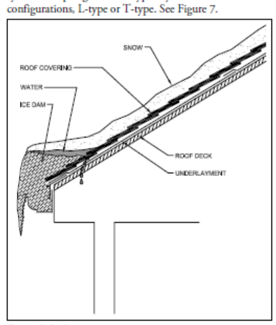

Figure 6A: Ice damming

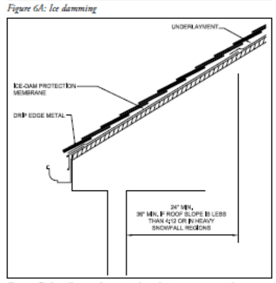

Figure 6B: Installation of water and ice-dam protection membrane

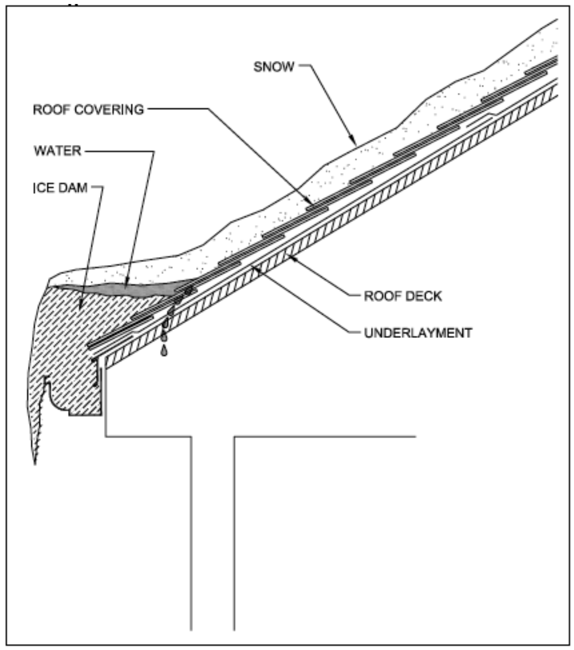

Figure 6A: Ice damming

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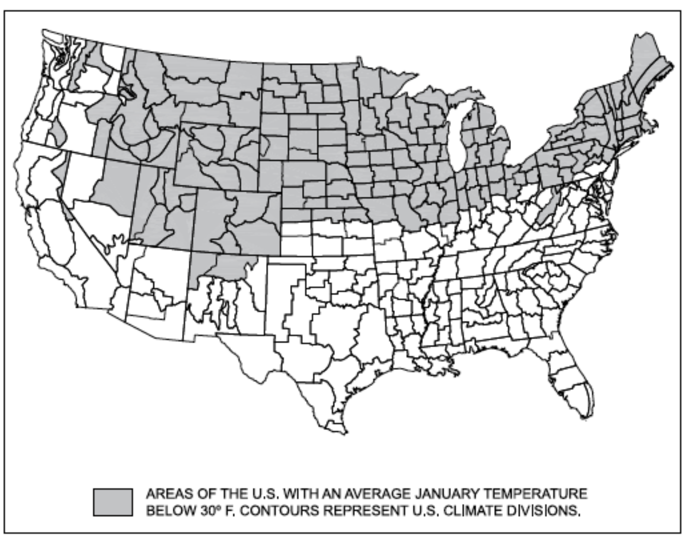

Figure 5: Areas of the U.S. with an average January temperature below 30 F, composite 1983-2007 data. Map is based on data provided by NOAA/ESRL Physical Sciences Division, Boulder, Colo., from its website, www.cdc.noaa.gov. Contours represent U.S. Climate Divisions.

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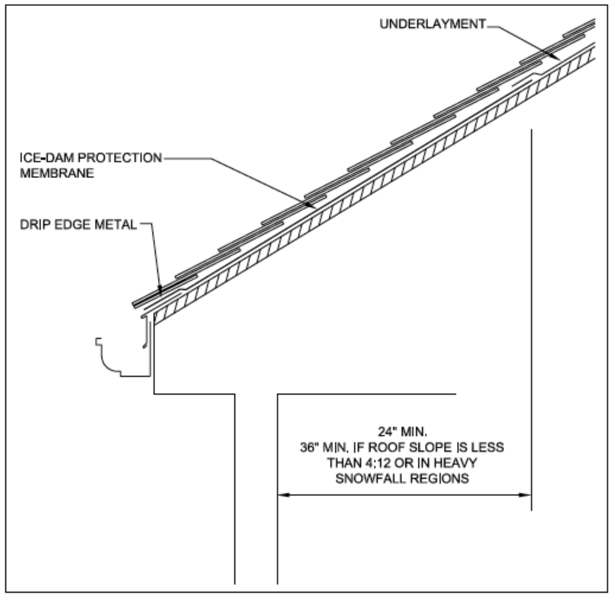

Figure 6B: Installation of water and ice-dam protection membrane

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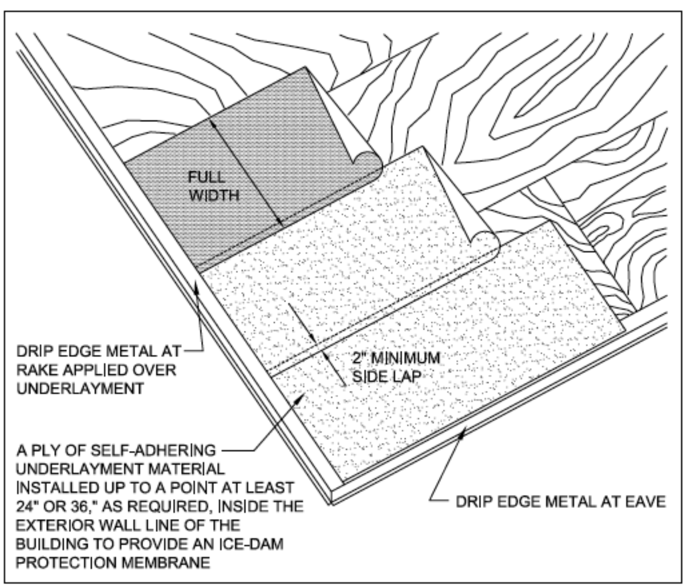

Figure 2: Single-layer underlayment with water and ice-dam protection membrane

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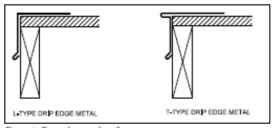

Figure 7: Drip edge metal configurations

The specific configuration and metal material used for drip edge metal usually depends on local practices.

NRCA recommends the use of drip edge metal at all eaves and rakes for asphalt shingle roof systems. Also, drip edge metal should be fabricated from one of the following metal types and minimum thicknesses:

- 28-gauge galvanized steel
- 28-gauge prefinished galvanized steel
- 28-gauge stainless steel
- 28-gauge Galvalume®
- 0.024-inch-thick aluminum
- 0.024-inch-thick prefinished aluminum
- 12-ounce copper
- 12-ounce lead-coated copper

NRCA suggests fastening drip edge metal at about 12 inches on center, slightly staggered. Spacing may need to be closer in high-wind regions.

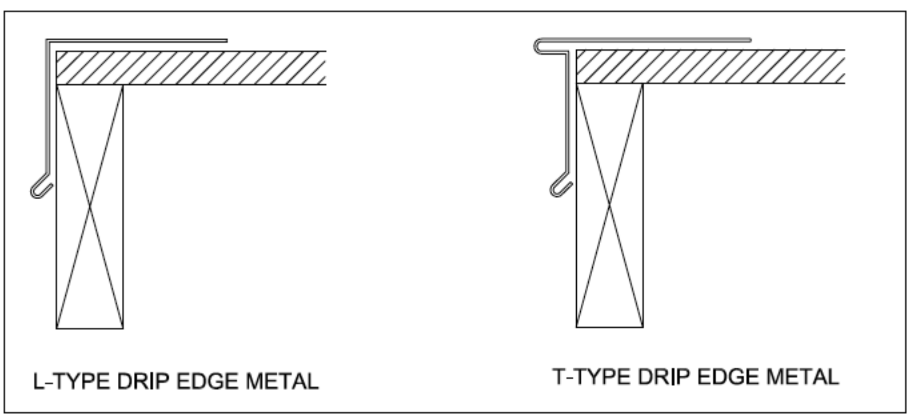

Figure 7: Drip edge metal configurations

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Chapter 3—Asphalt Shingles

Asphalt shingles are designed for use as multilayered, water-shedding roof components that rely on the slope of a roof substrate to effectively shed water.

Asphalt shingles are categorized by their reinforcements and shapes.

Asphalt shingles that use organic reinforcing mats are referred to as "organic-reinforced asphalt shingles," and those that use glass-fiber reinforcing mats are designated as "glass-fiber-reinforced asphalt shingles."

The shapes or styles of asphalt shingles are identified in Figure 8 as follows:

- **Strip shingles:** These shingles are in strip form and generally longer in width than height. Common dimensions for standard shingles are 12 inches by 36 inches. For metric shingles, the common dimensions are about 13 inches by $39\frac{3}{8}$ inches. These

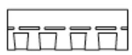
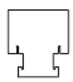
PRODUCT	APPROXIMATE SIZE		TYPICAL EXPOSURE	QUANTITY PER SQUARE	
	WIDTH	LENGTH		SHINGLES	BUNDLES
SELF-SEALING STRIP SHINGLE  MULTI-TAB, THREE-TAB, NO CUTOUT	12 TO 20 INCHES	36 OR $39\frac{3}{8}$ INCHES	5 TO $8\frac{1}{2}$ INCHES	40 TO 81	3 TO 4
STRIP SHINGLE MORE THAN ONE THICKNESS PER STRIP  LAMINATED	$11\frac{1}{2}$ TO 20 INCHES	36 OR $39\frac{3}{8}$ INCHES	4 TO $8\frac{1}{2}$ INCHES	64 TO 90	3 TO 5
INDIVIDUAL LOCK DOWN  BASIC T-LOCK DESIGN	$23\frac{7}{8}$ INCHES	$20\frac{7}{8}$ INCHES	16 INCHES	72 TO 120	3 TO 4

Figure 8: Shapes and styles of asphalt shingles

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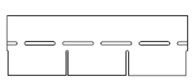
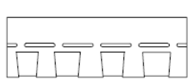
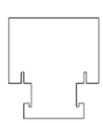
PRODUCT	APPROXIMATE SIZE		TYPICAL EXPOSURE	QUANTITY PER SQUARE	
	WIDTH	LENGTH		SHINGLES	BUNDLES
SELF-SEALING STRIP SHINGLE  MULTI-TAB, THREE-TAB, NO CUTOUT	12 TO 20 INCHES	36 OR $39\frac{3}{8}$ INCHES	5 TO $8\frac{1}{2}$ INCHES	40 TO 81	3 TO 4
STRIP SHINGLE MORE THAN ONE THICKNESS PER STRIP  LAMINATED	$11\frac{1}{2}$ TO 20 INCHES	36 OR $39\frac{3}{8}$ INCHES	4 TO $8\frac{1}{2}$ INCHES	64 TO 90	3 TO 5
INDIVIDUAL LOCK DOWN  BASIC T-LOCK DESIGN	$23\frac{7}{8}$ INCHES	$20\frac{7}{8}$ INCHES	16 INCHES	72 TO 120	3 TO 4

Figure 8: Shapes and styles of asphalt shingles

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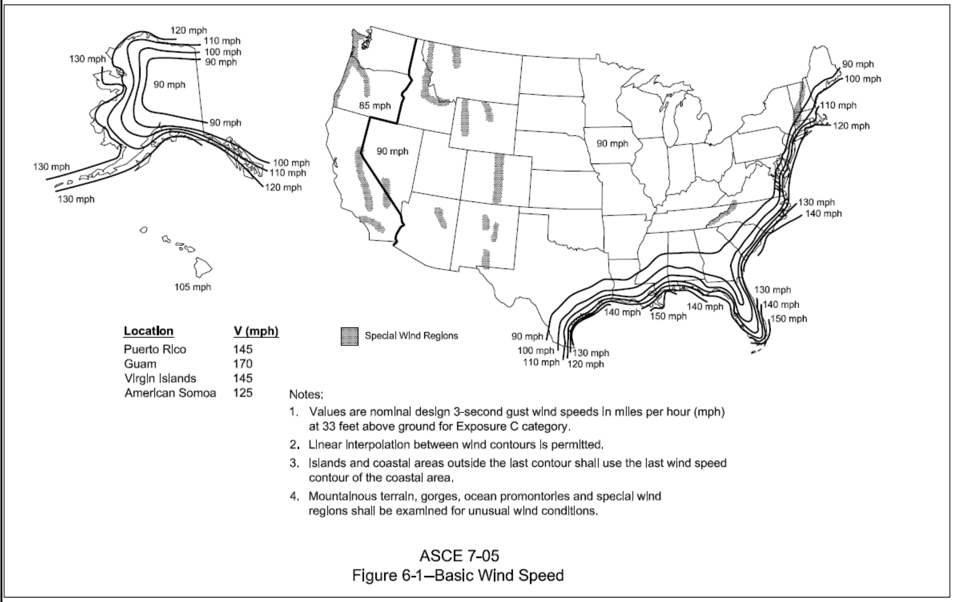

Figure 9: Basic wind speed map based on three-second peak gust from ASCE 7

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Wind Speed	UL 997 or ASTM D3161	ASTM D7158[1]
60 mph	Class A	–
90 mph	Class D	Class D
110 mph	Class F	–
120 mph	Not applicable	Class G
150 mph	Not applicable	Class H

[1] The assumptions in ASTM D7158's classifications are based on a standard building environment, including a three-second wind gust exposure from ASCE 7, Exposure Categories I or II, Ground Roughness B or C, and a mean roof height of 60 feet or less.

Figure 10: Asphalt shingles' wind-resistance classifications

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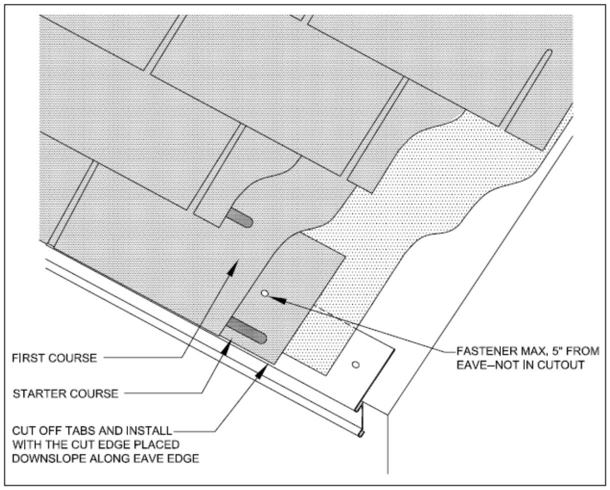

Figure 12: Starter course for asphalt shingles

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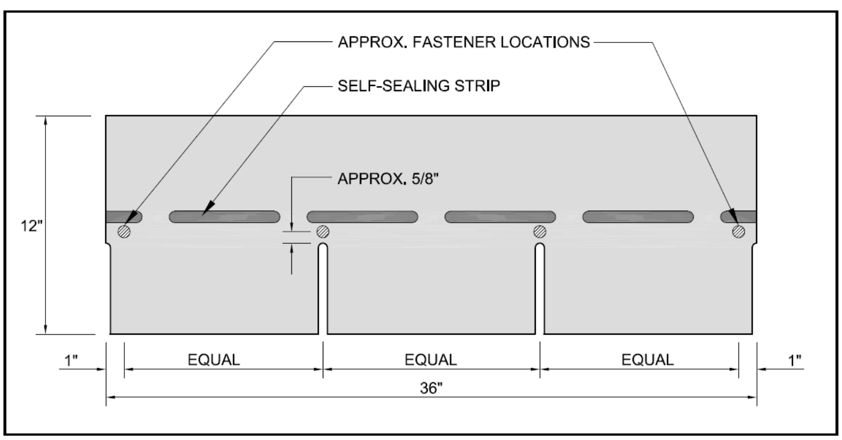

Figure 16: Four-nail attachment locations for three-tab strip shingles

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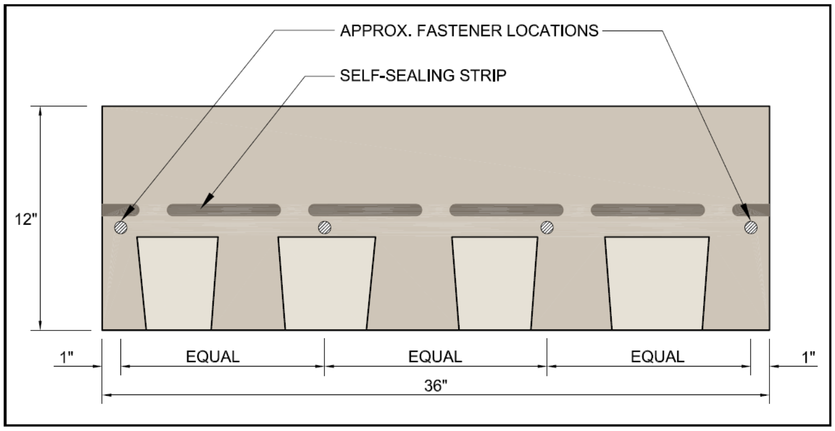

Figure 18: Four-nail attachment locations for laminated strip shingles

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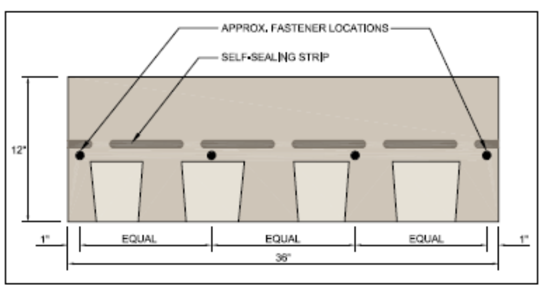

Figure 18: Four-nail attachment locations for laminated strip shingles

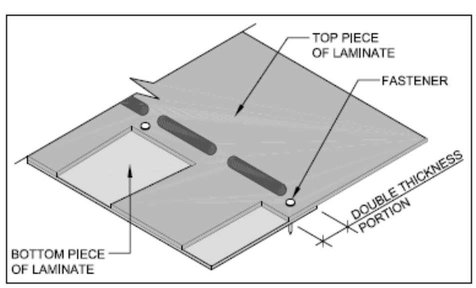

Figure 20: Nail placement in double-thickness portion of laminated strip shingles

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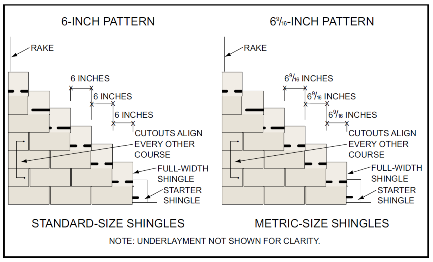

Figure 13A: 6-inch offset pattern (standard), and a 6 9/16-inch offset pattern (metric)

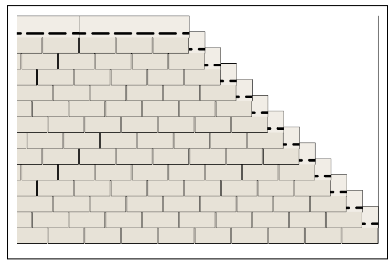

Figure 14B: Appearance of 5-inch (standard) offset pattern and a 5⅝-inch (metric) offset pattern

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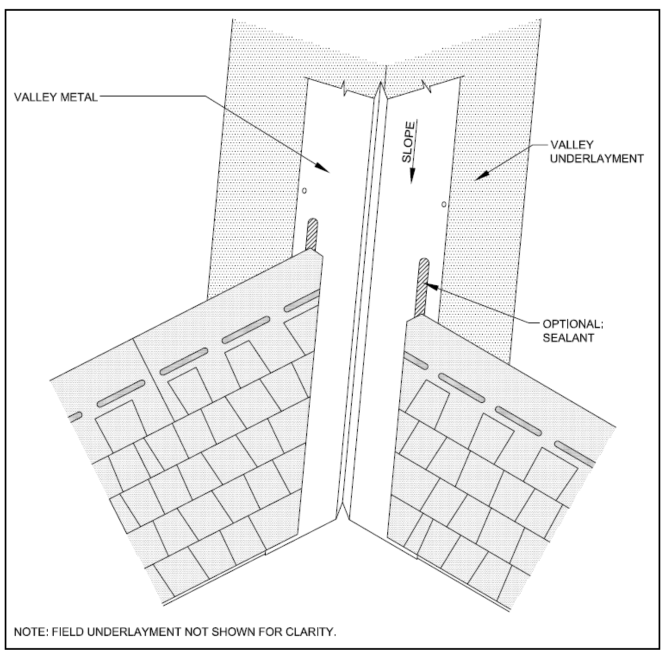

Figure 23: Open valley using metal valley flashing

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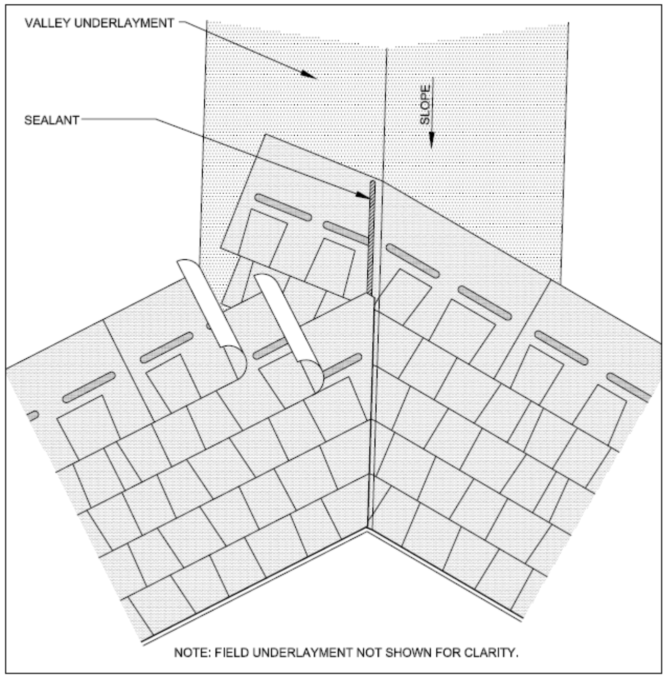

Figure 24: Closed-cut valley

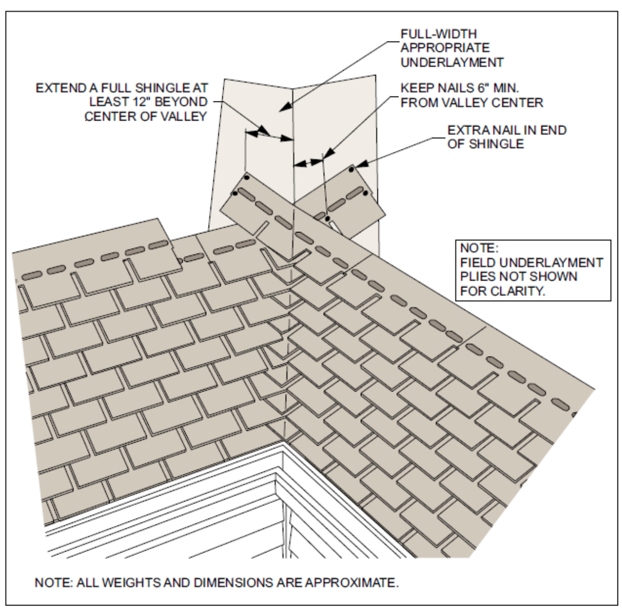

Figure 25: Woven valley

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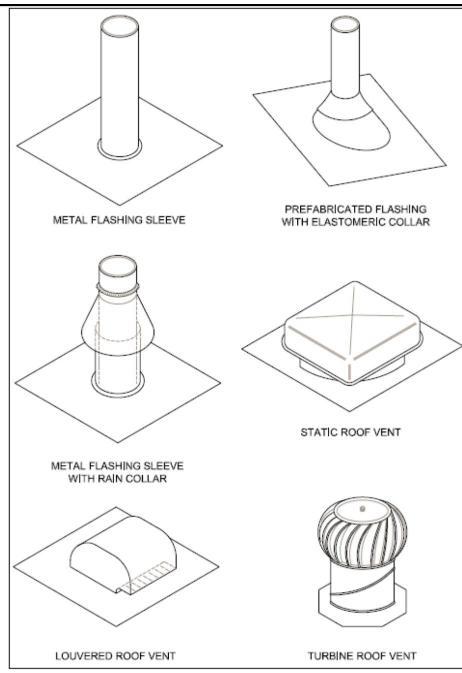

Figure 26: Various types of penetration flashings

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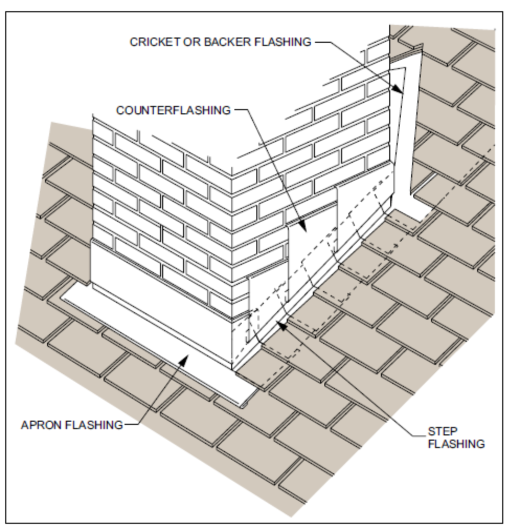

Figure 27: Sheet-metal flashing components used at a chimney

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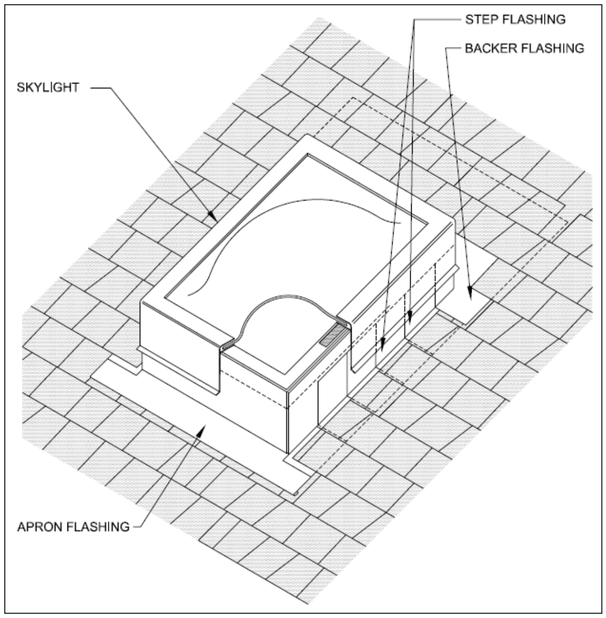

Figure 36: Sheet-metal flashing components used at skylight

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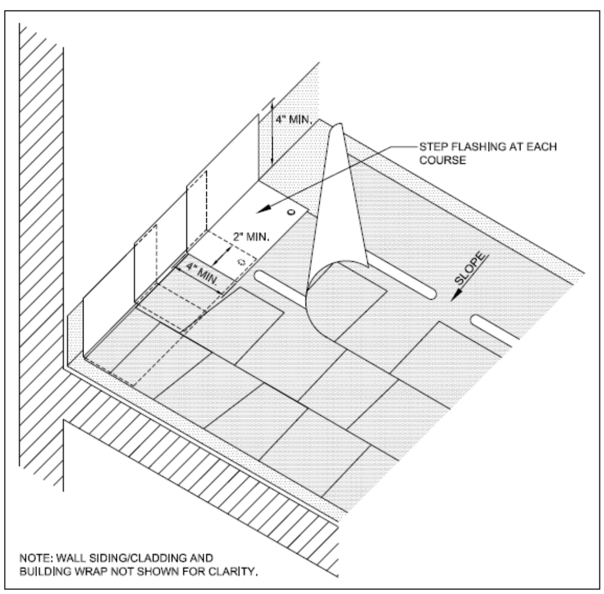

Figure 29: Step flashing at a vertical wall

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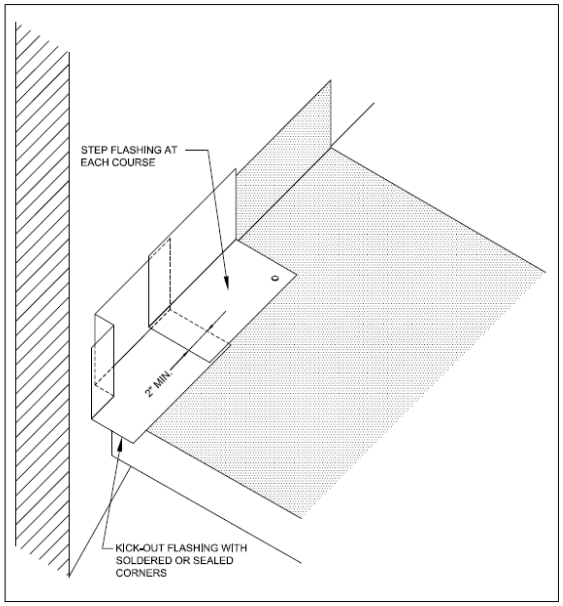

Figure 31: One-piece or preformed kick-outs at bottommost step flashing at eave-to-wall interface

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A1.2 Attic Ventilation

The issue of attic ventilation and the amount of ventilation necessary to prevent moisture condensation and accumulation and adequately reduce attic temperature is controversial. Several research projects have been conducted to determine the effectiveness of ventilating attic spaces and optimum ventilation levels.

Generally, ventilation of attic spaces can be accommodated by using one of two methods:

- Static ventilation
- Mechanical ventilation

Static Ventilation: The most common means of providing attic ventilation for steep-slope roof assemblies is by nonmechanical, static ventilation.

Using this method, ambient outside air enters into the attic space via soffit or eave vents; this air passes through the attic space where it accumulates excessive heat and moisture; and this air then exits the attic via vents positioned at or near the top of the attic space as shown in Figure 1.

This method is based on the concept of convection, where heat and vapor pressure naturally rise. For this method to effectively serve its intended purpose, approximately equal amounts of ventilation must be placed at the soffits or eave and at or near the top of the attic space. This is referred to as balanced ventilation.

The intent of a balanced ventilation system is to provide nearly equivalent amounts of ventilation area at the eave/soffit and at or near the ridge. For a balanced ventilation system to function properly, approximately one-half of the ventilation area must be at or near the ridge. A balanced ventilation system relies on natural convection to promote ventilation.

The International Building Code, 2009 Edition, provides the following requirement regarding attic 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 ventilating openings protected against the entrance of rain and snow. Blocking or bridging shall be arranged so as to not interfere with the movement of air. A minimum of 1 inch (25 mm) of airspace shall be provided between the insulation and the roof sheathing. The net free ventilating area shall not be less than 1/300 of the

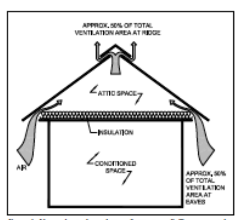

Figure 1: Nonmechanical ventilation of attic space. Soffit or eave with ridge ventilation in a balanced ventilation configuration is shown.

> space ventilated, with 50 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be vented at least 3 feet (914 mm) above the eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents."

The International Residential Code for One- and Two-Family Dwellings, 2009 Edition, provides the following—somewhat different—requirement regarding attic ventilation.

> "**R806.2 Minimum area.** The total net free ventilating area shall not be less than 1/150 of the area of the space ventilated except that a reduction of the total area to 1/300 is permitted, provided at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above the eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1/300 when a vapor retarder having a transmission rate not exceeding 1 perm (5.7×10^{-11} kg/s•m^2•Pa) is installed on the warm-in-winter side of the ceiling."

When designing for attic ventilation, NRCA recommends designers provide for attic ventilation in the minimum amount of 1 square foot of net free ventilation area for every 150 square feet of attic space (1:150 ventilation ratio) measured at the attic floor level (e.g., ceiling).

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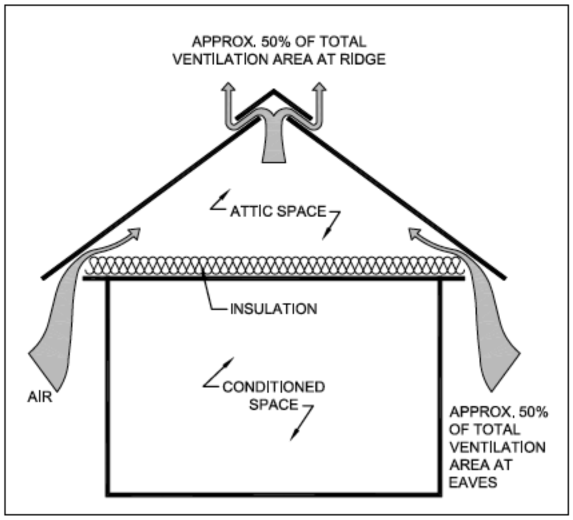

Figure 1: Nonmechanical ventilation of attic space. Soffit or eave with ridge ventilation in a balanced ventilation configuration is shown.

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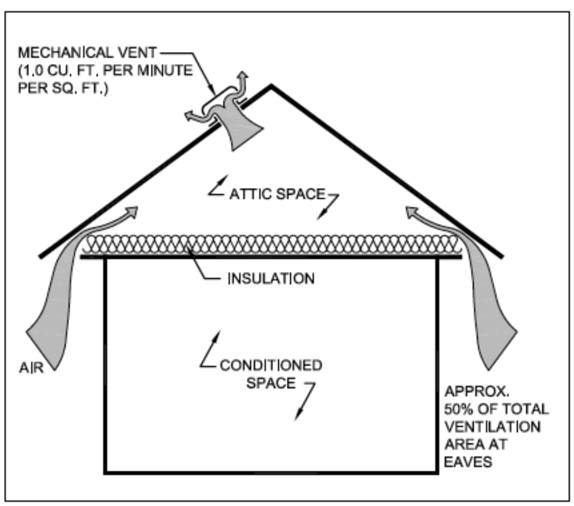

Figure 2: Mechanical ventilation of attic space. Mechanical vent near ridge with intake vents at the soffits or eaves are shown.

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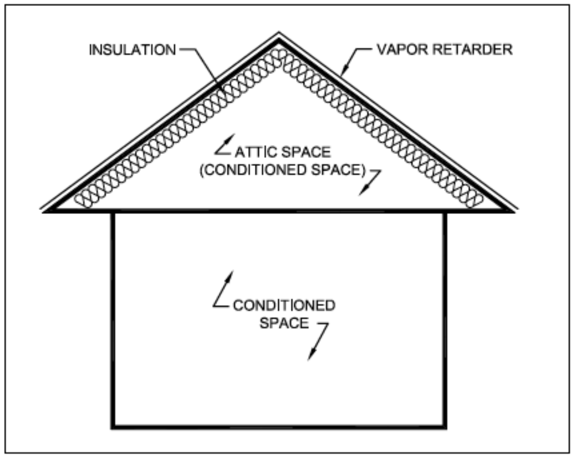

Figure 3: Configuration of conditioned, unvented attic

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Other issues

- Algae

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Other issues

- Algae
- Warrantees
- Others?

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Other roof system types

- Steep-slope (greater than 2:12 slope):
  - Clay tile
  - Concrete tile
  - Fiber cement
  - Metal panels
  - Metal shingles
  - Wood shakes
  - Wood shingles
  - Slate
  - Synthetic

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Other roof system types – cont.

- Low-slope (2:12 slope or less):
  - Built-up
  - Modified bitumen
  - Single ply
  - Metal panels
  - Spray foam

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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
1-800-323-9545
FAX: (847) 299-1183

www.nrca.net
mgraham@nrca.net

Twitter: www.twitter.com/MarkGrahamNRCA
Web site: www.marksgraham.com

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