

MAINTENANCE NEEDS: AN OWNER'S PERSPECTIVE

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Most building owners are insensitive to the fact that roof systems require periodic inspection and maintenance to perform as advertised. Probably contributing to this insensitivity is a lack of emphasis on maintainability during design. Manufacturers, on the other hand, are very sensitive to the need for roof maintenance, as they clearly define roof maintenance as an owner's responsibility in their roofing warranties. Installers are not pushing roof maintenance simply because owners are not demanding the service. Several contractor and manufacturer associations address the roof maintenance issue through seminars and published literature. The Roofing Industry Educational Institute offers an excellent course on roof maintenance. The writer applauds all efforts by the industry to introduce the roof maintenance concept to the building owner, but feels that the message is falling on deaf ears. Generally, the industry is geared towards new and reroof construction with very little emphasis given to roof maintenance needs, primarily because the consumer, the building owner, is not demanding this emphasis. The biggest need is an awareness of and a sensitivity to proper roof installation and maintenance by everyone involved in the roofing process—this includes the designer, manufacturer, installer and building owner. This article emphasizes the importance of proper roof installation and maintenance. It suggests ways that everyone involved in the roofing process can increase the probability of the desired result, a leak-tight facility and maintainable roofing system.

WHAT IS ACCEPTABLE?

Webster defines maintenance as "the work of keeping something in suitable condition." To a building owner, a suitable condition for a roofing system is a "no leak" condition.

Once a leak occurs, the building owner is in a no-win situation. Moisture is entrapped in the roofing system and in most cases will remain there until the wet materials are physically removed. The entrapped moisture starts to corrode or degrade roofing system components such as fasteners, insulation, decking and metal flashings. The thermal resistance of the roof insulation may also be significantly reduced. The water leaks into the facility interior, the perpetual "drip-drip" damages building finishes and furnishings, and most importantly, irritates the building occupants. A leak-tight facility may be asking too much, but this should be our goal.

WHAT IS THE OBJECTIVE?

The objective of proper roof installation and maintenance is to have leak-tight roofs and reduce the life-cycle cost. Reroofing can be an expensive process. Cost to the Air Force for a tear-off and reroof can range from \$2.60 to \$6.97 per square foot, depending on numerous factors, starting with the type of roofing system.¹ If you install a new roof and do

not inspect and maintain the roof, it usually will be leaking after a couple of freeze/thaw cycles, and you will be reroofing at about half the expected life of the roofing system.² This no-maintenance approach costs about 15 cents per square foot each year, figuring \$3 per square foot replacement cost, a 20-year design life for the roofing system and money discounted at 10 percent per year. The alternative, proper roof inspection and maintenance, costs about 3 cents per square foot each year.¹ The choice of annual roof inspection and maintenance compared to no maintenance may offer as much as a 5-to-1 payback ratio.

When it costs too much to stop the roof from leaking, or unsafe conditions exist, the roof gets replaced. Following are some suggested roof replacement criteria: (1) annual maintenance and repair costs consistently exceed 5 percent of the roof replacement cost; (2) roof leaks persist despite maintenance and repair efforts; (3) roof systems or supporting structures become severely weakened by moisture or other elements to the point where an unsafe condition does or could exist; and (4) roof insulation becomes wet and loses 20 percent or more of its insulating ability on the average over the entire roof area.²

HOW THE DESIGNER CAN HELP

If the building owner begins with a roofing system that has built-in maintenance concerns, the chances of maintaining a leak-tight condition for an extended period of time are bleak. The following concepts can significantly increase the maintainability of a roofing system by design.

Slope-to-Drain

Virtually all the roofs in the world can be classified as either waterproofing or watershedding roofing systems. A waterproof roofing system provides a continuous, impermeable membrane that enables the roof to hold water until the water can either be removed by the drainage system or evaporate. The most commonly used waterproofing membranes are built-up, ethylene propylene diene terpolymer (EPDM), modified bitumen (MB) and polyvinyl chloride (PVC). A watershedding roofing system, on the other hand, cannot hold water and relies on slope to remove the water. Watershed systems include all forms of shingle and tile roofs such as asphalt, metal, clay, concrete, slate and wood.

Slope-to-drain sounds awfully basic, but it is a known fact that water flows downhill. Most waterproofing membrane manufacturers recognize the wisdom of roof slope and will void their warranty for ponded water areas on their system. The exclusion from coverage as written in most warranties generally reads as follows: "Damage resulting from lack of positive, proper or adequate drainage; ponding on roof." About one-third of the approximately 180 warranties and

guarantees surveyed contain this exclusion.

Waterproofing membrane roofing systems require slope-to-drain. More often than not, building owners find interior roof drains located at columns for obvious reasons. Deflection of the structure over time can leave drains located near columns high and dry. To maintain slope-to-drain over time, consideration should be given during design to locating roof drains at one-quarter to midspan. One-quarter inch per foot slope has proven to provide adequate drainage for the field of the membrane, but building owners still find ponded water on roofs with this slope specification. Lack of consideration of the roof topography is usually the cause. The designer should not just specify a standard slope per foot but should make provisions in the design for positive drainage. In order to achieve the necessary design roof slope, the designer must consider the structural framing of the roof, the deck type, the membrane specification, roof deflections, the building layout, location of roof drains and roof mounted equipment.³ Crickets should be specified and shown on a roof plan for low or flat areas between drains and on the high side of all curbs located perpendicular to the roof slope.⁴ If these measures are taken, one-quarter inch per foot slope should provide adequate drainage. Greater slopes for waterproofing membrane roofing systems aren't necessary for drainage and may not prove cost effective over a life cycle.

Watershedding roofs with a slope greater than 3 inches in 12 inches should be specified whenever practical. Watershedding roofs require minimal inspection and maintenance. Inspection frequency for watershedding roofs should be once every three years as opposed to twice annually for membrane roofs. However, the drainage system of all roofing systems, whether waterproofing or watershedding, should be inspected and cleared of debris semiannually or as required.

For reroof construction, slope conversion from a low-slope membrane roofing system to a watershedding roofing system should be considered where practical. This conversion may be cost effective when considering life-cycle costs, particularly for smaller buildings.⁵

Details That Work

The National Roofing Contractors Association (NRCA) and the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) provide standard generic roofing details for the roofing industry. Details not found in the *NRCA Construction Details* or the *SMACNA Architectural Sheet Metal Manual* probably should not be used.

Pitch pans and embedded metal conditions should be avoided whenever practical. Pitch pan filler may shrink and crack and provide a leak path directly into the facility. If pitch pans are absolutely necessary, provide a watertight umbrella over the pitch pan. Metal embedded in the roof membrane may eventually split the membrane or the membrane may pull away from it, resulting in a leak. If embedded metal edge flashing cannot be avoided, elevate the detail so that water does not drain over the embedded metal condition. In some instances, embedded metal is necessary (e.g., lead at roof drains), and in other instances, it typically does not present problems and can be successfully used (e.g., lead at vent, trap and return penetrations and small flanges of mechanical/electrical equipment penetrations).

Another common problem to the maintainer is mechanical equipment stands located too close to the membrane, hin-

dering maintenance efforts in that area. Proper clearance for mechanical equipment frames are shown in the *NRCA Roofing and Waterproofing Manual*.⁴

Fixing base flashings to both walls and roof decks that allow independent movement should be avoided for built-up and modified bitumen roof systems. This is mentioned because it is a common error found during maintenance inspections. EPDM and PVC membrane systems can be attached directly to walls that do not support the roof deck.⁴

Expansion joints and area divider details should be elevated a minimum of 8 inches above the plane of the waterproofing membrane. The top of any base flashing detail or penetration through the roof should also be a minimum of 8 inches above the membrane. This should prevent water from draining over or behind the detail.

REDUNDANCY

Preventing leaks is the goal of a maintenance program. If the system has no redundancy at known weak points, how could you ever hope to achieve this goal? The maintainer has to react on early warning signs and perform needed maintenance before the water is allowed to enter the roofing system and eventually the facility interior.

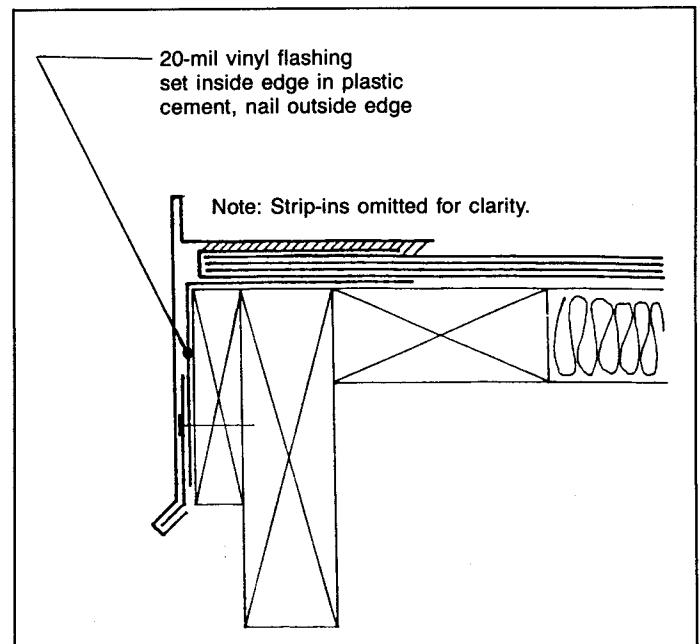


Figure 1 Gravel stop section showing redundant additive (Courtesy of Bradford Roofing and Insulation, Billings, Mont.)

The weak points for built-up roof systems are traditional flashings and embedded metal conditions. Eighty percent of built-up roof leaks can be traced to these two locations.⁶ Base flashings should be a minimum of two plies so that open laps or tears can be detected during a maintenance inspection and repaired before water is allowed to enter the roofing system. Several methods are available for providing redundancy at embedded edge metal details. Three recommended details that work are shown in Figures 1 through 3. These details may look like expensive overkill, but if these provisions are made during the design, the cost is insignificant when compared to total project cost. Furthermore, they provide the building owner with system redundancy at a known weak point.

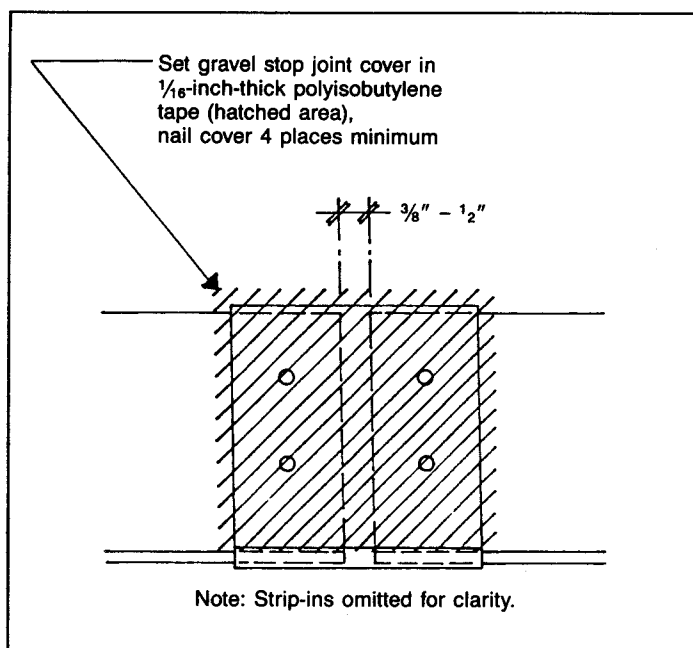


Figure 2 Gravel stop plan showing redundant additive
(Courtesy of Bradford Roofing and Insulation, Billings, Mont.)

Forty percent of the callbacks on single-ply roofing systems during the first year after installation are to fix leaking seams (lap or flashing defects).⁷ Most single-ply seams do not have redundancy and provide a direct path for water into a facility once they fail. Single-ply seams without redundancy can be a real problem to a maintainer. The building owner needs a telltale sign at the one-ply seam, backed up by a redundant condition, that can be noted during a maintenance inspection and fixed before leaks occur. Without seam redundancy, a one-ply system should not be considered maintainable.

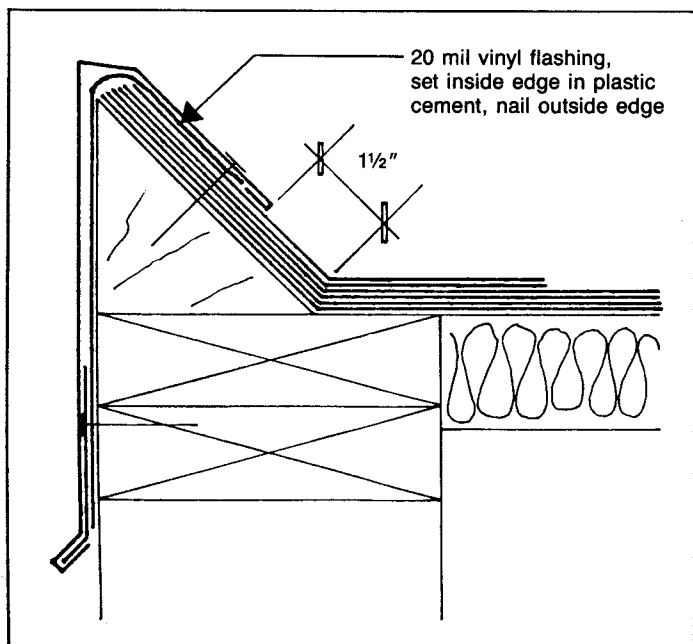


Figure 3 Metal roof edge section showing redundant additive
(Courtesy of Inspec Inc., Minneapolis, Minn.)

Accessibility

Once again, preventing leaks is the goal of a maintenance program. If the weak points of the system are not readily accessible for inspection and maintenance actions, this goal cannot be achieved. For this reason, ballasted or protected membrane systems using a single-ply are not considered maintainable systems. The weak points of the system, the seams, are not readily accessible for inspection and necessary maintenance actions. The logistics of moving and storing the ballast make maintenance of these systems virtually impossible. Where can the 10 to 12 pounds per square foot of ballast be piled while the seams are being inspected for potential leak problems? Will the structure hold the concentrated load of a rock pile consisting of stones from 3/4 to 1 1/2 inches in diameter? A more basic question is how the ballast can be cleared away from the membrane seam; procedures such as using a shovel or small front-end loader could cause more leaks. Paver systems could be more easily removed and reinstalled for maintenance inspections and repairs. However, the tongue-and-groove interlocking features provided with some paving systems could present quite a challenge with time.

Minimize Penetrations Through The Roof and Equipment on the Roof

Each penetration through the roof membrane is a potential leak source and a maintenance liability. Route the penetrations through side walls when possible. Do not mount mechanical equipment on the roof unless absolutely necessary. Contrary to popular belief, a low-slope roof is not a mechanical work platform. Equipment on the roof attracts non-roofing trades to the roof surface. Lack of understanding and respect for membrane integrity by other trades will increase the maintenance factor for the roofing system.

HOW THE MANUFACTURER CAN HELP

The industry has been flooded in the past 10 years with many new roofing products that have not passed the test of time. Generic standards are not available for some materials now in use. Systems are being installed by contractors with minimal training. All of these factors often leave the naive building owner with short-lived roofing systems that cannot be maintained. Following are some suggestions on how the manufacturer can help deliver more maintainable roofing systems.

Material Standards

Generic material standards are necessary to establish a benchmark of product acceptability. The author is defining a generic standard as one developed by a non-proprietary organization such as the American Society for Testing and Materials (ASTM). Until about three years ago, roof material standards were not available for the single-ply membranes most frequently used in industry. Standards are available for PVC and EPDM membranes. They are ASTM D4434-85 and ASTM D4637-87, respectively. Both of these standards are relatively new. How good are these standards? Time will tell.

A major concern is the lack of a generic material standard for modified bitumen roofing materials. This product comprised approximately 16 percent of the market in 1986 and 13 percent in 1987.⁸ About 50 companies are marketing over 120 different modified bitumen roofing systems without a generic standard. Eighty percent of the modified

bitumen companies have 10 years or less field installation experience in the United States.

Building owners that are thinking about maintenance programs should be looking for roofing systems that meet generic material standards and have passed the field performance test of time.

Manufacturers can help by continuing to work through organizations such as ASTM to develop and refine material standards for all generic roofing materials. The author greatly appreciates the efforts of manufacturers that are deeply involved in standards development and encourages those who are not to get involved. Maintenance-oriented owners are watching and taking notes on those manufacturers that are not interested in standards development.

Approved Applicator Program

Although product sales volume is the objective of most manufacturing companies, selling roofing products to installers without any kind of specialized training can often leave the building owner with a very short-lived roofing system that cannot be maintained. Owners should question the qualifications of the installer; but likewise, the product manufacturer also should question the qualifications of the installer.

Speaking from experience, if a building owner has a prematurely failed roofing system due to poor workmanship, the installer most likely will not be used again—and most often neither will the manufacturer of the membrane. This may sound unfair, but quite often the manufacturer will carry the black eye of a poor installation even though the roofing system was not warranted or guaranteed and the materials did not fail.

The quality of “approved applicator” programs varies with manufacturers. Some manufacturers do not have applicator training programs. Manufacturers need to get serious about their approved applicator programs and publicize to the industry that a quality roof system installation by an approved applicator is key to delivery of a maintainable long-life roofing system. Owners should insist on working only with manufacturers that have quality “approved applicator” programs.

Following are some of the requirements that manufacturers require their approved applicators to meet:

- Pass three out of five roof inspections by an independent auditor.
- Be in business for three years.
- Belong to the NRCA and an affiliated association.
- Meet minimum insurance requirements.
- Receive appropriate system application training.
- Ninety percent of all the work must be performed by the contractor’s employees.
- Must have adequate and appropriate equipment.

Involvement in the Design and Construction Process

Manufacturer involvement in both the design and construction processes is absolutely necessary for the delivery of a maintainable roofing system to the building owner. Only the manufacturer knows the unique design and construction limitations for its particular roofing system. Building owners need to be aware of this and ensure that manufacturers are involved in the design and construction process.

Most manufacturers provide both system-unique and area-specific details and specifications for their products. Main-

tainable roofing systems must comply with these manufacturer recommendations.

Manufacturers need to be involved in the design and construction process and should publicize this fact to building owners and designers. As a minimum, the manufacturer should review the project drawings for compliance with its recommendations, attend the pre-construction conference and inspect the job both during construction and after completion of the project.

Emphasize Owner Maintenance Responsibilities

Warranty and guaranty programs suggest or imply a hands-off response from the building owner. The building owner has the responsibility to understand and uphold certain obligations under any such agreement, but manufacturers could, with minimum effort, increase the longevity of roofing systems by emphasizing owner maintenance responsibilities up front.

Manufacturers proudly market five-, 10-, 15- and 20-year warranted roofing systems, but almost without exception, manufacturers fail to emphasize the fact that the building owner plays a key role in keeping the building “in the dry” after the first year of waterproofing service. As a minimum, most roofing warranties require the building owner to keep the drainage system free from debris. Maintenance of all metal work to include metal embedded in the roofing membrane is usually owner responsibility. Base flashings and ponded water areas are also user maintenance liabilities. The NRCA, the Asphalt Roofing Manufacturers Association, the Roofing Industry Educational Institute and the government have published generic maintenance and repair guides. Publication of owner-oriented and system-specific roof inspection, maintenance and repair procedures by manufacturers would be extremely helpful.

HOW THE INSTALLER CAN HELP

A roofing system riddled with workmanship problems cannot be maintained. Many experts believe that continuous visual inspection by trained personnel is the key to a quality installation, but this author contends that having trained, motivated installers is the key to a quality installation.

Trained Installers

Most people want to do a good job but lack the knowledge to do it. The reduction or elimination of callbacks on one roof job probably would pay for an installer training program. Building owners must demand this training commitment from installers if they want to buy maintainable roofing systems. Excellent training programs sponsored by both contractors and manufacturers are readily available. Manufacturer training programs can be as thorough and effective as the installer demands. The more than 60 roofing contractor associations offer or promote many installer training programs. Owners should verify the credentials of not only the roofing company but also the installers of their roof systems.

Quality Installations

Quality control needed to obtain a quality installation is a contractor responsibility. However, the building owner has the responsibility to provide adequate funding to sponsor a quality installation. An emphasis by contractors to encourage owners to purchase top-of-the-line roofing systems

is needed to improve the quality and maintainability of the finished product. Most manufacturers will only let well trained and highly qualified contractors install their top-of-the-line roofing systems.

HOW THE BUILDING OWNER CAN HELP

Since building owners fund the installation of roofing systems, they seldom assume responsibility for a roof leak. As soon as the roof starts leaking, the owner looks to either the designer, the installer and/or the manufacturer for relief. If the roof leak is not fixed to the building owner's satisfaction, quite often an attorney is brought in. More often than not, the building owner contributes to most roof leaks due to lack of roof maintenance. Following are some suggestions on how the building owner can help maintain a leak-tight roofing system.

Provide Adequate Funds

The old "pay me now or pay me later" adage holds true for the installation of maintainable roofing systems. Owners must commit adequate funds to the project to provide for proper design and installation, and to buy the manufacturer's best quality roofing system. This commitment buys many of the key elements mentioned earlier that are absolutely necessary to obtain a maintainable roofing system, i.e., manufacturer involvement in the design and construction process, a trained and qualified installer and an extended warranty agreement.

The owner should also provide funding for a third-party quality assurance inspector. This person should have full authority to shut the job down when work is not going according to specification.

Accept Maintenance Responsibility

Roof maintenance is a building owner's responsibility. The building owner must commit to performing semiannual inspections with follow-on maintenance actions or fund for third-party accomplishment of these actions. Staying "in the dry" after the first year of construction is dependent upon the quality of the design, roof installation, materials and the effectiveness of the owner's maintenance program. Missed maintenance can lead to premature roof failures. If maintenance actions aren't performed and documented by building owners, then valid claims against the designer, manufacturer or installer for design, material or workmanship problems become extremely difficult to administer.

ROOF WARRANTY—LAST RESORT

We have discussed how everyone involved in the roofing process can improve the maintainability and leak-tightness of a roofing system. A well-written warranty agreement between the building owner and the manufacturer can consummate the roof construction process by clearly defining limits of responsibility during the service life of the roofing system. Clearly, the building owner is responsible for the leak-tightness of the roofing system. This involves identifying early warning signs at system weak points and performing necessary maintenance before leaks occur. Defects attributable to material or workmanship can usually be referred to the manufacturer for correction. If the roof leaks and the building owner can prove that it was not owner or designer negligence that caused the leak, then the manufacturer most likely will stop the leak. Building owners should realize that staying "in the dry" after construction is complete is primarily their responsibility. At best, they may get the system manufacturer to "stop a leak" or "fix a defect." We building owners, pay money for a warranty/guarantee that limits the writer's—the manufacturer's—responsibility.

SUMMARY

In summary, the road map to a maintainable roofing system and staying "in the dry" is as follows:

- Concentrate on maintainability during design.
- Buy the manufacturer's best quality system.
- Demand trained, qualified installers.
- Commit to a semiannual inspection and maintenance program.

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