WINDOW RECEPTOR FRAMES:

What You Need to Know

By Derek B. McCowan and Michael J. Louis, PE

INTRODUCTION

Designers often wrestle with the question of whether or not to include a receptor frame (or sub-frame) around aluminum window assemblies and how to specify these important components. In general terms, receptor frames are additional framing components that encase or surround one or more window (or storefront) components (much like stud tracks hold light-gauge metal studs in place; see *Figures 1A* and *1B*). In some instances, receptor frames enclose all four sides of a glazed assembly, while in other cases, receptors are installed only at the head or sill.

Receptor frames are most commonly used to simplify window installation, accommodate variations in size or level/plumbness of window openings, or allow deflection of structural slabs.

A lack of understanding of the potential benefits and drawbacks of receptor frames can often lead to unwise decisions during design. Glazing subcontractors often decide whether or not receptor components will be provided. Sometimes these decisions are made for strong technical reasons, though more often than not, the main reason is to simplify installation (thereby reducing labor cost). Often, little thought is given to the potential drawbacks.

This article examines general pros and cons of receptor frame assemblies and some common problems observed with these systems in fabrication facilities and in the field. General recommendations about how to design and construct functional receptor frame assemblies will also be provided.

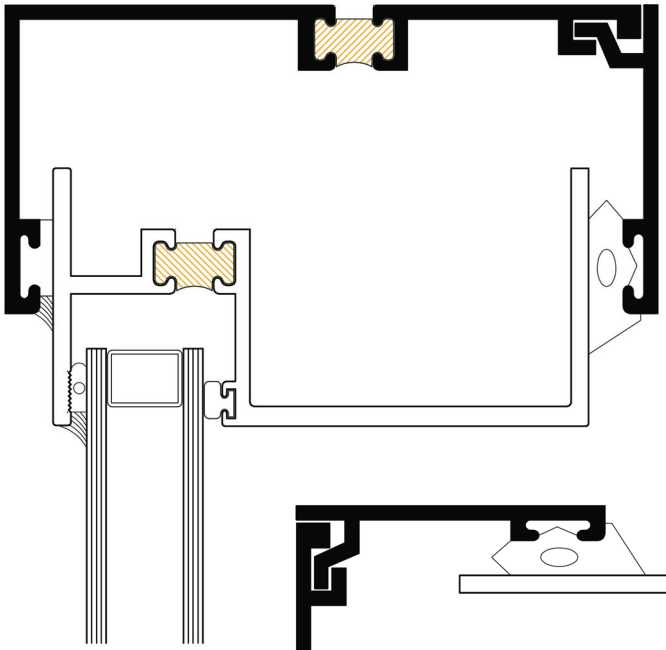


Figure 1A

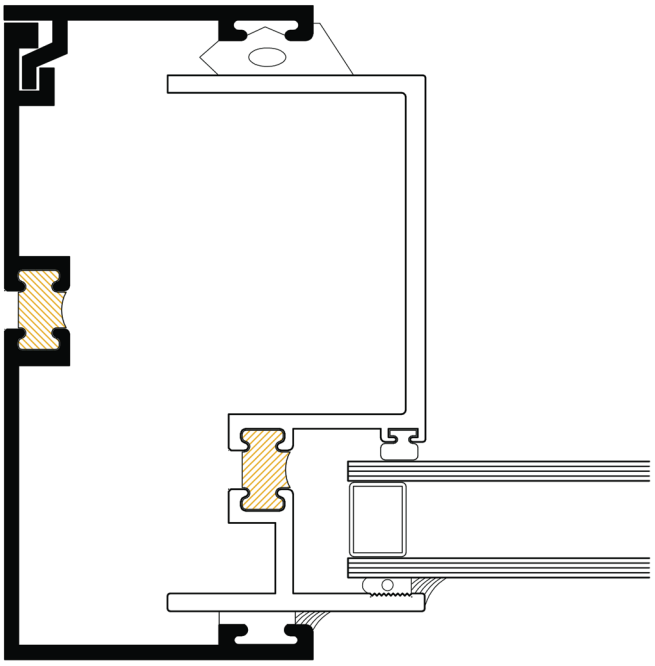


Figure 1B

Figures 1A and IB show schematics of head (1A) and jamb (1B) receptors.

Terminology

There is scant information about receptor frame assemblies in industry standards, such as those published by the American Architectural Manufacturers Association (AAMA), American Society for

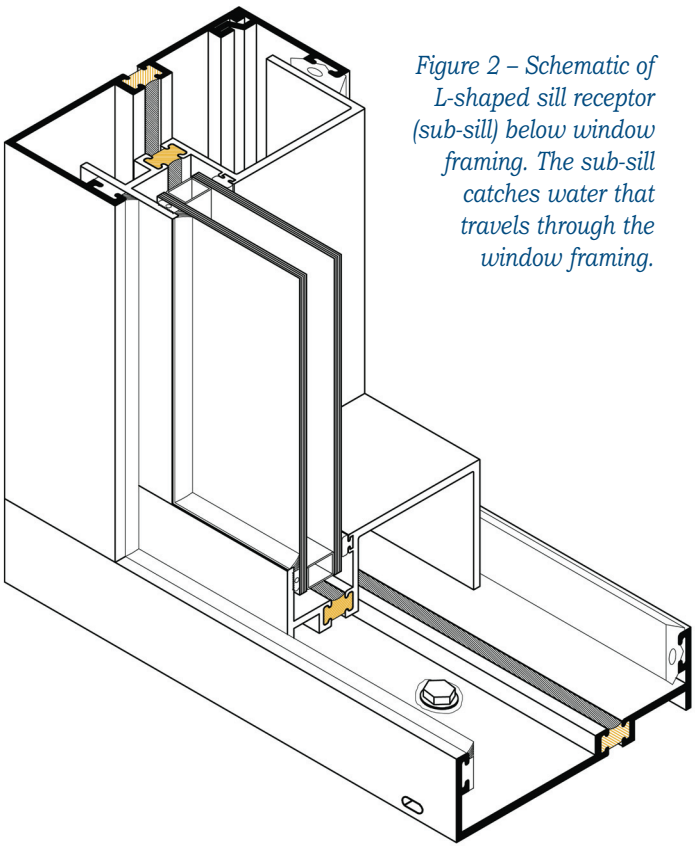


Figure 2 – Schematic of L-shaped sill receptor (sub-sill) below window framing. The sub-sill catches water that travels through the window framing.

Testing and Materials International (ASTM), and the Glass Association of North America (GANA). However, through discussion with various glazing subcontractors and window manufacturers, and a review of numerous manufacturers' catalogues, it is clear that these industry professionals are very familiar with receptor frame components.

Common synonyms for sill receptors include "sub-sill," "starter sill," and "sill pan." The term "panning" is often used (even in manufacturers' literature), though it is not truly accurate; panning is simply surface-applied trim. Sill receptors have also been referred to simply as "flashing," which could be considered an accurate description, as sub-sills are often used to contain and drain incidental water (*Figure 2*), though true flashing provisions are recommended as discussed later in this article. If properly designed and constructed, the water management capabilities of a receptor frame assembly can provide tremendous benefits to a glazed system.

THE GOOD...

Water Management

Receptor frames can be used to effectively contain and drain water that infiltrates the enclosed window assembly and the joints between the window and the receptor frame itself. With respect to water management, a properly constructed sub-sill is probably the most important component of a receptor assembly, though jamb and head conditions (if included) and their related intersections must also be carefully designed. At a minimum, sub-sills should include the following:

- Mechanically-attached metal end dams or end caps, to prevent water from draining off the ends of the sub-sill and into the building (or underlying flashing system, if provided; see *Photo 1*). End dams should be sealed with a reliable sealant (sheet products such as preformed silicone sheet can be used for additional protection) and should be sealed to jamb receptors (if provided) so that water traveling down the jamb is directed into the sub-sill and out the weep holes in the sub-sill.
- Sealed end dams at head receptors to prevent unabated air infiltration, as well as water penetration.
- Alternately, intersections that can be mitered, keyed, fastened, and sealed (*Photo 2*). This is typically only an option if the abutting extrusions have similar profiles.
- Where sub-sills are used under long horizontal window runs, transverse joints should include flexible membrane waterproofing to accommodate thermal movement of the sub-sill while providing more reliable waterproofing protection than is afforded by sealants alone.

In some cases, a sub-sill or some other form of sill flashing is essential due to the construction of the system above, such as the following:

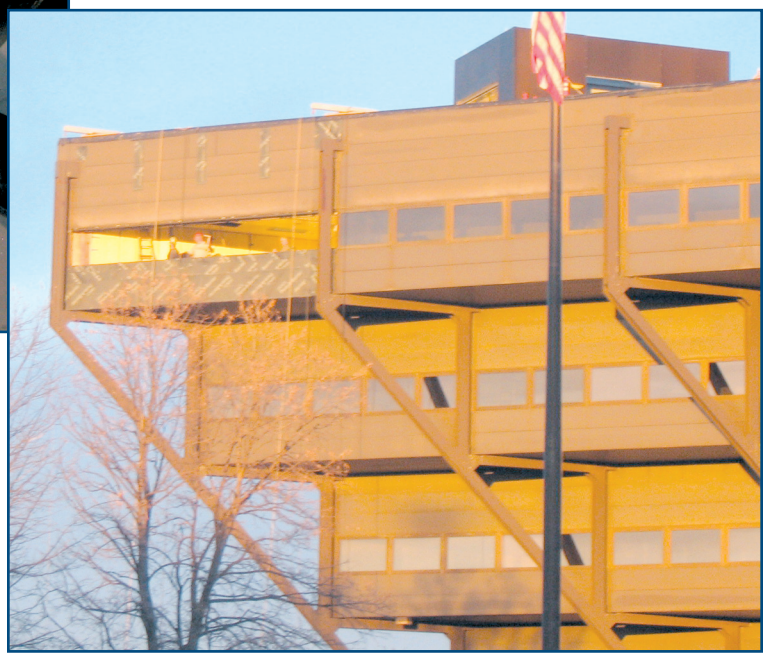
- Internally-draining systems that direct incidental water down within the vertical mullions to the base of the wall; and
- Systems that use interlocking/"nesting" vertical mullion joints, such as ribbon/strip window assemblies (*Photo 3*). Water often bypasses these joints, even when they are gasketed or sealed.

If a sub-sill or similar flashing condition is not provided to catch and drain this water, the system may leak from the time of installation. By the same token, window

Photo 1 – Sample sub-sill with sealed end dam installed. Also note the black weep cover (which covers a slotted weep hole) and the slope to the exterior.

Photo 2 – Sample mitered receptor frame corner intersection; corner is keyed, fastened through screw bosses, and back-sealed.

Photo 3 – Photograph of ribbon/strip windows; installation in progress.



assemblies can be wept down into a sub-sill to mitigate some of the risks associated with providing exposed weeps at the face of smaller, more "leak-sensitive" glazing pockets.

Structural Deflection

In addition to water management capabilities, receptor frames can be used to accommodate a limited amount of structural deflection. Similar to slip-track connections used with light-gauge metal studs, the nesting nature of the receptor frame can be designed to allow a minimum of slab deflection without transferring structural loads to the window units (see *Figure 1*).

If significant movement is expected, anchorage and connection details should be designed with this in mind. For example, a four-sided receptor frame with screwed corners is likely to be damaged by slab edge deflection if the receptor frames are rigidly anchored across moving joints. Often, only head and sill receptors are used if slab edge deflection is a significant design consideration.

Construction Variation/Tolerance

Receptor framing can be used to accommodate variations in the size, level, plumbness, and other irregularities of rough window openings, such as may be the case within existing buildings. A standard-size window can often be manufactured, and the nesting qualities of the receptor framing can [illegible] the variations in rough window openings. The resulting appearance of a varying sightline may, however, be an aesthetic concern.

THE BAD...

Many of the potential drawbacks of receptor frames are straightforward and include:

- More metal framing means more metal joinery that must be sealed, as well as additional material cost. Sealed intersections are often the weak points of glazed systems and must be carefully designed and installed to be effective. Additional joints increase the risk of air and water penetration.
- While window units are generally fabricated and glazed in the shop under controlled conditions and (theoretically) substantial supervision, receptor frame components are typically assembled in the field. The quality of the construction (including the critical joinery seals) can be affected by bad weather, extreme temperatures, dust, debris, other work in progress nearby, workmanship and supervision issues, and various other challenges. Such construction challenges are why knock-down window systems (systems that are assembled entirely in the field from loose components) are now rarely used.
- A receptor frame creates a continuous air loop around a window assembly, which may encourage convection-induced air movement resulting in air leakage. The creation of cold spots, which increase the risk for condensation, may also occur. Adding some form of insulation or air seal between the window and receptors helps mitigate this risk.
- Even insulated receptor frames can result in reduced air penetration performance because the building's air barrier (often the underlayment of an adjacent wall system) can be connected to the receptor frame, but not the actual windows. This makes the joint between the two units a critical one with respect to air leakage. Most energy codes (including theIBC/IEC) require that a continu-

Photo 4 – Sample receptor frame intersection; note the open corner.

Photo 5 – Large end cap installed at ends of the head receptor.

ous air barrier be provided between glazed systems and the surrounding wall assemblies. Some would interpret a gasketed, unsealed joint as a breach in this continuity (gasketed joints often allow at least a small amount of air and water movement).

A concern that is not so obvious is that receptor frames are rarely included in performance tests performed by manufacturers and testing/certification agencies. Designers may specify a high-performance (rated) window assembly and receive a high-performance window set in an untested receptor frame that will not provide the same level of performance. Such a shortcoming may not be uncovered until the construction phase or when the system is in service. Numerous problems, such as cold air infiltration, condensation, and water leakage, can occur as a result of receptor frames. In most instances, designers were aware of the benefits of the receptor frames (e.g., speed of installation), but unaware of the risks with respect to thermal performance and water leakage.

Designers should require that receptor frames, as well as gang mullions, T-bars, and other associated framing components, meet the same performance criteria as the core window unit; i.e., the whole assembly should pass the performance tests. such a requirement seems like common sense, though it may be difficult to defend on paper if specifications are not abundantly clear.

Some industry organizations, such as AAMA (per its certification program, *Bulletin 2007-01*) and the International Code Council (ICC), are making efforts toward requiring full and combination glazing assemblies to meet standardized performance testing requirements. This is a move in the right direction and is likely to find support from the design and end-user communities.

THE UGLY...

Receptor frame joints, intersections, and corners can be ugly and difficult to seal reliably if not carefully considered prior to fabrication. Wide-open corners (*Photo 4*), large, haphazardly sealed end caps (*Photo 5*), and various other disconcerting conditions have been observed. As noted above, poorly constructed receptor frame joinery can lead to significant air and water leakage. A back-up flashing system, which is always a good idea, can help

Photo 6 – Extremely heavy corner seal.

Photo 7 – Up-close view of a splice joint in a sub-sill (viewed from interior, with interior finishes removed). Note the corrugated profile of the splice material.

Photo 8 – Heavy leakage is shown through a splice in the sub-sill (shown in Photo 7) due to failed seal with irregularly spliced material (viewed from interior and below, with interior finishes and insulation removed to expose the leakage).

reduce this risk.

Missing corner seals are an obvious problem, though oversized corner seals can also be problematic. Large mounds of sealant that are not tooled or that consist of multiple sealant types are no better than other haphazard seals (*Photo 6*). Significantly oversized seals can actually dam up the intersections to the point where water traveling down the jamb receptor cannot reach the sub-sill and associated weeps.

Transverse joints in a sub-sill are also common sources of leakage. These splice joints typically experience considerable thermal movement and, therefore, a flexible sheet flashing material is needed. Joints sealed with metal splice plates and sealant should not be expected to remain watertight. Experience has shown that silicone

sheet seals applied over metal backer plates perform well. Splice materials that include an irregular profile (such as corrugated sheet) should be avoided because they create an impractical substrate against which to apply a weather seal (*Photos 7* and *8*).

ADDITIONAL CONSIDERATIONS

Flashing

Even if a quality sub-sill receptor frame system is provided, it is not a substitute for a durable and reliable flashing system. A metal flashing with soldered end dams will remain watertight for many years after a silicone end dam fails (perhaps 50 years versus 10 to 20 years). In addition, a sub-sill typically cannot be integrated with the air/water/vapor retarders that may exist in the adjoining wall assemblies as well and easily as a true flashing can.

Performance Tests

Design teams should require performance tests of fully assembled window systems, including all related receptor framing. Laboratory and job-site testing early in the construction process can be helpful tools for identifying design, fabrication, and installation issues that may reduce performance of the system.

Construction of laboratory mock-ups and field mock-ups should be completed by the mechanics who will be performing the installation work. This will result in a more representative test of actual field conditions. Similarly, failed tests and resulting corrective action are more likely to be completed in the final construction if the responsible mechanics witness the tests and understand the subtleties of the failures and how the corrective action solves the problem.

With all performance testing, it is helpful to observe the construction of the assembly to be tested to confirm that it is representative of the conditions to be provided at the job-site. Subcontractors sometimes apply generous amounts of caulking to mock-up window assemblies (see *Photo 6*), and then apply only a small amount of sealant during the actual installation work.

Early Identification of Problems

Many of the potential problems with window receptor frames can be identified and avoided early on in the process by adding a waterproofing consultant to the team. A consultant who has extensive forensic experience investigating failures of window systems can be particularly helpful.

CLOSING

Window receptor frames can be very helpful and functional components of a glazed system if properly designed, manufactured, and installed, and may, in some cases, be a necessity. Designers should evaluate how receptor frames will affect performance of the window system and the overall wall assembly on a case-by-case basis to ensure that the project requirements are met.

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Commercial Insulation Requirements to Change

For the first time in over 18 years, ASHRAE (the American Society of Heating, Refrigeration, and Air-conditioning Engineers) has proposed increases to the minimum required roof and wall insulation levels in Standard 90.1 – the national model energy code for commercial buildings. The Standard 90.1 committee has approved these proposed changes for the next version of the code.

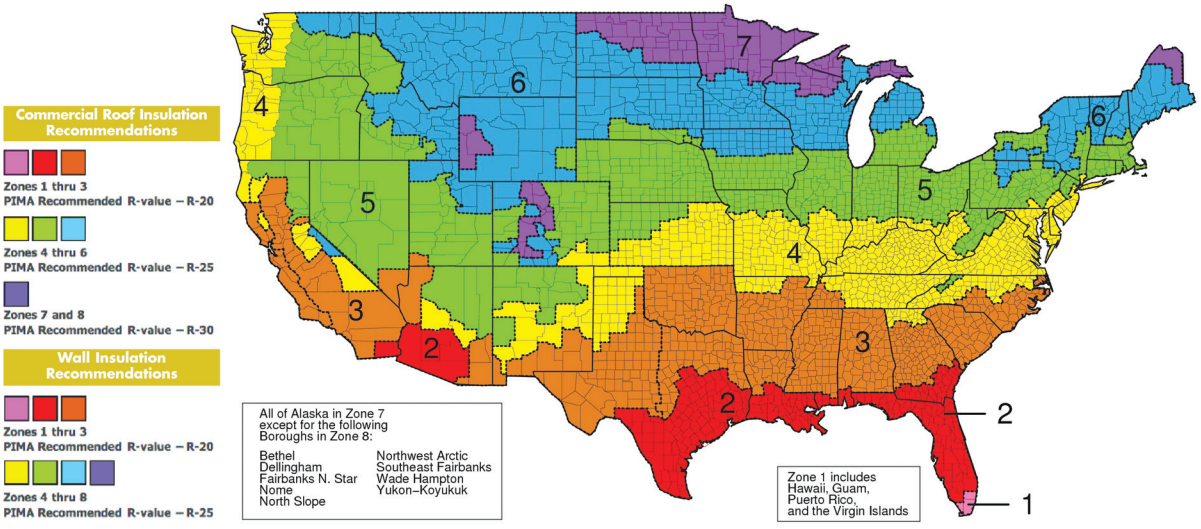
What does this mean?

The above-deck roof insulation requirements currently at R-15 go to R-20 – a 33% increase in roof insulation levels. Similar increases are proposed for walls. The next step in this process is ratification of the committee's approval by various levels of the ASHRAE Standards development process, culminating in acceptance by the ASHRAE Board of Directors, expected in June of this year.

The board had charged the 90.1 committee to deliver a new commercial building energy standard that is 30% more efficient than the 2004 version by the year 2010. The actual changes are climate zone- and building type-specific. The ASHRAE Standard has various performance compliance mechanisms – from prescriptive requirements to computer simulations and trade-offs. Regardless of the code compliance approach used, these new insulation values establish a new benchmark for commercial building energy efficiency. The ASHRAE Standard addresses building envelope and system requirements for commercial buildings, residential buildings higher than three stories, and semi-conditioned buildings (warehouses, etc.).

In many ways, these new insulation levels are long overdue. Architects across the country are already installing insulation at levels that exceed these values. Those architects and designers seeking beyond-code recognitions (such as LEED, Energy Star®, Building America, etc.) will now go even further to deliver advanced building envelopes and higher levels of insulation.

— PIMA



Shown is ASHRAE's Climate Zone Map delineating recommended R-values for different climate zones.