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New Options in Reroofing

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At some point, building owners and managers will face a reroofing project. Whether leaks have become recurrent and pervasive, maintenance efforts are unsuccessful in correcting roofing distress, or the effects of environmental stressors or improper installation have caused premature membrane failure, the life of a roofing system is finite.

Promptly addressing roofing distress can pay dividends in the long run. Over time, roof leaks can damage other building systems, from exterior walls and structural systems to interior finishes and equipment. While reroofing was once a logistical headache in an occupied building, with 400-degree kettles of hot asphalt creating fire and health hazards, today's roofing technologies allow the building owner or manager to breathe a bit more easily. Options in line with energy, safety, durability, and practical concerns make reroofing projects less complex and disruptive than they were in the past.

So what's out there? And how to choose? Begin by exploring the considerations in this guide, which will introduce you to basic types of low-slope roofing assemblies, as well as offer you criteria for comparing those systems and applying them to your specific structure. Then, talk to an architect or engineer specializing in roofing. Each building has a different set of existing conditions, and undergoing an expensive, noisy, dust-producing project only to find water leaking into the building soon after would be an excruciating experience. With the right guidance, though, an appropriately designed reroofing project is an investment in the future: you can look forward to decades of not having to worry about your roof.

Liquid-applied roofing membranes offer easy application, with no bulky rolls or open flames to negotiate.

Recover or Replace?

The first decision to make in the reroofing process is whether to tear off the existing roof and start from scratch, or to leave the old system in place and lay the new one on top. The best results are gained from complete replacement, as this not only eliminates the possibility of trapping moisture in the old system, but it also allows for a thorough inspection of the roof deck. Before the new system is installed, any deterioration in the substrate, such as rusted steel or spalled concrete, can be remedied.

Compatibility between the old and new materials can also be a concern in a recover project. Although a divorcing layer of new insulation between the old and new layers can help to minimize incompatibility problems, investigating and understanding the properties of both the existing and new systems is critical to success. For example, hot asphalt can melt existing

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polystyrene insulation. Coal tar is also incompatible with asphalt-based and single-ply roofing systems. Mechanically attaching insulation or a new roofing system through an existing coal tar pitch system can also lead to trouble, as the fasteners can conduct enough heat to soften the coal tar and allow it to drip into the building.

Recovering can be a viable option in some special circumstances. A recover project offers a lower cost and shorter project schedule than does a tear-off and replacement. As there are fewer removed materials, disposal is simpler and therefore more economical. And in cases where the contents of the building are so critical that they cannot be exposed to possible water damage for even a short time while the existing roof is removed (as in a museum or rare book library), recovering makes it easier to maintain a water-tight structure during reroofing.

If you are considering recovering for your roofing project, a qualified architect or engineer can help you determine whether this option is feasible for your building, examining both the existing structure and relevant building codes. In general, the basic conditions to be met are as follows:

1. The structure must be able to safely support the added load of the new roof.
2. There is no trapped moisture in the existing roof covering and insulation.
3. There are no more than one or two (varies by local code) existing coverings on the structure.
4. The roof deck is structurally sound.
5. There is a means of positive attachment of the new roofing system to the building structure.
6. Existing flashings are replaced when the new roof is installed.
7. Fire resistance and wind uplift requirements are maintained.

Once an architect or engineer has given the go-ahead for a recover project, options for the new roofing system must be evaluated in terms of system compatibility. Manufacturers provide recover specifications which indicate how to prepare the existing system and how to attach the base of the new system to the structure.

Choosing a Roofing System

Two decades ago, single-ply systems were coming into their own as an easy-to-install alternative to traditional built-up roofs. The single-plies were not only less susceptible to installer error than were the unwieldy layers of a built-up, many were also less sensitive to temperature shifts and other factors during the installation process.

While newer developments, such as improved seam tapes and backings, have improved the resilience of single-ply systems, they still lack the redundancy and self-healing properties of the old built-ups. How, then, to have the best of both: ease of installation (and reduced likelihood of installer error) as well as durability?

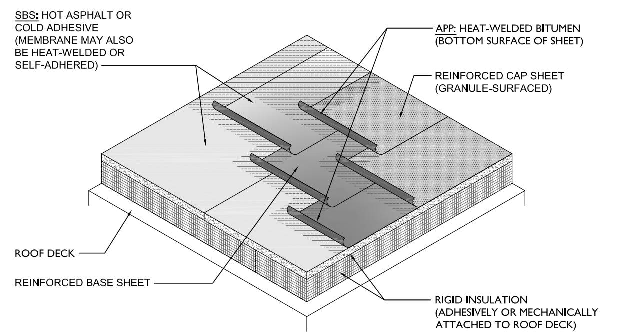
Enter the new generation of modified bitumen and fluid-applied roofing systems. These systems can be cold-applied, which reduces environmental toxins and offensive odors, and they are suited to a variety of applications. A number of newer products are on the market; here's a look:

Modified bitumen roofing (MBR) systems are comprised of two or

■ Torch-applied (*left*) and cold-applied MBRs (*see photo on page 4*) provide the resilience and durability of traditional built-up systems, without the need of lifting or pumping 400°F molten asphalt onto the roof (*above*).

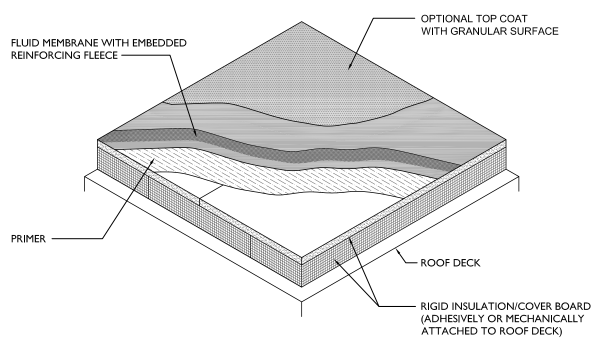
more layers of modified asphalt which waterproof a reinforcing material, and are essentially a factory-made built-up roof. The modifier is either APP (atactic polypropylene), a thermoplastic material, or SBS (styrene-butadiene-styrene), a synthetic rubber. The former provides added flexibility and increased tensile strength, and may provide UV protection without added surfacing. SBS asphalts have enhanced elongation and recovery characteristics and an extended range of temperatures under which the product can be handled without cracking or flowing. Reinforcing materials in MBR systems are made from polyester, fiber glass, or a composite. Polyester has excellent tear strength and puncture resistance, while fiber glass offers tensile strength and stability, qualities that work well in high-traffic areas. Composites offer the strength of fiber glass and the flexibility of polyester, for added durability.

Traditionally, MBRs consist of a base sheet and a cap sheet, which can be torched, hot-mopped, or mechanically attached to the deck. New developments in cold adhesives, however, have made "peel-and-stick" MBRs enormously popular, as these offer relatively simple application and depend less heavily on expert installation technique than do other types of MBR systems.

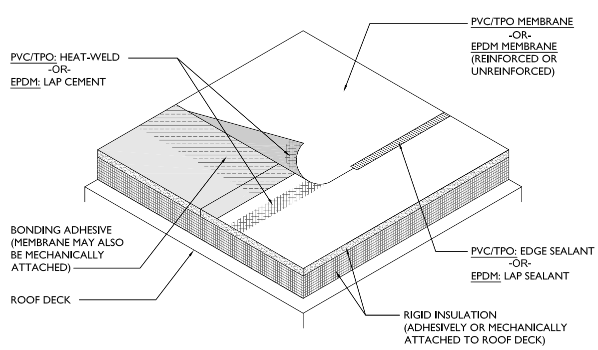


Modified Bitumen Roofing System (MBR)

SBS (STYRENE-BUTADIENE-STYRENE) APP (ATACTIC POLYPROPYLENE)



Fluid-Applied Roofing System



Single-Ply Roofing System

PVC /TPO: THERMOPLASTIC EPDM: ELASTOMERIC

Because of their multiple layers, MBRs offer a level of redundancy not available with single-ply sheet systems. Their material properties accommodate stress from building movement, foot traffic, and UV radiation, and they provide excellent puncture resistance and self-healing properties, similar to traditional built-up roofs of the past.

Single-ply roofing systems include the elastomerics, thermoplastics, and rubberized asphalts. Also called *sheet systems*, the single-plies are comprised of sections of membrane that are attached to the deck and bound together with seams. Because they have only one layer of membrane, they lack the redundancy of the MBR systems, and they have little self-healing properties, so any tears that form remain until repaired. What they do have going for them is their ease of installation, especially around penetrations and corners, compared with the bulkier built-ups. They also tend to recover well from stresses of installation, thermal change, and building movement.

Elastomerics are dominated by EPDM (ethylene propylene diene monomer), which weathers well in a wide range of temperatures and has a relatively simple installation. Seams are the weak point with any sheet system, but newer advances in seam tapes have improved installation outcomes for EPDM roofs. As with MBR systems, EPDMs can be reinforced with polyester for added strength and durability.

Thermoplastics include PVC (polyvinyl

Some cold-applied MBRs offer a simple, "peel-and-stick" installation that minimizes the chance of installer error.

chloride) and TPO (thermoplastic olefin) membranes. As part of the "cool roofs" energy movement, demand for high-reflectivity roofing materials has seen an upsurge in the last few years, and manufacturers have created a number of white or light-colored PVC and TPO roofing products that provide resistance to ultraviolet rays and ozone, while mitigating the urban "heat island" effect by keeping surface and surrounding air temperatures cool.

PVC and TPO roofs use mechanical fasteners or heat welding at the seams, techniques which must be precisely performed. While the heat welding can reduce the risk of seam failure associated with EPDMs, it requires an absolutely stable temperature to achieve an even weld. Even a shadow cast over the roof or a fluctuation in line voltage to the welding machine can create a non-uniform seam that can split over time.

Rubberized asphalts offer an alternative when asphalt fumes, solvent odors, or open flames would be objectionable. They can be self-adhered to a concrete roof deck, which helps prevent moisture from traveling laterally along the deck, making leaks easier to localize and repair. Because they are extremely UV-sensitive, though, rubberized asphalt membranes require a total-coverage ballast, and are best used on plazas or roof terraces where a protected membrane system configuration (with insulation and ballast above the membrane) is possible. Surface preparation is critical to achieve a uniform bond with the substrate, so the deck must be absolutely clean of dust and debris at the time of installation, and parapets, penetrations, and equipment must also be accommodated. In many cities with stringent regulations prohibiting dangers from torch application, asphalt, or adhesive fumes, peel-and-stick rubberized asphalts have gained popularity as a low-volatility option.

Fluid-applied roofing systems are relatively new on the market, with product development expanding over the last decade. These roofing systems eliminate sheets altogether, using instead the fluid binder itself as the primary waterproofing. The liquid is squeegeed or spray-applied to the roof area, and reinforcing may be embedded under a second layer of fluid. When the material cures, it creates a monolithic, seamless membrane.

Some fluid-applied products contain bituminous asphalt and therefore are compatible with asphaltic-based roofing products for recover applications. Others are intended to coat single-ply or metal roofing systems. Some higher-performance liquid membranes can be used to cover higher-traffic areas, including parking decks, making them suitable for a diverse range of challenging waterproofing applications. Cure times vary, but most products dry quickly enough to avoid concerns about watertightness after a crew is finished for the night. Liquid products that can be applied in freezing temperatures are also available, allowing reroofing projects to proceed even during the winter months.

Weighing the Options

When selecting a roofing system for their buildings, most owners and managers focus on cost, durability, construction schedule/logistics, and maintenance projections. Given the condition and composition of the existing roof, the climate and geographical location of the building, the configuration and style of the roof area, and the needs of the building occupants, some factors may weigh more heavily than others. For example, if the building is on the coast, building codes dictate that the roofing system must have a higher wind uplift rating, which may rule out some peel-and-stick options. Or if unusual construction methods in the existing roof mean removal might incur structural damage, then recover compatibility issues might limit the appropriate reroofing choices. In general, though, each roofing system has its inherent benefits and shortcomings. Comparing the systems based on critical decision criteria can help narrow the search for the right reroofing option.

Cost. Comparing roofing systems purely on a cost-per-square-foot basis is only of limited value, in that the cost of a roofing system encompasses more than just the initial expense. Endurance, weatherability, and ease of installation all factor into the cost-comparison equation. Ultimately, the most cost-effective roofing assembly might not be the cheapest in materials or labor costs, but rather the system that offsets initial expense with reduced maintenance and longer lifespan.

Performance and durability. Selecting a product on the cutting edge of technology, such as a new fluid-applied membrane or high-reflectivity TPO, necessitates some risk-taking where endurance is concerned, in that little lifespan data exist for the latest products. Still, even the newest systems tend to share properties in common with the tried-and-true, enabling some degree of accuracy in projecting their long-term performance. For example, bitumen-based fluid-applied membranes retain the self-healing properties of the material, which means that they recover well from minor damage as did their built-up roofing predecessors. If endurance tops your list of priorities, though, it's best to go with an updated version of a system with well-documented performance results, such as an MBR.

Construction schedule and logistics. Recover projects offer the shortest construction schedule and less debris to extract from the site. In tear-off and replacement projects, "peel-and-stick" systems can be installed quickly in a single application, whereas any system requiring mechanical fasteners or heat-welded seams will be more labor-intensive and so take more time to complete. Individual roof characteristics must be considered to make the final determination, however, as self-adhered systems might not save much time on a roof with many penetrations and terminations, which require labor-intensive hand detailing with thick, unwieldy strips of membrane.

Projected maintenance. Before settling on a reroofing assembly, check with manufacturers about maintenance schedules and upkeep. How often will drains need to be cleaned or pitch-pans need to be filled? When will ballast and/or coatings require reapplication? How easily is the membrane cleaned of storm debris or repaired due to vandalism? The resources you're prepared to devote to roofing stewardship may determine which systems are practical for your facility.

Health and environmental concerns. Systems with higher levels of volatile organic compounds (VOCs), chemicals which can cause lung damage, not only disturb building tenants and the surrounding community, they may be restricted by local codes. Other carcinogens, such as coal tar, present a risk both to workers and occupants. Newer systems offer lower levels of these harmful compounds than did their predecessors, but some are better than others. Thermal and noise insulation, as well as solar reflectivity, can impact energy consumption and so might factor into roofing system choices.

Roof Design Criteria

Ultimately, code and insurance requirements may trump considerations about scheduling, maintenance, or even cost. Criteria for fire or wind resistance might impose constraints that drive roofing design and even limit the systems that are compatible with your reroofing project.

Underwriters' Laboratory (UL) and Factory Mutual Research Corporation (FM) are independent organizations which test and classify roof materials and assemblies based on their fire and wind-uplift resistance. The American Society for Testing and Materials (ASTM) also develops standards for a wide range of materials and practices, which are used by architects and engineers in developing reroofing specifications.

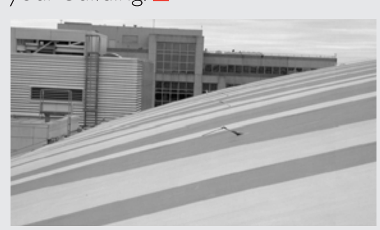
Fire resistance criteria evaluate resistance

"Cool Roofs"

As the demand for environmentally-friendly building materials surges amidst talk of global warming and shrinking energy reserves, roofing product manufacturers have raced to develop products that provide reliable waterproofing while reducing heat absorption and cooling demands. White or light-colored roofing systems reflect much of the sun's UV rays, keeping both the building and the surrounding area significantly cooler. In urban settings, this higher reflectivity helps to offset the urban "heat island effect," which refers to the higher temperatures within a city as compared with the surrounding countryside.

What are the "cool" options? Thermoplastic TPO and PVC systems are available in white, and most fluid-applied systems are offered in pale grey and tan tones. Some MBR manufacturers have even developed white aggregate surfacing as an alternative to traditional dark grey and brown colors to deflect the sun from the black asphalt membrane.

What these high-reflectivity options, which can cost more than traditional roofing choices, mean in terms of direct energy savings in cooling costs can vary greatly depending on roof size, location, and climate. A qualified architect or engineer can help determine if these are worthwhile options for your building. ■

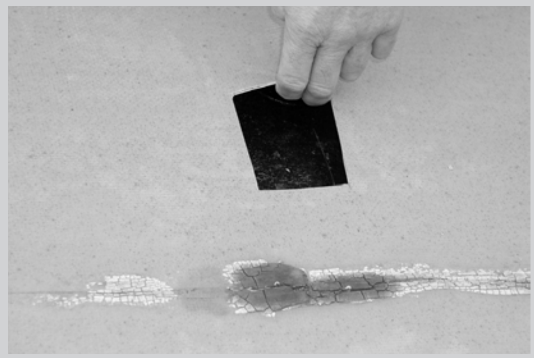


Warranties Don't Prevent Leaks

Warranties have an enticing allure, and they seem simple enough: you pay extra, and your roof is guaranteed not to leak. But what if it does? It might not be as easy as you would think to goad a manufacturer into sending an inspection team to look at the roof, much less fix it. And all too often, legal battles ensue while installation procedures are scrutinized to determine if all materials and methods fit the terms of the warranty agreement. Even if the manufacturer does perform warranty repairs, it's possible that the same roofing system defect could fail again—and this time, it could do so outside the warranty coverage period.

The best guaranty of roofing durability is not an expensive warranty, but rather a roof system that is well designed, manufactured, and installed from the outset. Warranties are largely reactive, rather than proactive, and shouldn't distract from proper specifications and application. Looking into the requirements for a long-term warranty, however, can bring to light potential weaknesses in a product or technology. For example, if the warranty requires extra or redundant provisions in installation procedures or details for certain areas, it would be prudent to pay special attention to those weak spots should you select that roofing system.

No warranty can replace proper investigation into the root causes of roofing distress. Better to find the source of water damage now than to waste time and money chasing down warranty-covered repairs later. ■



^ Weak points to watch out for in a single-ply roofing system: seam failure (*top photo*), delamination (separation of membrane from backing - *bottom photo*), and splitting (here, a split was repaired with sealant, which then cracked - *bottom photo, lower portion*).

to fire exposure from both the inside and outside of the building, as well as combustibility and contribution to the spread of fire. Installation guides detail correct procedures to achieve a roofing product's listed fire rating.

UL and FM test data for ***wind uplift resistance***, as incorporated in local and state building codes, guide architects and engineers in specifying anchoring systems both at the perimeter and in the field of the roof. The windstorm ratings can also determine whether a recover project is feasible, given the length and type of fasteners or composition of adhesive necessary to meet code.

Energy code requirements have been tightened in recent years, although they vary by city and state. Most new roofing materials are designed to meet these updated codes for thermal efficiency and absorptivity. Some products are specifically designed to maximize energy conservation. (See sidebar, "Cool Roofs.")

When considering partial replacement of an older roof, check local building codes to determine the percentage of roofing area that can be replaced without necessitating a code upgrade for the entire roof. In order to meet current standards for thermal efficiency, some existing roofs would require additional insulation, which may exceed the load-bearing capacity of the structure or which may be costly enough to justify full roof replacement. Fire and wind uplift codes might also have become more stringent since the existing roof was installed, and new fasteners or coatings might be necessary.

The building code in each area provides additional requirements for structural capacity, seismic loading, drainage, snow loading, safety protection (such as rooftop guardrails and pedestrian traffic patterns), environmental pollutants, and potential vandalism. If the building is on the National Register of Historic Places or if it is a locally significant landmark, additional restrictions may govern the acceptable types of roofing materials. An experienced architect or engineer can determine which codes apply to your structure, and how these criteria affect your reroofing options.

(continued on page 8)

representative projects

Reroofing

As specialists in the rehabilitation of building exteriors, Hoffmann Architects' design professionals understand roofing distress. The firm's architects and engineers begin with an analysis of problem areas, investigating the causes of deterioration. Repair, recover, or replacement decisions are made using the survey data, as well as information on structural integrity, building life cycle, code requirements, logistics, schedule, and budget. Thorough specifications, including detail drawings and plans, are prepared for competitive bidding. During construction, contract administrators and site representatives monitor progress and adherence to details.

Since 1977, Hoffmann Architects has guided clients through the selection, installation, and rehabilitation of roofing systems. A sampling of the firm's recent roofing projects:

Scholastic, Inc. Headquarters
New York, New York
Roof and Façade Rehabilitation

Kings County Hospital
Brooklyn, New York
Façade and Roof Rehabilitation

Burr Hall
Eastern Connecticut State University
Willimantic, Connecticut
Roof Replacement and Façade Rehabilitation

IBM Buildings
Poughkeepsie, New York
Sterling Forest, New York
Southbury, Connecticut
Roof Rehabilitations and Replacements

Arts and Industries Building
Smithsonian Institution
Washington, District of Columbia
Roof Rehabilitation

Home Box Office, Inc. Headquarters
New York, New York
Roof Replacement

Three Rivers Community College
Norwich, Connecticut
Roof Replacement

Gonzaga College High School
Washington, District of Columbia
Roof Replacement

The Loews Regency Hotel
New York, New York
Roof Replacement

Schering-Plough Headquarters
Kenilworth, New Jersey
Roof, Parapet Wall, and Coping Rehabilitation

Newton White Athletic Center
Natatorium
Johns Hopkins University
Baltimore, Maryland
Roof Replacement

Ford Foundation
New York, New York
Roof Replacement

UBS Building
Stamford, Connecticut
Roof Rehabilitation

Various Elementary, Intermediate, and High Schools
New York City School Construction Authority
New York, New York
Roof Investigations and Rehabilitations

Vander Clute Hall
State University Maritime College at Fort Schuyler
Throgs Neck, New York
Roof Replacement

Marsh McLennan Headquarters
New York, NY
Roof Investigation and Replacement

Folger Shakespeare Library
Washington, District of Columbia
Roof Replacement

Low Memorial Library at Columbia University in New York, NY. *Roof Replacement.*

Art and Architecture Building at Yale University in New Haven, CT. *Building Envelope Rehabilitation, including Roof Replacement.*

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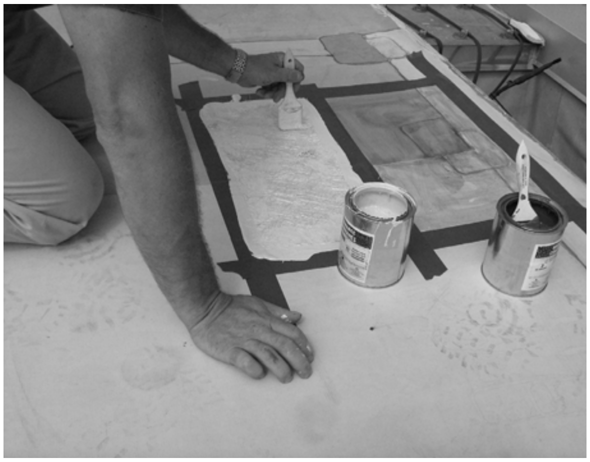

When sensitivity to dust, noise, and potential water intrusion rules out full roof replacement, recovering provides an alternative. Here, liquid-applied products are compatibility tested on an existing Hypalon single-ply membrane.

Before the new roof is installed, the substrate should be thoroughly inspected and prepared, correcting any spalled or cracked concrete, rusted steel, or loose areas of fill to create a solid underlayment. Flashings and terminations should be checked and installed at the proper height for the new system, and the area should be clear of moisture, dirt, and debris that could affect adhesion of the membrane.

Improving Outcomes

Even if a system is selected that is compatible with the existing roof deck and structural system and with the owner's and occupants' concerns, proper installation is critical to a successful outcome. The design team should have a representative onsite to administer construction, and should consult with the manufacturer on compatibility of the new roofing system with existing conditions. Documents should include complete specifications as well as detail drawings of all edges, terminations, and penetrations.

Once the new roof is in place, the design professional should work with the owner or manager to establish a regular program of maintenance to preserve the new roof. With improved installation outcomes afforded by new technologies, the owner or manager can be confident that, if an appropriate and exacting process of roofing system selection and application are followed, and routine maintenance is diligently performed, the roof will provide reliable protection from the elements for many years to come. ■

JOURNAL is a publication of Hoffmann Architects, Inc., specialists in the rehabilitation of building exteriors. The firm's work includes investigative and rehabilitative architecture and engineering services for the analysis and resolution of problems within roofs, facades, glazing, and structural systems of existing buildings, plazas, terraces and parking garages.

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