

Ventilation for Durability in Residential Design

Excerpted from *Durability by Design: A Guide for Residential Builders and Designers*

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SUMMARY

Durability by Design: A Guide for Residential Builders and Designers, published by the U.S. Department of Housing and Urban Development (HUD), is intended to raise the awareness and understanding of building durability as a design consideration in housing. The *Guide* covers basic concepts of durability and presents recommended practices, including numerous construction details and design data for matters such as moisture management and protection against ultraviolet (UV) light, insects, decay, corrosion, and natural hazards. Some attention is also given to issues such as serviceability (normal wear and tear), aesthetics, and functions not immediately associated with durability. This article is excerpted from Chapter 4, "Rain and Water Vapor."

TO VENTILATE OR NOT TO VENTILATE

The use of ventilation has been a topic of confusion for some time. Until recently there has been little convincing research to confirm traditional practices or to suggest better ones. To aid in decisions regarding roof and crawlspace ventilation, Table 4.8 provides recommendations based on the best information available on the topic. Prior to use, the reader should consult local building code requirements and roofing manufacturer warranties to identify potential conflicts.

ROOF VENTILATION

Roof vents (when required) must be installed in accordance with the local building code or accepted practice. Plastic vent louvers commonly used on gable ends must contain UV inhibitors. Vents must be adequately screened to prevent vermin or insect entry. In addition, ridge vents (if used) should be installed and attached to the roof in accordance with the manufacturer's recommendations.

Numerous incidents of improper installation have resulted in damage during wind events or rain/snow entry to the roof. Vent area ratios, such as 1 square foot of vent opening for every 300 square feet of attic area refer to the net vent area, not gross area;

so the sizing of vents must account for obstructions to vents from louvers and screens.

The roof ventilation recommendations in Table 4.8 below are based primarily on durability concerns. These recommendations are further based on the assumption that the following good practices have been employed:

- All bath and kitchen exhaust fans exhaust moist indoor air directly to the outdoors.
- Indoor relative humidity is kept within reasonable limits (i.e., 40 percent to 60 percent), and significant point sources of moisture (e.g., hot tubs) are controlled with ventilation.
- Ceiling vapor barriers are used in accordance with Table 4.6 (next page).
- Proper attic insulation levels are installed for the given climate and location.

TABLE 4.8 - ROOF AND CRAWL SPACE VENTILATION RECOMMENDATIONS

Climate ³	Attic ^{1,5}	Cathedral Roof ⁴	Crawl Space ²
Hot/Humid	Yes	Yes	No
Mixed	Yes	Yes	Not Preferred
Cold	Yes	Yes	Optional
Arid (dry)	Yes	Yes	Optional

NOTES:

¹All roof ventilation recommendations are based on the ceiling being sealed at all major air leakage points (i.e., chases, electric and mechanical penetrations, etc.) and bath and kitchen vent ducts adequately routed to expel air out-of-doors. In some climates (see Table 4.6), a ceiling vapor retarder (i.e., vapor retarder paint, polyethylene sheet, or asphalt coated paper) is required in addition to adequate attic/roof insulation.

²All recommendations are based on properly graded sites and the use of a continuous ground vapor retarder applied to the foundation area.

³Climates are defined as in Table 4.4.

⁴Cathedral roof ventilation must be continuous along soffit/eave and ridge.

⁵Net attic vent area should be 1/300 of attic area and vents shall be continuous along soffit/eave and also located at the ridge and/or gable ends.

NONVENTED ASSEMBLIES

While nonvented roof assemblies are a viable alternative (especially in hot/humid climates), performance data on such designs over time is still lacking. Further, the required detailing that goes along with such a design (e.g., insulation detailing, controlling surface temperatures in the assembly to prevent condensation) may be less forgiving than a traditional ventilation approach in terms of durability.

If a nonvented design is employed, some critical items to consider include

- Local building department approval
- Implications for roofing material warranty
- All major air-leakage points between the living space and the attic (wire penetrations, recessed light cans, plumbing lines, HVAC boots and chases, attic hatches) sealed to limit air leakage
- Perimeter wall insulation detailing to satisfy local fire and insect design requirements

CRAWL SPACES

For crawl spaces, an unventilated crawl-space design can be employed in all of the climate regions shown in Table 4.8. An unventilated crawl space offers benefits in terms of both moisture control and energy performance. Ventilated crawl spaces, especially in humid and mixed regions, often introduce moist outdoor air into a cooler crawl-space environment. The result is condensation and resulting problems like mold and degradation of building materials. In terms of energy, an unventilated crawl space also provides an area for HVAC equipment and ducts that does not present the temperature swings (and energy penalties) found in ventilated crawl spaces.

TABLE 4.8 - RECOMMENDED VAPOR RETARDER CHARACTERISTICS FOR BUILDING EXTERIORS OR INTERIORS IN VARIOUS CLIMATE CONDITIONS

Climate Condition ¹	Location of Vapor Retarder	Water Vapor Permeability ² (low = little vapor passes high = vapor passes easily)	Recommended Product Type ³
Hot and Humid HDD < 2,500	Outer side of wall	Low to moderate (see Table 4.4, Drainage Plane) ⁴	15# tarred felt
	Foundation (slab, crawl, or basement)	Low	6 mil polyethylene plastic sheet on ground
	Attic & Cathedral Roof	High	None
Mixed 2,500 < HDD < 6,000	Inner side of wall	Moderate (2,500 HDD) to Low (6,000 HDD)	Kraft paper on batts or vapor retarder paint on interior
	Foundation (slab, crawl, or basement)	Low	6 mil polyethylene plastic sheet on ground
	Attic & Cathedral Roof (ceiling side) ⁵	High (2,500 HDD) to Moderate (6,000 HDD)	None to Kraft paper on batts (6,000 HDD)
Cold HDD > 6,000	Inner side of wall	Low	3 mil polyethylene or vapor retarder paint on interior
	Foundation (slab, crawl, or basement)	Low	6 mil polyethylene on ground
	Attic & Cathedral Roof (ceiling side) ⁵	Moderate (6,000 HDD) to Low (8,000 HDD)	Kraft paper on batts to 3 mil polyethylene or vapor retarder paint on interior

Notes:
¹HDD refers to Heating Degree Days relative to 65°F (see Figure 4.7).
²These recommendations are based on both the material properties (perme) and how they are used. A product that is not applied continuously over a surface (e.g., kraft faced batts in a ceiling) will allow more vapor to pass than a continuous layer.
³Because it is equally important to ensure that the interior surface of a wall has a high permeability finish, select paint with high permeability and avoid finishes such as vinyl wall paper that act as a vapor barrier. Prevention and Control of Decay in Homes, USDA/NIH, 1978, recommends that in warm climates, walls and ceilings without vapor barriers are safer.
⁴Water vapor barriers for hip and gable roofs, if used in mixed and cold climates, should be placed on the warm-winter side of the attic insulation. The same applies to cathedral ceilings.

There is more to it than just taking out the vents, however. The following steps must also be followed when building an unventilated crawl space:

- Careful attention to exterior grading (4 percent slope minimum)

- Air sealing between outdoors and the crawlspace area to prevent humid air from getting into the crawl space
- Insulating at the crawlspace perimeter walls—not the floor
- 6 mm polyethylene ground-cover in crawl space with joints lapped
- Damp-proof foundation wall

RESOURCES

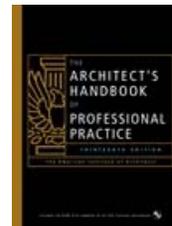
More Best Practices

The following AIA Best Practices provide additional information related to this topic:

- 16.02.03 Basic, No-Cost Green Building Practices
- 11.06.05 Six Approaches to Building Your Dream House
- 11.06.07 Eight Pillars of Traditional Design

For More Information on This Topic

See also “Sustainable Building Design,” by Muscoe Martin, AIA, *The Architect's Handbook of Professional Practice*, 13th edition, Chapter 18, page 656.



See also the 14th edition of the *Handbook*, which can be ordered from the AIA Bookstore by calling 800-242-3837 (option 4) or by email at bookstore@aia.org.



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Key Terms

- Building performance
- Physical design
- Durability