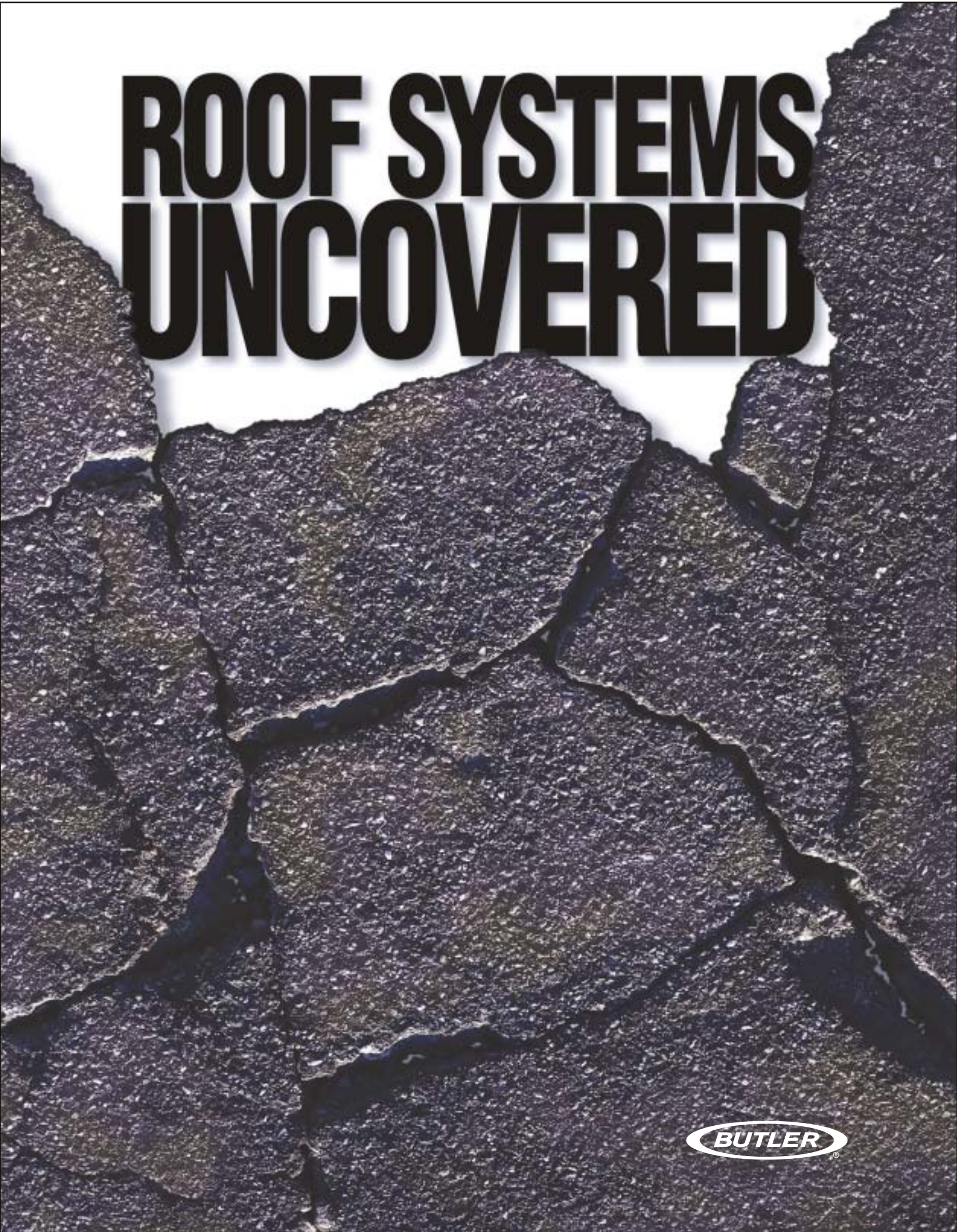
ROOF SYSTEMS UNCOVERED



BUTLER®

Roof Systems Uncovered

A Useful Guide for Comparing Roof Applications

Putting the right roof over your head can be just as important as building your facility on a solid foundation. The roof system you choose is your primary defense against the elements. It protects your assets from harsh weather conditions and must stand up under excessive exposure to ultraviolet radiation. Its condition has a direct impact on the value of your property. Every day it contributes to your bottom line by insulating and contributing to the energy efficiency of your facility.

Choosing the right roof for your building is more than a matter of assessing the up-front capital costs. Here we provide you with an overview of available roof options and look at overall lifecycle costs for each. We compare costs for installation, maintenance and disposal over the projected life of various roof systems to arrive at their comprehensive lifecycle cost.

The roof construction market can be segmented a number of ways:

- Commercial vs. residential
- Low-slope vs. high-slope
- New construction vs. retrofit or repair

Our focus will be on low-slope, commercial buildings with a more in-depth look at the growth in metal roof systems. We will touch on both new construction and retrofit or repair applications.

High-Slope Roofs

The high-slope roof market is heavily residential and dominated primarily by asphalt shingles. Available in a wide array of colors, styles, quality levels and price ranges, asphalt shingles satisfy the economic and aesthetic criteria for the high-slope market. Other traditional materials suitable for high-slope roofs include: wood shakes and shingles, slate, tile and standing-seam metal panels. Synthetic slate, tile and wood products are making new inroads into the high-slope roofing market as well - primarily in the residential market. However, metal roofs are more commonly used in the commercial market.

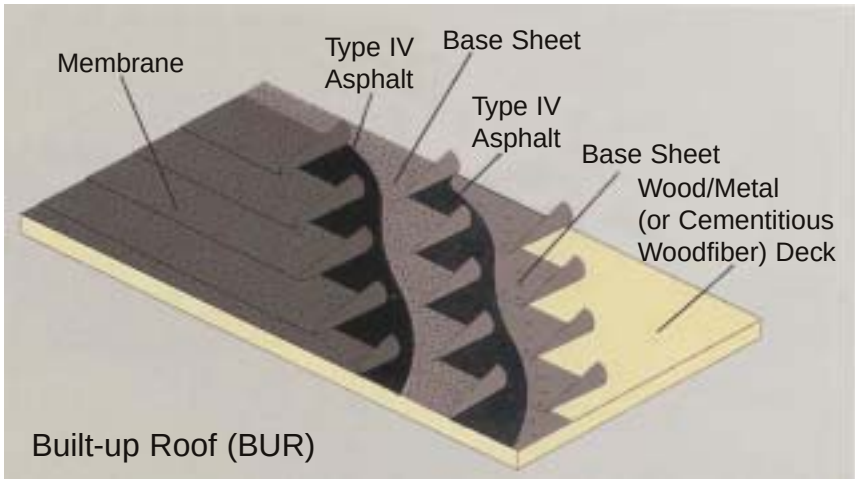
Low-Slope Roofs

Low-slope roofs are found more often on commercial buildings such as warehouses, office buildings, schools, retail centers, etc. These roofs typically feature a slope of 3" per foot or less. Almost two-thirds of all new, one and two story non-residential construction in the United States are pre-engineered metal buildings (PEMBs). Most use metal roofs. The remainder feature some type of hybrid built-up roof (BUR).

Built-up Roof (BUR)

A centuries old method for waterproofing buildings, built-up roofs combine multiple layers of felt (either organic or fiberglass) immersed in layers of hot asphalt or coal tar pitch spread on the roof by hand with a mop. These multiple layers called ply's (up to 4 or more make up a completed roof assembly) alternating with a coat of asphalt created a redundancy that provides waterproofing. All ply's would have to split or crack before any water intrusion is experienced. A BUR roof has to be protected from ultraviolet radiation in order to ensure long-term performance. Often these roofs are either coated or have granules/small pebbles embedded in a flood coat of asphalt for this protection.

BUR roofs require structurally sound solid substrates to provide adequate support and prescribed slope.



Built-up Roof (BUR)

Modified Bitumen Membrane Coverings

One method of covering an existing roof is with a roof membrane. Initially, a single-piece, semi-flexible fabricated synthetic sheet is installed over the roof surface. The membrane consists of multiple plies of saturated or coated fabrics assembled with alternate layers of bitumen (asphalt or coal tar). Bitumen is also the most commonly used waterproofing and bonding agent used in membrane installations and repairs. It is applied in a heated, semi-liquid form that hardens and forms a water-tight bond under normal outdoor temperatures. As a final step, the membrane must be covered with aggregate, bituminous materials, a liquid-applied coating or a granule-surfaced cap sheet to prevent ultraviolet degradation caused by sunlight.

Membranes are manufactured from a number of materials and may be strengthened by the incorporation of one or more reinforcing materials, including woven or nonwoven glass fibers, polyester mats or scrims, nylon, or polyethylene sheeting.

Common membrane types include:

Atactic Polypropylene (APP)

APP is a group of high molecular weight polymer membranes applied to roofs using an open torch.

Styrene butadiene styrene (SBS)

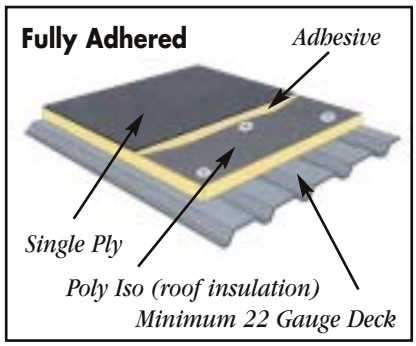
SBS is a high molecular weight polymer that has both thermoset and thermoplastic properties. It gives rubber-like qualities to asphalt roofing membranes and is mopped down with a layer of hot asphalt.

Single Ply

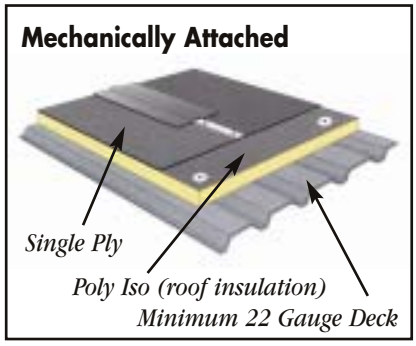
Single plies like EPDM (rubber) and thermoplastics became popular during the energy crisis of the 1970's. The cost increase combined with oil rationing spurred development in roofing technologies like synthetic rubber and Hypalon® products. Many manufacturers presented the idea that a single waterproof covering or sheet could adequately protect a building from the elements.

There are many variations of construction methods for single plies, but three are constant.

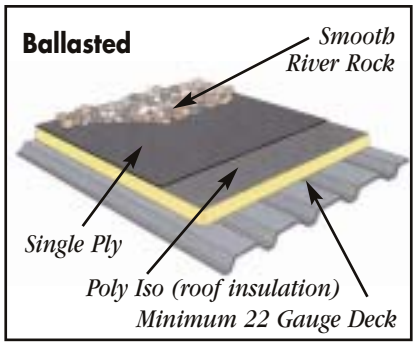
Fully adhered: The membrane is adhered (glued) down to an insulation type of board, which is, in turn, fastened to the deck.



Mechanically attached: The membrane is fastened to the deck through the insulation board.



Ballasted: A layer of heavy rocks is spread over a loose laid membrane to hold it and the insulation down to the deck. In this application a polyester protection mat is installed above the membrane in order to protect it from any sharp edges of the stones. A ballasted roof is most frequently seen in new construction because the additional weight (approximately 10 lbs. per foot) that is added to the building must be incorporated into the design.



Three commonly used types of single ply membranes include:

Ethylene propylene diamine (EPDM) is a type of thermosetting synthetic elastomer roof membrane that is glued or fastened to the roof deck.

Hypalon® is a rubber-like white membrane composed of high molecular weight chlorinated polyethylene (CSPE) that is mechanically fastened to the deck using a hot air gun for heat welding the seams.

Polyvinyl chloride (PVC) is a synthetic thermoplastic polymer prepared from vinylchloride. Similar to Hypalon, PVC is a white membrane that is installed using heat welding with a hot air gun to weld the seams.

Spray Polyurethane Foam (SPF)

SPF coating is another method to cover an existing roof. A self-setting polyurethane foam is sprayed over the deck surface, usually between 1/2" and 1-1/2" thick to provide a water-tight seal and control slope and drainage. SPF requires an additional protective coating to provide long-term weatherproofing, ultraviolet protection, resistance to roof traffic and to pass fire codes.

Acrylic Roof Coatings

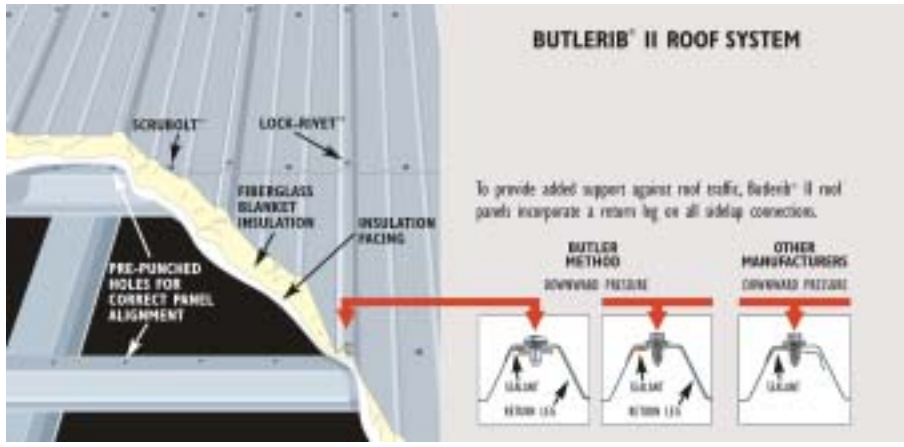
Acrylic roof coatings are required for SPF applications and may also be used with other roof systems for extended protection and system life. Roof coatings, or "roof paint," comes in a variety of colors and mixtures to adhere to different SPFs or membranes. It is important to check manufacturer's compatibility recommendations to ensure the paint adheres and therefore maintains a weather-tight seal.

Metal Roof Systems

A metal roof is a comprehensive system. The design or "pre-engineering" of the roof system, done by the manufacturer of the steel components, includes structural supports as an integral part of the solution. In repair or retrofit applications, it means you can avoid the time and costs associated with tear-off and repair of existing substrates because the new roof structure will, in most cases, be installed over the existing roof. More accurate cost projections are possible because often there is no need for exploratory tear-off to assess damage. In new construction, a metal roof is an integral part of the building design. Its construction can be handled by a single contractor, whereas other roofs often involve the coordination of several contractors with diverse areas of expertise. Another advantage is that the manufacturer designs and engineers each roof to meet local building codes for conditions such as wind, fire, hail, etc.

Through-fastened R-panel

Metal roofs typically employ 24 to 26 gauge coated steel panels installed over structural support and are designed for low-slope applications. Steel panels may be corrugated for additional rigidity and aesthetic reasons. The steel panels are fastened to the structural support at their sidelap and/or endlap joints.



Through-fastened R-Panel

One method used to connect ribbed panels is with self-drilling screws, nuts and bolts or rivets. With this type of system, gasket washers are used to provide weatherproofing. Neoprene washers are widely used, but dry and crack over time to exposure and are a potential cause for leaking. EPDM washers provide longer life protection against drying and cracking than the less-expensive neoprene washers.

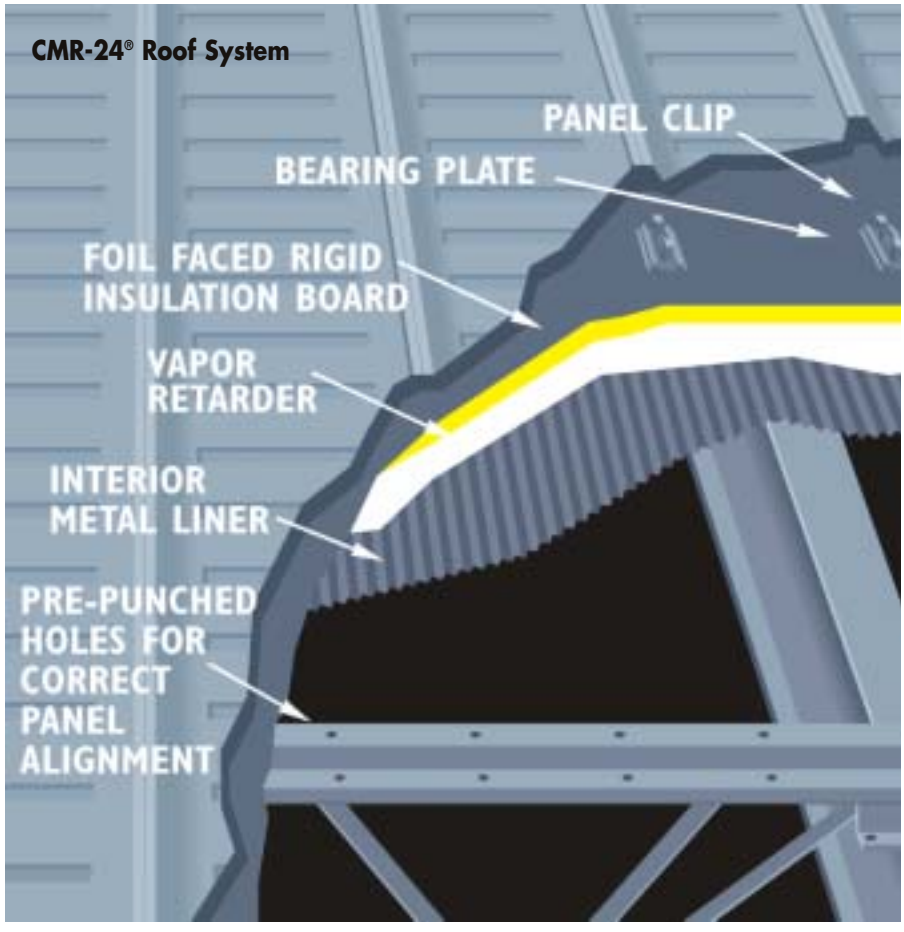
Panel joints may be sealed and waterproofed during installation using butyl rubber sealants and tape. Some last beyond the warranty life while lower quality sealers may last only a few years.

Butlerib® II Roof System

Butler Manufacturing Company offers a ribbed panel metal roofing system widely used on low-slope applications. The Butlerib® II roof system features an exclusive return leg to provide extra support at the overlap and a special sealant groove to ensure the sealant is applied at the proper location. Lock-Rivet™ fasteners attach the panels to the support structure without working lose over time. The Lock-Rivet head circumference is greater than the EPDM washer to provide additional protection from ultraviolet radiation and harsh weather conditions for additional life. Each panel is coated with Butler-Cote® (a fluoropolymer containing 70% Kynar 500® or Hylar 5000® resin). Pre-designed and factory-fabricated accessories (curbs, gutter, etc.) are available to minimize field modification and help maintain a weather-tight fit.

Standing Seam Metal Roofs

Another type of metal roof for low-slope applications is standing seam. This system incorporates panels designed and manufactured at a quality-controlled factory and seamed together on site. This method employs a portable electric roll forming machine that bends the edges of connecting panels together in one of several configurations to form a water-tight seal. Panels are designed with male and female edges that fit snugly together prior to forming. The bending or forming creates the water-tightness and strengthens the bond between panels. The panels are attached to the structural support with specially designed clips that allow for expansion and contraction from temperature changes.

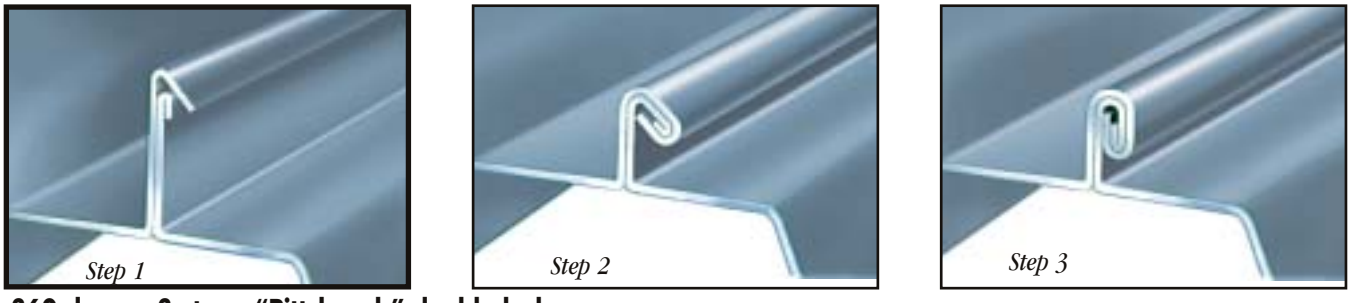


MR-24® Roof System – The Industry Standard

Butler manufactures two types of standing seam roof systems that use a 3-stage Pittsburgh double lock seam. MR-24® and CMR-24® roof systems by Butler assemble to produce a roof that acts like a monolithic steel membrane to protect buildings. Every connection is factory punched to ensure proper alignment and efficient installation.

Clips are made with stainless steel tabs that are 50% stronger than the galvanized standing seam tabs used by other manufacturers. The clips allow for 1-1/4 inches of movement in either direction to allow for expansion and contraction. Roof spans can be up to 250 feet wide without requiring special expansion joints. With special expansion joints, roof spans are virtually unlimited.

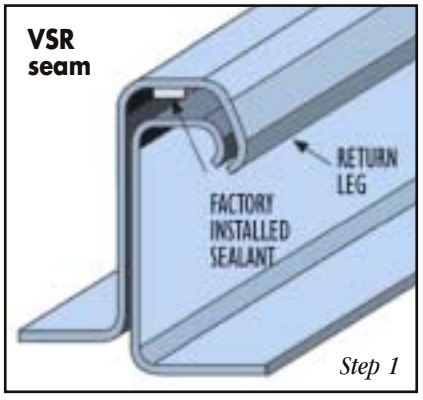
The CMR-24 system is like the MR-24 but is used when construction dictates a metal liner panel. The CMR-24 roof system includes a high R-value insulation board between the MR-24 panels and the corrugated interior metal liner panel. Both system panels are made of varying gages of aluminum/zinc coated steel and feature the durable Butler-Cote finish system, available in an array of colors. Butler's 25 year warranty also applies.

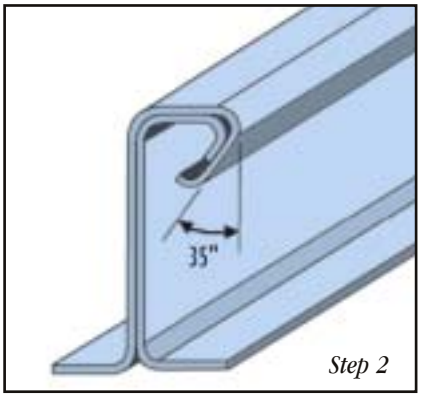


360 degree 3-stage "Pittsburgh" double lock seam

VSR™ Roof System – Strength and Beauty

The VSR™ roof system by Butler employs a modified roll formed seal (shown below) and extra protection against the elements in the form of a factory applied sealant.





All panels are also punched at the factory for precise alignment. Moveable clips allow for up to 2" of movement in either direction to allow for expansion and contraction of the roof. Panels are available in 22 and 24 gage and feature the Butler-Cote finish system for protection, available in an array of colors to give designers and building owners great latitude with design decisions.

The VSR system is very versatile and economic to install and maintain. It provides the strength, durability and weatherability of MR-24 that designers and building owners want to create a stronger visual impression. The system is engineered to accommodate complex roof configurations. It delivers clean flashing, hip and valley designs and can accomplish popular architectural treatments such as mansards and fascias.

A VSR roof can also be used as a structural or non-structural system; for new construction or for retrofit applications; or for both high-and low-slope roof designs. In non-structural applications, it is often installed over plywood or other substrates and can accommodate up to six inches of insulation for exceptional energy efficiency.

Standing Seam vs. Through-Fastened R-panel Metal Roof Systems

To determine whether a standing seam or through-fastened R-panel metal roof system is best for a particular application, you need to consider five factors.

The desired longevity and serviceability

Through-fastened R-panel roofs generally cost less to install, however, standing seam metal roofs tend to last longer. The longer life of standing seam metal roofs can be attributed largely to their ability to accommodate expansion and contraction more effectively.

Spacing of existing structural members

Standing seam systems are typically limited to structural spans of 5' or less. Through-fastened R-panel systems can be designed for spans of greater distance than 5'.

Amount of insulation required

Additional insulation (higher R-values) create larger temperature differentials and increase expansion and contraction movement in all roofs. Standing seam roofs are designed to accommodate expansion and contraction much more effectively.

Length of panel run

Through-fastened R-Panel roofs are typically limited in length as a means of dealing with expansion and contraction issues. Butlerib II roof systems are available with a maximum length of 40'. Standing seam roofs typically span as much as 250' before special expansion joints are required.

Slope or pitch of the existing structure

Though-fastened R-panel roofs are not designed for extremely low-slope roofs. Not under 1" per foot is recommended and never below 1/2" per foot. Standing seam roofs can be used for roofs with slopes as low as 1/4" per foot.

New Construction Considerations

Any of the roofing systems mentioned previously can be used on new construction. You should allow for key considerations when making a final decision. Consult with a knowledgeable contractor and have them discuss how the following issues impact your roof system selection:

- Climate
- Roof size
- Roof angle
- Installation cost
- Maintenance cost
- Lifecycle cost
- Aesthetic considerations
- Building codes

Retrofit/Repair Considerations

In deciding which is the best method for repairing an existing roof, the decision may be more involved. Only certain types of roofing systems may be used effectively as repair options in certain applications. The following table outlines which systems work in different applications.

In many cases, the amount of damage may not be readily detectable until tear-off has begun.

Band-aid solutions such as patching membranes and applying additional layers of protective coating may cost less up front, but often lead to a quick return of problems. Metal roof retrofit applications give a building owner the added security and efficiency of simply installing a whole new roof system on top of an existing roof without the expense of tear-off and disruption of the business.

Allowable Reroofs Over Existing Roofing

Existing Roofing	New Overlay Roofing							
	BUR	Single Ply	Wood Shingle	Asphalt Shingle	Tile Roof	Metal Roof	Modified Bitumen	Spray Polyurethane Foam
Built-Up	Yes (.25:12)*	Yes (.25:12)	Yes (3:12)	Yes 2:12	Yes 2.5:12	Yes	Yes	Yes
Wood Shingle	NP	NP	Yes	Yes	Yes	Yes	NP	NP
Asphalt Shingle	NP	NP	Yes (3:12)	Yes (2.5:12)	Yes	Yes	Yes	NP
Asphalt over Wood	NP	Yes (.25:12)	NP	Yes	Yes	Yes	Yes	NP
Asphalt over Asphalt	NP	NP	NP	Yes	Yes	Yes	Yes	NP
Tile Roof	NP	NP	NP	NP	NP	NP	NP	NP
Metal Roof	NP	NP	NP	NP	NP	Yes	NP	NP
Modified Bitumen	Yes (.25:12)	Yes (.25:12)	Yes (3:12)	Yes	Yes (2.5:12)	Yes	Yes	NP

NP = Not Permitted.
* Note: (Minimum Roof Slope)

Comparisons

In a recent nationwide survey* of the roofing industry, facts about the life span and overall cost of various roofing systems were compared. The results reveal that metal roofs, while sometimes presenting higher up-front costs, deliver a consistently very low lifecycle cost due to their longevity and low maintenance requirements.

Roof System Comparison

Low-Slope Roof Membrane	Average Life	Installed Cost	Maintenance Cost	Disposal Cost
Asphalt-organic Felt & Asphalt BUR	14.7	2.27	0.12	0.86
Coal-tar Organic Felt & Pitch BUR	23.0	2.97	0.14	1.10
Asphalt-glass Felt & Asphalt BUR	16.7	2.28	0.12	0.81
Asphalt-glass Felt & Pitch BUR	17.7	2.87	0.09	1.07
Coal-tar-glass Felt & Pitch BUR	21.9	3.23	0.10	1.12
APP Multiply Modified Bitumen	13.7	2.35	0.12	0.72
SBS Multiply Modified Bitumen	15.9	2.70	0.11	0.93
Polyisobutylene	10.6	2.76	0.09	0.76
EPDM (Ethylene-propylene-diamine)	14.2	2.21	0.10	0.98
Reinforced Polyvinyl Chloride	13.8	2.54	0.11	0.84
Reinforced Hypalon, CPE	12.8	2.69	0.11	0.75
Other Thermoplastic Single Plies	12.7	2.61	0.11	0.73
Foamed in place urethane	12.1	2.57	0.15	1.27
Prefabricated Sheet Metal	25.0	4.94	0.11	1.27+
Butler Roof Systems	30.0	5.08	0.002**	1.27+

*The Fourth International Symposium on Roofing Technology

**KPMG. A leading public accounting firm has examined this data and found that roof maintenance costs for the MR-24® Standing Seam Roof System had "substantially lower maintenance expenses than other similar roof systems".

+ Cost for labor only. Steel is recyclable. Overall disposal cost can be even lower if the steel is sold to a recycler.

Summary

The final determination of which roof system to use should always be done with the advice and counsel of an expert. In addition to issues previously presented, you will want to get answers to the following questions before making a final decision.

1. Who will secure an engineer for structural certification?
2. What are the inherent risks of moisture damage during construction or during tear-off in a reroof application?
3. Who will provide temporary interior moisture protection?
4. Who will be responsible for relocation of office furnishings, stock or inventory to prevent possible water damage?
5. Who will handle removal and/or replacement of landscaping, damaged sidewalks, curbs and paved surfaces?
6. How will traffic flow around the building be affected?
7. What is the time frame/completion date for the project?

Butler Manufacturing Company also has a network of highly trained and skilled Butler Builders® throughout the world. Your local Butler Builder® is an expert in all building codes, permits and the type of roof systems best suited for your area. Rely on their expertise. To find the Butler Builder® nearest you, simply visit **www.butlerbuilder.com**. For more comprehensive information on Butler products and services, visit **www.butlermfg.com**.

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Appendix A

Basic Roof Maintenance Guide

The roof of your building is an area that is seldom seen and consequently too often forgotten in planning routine building care. Roof systems are designed to withstand the severest of weather conditions and provide years of maximum protection at the lowest possible cost; however, certain areas of the roof are not completely immune to the effects of severe weathering. Following these simple suggestions will greatly enhance the probability of continuing trouble-free service.

1. Protect the Roof from Foot Traffic

Roof traffic should be kept to an absolute minimum but when access to the roof is required, the roof is designed to withstand normal traffic without sustaining damage.

When frequent or heavy traffic is anticipated, use roof service ways/walkway pads to protect the roof. This is particularly helpful where regular servicing of roof mechanical equipment is required or during the installation of such equipment that was not part of the original construction.

2. Roof Mounted Equipment

Roof mounted equipment should be mounted on curbs that are minimum 9" off roof surface. Curbs and flashings should be inspected regularly for signs of leakage.

In the case of metal roofs, water drippings from bare copper wire, copper pipe, or copper flashings contains copper ions, which are very corrosive to most bare panel materials. These items and adjacent panels should be painted to minimize the problem if the copper source cannot be eliminated.

Condensation from air conditioners should never be allowed to drain directly onto the roof. This condensate should be piped off the roof to drains. Plastic pipe is recommended. Never use copper pipe.

3. Restore Flashings Around Roof Openings

Flashings around roof openings for mechanical equipment, ventilation, roof jacks, etc., are particularly susceptible to deterioration from weathering. These areas should be inspected annually and resealed as needed.

4. Ice and Snow Removal

Excessive ice and snow build-up should be removed immediately to prevent damage from the freeze and thaw cycles or possible overload.

5. Keep Roof Free from Debris

Roof, curbs and gutter should be kept free of debris. The roof should be inspected periodically and any debris removed. Gutters and downspouts should be cleaned as necessary. Careful cleanup of all materials and debris following any roof activity or maintenance is extremely important. Drill chips, wire, metal scrap, insulation, and other debris left on the roof to weather and corrode can be very damaging to roof materials, and therefore should be removed immediately.

Also, flying debris from tools such as abrasive saws (hot saws) and welding equipment can create much roof damage. Extreme care and skill must be used with these tools.

Appendix B

Roof Inspection Worksheet

Use this form to perform seasonal inspections of your roof and as a guide to ensure proper maintenance is performed to extend roof life and reduce repair costs.

	Okay	Need Repair
Fasteners	☐	☐
Seams	☐	☐
Roof Drains	☐	☐
Roof to Wall Flashings	☐	☐
Exterior Gutter	☐	☐
Parapet Scupper	☐	☐
Valley	☐	☐
Skylights	☐	☐
Pipe Penetrations	☐	☐
Exhaust Fan Curbs	☐	☐
Mechanical Unit Curbs	☐	☐
Roof Slope Step Flashing	☐	☐
Interior Gutter	☐	☐

☐ Debris and foreign material have been removed from gutters, drain outlets and roof surface.

1. Are there any active roof leaks?

☐ Yes ☐ No

If yes, identify location and cause: _____

_____

2. Has previous roof repair work been done?

☐ Yes ☐ No

Describe the repairs made: _____

_____

3. Roof surface appearance:

☐ Ballasted (cannot see) ☐ Excellent ☐ Good

☐ Cracked ☐ Stained ☐ Rusted ☐ Split

☐ Alligatoring

4. Are there ponding water conditions?

☐ Yes ☐ No

If yes, identify cause and location: _____

_____

Notes: _____

_____

_____

_____

If you have any concerns or questions regarding the condition or proper maintenance of your roof, contact your local Butler Builder® – they will be glad to assist you.

To find the Butler Builder® nearest you, simply visit **www.butlerbuilder.com**.

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