

Retrofit Metal Roof Framing Systems

By John Pierson, PE

A low slope roof is the most abused surface on a building. Mother Nature is tough on building exteriors in general, but low slope roofs – or flat roofs – take the worst of it. Sun exposure is more intense; wind develops higher uplift pressures making them more susceptible to blow off; rain, snow, and ice accumulate causing damage; dirt and debris can build up and clog drains; and people walk on them without much regard to their impact on the roof system. If this sounds familiar, you might consider a Retrofit Metal Roof Framing System. Adding slope to a low slope roof with steel framing and standing seam metal roof panels has been in practice for a long time. Today's building owners can benefit from decades of experience with these systems and time-tested solutions. With that in mind, here are some important points that anyone considering a metal retrofit should review.



Typical Retrofit Metal Roof & Framing System

Benefits of Metal Retrofit Roof Systems

Sloped metal systems are architecturally compelling. In addition to solving low slope roof problems, metal roofs are often chosen for their contemporary style to modernize the appearance of a facility and breathe new life into an aging building. Or the system can be designed to maintain the original appearance of brick-and-mortar facilities. In either case, retrofit metal roofs provide fantastic benefits. From a facilities management perspective, it can dramatically reduce maintenance costs and contribute to energy savings. From the capital planning perspective, the longer service life means less expense over the life of the building. Additional benefits include, but are not limited to, the following:

Waterproofing – The initial cost of a quality retrofit metal framing and roof system package is usually more costly upfront than that of a quality low slope roof, but has lower life cycle cost.. Choosing a metal retrofit usually has to do with fixing long-term roof leaks because steeper slopes have an obvious advantage – water leaves them faster! But with waterproofing, it is important not to force a metal solution where building geometry won't allow standing seam panels to do their job properly. Metal roofing works great when the panels are installed at proper slope and are continuous. Retrofit framing systems use no deck or underlayment, so the standing seam metal roof panels must be designed to be completely watertight themselves. High quality standing seam metal panels are impervious to water penetration...until the panel ends. This requires careful consideration of the types of panel seam design, and details designed for the roof. For example, the only thing worse for roof leaks than internal drains are internal gutters which should be avoided whenever possible.

Lower Maintenance Costs – In general, metal roofing requires less maintenance than low slope membrane roofing. Water leaves the roof faster, solving many of the problems that plague low slope roofs. Regular maintenance is usually limited to cleaning gutters; however, periodic sealant work is also necessary. The best standing seam metal roof designs limit exposed sealants only to areas where the system meets masonry or other non-metal materials. Panel lap and fastener maintenance can also be eliminated with a well-designed roof.

Longer Service Life – Manufacturers' warranties on standing seam metal roofs are still limited to 30 years, however, many metal roofs last 40 years or more. To achieve this longevity, understand that this performance is limited to *structural, hydrostatic* standing seam metal roof systems. These are systems with 2-inch or more in seam height, use proper sealants, and are structurally seamed with powered equipment in the field. With these attributes, the system will be able to span the sloped framing system and remain watertight. Commonly used performance testing of these panels include ASTM E 1592, ASTM E 1646, and ASTM E 1680. Additional water leakage testing essential to performance includes ASTM E2140 and TAS 125. These tests cover more severe but common weather conditions including wind-driven rain at storm measured wind speeds.

Even with the proper standing seam panel, another consideration in expected service life for a standing seam metal roof is the color retention of the paint system. The major fluorocarbon paint manufacturers now provide 30-year warranties on their paint systems. Further, manufacturers now offer field painting systems for faded metal roofs, which extend the life of the paint systems up to 10 years.

Energy Conservation – Energy conservation is a huge incentive and a driving force for decision-making today. Energy Conservation Measures (ECM) are defined by the U.S. Department of Energy as: “Measures that are applied to a building that improve energy efficiency and are life cycle cost effective and that involve energy conservation, cogeneration

facilities, renewable energy sources, improvements in operations and maintenance, or retrofit activities.” The following are important ECM’s provided by metal retrofits.



Retrofit Metal Roof with Insulation

Increase Insulation Value – Outside of a large-scale renewable energy system, adding insulation to a roof assembly provides the greatest impact to energy conservation. Although inexpensive when compared to renewables, insulation materials do provide a higher return on investment.

Use of Cool Roof Colors – Infrared reflective pigments have been available in the fluorocarbon paints used in most commercially available metal panel finishes for more than 10 years. These pigments are what make some standing seam roof colors, even the dark ones, “cool” by reflecting the UV infrared spectrum, thereby reducing the surface temperature of the metal. These have become very popular, especially because darker colors are often preferred on sloped metal roofs. In the cases of LEED®, ENERGY STAR®, or other program credits, darker colors only qualify over slopes of 2:12¹.

Recyclable Metal – While very little recycled materials are used in the manufacture of the steel used in standing seam metal roof and light gauge framing, about 25 percent and as much as 100 percent of the panel material can be recycled at the end of its service life, according to the Steel Recycling Institute².

Ventilation Benefits – Ventilation of the space between the new roof and the old provides a means to reduce the heat load on the building. The size of the attic space a new retrofit system creates is dependent upon the slope, and this will dictate whether passive or powered ventilation should be used. In general, building code provides guidance for how to ventilate an attic space in IBC section 1203.2. Most agree that venting metal retrofit applications is necessary and provides the following benefits:

1. The most important factor in regards to energy conservation is airflow, which reduces the heat gain of the attic space and reduces the workload of the building HVAC.
2. Ventilation reduces condensation by removing moisture from the attic air space. When condensation does occur, ventilation provides a means for drying that moisture from the attic.
3. Ventilation also reduces the occurrence of ice damming (with the use of proper insulation and air barrier).

Renewable Energy – A new retrofit metal roof can provide a suitable platform for renewable energy systems. While renewable options are certainly an incentive to reduce energy consumption, there are some important considerations to take to heart:

1. Weight – Photovoltaic multicrystalline panels or independent solar thermal modules can double the weight of a retrofit roof application. Modifications to the new framing system, and to the attachment to the building structure are usually necessary, which can increase costs.
2. Warranties – There are usually warranty restrictions for rooftop mounted solar systems, especially with metal roof systems.
3. Future Options – Metal retrofit systems may be designed for future renewable energy applications. These “solar ready” applications are becoming more popular as owners want to have the option to add renewables at a later time.



Solar Installation over a Retrofit Metal Roof

Design Criteria

Retrofit metal roofing systems require a significant amount of planning. Changing the appearance of the building with a retrofit system may also require significant changes to other building systems, which may involve several different professional disciplines. It is important to work with a partner that is capable of providing all the services necessary with responsibility that carries from design through the installation of the system. Design criteria that should be addressed include the following:

- **Structure** – The framing system is engineered to seamlessly integrate with the existing building structure. While the light gauge steel and sheet metal used for these roofing systems is relatively light (usually about 3 pounds per square foot), combined with built up roof materials it can double the weight of the existing roof. A structural evaluation should be performed to determine whether the building could support the additional weight. This evaluation is not only necessary for sheer weight concerns, but also to determine
 - feasibility of attachment points
 - load distribution
 - existing condition of the structure

All of these factors play a part in determining the feasibility and budget for retrofit projects.

Structural design of the framing system and standing seam metal roof should be done in conjunction with one another. Framing system purlin spacing needs to be cohesive with the spacing of standing seam metal roof clips. Roof system specific ASCE 7 wind uplift calculations will ensure clip spacing and roof panel selection is designed properly.

- **Existing Mechanical Rooftop Units** – A low slope roof is a great out of the way place for HVAC units. The application of a new, sloped metal roof requires relocation of existing rooftop units (RTUs). There are three options:
 1. Raise the units above the new roof line in a framing supported curb.
 2. Move the units to the ground.
 3. Keep the mechanical under the new roof.

Option one, of course, is the most feasible for existing equipment and is the most common choice. However, a retrofit metal project is a great time to modernize rooftop HVAC equipment so choice two may make financial sense if equipment is being consolidated to one or a few ground based units. This choice is usually accompanied by a significant interior renovation. Option three does not work with all equipment. Be aware, studies on attic based HVAC have discovered issues with performance and shortened service life of the units. Air leakage, heat in the attic space, and supply air issues all dramatically reduce the efficiency of HVAC designed for external use. The units must work harder than if they were in open air space on the roof, which increases maintenance expenses and reduces service life.

- **Storm Water Drainage** – The new roof will now direct rain and snow melt to the eave of the roof. Gutters and downspouts will be needed, and site storm water drainage may need to be modified. Roof slope and geometry should be addressed to provide the best drainage. This is a case where simple is better, more slope plus less transitions equals better performance.
- **Insulation** – Adding insulation in the newly created attic space can help with the energy efficiency of the building. By adding an attic space to the equation, the energy code requirements change³. Roof insulation on a low slope is referenced as “insulation entirely above deck” whereas “attic and other” is significantly higher. However, a prudent designer can rely on the maximum U-factor method⁴ to determine a value for the entire assembly. A thorough condition assessment of the existing roof is critical to determine the best opportunities to maximize insulation value. Fiberglass insulation is the most economical option, but it should only be used if a proper air barrier is in place.
- **Temporary Waterproofing** – The construction schedule for a retrofit metal roof installation includes significant time where the framing system penetrations will be exposed before the metal roof panels are installed. Temporary waterproofing of these penetrations should be planned according to existing roof conditions and the scope of the project. Complete removal of the existing roof system is usually the conservative, initial recommendation. However, removal of the existing roof may make it impossible to use the existing internal drains during construction. Installation over the existing roof system usually saves money, but can be difficult if a large amount of tapered insulation is present. Whatever the scope, inspection of temporary waterproofing is essential to a successful project.



Temporary Roof under a Framing System

- **Vapor Retarders and Air Barriers** – Condensation concerns are a close second to waterproofing. A vapor retarding air barrier is usually a necessary component in metal retrofit roof systems. How they are installed depends on the

climate and building. The benefit of the retrofit process is that other systems may pull “double duty” and provide the VR and/or AB function. All of the many fastener or steel penetrations that the framing system creates will interrupt the insulation (new or old) in some way. Simply put, an air and moisture barrier is necessary to provide a seal at all of those penetrations. An existing roof or a new temporary roof membrane may pull “double duty” as an air/moisture barrier.

- **Ventilation** – Creating proper ventilation under the new roof is important for the energy conservation incentives mentioned earlier. Passive ventilation is only acceptable if you can create suitable soffit to ridge venting. The available open vent space created plays an important role in the architecture of the new roof such as overhang width, and using hip ridges instead of gable end walls. Approximately 30 percent of soffit and ridge space should be open for passive ventilation to meet minimum requirements. If powered ventilation is selected, it must be designed appropriately to work effectively and efficiently so conditioned air is not drawn from inside the building, resulting in a negative energy impact.
- **Life Safety** - Fire separation walls and sprinkler systems may be required depending on the use of the building. All life safety code issues should be reviewed in full with local code enforcement officials.
- **Snow Guards** – The new steep slope roof should include snow and ice retention over entranceways and active areas beneath the roof. Snow retention is usually a safety consideration, but is also important to protect the metal roof. It should be employed throughout the slope of the roof at conditions such as valleys, dormers, and behind rooftop mounted equipment to protect those areas from snow and ice damage.

Architectural Considerations

Not every roof is right for retrofit. With all of the benefits metal retrofit systems provide it is important not to lose sight of the primary reason, which is to provide waterproofing protection. One of the biggest considerations in determining whether a retrofit will work is the existing layout of the building, including slope and building geometry.



New Retrofit Metal Roof with Replacement Low Slope Roof Area

A combination of retrofit metal with low slope areas is often a good solution for buildings that were not originally designed with sloping roof lines. This should not cause distress as low slope systems with performance and life expectancy similar to metal roof systems are available. Using low slope materials in conjunction with retrofit metal does not have to be tricky or difficult; it is done quite often and experienced professionals can guide the process. It is important to consider the warranty impact of how these materials are specified because the tie-in details where these systems meet are often a no-man's-land of responsibility. Ensure your details and specification address each detail properly. Manufacturers now provide 30-year warranted metal and low slope systems providing better support in these applications.

The industry has many examples of retrofit applications that solve problems and even make the building look better at the same time. This success depends on expert knowledge of the subjects discussed above. Seek out industry professionals who can build a team with necessary design experience, proven product performance, and quality installation.

References

¹ Kriner, S. "Cool Metal Roofing: Crowning The Building Envelope With Energy Efficient And Sustainability"

² Steel Recycling Institute, Steel: The Clear Cut Material for Residential and Commercial Construction, <http://www.recycle-steel.org/Steel%20Markets/Construction/Light%20Gauge.aspx>

³ ICC, 2012 International Energy Conservation Code

⁴ ASHRAE 90.1 2010 5.5.2.b Prescriptive Building Envelope Option

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