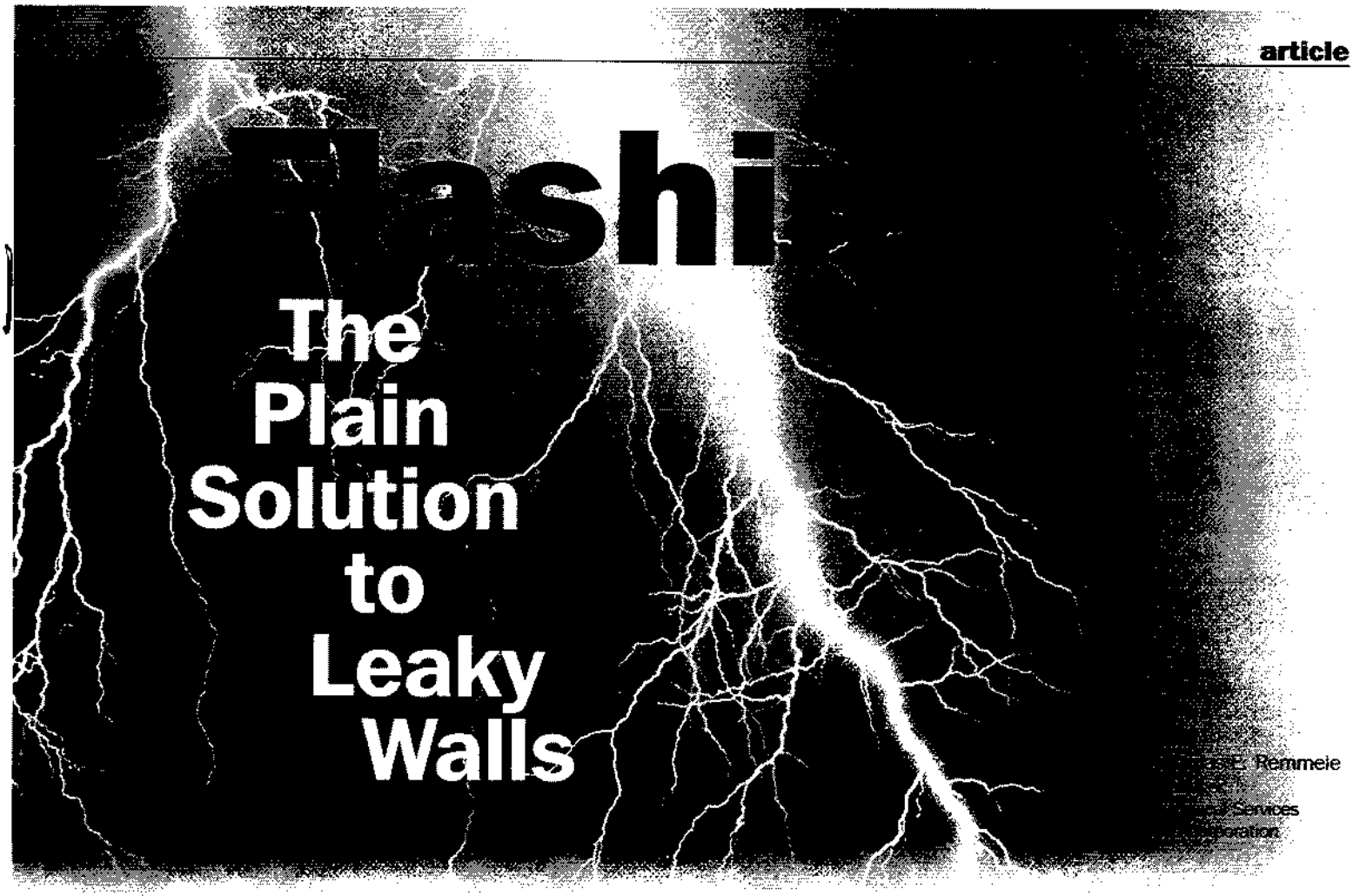
Flashi

The Plain Solution to Leaky Walls



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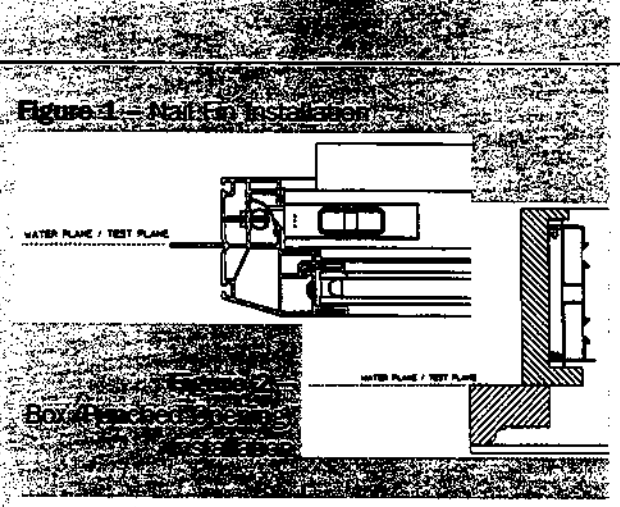
Leaky buildings are a major problem in today's construction industry. Pick up any construction forensics journal and you will most likely find information inside about how leaks caused construction failure or unexpected material degradation to the dismay of the building owner or occupants. A recent issue of *The Construction Specifier* reported on how more than one mile of stainless steel flashing had to be installed in a brick cavity wall at a cost of more than one million dollars over a two-year period, in part because of improper integration of flashing in the original wall construction.[1]

The building was less than 15 years old at the time it was repaired. The "leaky condo" crisis in British Columbia is a multi-billion dollar construction problem that has been publicized extensively in area newspapers. An independent study commissioned by the Canadian government showed that 37 of the 46 buildings included in the study had water damage, with repair costs ranging on average from $1,818 CN per unit for vinyl siding to almost $8,552 CN per unit for buildings with conventional stucco siding.[2] The study focused on low-rise (four stories or less) residential buildings that were generally less than 10 years old, in coastal British Columbia and of wood frame construction. In a more recent case involving Exterior Insulation and Finish System (EIFS) cladding in Wilmington, North Carolina, the National Association of Homebuilders Research Center report entitled *Investigation of Moisture Damage in Single-family Detached Houses Sided with Exterior Insulation Finish Systems in Wilmington, NC*, states: "The cause of moisture accumulation is rainwater intrusion from a combination of factors, including improper sealing at joints around windows, doors and other penetrations; improperly sloped horizontal EIFS surfaces, inadequate flashing at roof lines, dormers, decks, fireplaces, chases, etc.; and window frames that leak into wall cavities."[3] So chronic is the leaky building problem that the American Society for Testing and Materials has formed a task group within committee E06.55.04, Weather Resistance of Frame Buildings, whose scope of work includes finding solutions to minimize the potential for building leakage, particularly in the residential sector, where it has "cost the building industry hundreds of millions of dollars."

If you read the construction journals and the reports that have been written by professionals who have studied the problems, a common theme appears over and over as a major cause of water leakage and material degradation—flashing! But neither the flashing material nor its degradation causes the problem; instead the absence or improper installation of flashing is often the cause. Many flashing problems start where the

The views expressed here are those of the author and do not necessarily reflect the opinion or agreement of the International Conference of Building Officials.



Figures 1 and 2 – Window water penetrations resistance testing in conflict with durability requirements for wall assemblies (Source of figures: AAMA/NWWDA 101/I.S. 2-97, Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors)

The important phrase in the 1995 *CABO One and Two Family Dwelling Code* in relation to window sills is the requirement for "leakproof" flashing "under and at the ends of masonry, wood, metal coping and sills [underline by author]," unless the window is "self-flashing." Few windows are "self-flashing." If they were they would conduct their leakage to the building exterior, not into the wall assembly. Today's water penetration resistance standards for windows, which allow leakage at the sheathing face plane, are in conflict with one of the basic design principles for durability—to eliminate deposit of moisture into walls. The American Architectural Manufacturers Association/National Wood Window and Door Association manual entitled, *Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors* indicates that the plane of water penetration resistance for windows is coincident with the mounting flange or back plane of the brick mold, depending on window type (Figures 1 and 2).[11] This standard in effect makes leaks outbound of the plane of water penetration resistance inconsequential in relation to the pass/fail verdict of a window for water penetration resistance. By disregarding leaks outbound of the plane of water penetration resistance, significant amounts of water can enter into the wall assembly behind the exterior wall covering when the window is put in the context of real construction and is no longer in the test laboratory. One could suppose that building paper affords the necessary moisture resistance to prevent water damage, or that water that enters the wall assembly will readily drain or dry without causing material degradation, and thus can be ignored. But by admitting unlimited amounts of water into the wall assembly, the durability of many types of wall assemblies typical of Type V construction are at risk, especially when one considers that the 1995 *CABO One and Two Family Dwelling Code* does not require a weather-resistive barrier behind many wall coverings. The common sense solution to this problem is to use sill flashing, as the code requires, which would control window leakage and redirect it to the exterior.

Figure 3 – Unfortunately, sill flashing is often omitted or incomplete beneath windows. The omission of flashing that would conduct window leakage to the exterior has caused wood rot beneath this window. Note that the presence of building paper and a housewrap material behind the siding failed to prevent water damage. The code must have clear, unambiguous requirements to prevent this problem. The window industry must play a role in developing such requirements.

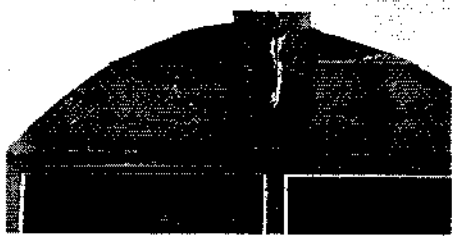
exterior wall covering ends and other components begin—ledges, decks, projections and through-wall penetrations—elements of construction intended to be flashed in accordance with the provisions of the building code such that the flashing is "leakproof." Too often the flashing that should be behind, over or around these components is either omitted or improperly installed. This causes significant amounts of water to enter behind the wall covering and into the wall assembly, which can, in some cases, result in substantial material degradation. Such news is not entirely new. An article entitled "Weatherproofing—Time for Industry to Apply Standards," in the September-October 1994 *Building Standards*™, recites sections of the code related to weather protection and, among other things, points out that openings and penetrations are flashed in varying ways which, despite the standard to make them weatherproof, is a likely cause of leaks.[5] Today's flashing crisis appears to be more pervasive than it was five years or a decade ago. Lessons should have been learned from past mistakes. Poor construction practices with flashing seem to be getting worse rather than improving.

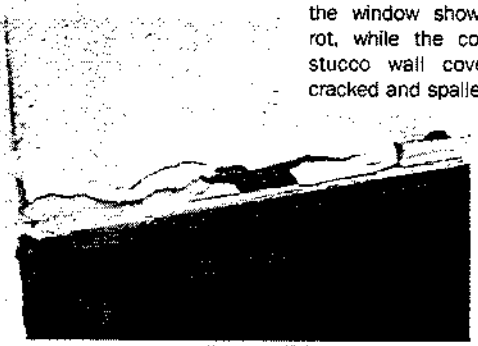
Chapter 7 of the 1995 *CABO One and Two Family Dwelling Code* establishes requirements for flashing in residential construction in Section 703.8:

> **703.8 Flashing—** Approved corrosion-resistant flashing shall be provided at top and sides of all exterior window and door openings in such a manner as to be leakproof, except that self-flashing windows having a continuous lap of not less than 1 1/8 inches (28 mm) over the sheathing material around the perimeter of the opening, including corners, do not require additional flashing; jamb flashing may also be omitted when specifically approved by the building official. Similar flashings shall be installed at the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings; under and at the ends of masonry, wood, metal coping and sills; continuously above all projecting wood trim; where exterior porches, decks or stairs attach to wall or floor assembly of wood-frame construction; at wall and roof intersections.[7]

Common construction situations are depicted in the photographs accompanying this article that show the extent of material degradation that can occur if flashing is omitted or not installed properly to meet the intent and provisions of the code. One may think that these examples represent isolated cases of water intrusion as a result of poor construction practice; but, as you go through your own neighborhood, look to see for yourself if flashing is present above and beneath the windows, at the ends of side wall or rake flashing, and at the ends of attached decks. If it is present, is it "leakproof"?

Flashing is a critical component in the wall assembly that is necessary for long-term durability. Yet it seems to get the least attention in design, specification and construction of any material or component in the wall assembly. To fix the water intrusion problems related to





Figures 4 and 5 – The ramifications of flashing omission or improper installation at window heads can be serious, as demonstrated by these photographs of areas where flashing was omitted above the windows and wood trim. The wood window head and trim above the window show signs of rot, while the conventional stucco wall covering has cracked and spalled.

flashing omission or improper installation, there is a tendency among some in the construction community to specify more waterproofing layers in wall assemblies or to improve the layers of waterproofing that already exist—the assumption being more is better. Witness the evolution of the ICBO ES *Acceptance Criteria for Exterior Insulation and Finish Systems (AC24)*, which, as a result of the controversy surrounding water intrusion in EIFS-clad wood-frame residences in the Carolinas, now requires building paper behind EIFS for Type V construction. During the development of the criteria, debate took place over whether two layers of Grade D building paper with 10-minute water resistance each or one layer of Grade D 60-minute building paper were needed to provide adequate moisture protection beneath an already effective moisture barrier, the EIFS wall covering. Placing building paper, multiple layers of paper or more water-resistant grades of paper does not, however, address the root cause of most water intrusion problems in walls. That is, the lack of understanding or execution of basic weatherproofing principles and the improper use and integration of flashing with other components of wall construction. This being said, the solution to the flashing problem and, hence, many water intrusion problems is not complex. The materials and methods of construction are already available and have been used for many years. There is no need to invent new materials or new techniques. The only need is to follow existing provisions of the code by correctly installing flashing where it is prescribed.

Figure 6 – The deck in this photograph was not flashed at all. Contrary to the requirements of the code, this deck has been attached to the structure through the cladding. The bolt penetrations become sources of water penetration behind the cladding.

As a manufacturer, who for many years, has spent considerable resources to educate installers of our stucco products on proper mixing and placement procedures, we have broadened our educational curriculum considerably in light of the abuses we have found with flashing. Our curriculum now includes more emphasis on weatherproofing principles in general and the proper use of flashing in accordance with the provisions of the building code. We have introduced flashing into our product line, tested flashing details to confirm that they are leakproof, and demonstrated flashing assembly and folding techniques in hundreds of seminars across North America. Ironically, much of what we learned about water intrusion through investigation of field problems, and much of what we developed in details, was merely a reiteration of what already existed in the code and what we assumed to be understood and practiced by the construction community.

To be sure, flashing is not the only culprit in the water intrusion problems that plague the construction industry. I could have spent as much time writing about design features like minimal roof overhangs and how much they expose walls and openings in walls to rainfall and increased risk of leakage. [The Clemson University Cooperative Extension Service on Residential Housing reports "extensive moisture damage in residences across the state from multiple causes"[8] and stresses the use of generous roof overhangs of two to three feet (51 mm to 76 mm) for residential construction.]

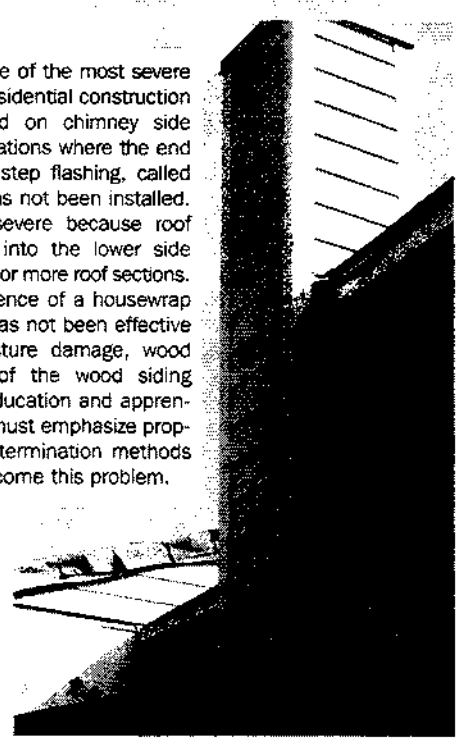


Figure 7 – Some of the most severe water damage in residential construction has been detected on chimney side walls and other locations where the end piece of side wall step flashing, called diverter flashing, has not been installed. Damage can be severe because roof water is funneled into the lower side wall, often from one or more roof sections. Note that the presence of a housewrap behind the siding has not been effective in preventing moisture damage, wood rot and swelling of the wood siding material. Builder education and apprenticeship programs must emphasize proper integration and termination methods for flashing to overcome this problem.

Certainly, more emphasis must be placed on flashing to win the battle against water intrusion. As a first step we must reinforce the existing provisions of the code. The final draft of the *International Residential Code*™ (IRC) accomplishes this to some extent but could be improved in several ways. The IRC text reads as follows:

R703.8 Flashing— Approved corrosion-resistive flashing shall be provided in the exterior wall envelope in such a

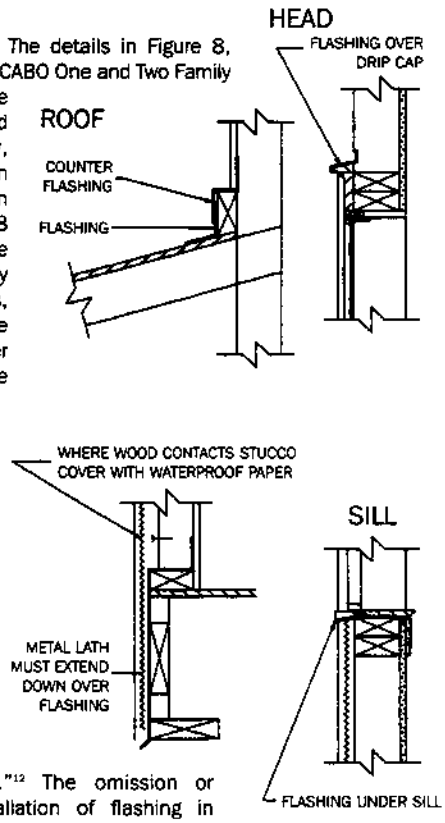


Figure 8 – The details in Figure 8, taken from the CABO One and Two Family Dwelling Code Application and Commentary, expand upon what is said in Section 703.8 of the code. The commentary manual states, "To minimize the chance of water leakage in the interface between wall coverings and the juncture of other materials, flashing is required [underline by author] to be installed properly. Examples of flashing are illustrated in Figure 703.8."[12] The omission or improper installation of flashing in these locations compromises durability.

manner as to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. The flashing shall extend to the surface of the exterior wall finish and shall be installed to prevent water from reentering the wall envelope. Approved corrosion-resistant flashings shall be installed at all of the following locations:

1. At top of all exterior window and door openings in such a manner as to be leakproof, except that self-flashing windows having a continuous lap of not less than 1 1/8 inches (28 mm) over the sheathing material around the perimeter of the opening, including corners, do not require additional flashing; jamb flashing may also be omitted when specifically approved by the building official;

2. At the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings;

3. Under and at the ends of masonry, wood or metal copings and sills;

4. Continuously above all projecting wood trim;

5. Where exterior porches, decks or stairs attach to a wall or floor assembly of wood-frame construction;

6. At wall and roof intersections;

7. At built-in gutters.[9]

The first paragraph of the code text emphasizes the need for flashing to "prevent entry of water into the wall cavity or penetration of water to building structural framing components," while pointing out that flashing must extend "to the surface of the exterior wall finish . . . and prevent water from reentering the wall envelope." These statements and the itemized list of critical locations where flashing must be installed help to reinforce the fundamental principle behind the use of flashing; i.e., to keep water out of walls at likely points of entry. However, the code could further clarify flashing requirements as follows:

1. Plainly state that flashing is required to evacuate water to the exterior at sources of water entry.

2. Omit the term "self-flashing." Windows with mounting flanges have often been confused with being "self-flashing" but, in fact, are not. Even those that are true "self-flashing" windows must be flashed because they are often "ganged" together with field-installed mullions that are not flashed and can allow leakage into the wall assembly.

3. Address the flashing of window head, jamb and sill, and the integration of flashing with the weather-resistive barrier in the assembly as a whole, not separately. Separation causes these items to be treated in isolation and creates ambiguity.

4. Eliminate the term "wall cavity." It is confusing. Some walls do not have cavities and some have multiple cavities. For example, some stucco and hardboard siding wall assemblies do not have cavities, while some brick veneer wall assemblies have a cavity immediately behind the brick and another within the framing. Emphasize instead the requirement for flashing to integrate with the weather-resistive barrier in the wall assembly to prevent water infiltration inbound of the weather-resistive barrier.

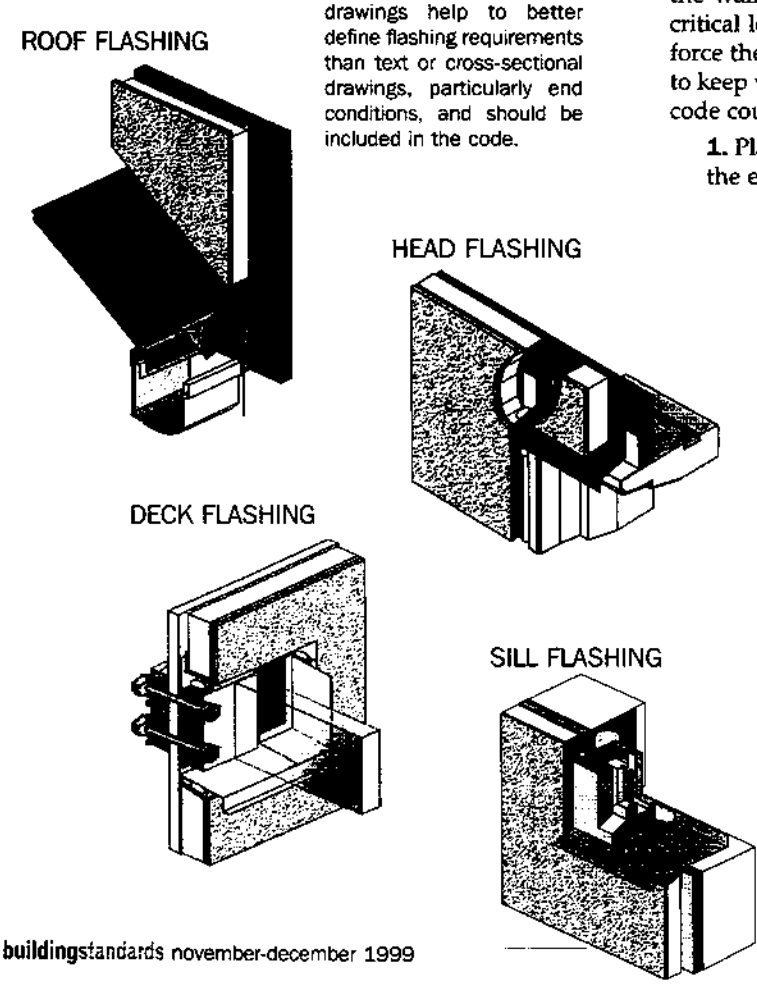


Figure 9 – Isometric drawings help to better define flashing requirements than text or cross-sectional drawings, particularly end conditions, and should be included in the code.

5. Supplement text with isometric illustrations to clarify and reinforce the intent and provisions of the code (see Figure 9). Isometric illustrations would be particularly helpful in clarifying flashing requirements for penetrations such as windows.

6. Require flashing at the base of the wall.

Beyond these clarifications, a weatherproofing inspection of the exterior wall should be required. Such inspections would check for the presence of flashing at critical locations cited in the code and verify its proper integration with the weather-resistive barrier in the exterior wall assembly.

Lastly, better educational programs on flashing and weatherproofing in all sectors of the construction community should be implemented to stress the importance of flashing and how it must be installed to meet the provisions of the code. Among the 82 recommendations made by the Canadian government commission that investigated the "leaky-condo" crisis in British Columbia were the recommendations to "allocate sufficient resources for training and apprenticeship programs, in association with business and labour in the residential construction industry" and to provide additional training "through educational institutions and continuing education."[10]

Reinforcement and clarification of existing code provisions on flashing, weatherproofing inspections to enforce the provisions, and training for all segments of the construction industry on flashing and weatherproofing would seem a small price to pay for durability, considering the number of leaky buildings we are confronted with today and the massive costs associated with repairs and litigation. ■

NOTES

1. *Michael D. Conklin and James C. Meyers, "A Facade Failure Fix," The Construction Specifier (June, 1997), pp. 37–38.*
2. *Morrison Hershfield Limited, Survey of Building Envelope Failures in the Coastal Climate of British Columbia (Burnaby, 1996), pp. 7–13.*
3. *Jay Crandell and Thomas Kenney, Investigation of Moisture Damage in Single Family Detached Houses Sided with Exterior Insulation and Finish Systems in Wilmington, NC (Upper Marlboro, 1996), p. 2.*
4. *ASTM Task Group E 06.55.04, Weather Resistance of Frame Buildings, Announcement of Meeting in St. Louis, MO, 1997 (West Conshohocken, 1997), p. 1.*
5. *Peter Kuchinsky II, Glenn Schwartz and Bobbie Haught, "Weatherproofing—Time for Industry to Apply Standards," Building Standards (September-October, 1994), pp. 9–10.*
6. *Council of American Building Officials (CABO), CABO One and Two Family Dwelling Code (Falls Church, 1995), p. 86.*
7. *Ibid.*
8. *Wood Moisture Content, Clemson University Cooperative Extension Service Bulletin No. HL 255 (Clemson, 1997), p. 1.*
9. *International Code Council, International Residential Code for One-and Two-Family Dwellings, Final Draft™ (Falls Church, 1998), pp. 7.12–7.13.*
10. *The Renewal of Trust in Residential Construction, Commission of Inquiry into the Quality of Condominium Construction in British Columbia, Chapter Three: Plan for Action (Vancouver, 1998), pp. 2–3.*
11. *American Architectural Manufacturers Association and National Wood Window and Door Association, Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors, AAMA/NWWDA 101/I.S.2-97 (Schaumburg and Des Plaines, 1997), p. 6.*
12. *Council of American Building Officials (CABO), CABO One and Two Family Dwelling Code Application and Commentary (Falls Church, 1995), p. 134.*

Other References

Controlling Moisture with Overhangs and Flashings. Clemson: Clemson University Cooperative Extension Service Bulletin No. HL 254, 1997.