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Roof Maintenance Master Plan: A Strategy for Preserving a Roof's Useful Lifespan

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The manner in which a roof and its appurtenances integrate with the façade and impact the spaces within is critical to the overall health and longevity of a building. Water infiltration and other causes of building deterioration damage far more than the original point of entry if not diagnosed, treated and prevented through long-term care and maintenance. So, how does a building owner ensure that a roof withstands the tests of time and Mother Nature? One calls upon a design professional to create a roof maintenance master plan.

For a building to sustain its integrity 15, 20 or even 50 years into the future—through all that the environment and time have doled—requires the development and utilization of a financially sound and time-sensitive plan. In a world driven by timelines and bottom lines, it is not by accident but rather through the care and attention of a facility manager, property manager or building engineer that a structure—including its roofing systems—is successfully maintained at reasonable expense to the owner. An effective roof maintenance master plan enables a facility manager to identify, budget and manage for anything from the eventuality of minor repairs and routine maintenance to a full roof replacement, by providing a cost-effective and time-efficient strategy for

extending and preserving the useful life of a building's roofing systems.

Though contributing factors vary due to the diversity among buildings in terms of design, function and current conditions, the criteria necessary to create a successful roof maintenance master plan remain consistent across the board. The key elements include a comprehensive review of all existing plans and specifications followed by on-site evaluations of existing conditions, and, finally, the development of recommendations for maintenance and remedial action that will well-prepare managers for the upkeep of the roofing system.

As all roof systems inevitably deteriorate over time, the creation of a master plan is viable for a single building with multiple roofing systems, for a collection of buildings with single roofs or for any combination in between. Age and geographic location matter not; the question is how to initiate the plan.

An investment in a roof maintenance master plan is as important as a manufacturer's roofing warranty when it comes to ensuring that the building and



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Scott D. Chamberlain and Paul C. Lanteri, AIA, Project Manager and Senior Architect with Hoffmann Architects, develop a variety of roof maintenance master plans for the firm.

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▲ One of the most noticeable and, often, most troublesome signs of a failed roofing system is interior water damage.

its contents are protected from water damage. One does not preclude the other. A manufacturer's warranty does not relieve the owner of the responsibility of proper roof maintenance. In fact, a lack of proper maintenance not only increases the rate of deterioration but will very likely void the warranty as well.

Visual Inspection

The development of a roof maintenance master plan begins with a comprehensive visual inspection. And, as consistent, ongoing attention is critical to the plan's success, semi-annual inspections should be conducted each spring and fall. These inspections are best made by a design professional, accompanied by the structure's facility manager, property manager or building engineer. The manager or engineer should conduct additional roof inspections after severe storms or other events that may cause structural damage to the building.

During a roof inspection, problem areas should be examined to detect the root causes of deterioration and to determine the most effective repair solutions. By detecting and addressing the causes—both natural and man-made—early on, a building owner can avoid even more costly roof repairs and/or replacements in the future.

How to begin

The first step in a roof inspection is to prepare a plan of the roof showing the location of all penetrations and rooftop equipment. This plan will be used to locate any detrimental conditions that are observed during the examination of the roof.

The second step is to observe conditions at the interior of the building. Walls and ceilings are checked for signs of water infiltration, such as leaks and staining. Later, any negative conditions will be correlated to conditions found at the roof surface.

After inspecting the interior, the exterior walls or overhangs are examined for signs of moisture damage, structural movement (cracks or material displacement) or other deterioration that might relate to the roof or explain moisture damage at the interior.

What to look for

Finally, the following questions should be considered during inspection of the roof itself:

- Are there any conditions that would prevent a safe inspection of the roof?
- Is trash or debris present?
- Does the roof appear to be draining adequately?

All roof components—the field of the roof, base flashings, cap flashings, drains, penetration pockets, rooftop equipment and skylights—should be examined, and it is important to do so in the same order during each inspection. Observed conditions should be compared to those found during previous inspections.

Field of the roof

When examining the field of the roof, ensure that:

Causes of Deterioration:

Natural

- Long-term exposure to the elements such as the sun, water and freeze-thaw cycles;
- Extreme weather such as hail, lightning, high winds and extremely heavy rain;
- Structural movement such as building settlement and thermal expansion and contraction;
- Animal intrusion, such as insects and birds;
- Biological growth including algae, vegetation and fungus; and,
- Exposure of the roof to air pollution.

Man-Made

- Inadequate design of roofing elements, drainage and structural systems;
- Defects in manufactured materials;
- Installation deficiencies including improper preparation of substrates, improper storage of materials and installation of roofing materials during inclement weather;
- Improper installation of penetrations or equipment following the original roof installation;
- Changes in the interior use of the building that could cause condensation problems;
- Contaminates either spilled or exhausted onto the roof; and,
- Abuse, vandalism and excessive rooftop traffic.



▲ Inappropriate repair measures can do more harm than good. Here, roofing mastic used to patch this balustrade base led to further water retention and deterioration.

- surface coatings (if present) are not deteriorated;
- laps in membrane are sealed;
- membrane is free of wrinkles, blisters, ridges, worn spots, cracks or holes;
- insulation fasteners are not protruding through the membrane;
- there are no spots where the roof surface feels soft; and,
- the ballast (if any) is evenly distributed.

Base flashings

Areas where the field membrane terminates at walls, curbs, parapets, etc. should be examined to ensure that:

- the top of flashings are sealed;
- termination bars are securely fastened;
- flashings are well adhered and have not slipped;
- laps in flashing membrane are sealed;
- there are no splits, cracks or holes in flashing; and,
- there are no signs of excessive weathering at flashing.



▲ While attractive as landscaping elements, trees can pose problems when allowed to overhang a flat roof for an extended period of time. This tree's shed pinecones and needles retain moisture and provide an ideal climate for bird nesting and organic growth, both of which can severely damage roofing materials.

Cap flashings

When examining copings, counter-flashings, expansion joint covers, etc. that protect membrane terminations, ensure that:

- fasteners are not loose or missing, and that they are well sealed;
- sections of the cap are not loose or missing;
- metal components are not corroded;
- materials are not deformed or sloped to direct water toward joints; and,
- sealants are not deteriorated.

Gravel stops or metal roof edges

Gravel stops or metal roof edges should be examined to ensure that:

- metal is well secured with no missing sections;
- there are no open joints between sections of metal; and,
- sealants are not deteriorated.



▲ In this case, a cementitious coating left the brick parapet saturated with trapped moisture, which eventually caused spalling and crumbling of the masonry.



▲ A dramatic example of *ponding*, or water retention on the roof membrane.

Drains

When examining drains, ensure that:

- drains are clean and free of obstructions; and,
- clamping rings are securely in place.

Penetration pockets

Penetration pockets should be inspected to ensure that:

- pocket is filled with the proper sealant;
- sealant is well adhered to metal;
- pipe boots and flanges are tightly sealed to the roofing membrane; and,
- tops of pipes are tightly sealed.

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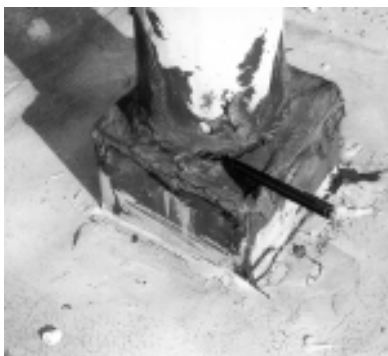
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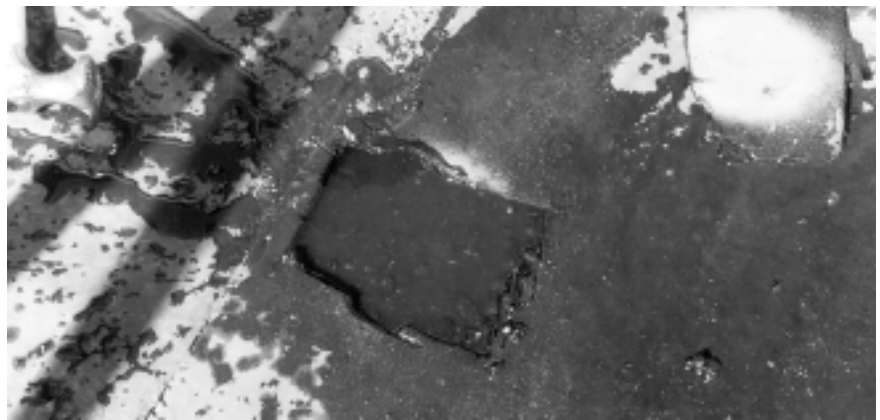
▲ Counterflashing is designed to protect the termination of an up-turned roof base flashing. This counterflashing has dislodged, exposing the base flashing and allowing water to slip behind the assembly near the corner of the wall.



▲ Thermal factors often play a central role in roofing material deterioration. Due to expansion and contraction, this flexible termination bar has buckled between fasteners, leaving openings for water to infiltrate the EPDM roofing system flashings.



▲ A failed penetration pocket. The pen is inserted into a deep crack, which is a point of water entry.



▲ Although a roof may look good on the surface, test probes (roof cuts) can sometimes tell a different story. From top to bottom: here, removing the roofing membrane reveals underlying layers of saturated insulation.

Roofing equipment/skylights

- Evaluate indicators of deterioration that may cause a leak or associated problem.

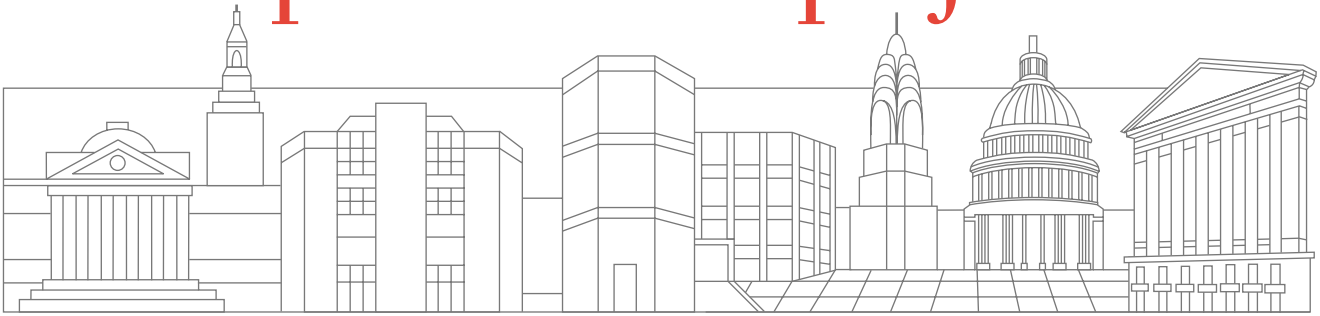
Evaluation and Recommendations

Once the visual inspection is complete, recommendations for repairs and/or roof replacements will be made based on

evaluation of the roof conditions and presented to the client in the form of a written report. Recommendations should accommodate budget, time and occupancy considerations and be prioritized according to the urgency of any repairs and/or replacements. (i.e. If a problem causes significant damage to a

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representative projects



Roof Maintenance Master Plans

Roof maintenance master plans are as diverse as the buildings for which they are developed. The following case histories depict the plans Hoffmann Architects has developed for an urban corporate manufacturing facility, a science and technology research center and a landmarked, historic structure.

Pfizer, Inc.

Brooklyn, New York

Pfizer, Inc.'s manufacturing facility in Brooklyn, New York consists of interconnected buildings, each with multiple roof levels, constructed from the late 1930s to the early 1950s.

Although the roofing at these buildings had been replaced in the recent past, the building owner expressed concern over leaks into the interior of the facility. The owner requested that Hoffmann Architects develop a remedial program to address the roofing problems with a particular emphasis on prioritizing areas for repair or replacement.

Hoffmann Architects and Pfizer, Inc. began the planning of this program with an initial review of conditions at the roofs. Observed at this time were conditions of heavy foot traffic related to equipment installation and equipment maintenance required by the constant need to upgrade the manufacturing process for the pharmaceuticals produced within the facility. A walkthrough was conducted

through the buildings' interiors to assess potential damage to finishes and disruption to the function of the facility.

Next, Hoffmann Architects conducted a survey to assess the conditions of the roofs and prepared a report that documented these conditions and evaluated the existing roofing materials and details. The firm developed recommendations for the repair or replacement of each roof, suggesting the best roofing system for each particular area based on activity on the roofs and interior occupancy. Recommendations were prioritized according to the severity of the leaks and to the sensitivity of the interior spaces below the roofs and were accompanied by opinions of probable construction cost.

Based on this survey, Hoffmann Architects developed a master plan to rehabilitate the roofs. Rehabilitation included designs for replacement roofing systems and the development of repair details for those roofs where replacement was not necessary. The firm successfully implemented the plan over a three-year period to provide a water tight roofing system for the complex.

The Landmark at Eastview

Tarrytown, New York

The Landmark at Eastview is a science and technology research center consisting of 12 buildings with 47 roof levels, totaling over 350,000 square feet of

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✓ Hoffmann Architects has developed roof maintenance master plans for a variety of facilities, including this urban manufacturing complex.



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roof area. After the purchase of the Landmark property in 1999, the new owners and their management company immediately initiated a program to evaluate and address exterior rehabilitation. Knowing that many of the roofs at the site were in poor condition, based on a brief survey conducted prior to the purchase of the property, management's first task was to prioritize the severity of the conditions. To accomplish this, Hoffmann Architects was retained to develop a roof maintenance master plan.

Hoffmann Architects began by gathering information, including the review of as-built drawings and specifications, shop drawings, construction field reports and other documentation helpful in forming a basic understanding of the design of each building and the conditions under which each was constructed.

Next, the firm conducted an in-depth investigation to verify existing conditions related to building construction and to re-evaluate the condition of existing roofing systems. During the investigation phase, samples of roofing and other construction materials were collected and tested for the presence of hazardous components such as asbestos. This step was key in determining accurate budgetary costs for removal of such materials should repairs or replacement be required.

Finally, Hoffmann Architects presented the owner with a master plan that indicated the condition of each roofing system, the priority for which the roof replacement should take place based on the severity of conditions, the recommended replacement systems and estimated construction costs for the work.

Accommodate Tenant Needs

The priority for which each roofing system was evaluated was based not only on its physical condition and ability



▲ The Landmark at Eastview Tarrytown, New York (Eastview Holdings LLC)

to perform as an effective waterproofing system, but also on what effects those conditions might have on the underlying structure, the spaces within the building and tenant ability to function within those spaces. While physical conditions and their effects on the building are relatively easy to assess, the owner or building manager is key in providing an understanding of how tenant space is used and what conditions within the building might demand higher priority.

Replacement roofing systems were developed with several considerations in mind. For one, the selected roofing system needed to be durable. Because Landmark is a research facility, most of the buildings house laboratories in addition to tenant office space. Continuously changing needs of the occupants and reconfiguration of laboratory spaces require adding and removing roof penetrations and mechanical equipment in addition to maintaining the existing systems. This means increased foot traffic from maintenance personnel who may not give a second thought to protection of the roofing system.

Consider Maintenance

Maintenance was another consideration.

It is true that most roofing systems can be purchased with some type of warranty, and the majority of roofing contractors will provide a service contract for the right price. However, roofing warranties eventually come to an end, and building maintenance personnel inevitably take on the responsibility of roof maintenance. And, while many maintenance personnel may have experience in maintaining some types of roofing systems, most do not have expertise in maintaining a variety of systems. For this reason, the selection of roofing materials was focused on a single type of system for all of the roofs with as few variations as possible.

Spend Wise

Cost frequently becomes the overriding factor during the selection of a roofing system. However, it is important to realize that the selection of a roofing system is an investment that, if properly installed and maintained, will be in service far into the future. In the case of Landmark, estimated construction cost turned out to be much higher than the owner originally anticipated due to the expenses associated with the removal of hazardous materials, repairs to structures and the level of difficulty in accessing many of the roof areas. The rise in cost,

however, did not deter the owner from proceeding with the selection of a quality system that would inherently increase the value of the property.

Drawings were developed to indicate the scope for each project and were distributed to several contractors for pricing. This helped the owner form a clearer understanding of the project cost and establish a basis for budgeting.

Coordination is Key

Currently, Hoffmann Architects provides project management services during construction at The Landmark at Eastview. Because the schedule calls for work on multiple buildings simultaneously to reduce the overall project duration, coordination among roofing contractors, subcontractors, site maintenance personnel and building tenants is vital. Work performed outside of the roofing contracts, which directly affects the roofing work, also requires coordination.

Due to the close proximity of some of the buildings, concerns have risen regarding atmospheric conditions at the job site during construction. Poor air quality, excessive noise and other disruptions are minimized during construction in order to limit disturbances to building tenants. These types of issues sometimes result in dramatic schedule changes or require displacement of the building occupants, which can add significantly to the overall project cost.

As a result of careful planning, coordination and cooperation among the building owner, design professional/project management team, building occupants and the construction forces, the master plan for roof replacements at The Landmark at Eastview will continue with a minimal amount of inconvenience to building tenants and will be completed on or ahead of schedule.

Lockwood-Mathews Mansion Museum Norwalk, Connecticut

A large roof area is not a prerequisite for the development of a master plan for roof rehabilitation projects. The Lockwood-Mathews Mansion Museum in Norwalk, Connecticut is one such building where 20 small roofs, with varying degrees of deterioration, cover a structure.

Completed in 1869, the mansion is an early example of the French Second Empire Style in the United States. Its design is a precursor to that found at the Vanderbilt Mansions in New York and Newport, Rhode Island. A combination of steeply sloped gable and mansard slate roofs, metal-framed skylights, and flat roof areas cover the building. Time and neglect had taken their toll on the roofs to the point where leaks were threatening exhibits and recently restored interior areas of the museum.

Although it was obvious that all the roofs required replacement or major repairs, annual budget constraints made it impossible to do all the work at one time. The roofs were therefore prioritized based on the severity of the leaks and the sensitivity and value of the finishes and furniture located in the

rooms below the roofs. The next step was an investigation into the existing conditions to determine the original roofing materials, slate color, and paint finishes on the wood and metal elements of the roofs. This was accomplished by making exploratory openings through the layers of the existing roofing systems, conducting laboratory testing and analysis of materials, and a review of historic photographs and reference materials. Materials were also analyzed at this time for potential reuse during the restoration.

One outcome of this investigation and analysis was the determination that the original roofing material at the flat roofs was an unpainted terne (tin/lead alloy)-coated sheet metal. While it would be historically accurate to replace this material in kind, its high cost and low durability suggested the use of a substitute material. Lead-coated copper was selected as an alternate because of its similar appearance to the original metal, relative ease of installation and minimal maintenance requirements for the anticipated long lifespan of the roofs.

The decision process did not end here, however. Again, budget constraints would not permit the installation of new metal on all the flat roof surfaces. Therefore, lead-coated copper was

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▲ Lockwood-Mathews Mansion Museum Norwalk, Connecticut.



▲ Mechanical debris lies directly on the roof membrane. Not only may this lead to deterioration, but it may also prevent the safe inspection of the roof.

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structure, it should be given priority and repaired immediately.)

If a roof is covered by a manufacturer's warranty, the manufacturer and original roofing contractor should be contacted before any action is taken. The procedures outlined in the warranty should be carefully followed so nothing is done to void it.

Work the Plan

Adhering to the proper care and maintenance measures outlined in a roof maintenance master plan is critical to preserving the useful lifespan of a roof. Remembering that the master plan is dynamic by nature is equally important. Just as the building evolves, the roof maintenance master plan should evolve to accommodate the changes and additions made to the roof over time.

As the adage goes, an ounce of prevention is worth a pound of cure. Planning for the eventuality of minor repairs and routine maintenance today will save a building owner steep roofing failure expenditures in the future. ▲

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specified at the more visible roof areas and a less costly modified bitumen roofing membrane at those roofs not readily observed by the public. Rehabilitation strategies at the slate roofs and skylights were based on similar examinations and decision-making.

By developing a master plan that prioritized the rehabilitation work over a four-year period, the design team was able to successfully preserve the physical integrity and visual character of the Lockwood-Mathews Mansion Museum. ▲

JOURNAL is a publication of Hoffmann Architects, specialists in the rehabilitation of building exteriors. The firm's work includes investigative and rehabilitative architecture/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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