PANORAMA:

Nomenclature and Classification of Architectural Sill Pan Flashings

By Robert Bateman, AIA

INTRODUCTION

A wide variety of sill pan flashing types are available to the building industry, and their use is increasing. Integration of these flashings for the building envelope at windows, doors, and water-resistive barriers (WRBs) to exterior walls is desirable. However, differences in configuration and material selection can be obstacles to achieving optimum performance.

Sill pan flashing is recognized by both the design profession and the building industry as critical in preventing water intrusion. The inclusion of sill pan flashings is increasingly considered standard practice with window and door manufacturers and installers. However, there are few guidelines for the selection and design of sill pan flashings and even fewer resources that review the merits of how pans should be formed to control water penetration. Without guidance, current sill pans in use are commonly incomplete as useful flashings.

This article identifies various pan profiles and analyzes the leak paths where critical water control features are absent. Pans that drain water directly to the exterior are distinguished from those concealed pans that drain to a WRB behind wall claddings.

Our focus is directed to sheet metal flashings, but other flashing materials will have equivalent final configurations with similar expected performance. This applies to framed-wall construction with a concealed drainage membrane or WRB. Surface barrier wall systems, such as masonry or concrete, can use similar sill pans with differences in flange ends and attachment means.

"Sill covers" at the wall opening and "sill panning" that is partially exposed under window and louver sills are not addressed here, as these sheet metal components are essentially cosmetic. Sill covers are dependent on sealants and disconnected from a concealed WRB, with very little water control function except at the exterior wall surface.

CURRENT INDUSTRY DESCRIPTIONS OF SILL PANS

Few resources are available for developing the design and detailing of sill pan flashings. The "go-to" references available to the design profession and construction industry for sheet metal include publications from the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA)[1] and the Copper Development Association (CDA).[2] For other sill pan materials, there is ASTM E2112-07, *Standard Practice for Installation of Exterior Windows, Doors, and Skylights*, with only general descriptions of basic flashing materials (see Appendix, Table 5). Individual manufacturers of fenestration units and flashing membrane manufacturers may also offer independent flashing product instructions for sill pans that may not be complete.

Flashing detail development is typically the responsibility of the architectural designer of the building envelope waterproofing system. The graphic representation of sill and sill flashings is typically shown on a schematic section drawing (*Figure 1).* For the purposes of this article, "concealed" flashings (1) are flashings covered by a wall cladding, and "exposed front" (2) and "exposed collar" (3) flashings partially project beyond a wall cladding. All the examples

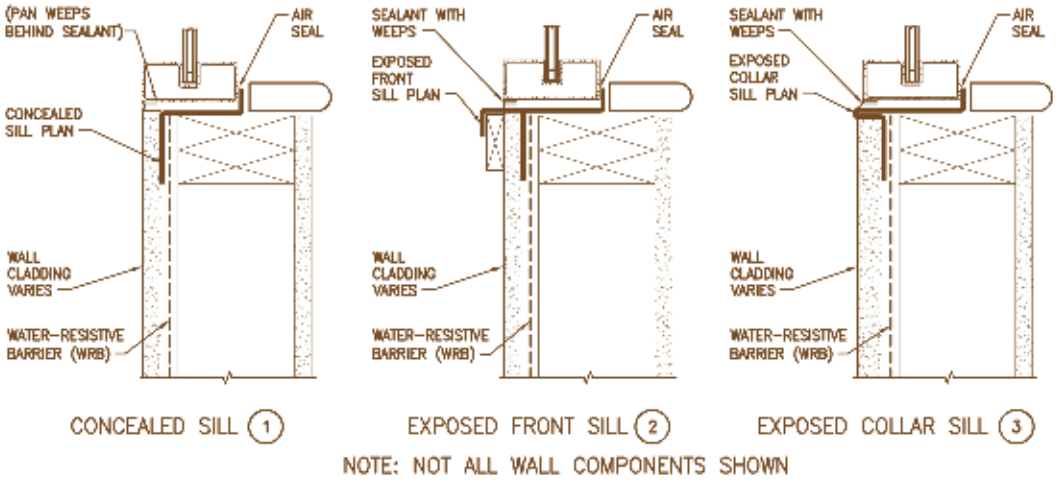

Figure 1 – Architectural windowsill section with sill pan types 1, 2, and 3.

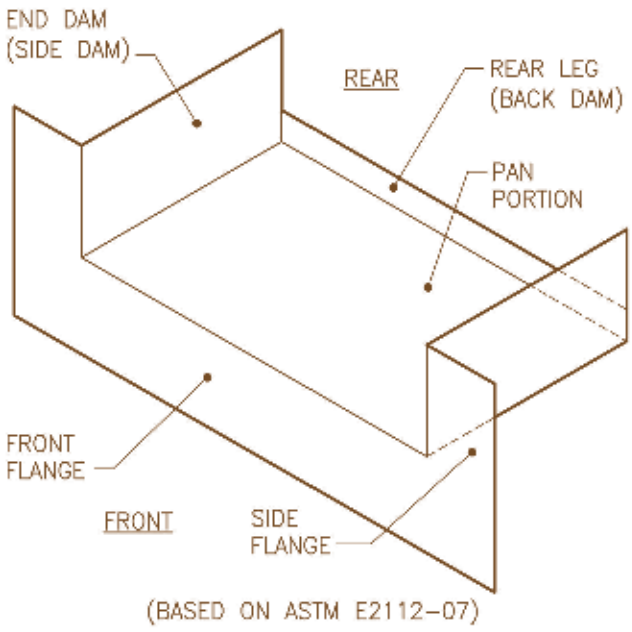

Figure 2 – Isometric or 3-D view of sill pan flashing (concealed type).

are intended to be integrated with a concealed and continuous drainage membrane (i.e., WRB behind an exterior wall cladding). Doors and louvers are also typically shown with section details for head, jamb, and sill (threshold) at wall openings.

Section details for wall openings have a serious limitation because critical corners and components beyond view are not represented. When drawing notes are added (such as "end dams at jambs") in an attempt to clarify the detail, confusion is common. The lack of three-dimensional (3-D) design details and the lack of rational choices of pan profiles are contributing factors in the performance failure of window and door opening waterproofing experienced by the construction industry. In the author's building forensic experience, missing or incomplete sill pan flashings are a common source of water intrusion at wall openings.

A sill pan flashing is a formed material acting as a waterproof barrier (defined as 24-hour minimum protection, but materials commonly used act indefinitely), usually fitted to a wall opening under a window, door, or louver product. It is intended to prevent water entry from a fenestration failure or perimeter opening leak from entering a room interior or wall assembly and causing material damage. Most contemporary sill pan flashings are fabricated separately from window/door products and the wall opening. Sill pans are typically constructed of a thin sheet material such as metal, plastic, or formable membrane such as self-adhering flashing (SAF) or liquid coating (see table in "Selected References" at the end of this article). The window industry standard, AAMA 711-07, *Voluntary Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products,* covers material properties of SAF membranes. The industry standard, ASTM E2112-07, defines pan flashings in the following manner:

> **3.2.91 pan flashing** — a type of flashing used at the base of rough opening to divert incidental water to the exterior or to the exterior surface of a concealed WRB.
> Note 3: Pan flashings have upturned legs at the interior edge and ends of the rough opening to form a three-sided pan. They are intended to collect and drain water toward the exterior, including water that may enter through the window unit (for example, between the jambs and sill) or around the window (between the rough opening and the fenestration). The pan flashing must be integrated with other flashings and the window assembly to capture water that may otherwise penetrate to the sill framing and allow it to freely drain to the exterior. The window, flashings, and pan are to be sealed in a manner that reliably inhibits air and moisture flow to the interior.[3]

The critical end and corner conditions of sill pans are often not represented as would be shown in isometric, axonometric, or 3-D details. The graphic in *Figure 2*, with a 3-D or isometric view, represents the basic sill pan flashing configuration (concealed type) with identified parts differentiated per Figure A3.4, ASTM E2112-07.

The ends and corners of sill pan flashings, when not detailed by the building designer, are determined by default from either the fenestration unit manufacturer or the flashing installer.

The rear leg of the sill pan prevents water entry from wind-blown rain or window corner leaks from being pulled into the interior under the window. A high rear leg or an interior air infiltration seal stops the water entry. ASTM E2112, Sec. 5.16 and Annex A3, include cursory recognition of interior air infiltration seals at the back of sill pan flashings that can reduce the required rear leg height. Otherwise, the rear leg needs to be raised to resist the expected differential wind pressure of potential wind-blown rain intrusion.

For the purposes of analyzing various configurations, the pan portion of the sill pan is assumed to be flat and level. Sec. 5.16.1 of ASTM E2112 allows the use of sill

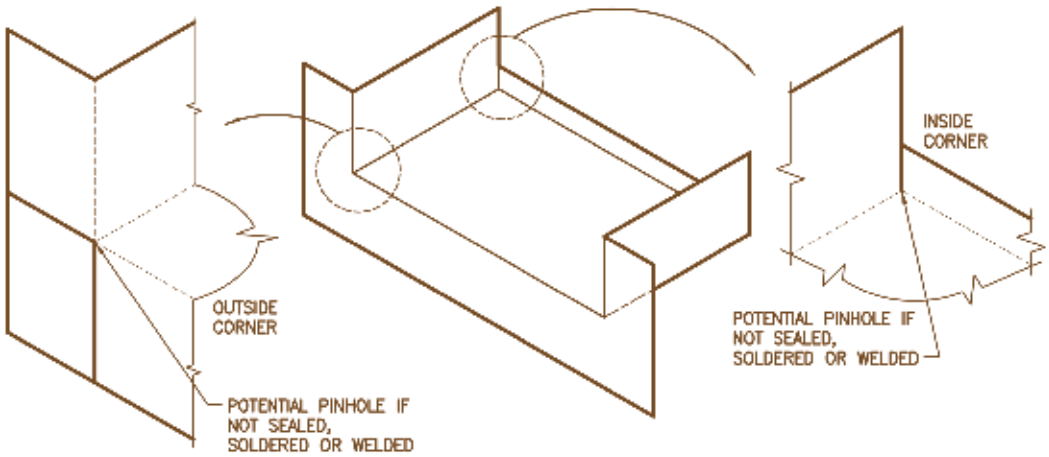

Figure 3 – Critical corners of a complete sill pan flashing.

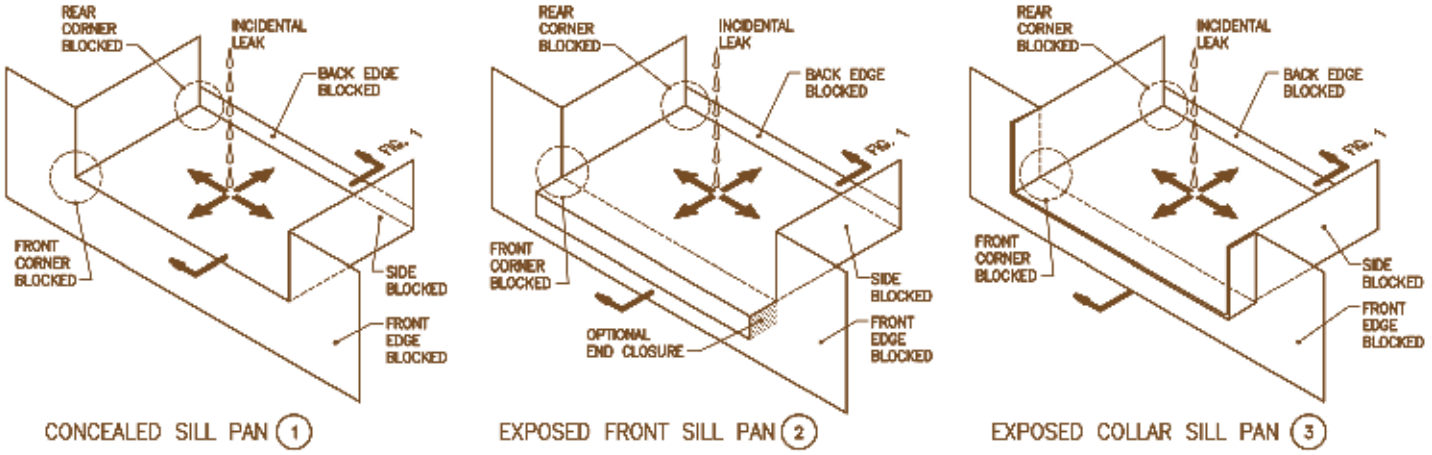

Figure 4 – Water control features of complete sill pan flashings.

pans with a flat and level pan portion without sloping up to a 6-in. pan depth. This is to recognize that such a relatively shallow wall depth still permits incidental water to have controlled drainage towards the wall exterior or concealed WRB. A sloping sill pan with drainage towards the outside will be less dependent on the rear leg to act as a dam but should not be a substitute for a rear leg and end dams.

The side dams (sometimes called end dams) also prevent water entry that may not reach the rear of the sill pan. The raised flanges of the side dam, when present, will be expected to be counter-flashed with jamb flashings that turn into the rough opening. The side dams require closure at the inside corner with the rear leg of the sill pan (*Figure 3*).

The front and side flanges of the sill pan assure continuity of the pan at the critical outside corners (see *Figure 3*). The flanges are to be integrated afterwards with separate jamb and sill flashings to provide continuity with the wall WRB. Open corners and incomplete flanges lack the necessary continuity with the wall WRB.

There are several possible sill pan configuration choices with varying degrees of water control performance. A sill pan profile

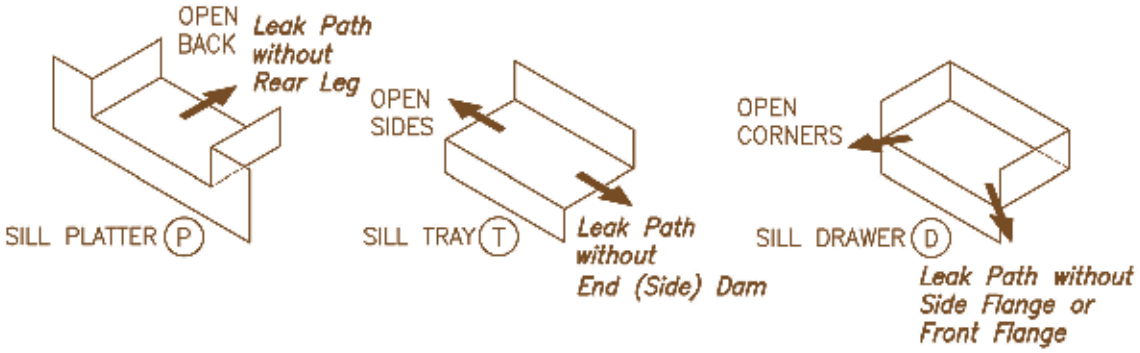

Figure 5 – Potential leak paths at incomplete sill flashings.

with consistent inclusion of the necessary water control features should be expected to perform under moderate to major weather conditions. Three basic types of sill pan flashings: concealed (1), exposed front (2), and exposed collar (3) are shown with water control features blocking the paths of an incidental leak in *Figure 4*.

CLASSIFYING THREE INCOMPLETE SILL PAN PROFILE TYPES

The first task is to survey the possible basic types of pan configurations used in building construction. The sill pan flashings are shown in isolation from other components required to complete the flashing system and wall waterproofing. The pans are also presumed to have a flat and level pan portion. An outward slope to the pan portion is preferred and will increase the water control aspects of the rear edge.

Three basic configuration differences divide the pan types, which lack one or more essential parts to complete the sill pan assembly. The arbitrary terms of Platter (P), Tray (T), and Drawer (D) identify the three basic pan profiles (shown in *Figure 5*), which can be ineffective if they lack one or more water control features.

The second task is to recognize the failure modes of sill pans that incompletely control water entry from various potential directions. The waterproofing failures occur where there is no front flange, end or side dam, or back dam to block the potential leak paths at the pan edges and corners (see *Figure 5*).

The third task is to organize the pan types and identify their profiles for the convenience of a common reference. Within each category of configuration of platter, tray, and drawer, there are variations that lack one or more of the water control features required for sill pan flashings shown in *Figure 4*. The variations are presented as sequence variations approximately grouped from least functional, starting at number 1, and progressing in potential performance to number 3 or 4.

Establishing a set of typical graphic profiles is an achievable objective. Adoption of common naming conventions or other identifying methods may encounter resistance to industry application due to the current practice, which lacks distinctions typically used when specifying sill pan flashings. Also, the number of possible profile variations exceeds the number of simple terminologies.

The precedent of the term sill "pan" metaphorically is based on the basic shape and use of a shallow open container—a commonplace piece of kitchen cookware. However, the variety of other everyday kitchen terms is limited for continued use as flashing terminology. There are only a few common usage-based prefixes to add to the kitchen pan example (e.g., fry, sauce, pie, cake, grill, and bake). But these terms do not extend well to describe subtle graphic properties of different flashing shapes.

We attempt here to create a combined alphanumeric naming system with the graphic profile variations of pan profiles. *Figure 6* represents the key for identifying the different configurations based on the complete Pan Types 1, 2, and 3 with the incomplete pan portions of profile types T, D, and P signifying rows of configurations. The alphanumeric naming starts with pan type, profile type, and sequence variation (see example, *Figure 6*).

At the numerical top of the sequence variation is the example of a complete sill pan flashing of Type 1, 2, or 3. The sequence variation should not be used to quantitatively or qualitatively evaluate differences to rank a particular sequence variation against another without some form of testing. The sequence variations should be explored in terms of missing water control features compared to the relevant pan type.

ORGANIZATION TO DEFINE SILL PAN TYPES

We compare various options for sill pan flashings and identify distinct profile types. We review existing conventions for sill pan design and highlight certain disadvantages for controlling incidental water intrusion at window, door, and louver openings. We present a range of sill pan flashing config-

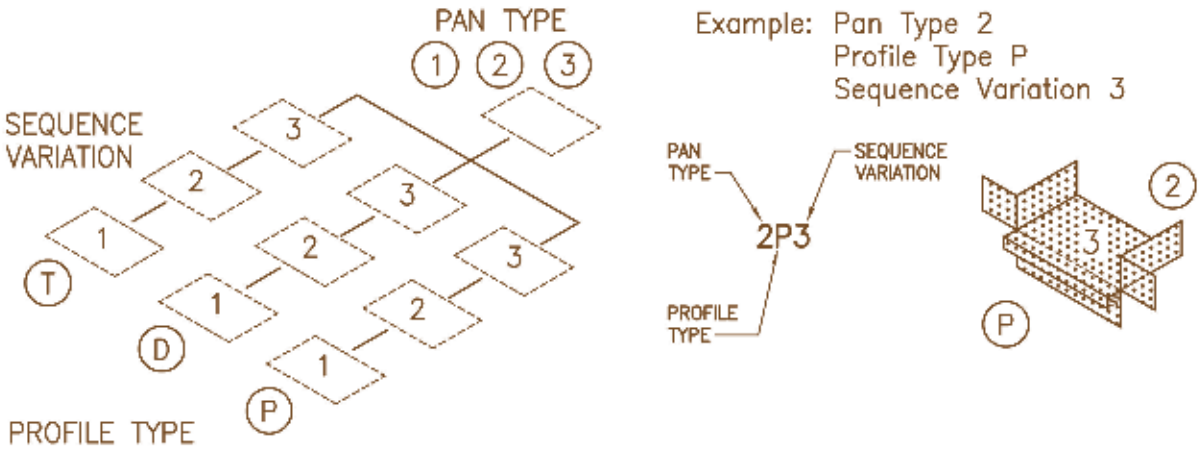

Figure 6 – Alphanumeric nomenclature for incomplete sill flashing variations and example.

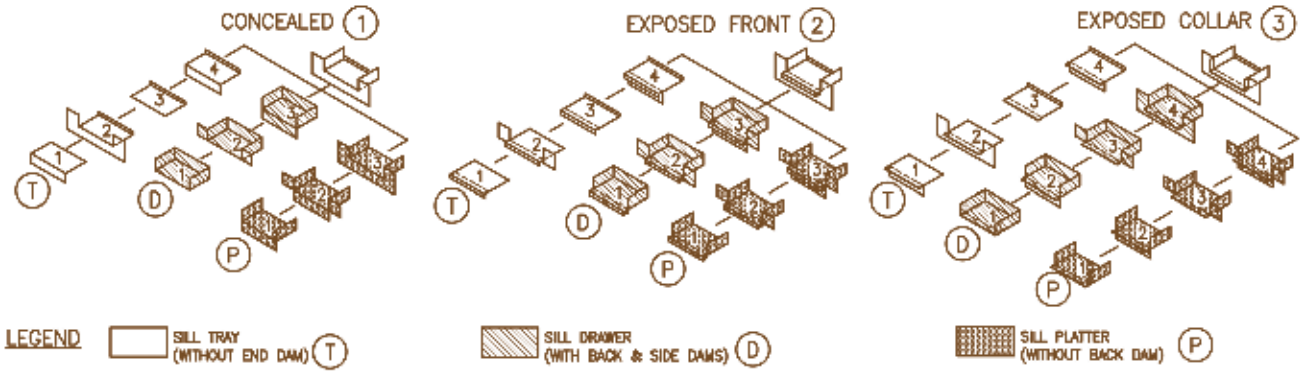

Figure 7 – Panorama of incomplete sill pan flashings.

urations in a graphic organization key for both analyzing as-built installations and selecting profiles for proposed designs.

The variety of sill pan flashing configurations is conceptualized as a "panorama" for concealed (1), exposed front (2), and exposed collar (3) flashings in the overall graphic organization of the sill flashing types in *Figure 7*. Each of the separate pan types is further shown enlarged in *Figures 8A, 8B,* and *8C*, with potential leak sources. The example profiles shown are schematic. Actual sill pan configurations will vary with adjustments to fit a particular wall opening, fenestration product, and environmental condition. The intention of this panorama is to show related types of incomplete pans and the progression of developing features for increasing water control toward a complete sill pan of Type 1, 2, or 3.

A concealed sill pan (1) is located behind a wall cladding and drains to a concealed WRB and/or other wall flashing. An exposed front sill pan (2) drains directly to the exterior wall surface under a window and appears as a distinct projecting architectural element. An exposed collar sill pan (3) drains to the exterior similarly to (2), but also continues the flashing up the jambs (side) to form a collar integrated with a separate head (top) piece. The exposed collar is often four-sided, with a perimeter seal to a box frame window or louver.

The variations shown in *Figures 8A, 8B,* and *8C* illustrate potential deficiencies due to uncontrolled leak paths. Not all variations shown will be encountered during field observations of installations. The deficiencies in incomplete sill flashings can be corrected with additional flashing components and do not require replacement.

Figure 9 represents the probable expected leak paths some different sill flashings could form if the "pan" fails to control water drainage. Due to space limits, not all sill pan variations are shown with potential

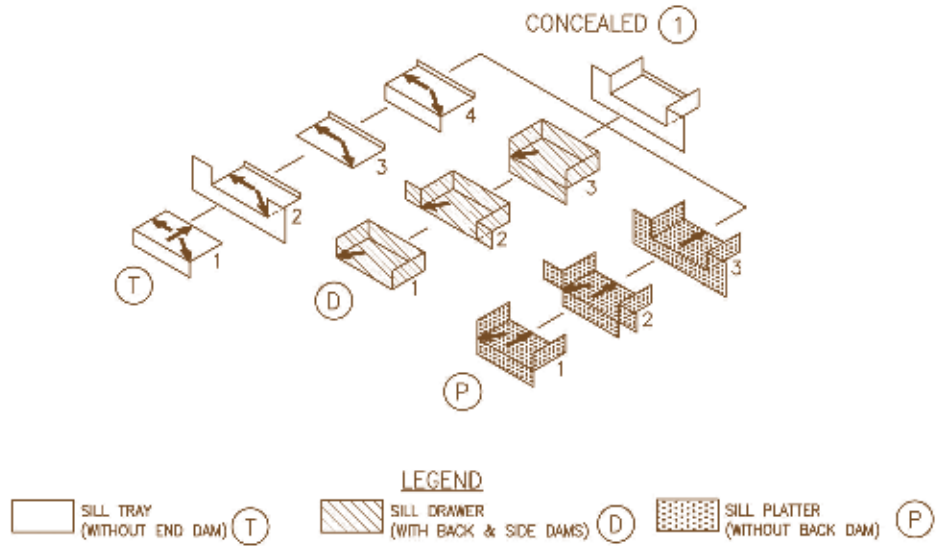

Figure 8A – Leak sources at incomplete "concealed" sill flashings.

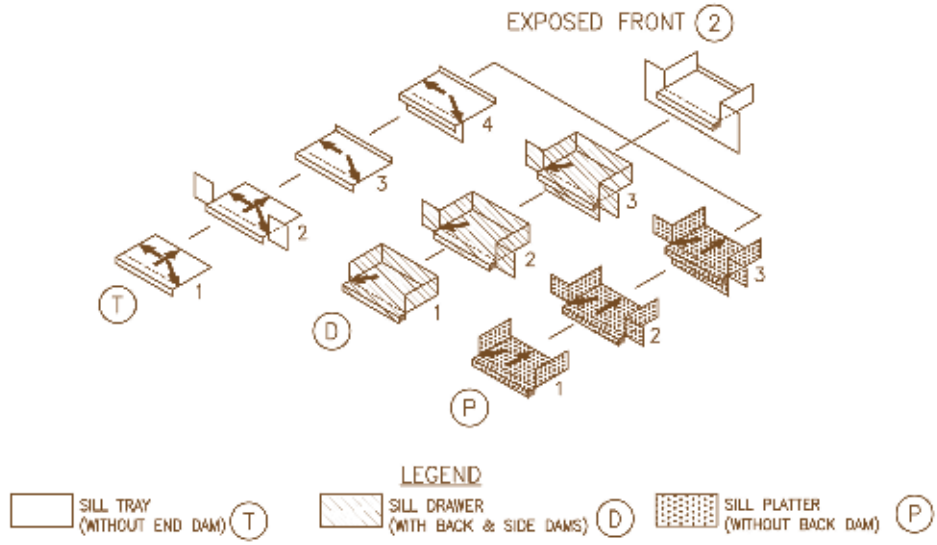

Figure 8B – Leak sources at incomplete "exposed front" sill flashings.

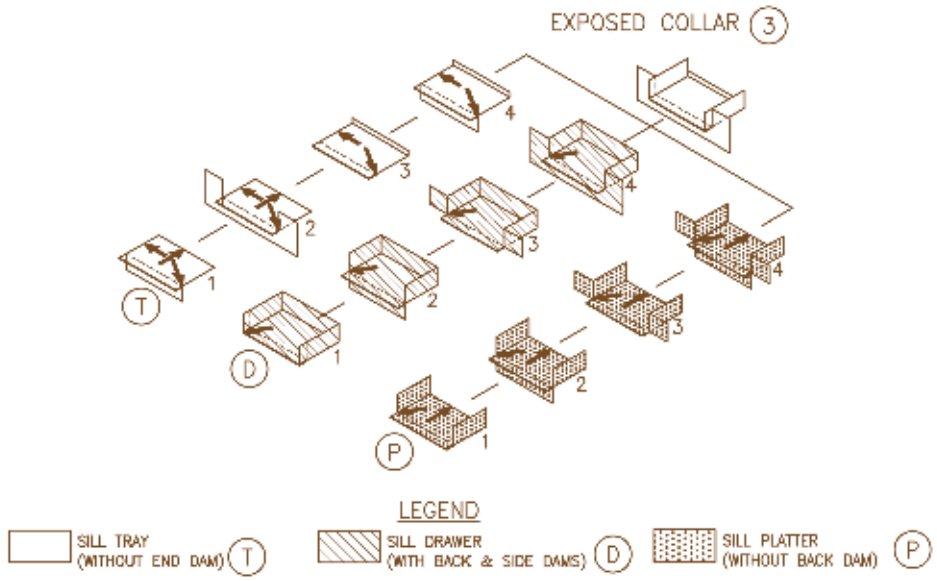

Figure 8C – Leak sources at incomplete "exposed collar" sill flashings.

leak paths. Leaks at the rear edge and rear inside corner are potentially the most damaging because water seeps directly to interior finishes. Leaks to the side edge are the next most potentially damaging to wall framing and the wall cavity. Leaks under the front edge and at the front outside corner are damaging to the exterior wall cladding and sheathing. Water control in this organization of sill pan flashings is grouped from worst at the lower left, increasing in performance to the upper right. The sill pans from *Figure 4* and shown at the top of *Figure 7* as Pan Types 1, 2, and 3 represent the best potential configurations for water control, incorporating all the required water-control features.

Figure 9 applies the leak path directions to specific examples of the various sill pan configurations to further demonstrate the expected performance of pan profiles that are incomplete or defectively fabricated. Pan profiles without complete water control features are at higher risk for leaks.

If the example sill pan 3-D profiles in *Figure 9* are represented as cross-section details, as in *Figure 1*, we see that components missing from a complete pan can be overlooked. Some pan profiles in *Figure 10* appear as complete as do the windowsill sections in *Figure 1*. However, the necessary end dams, side flanges, and front flanges in section details of *Figure 10* are absent.

CONCLUSION

The first objective of this article is to persuade readers that there are a number of sill pan types that provide varying degrees of waterproofing protection, with performance dependent on simple configuration differences with features that provide water control. Three examples of complete sill pan flashings are presented consistent with ASTM E2112. Sill flashings intended as drainage pans will be compromised without complete water control features at the rear, sides, flanges, and corners. An array of incomplete pans are shown and identified as lacking the necessary water control components.

The second objective is to encourage the use of 3-D diagrams for representing sill pan flashing differences in architectural details to illustrate the intended performance, show all the water control features, and confirm the continuity of waterproofing with the WRB system and other flashings at wall openings. Incomplete sill pans examples are shown in 3-D to illustrate the possi-

ble missing water-control features.

The third objective of this document is to create a single guideline serving as a common resource for avoiding incomplete sill pan flashings. This will allow designers and builders to recognize better-performing sill pan flashings and incorporate them into the architectural details for improved wall waterproofing. This nomenclature and classification of architectural sheet metal sill pan flashings should be viewed as a primer to be expanded and refined on the basis of its usefulness to practitioners.

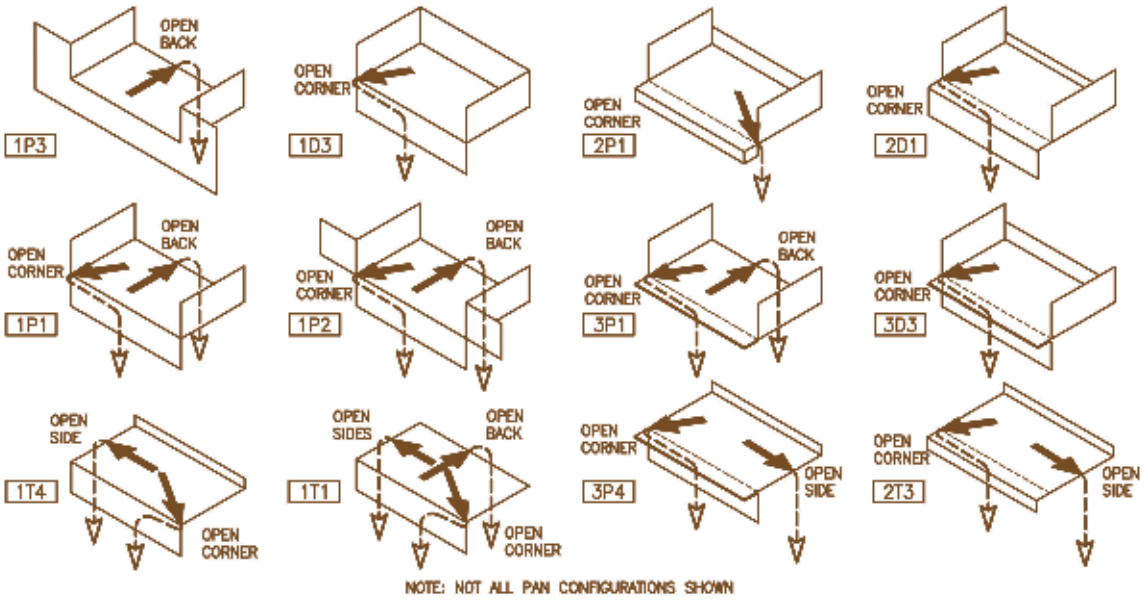

Figure 9 – Potential leak paths with examples of incomplete sill flashings.

An organization of flashing types can provide guidance to designers, specifiers, building contractors, and fenestration installers to avoid flaws and inconsistencies when reviewing and preparing for window and door installation. The common naming conventions and/or the assigned graphic identities will assist architects, builders, and manufacturers to readily understand the performance differences of a variety of sill pan flashings.

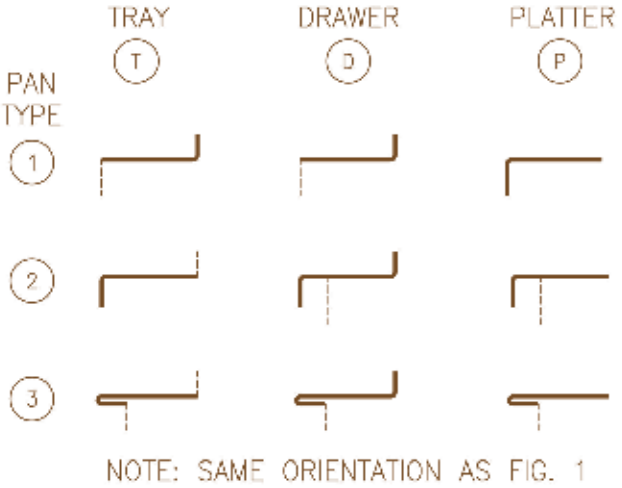

Figure 10 – Cross-sections of incomplete sill flashings.

FURTHER STUDY

This article does not include discussion of all varieties of sill pans, particularly those that act as evaporative reservoirs. Such sill pans can be formed with no provision for drainage under the fenestration product, but still be designed to contain small quantities of intermittent leaks. Door thresholds can be set in a sill (threshold) flashing in a complete bed of sealant without provisions for drainage underneath. In either case, these methods do not allow for sill drainage and are not expected to have high performance in moderate-to-major weather conditions.

ACKNOWLEDGMENT

The author thanks the original author[4] of the source paper on biomedicine noted below for the generous reuse of his paper as a template for the article format and for some borrowed relevant language. Changes were made to the subject matter of the ontological research paper. It was adapted to provide a less-rigorous form of graphic taxonomy. The original author of the cited paper has granted permission to allow adaption under the "Creative Commons" license, but this does not suggest endorsement for this nonscientific cross-discipline reuse nor of this author's opinions.[5]

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Materials and fabrication of sill pans have been classified in fabrication Types I-V. See *Table 1*.

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ENDNOTES

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4. D. Schober et al., "Survey-Based Naming Conventions for use in OBO Foundry Ontology Development," April 2009, *BMC Bioinformatics* [2009, 10:125] www.biomedcentral.com/1471-2105/10/125.
5. http://creativecommons.org/licenses/by/2.0/.

Types of Sill Pan Flashing – Fabrication (based on ASTM E2112-07, Appendix, Table 5)	
Type	**Material – Fabrication**
I	Rigid sheet –1 piece
II	Rigid sheet – Multiple pieces
II	Flexible membrane – 1 or multiple pieces
IV	Combination – Rigid + membrane
V	Liquid membrane

[Modified excerpt from "A Flash in the Pan…," Appendix 1]

Table 1

Robert Bateman

Robert Bateman is a staff consultant at the San Francisco office of Simpson Gumpertz & Heger, Inc., a national engineering firm specializing in the design, investigation, and rehabilitation of buildings and structures. Bateman has over 30 years' experience in architecture and currently specializes in building envelope waterproofing. His focus includes the analysis and design of window and door flashing installations with various wall claddings. He participated in the development of ASTM E 2112.