

The primary elements of a preventive maintenance program are:

1. Regular inspection of the roof system to determine:
 - The condition of all components and to document these conditions for future reference.
 - The level of repairs required if necessary
2. Removal of all debris from the roof surface
3. Cleaning of drains, gutters and waterways
4. Filling of pitch pans
5. Minor flashing and field repair
6. Providing the commitment of time, funding and personnel to follow a regular program

Regular inspection provides for assessments of the condition of the roof, thus eliminating surprises that are not planned or budgeted for. Regular inspections and subsequent repairs can correct minor problems that, if left unchecked, can cause the failure of a roof system.

Housekeeping on the roof removes items that can accelerate the deterioration of the system. Cleaning drainage paths minimizes ponding conditions that can also lead to accelerated membrane and component deterioration. Ponding water and materials left on the roof that retain ponding water, accelerates ultra-violet degradation, introduces biological growth on the roof surface and can retain process chemicals if left on the roof for long periods.

Minor repair of flashings and related components is an inexpensive way to assure that minor problems do not turn into expensive solutions.

In the mill environment there are roofs that accumulate excessive amounts of broke, wood chips and harsh chemical concentrations. Other areas of the mill may incur extreme foot traffic or no foot traffic at all. With these variables, each roof should have a specific plan tailored to meet its particular requirements.

For example, a broke room roof may need to be inspected and debris removed on a monthly basis, while a warehouse area may only require annual inspections. Critical production areas over the paper machine might necessitate semi-annual inspections, and of course roofs in marginal condition will require frequent inspection.

Because of the extensive number of roofs found on a typical mill it may be effective to develop three categories of roofs:

1. Those that need inspection and cleaning on a monthly basis
2. Those that need inspection and minor repair on a semi-annual basis
3. Those that need inspection and repair on a yearly basis

By classifying the roofs into different categories, resources can be targeted to those areas most in need. Resources can also be used more efficiently if roofs have scheduled inspections throughout the year as opposed to devoting a substantial block of time to do nothing but look at roofs.

There may be other criteria that is relevant based on the specific needs of a paper mill. The most important criteria is that establishment of a preventive maintenance program will minimize leakage, extend the life of a roof and allow for planned and budgeted repairs or replacement.

State of the Art Roof Preventive Maintenance

Preventive maintenance is defined as "the maintenance" of a system in which components are repaired or replaced periodically regardless of the system's current operational condition. This article focuses on how and why companies attempt to use preventive maintenance on roof systems.

Why preventive maintenance

It can generally be stated that one of a building manager's "dreams" is to have a building with a roof that provides leak free service, forever. Forever is impossible, but with preventive maintenance reasonable service can be anticipated for the design life of a roof system. An established preventive maintenance program protects the owner's investment and can add years to the serviceable life of a roof system. It can also detect minor problems before damage is widespread. If undetected, minor problems can escalate over time until they are extensive and expensive to resolve.

An effective functioning preventive maintenance program will allow capital expenditures to be requisitioned on an orderly basis, so that as each roof reaches the end of its life it can be replaced as a scheduled event rather than in response to a crises situation. A roof system is exposed to all manners of chemical, physical and environmental stress. The long term resultant of these forces is "natural aging". Natural aging along with small isolated problems caused by abuse or error can dramatically shorten the life expectancy of a roof system.

How to establish a program

A planned preventive maintenance program is simply a program of scheduled inspections and performance of the required corrective action. The best time to initiate a preventive maintenance program is during the design and installation stages of a new roof system. Key elements of a program should include the following:

Historical File

At the time of acceptance an owner should require the following information be compiled and submitted as a part of the closeout documentation. If a preventive maintenance program is being established for an existing roof, research of the archives should produce some if not all of the desired documentation. Once compiled, this information should be maintained in a central location to permit easy access and updating.

- As-built plans and specifications, including any addenda
- Current roof plans showing locations of penetrations and equipment
- Minutes of pre-bid and pre-construction meetings
- Shop drawings and product data submittals
- Daily construction quality assurance reports
- Change orders
- Correspondence relating to the installation of the roof system
- Manufacturer or contractor warranties
- Documentation of roof inspections or evaluations, including photos
- Documentation of repairs or corrective action performed
- Documentation of changes made to the roof or new equipment installed

Historical file information assists in the diagnosis of conditions observed during roof surveys and facilitates accurate and complete development of remedial actions.

Roof Survey

Visual roof surveys should be performed by a competent person at least twice a year, in the spring and fall. The spring survey allows observation of possible winter damage and performance of the repairs during favorable weather conditions. Fall surveys allow identification and repair of the roof prior to the onset of severe winter weather. Additional surveys should be performed after major storms or construction activities. Moisture surveys can be combined with visual surveys on a regular basis or when moisture infiltration is suspected.

The survey should consist of the visual evaluation of the various roof components, identification of deficiencies requiring corrective action, development of long range preventive maintenance needs, and discussions of conditions observed that may impact the long term performance of the roof system. Documentation of the survey should consist of a written report, photographs, and notations on a roof plan indicating the conditions observed. The roof plan should supply sufficient data to facilitate performance of the corrective action required. Several "checklists" are available for documenting conditions observed during a survey. However, these checklists sometimes fall short of conveying true condition assessment over the long term.

Corrective Action

Once the roof survey information is obtained, corrective activities can be implemented. These activities can be accomplished by in-house personnel, roofing contractors, or both depending on the quantity and types of action required and technical abilities of available personnel. Generally, minor repairs can be accomplished using industry standard repair procedures, thereby eliminating the necessity for lengthy repair specifications. However, if repairs are significant or are required on several roof areas, it is recommended that detailed repair plans and specifications be developed to assist with obtaining competitive pricing.

Frequency

The frequency of performing the various tasks associated with a roof preventive maintenance program depends on the age and condition of the roof, environmental influences, roof-top traffic, occupancy sensitivity, size and accessibility of the roof area. The following guidelines are provided for determining the frequency of the work elements involved:

- Comprehensive visual roof surveys should be performed semi-annually. However, for large roof areas in good condition with limited roof-top traffic, comprehensive surveys can be performed in the spring. Limited overview surveys can be performed in the fall to ensure adequate integrity prior to winter weather.
- Warranty surveys should be conducted prior to the expiration of a contractor or manufacture's warranty. This allows the repair of any deficiency covered, prior to the expiration of any possible monetary obligation.
- Housekeeping surveys are generally recommended on most roof areas monthly. These surveys are intended to keep drainage devices open and to identify potential damaging conditions. It may be necessary to increase the frequency of these surveys during certain times of the year. For example, roofs adjacent to trees may require removing vegetation from drains a weekly event during the fall.
- Corrective action or repairs should be accomplished reasonably soon after the survey is conducted. If corrective action is delayed, small isolated deficiencies may become major problems that can be expensive and difficult to repair.
- Roof moisture surveys are recommended on three year cycles, unless specific conditions exist that warrant or suspect moisture intrusion into the roof system. The initial or baseline survey should be performed prior to the expiration of any contractor's warranty to enable performance of any repairs covered under the terms of the warranty. In any case, I recommend the first roof moisture survey be performed within the first two to three years after installation.

Staffing

As previously mentioned, the comprehensive visual roof survey should be performed by a competent person knowledgeable in the applicable roof system types. This person should be thoroughly familiar with the design, installation, repair and modes of failure for the roof systems to be surveyed. Whether this is performed with in-house staff or contracted to consultants depends on the technical competence and availability of resources. Limited overview surveys, such as those performed in the fall, can easily be performed by in-house personnel who have had additional training in roof inspection, diagnosis and repair.

Housekeeping surveys can normally be assigned to mechanics responsible for day to day building preventive maintenance duties. In most cases, initiation of the housekeeping survey can be included on a computer generated work order system and can become an integral part of the building preventive maintenance schedule.

Staffing requirements for corrective action depends on many of the same technical and availability issues previously discussed. Housekeeping and minor preventive maintenance activities can usually be performed with in-house personnel. Specialized or extensive repairs and roofs covered by an active warranty are generally contracted to roofing professionals.

Specialized equipment and training generally necessitates contracting out roof moisture surveys. These surveys can be included as a part of the comprehensive visual roof survey or can be purchased as an independent service.

What to do

Each type of roof system has its own potential for failure. Understanding these potential influences and the overall modes of failure provides significant insight into the development of corrective action to maintain or extend the life of a roof system. This insight comes with years of evaluating and repairing roofs and should be one of the key services obtained in the comprehensive visual roof survey. The following is a listing of common problems encountered during housekeeping or limited overview surveys. Corrective actions have been provided that can generally be considered "owner performed preventive maintenance".

- Debris - Debris such as vegetation, construction materials and other foreign matter should be removed from the roof surface. This includes all drains, scuppers, gutters and downspouts. Allowing debris to accumulate on the roof restricts drainage, accelerates membrane deterioration, and poses a potential for punctures from sharp edges or wind driven movement. If vegetation has penetrated the membrane, removal should

only be done when a roofing professional is available to perform the necessary membrane repairs. Trees should be trimmed back from the roof surface to prevent accelerated surface erosion from movement of the branches by wind.

- Ice/Snow - If a drain, scupper or gutter is restricted by ice or snow, removal of the blocking material may become necessary to facilitate drainage and reduce detrimental structural loading. Extreme caution should be exercised when removing frozen material with scrapers or shovels so as not to damage the membrane. A heat tape can be utilized to eliminate blockage. The use of de-icing salt should be closely monitored as it tends to accelerate corrosion of metal drain lines.
- Traffic Patterns - Continual traffic patterns cause erosion of the surface and accelerated deterioration of the roof system. If these areas are noticed, precautions should be taken by installing walkways or additional surfacing to protect the membrane.
- Aggregate Ballast - One of the primary functions of aggregate ballast on a roof is to hold it in place. During periods of high winds this ballast can become displaced and the membrane is subject to wind up-lift. Redistribution of displaced ballast can be accomplished using a push broom. If ballast redistribution becomes a frequent requirement alternate ballasting solutions should be investigated.
- Aggregate Surfacing - Wind erosion of the aggregate surfacing is common, especially in corners. Unlike ballast, this aggregate is embedded into a bitumen flood coat and provides protection to the flood coat from the sun's actinic rays. Resurfacing can be accomplished by broadcasting aggregate into a compatible cold process coating over the eroded area.
- Roof Field Membrane - Examine the roof membrane for evidence of physical damage and environmental deterioration. Take immediate action to prevent further damage by installing emergency repairs to the affected areas. Permanent corrective action should be accomplished by qualified roofing mechanics.
- Flashing - The flashing of a roof system is the material that provides waterproofing at the transition from horizontal to vertical surfaces, such as perimeter parapet walls, interior elevation transitions, equipment curbs and penthouses. During the survey, flashings should be examined for physical damage and deterioration from weathering. Due to their exposed nature, flashings are highly susceptible to damage and deterioration. Common areas of damage are at curbs where window washers tie off ropes and at access points (ladders and hatches) where toes tend to get kicked into the flashing. Weather exposure can cause accelerated deterioration of the flashing. Periodic coating of flashings can assist in extending its serviceable life. Again, emergency repairs should be performed to prevent further damage and permanent corrective action accomplished within a reasonable time period.

Performance Benefits

Primary performance benefits of an established preventive maintenance program are extended service and reduced leakage. Secondary benefits include minimizing or reducing:

- Costly emergency or crisis repairs
- Product damage
- Building structural damage, including framing members and exterior finishes
- Interior finish damage, including walls, floors and ceilings
- Occupancy downtime and disgruntled tenants

One overlooked benefit of a regular maintenance program is found within most roofing manufacturer's labor and material warranties. A common provision of these warranties is that they can be voided if an owner fails to perform regular inspections, repairs and routine maintenance in a timely manner.

Cost Effectiveness

Cost to establish a preventive maintenance program depends significantly on the amount of roof area, type of facility and how many of the activities will be performed by in-house employees or outside contractors. For example, establishing a program on a new roof of average size, maintenance costs will generally range in the following:

| Year | Estimate Costs | Comments |
|-------|------------------------|---|
| 1-2 | \$0.01-\$0.03 /sf/year | Defects repaired under contractor's warranty. Some owner performed maintenance will be required. |
| 2-10 | \$0.03-\$0.05 /sf/year | Workmanship and labor deficiencies repaired under manufacturer's warranty. Some owner performed maintenance will be required. |
| 11-20 | \$0.05-\$0.07 /sf/year | Owner performed maintenance will be required. |

These estimated maintenance costs do not include administrative, surveying or training costs and are provided as a representative range for comparison only. When estimated maintenance costs are combined with roof construction costs and average roof longevity, one can begin to understand the cost effectiveness of a preventive maintenance program.

This example presupposes that the average life expectancy of a non-maintained roof will be 12-15 years and that a reasonable expectation for a maintained roof

is 20 years. No allowance has been added for leak repairs that one would expect to be higher for the non-maintained system. No increase has been included for inflation that may bias the example.

| Activity | Estimated Costs /sf/year No Preventative Maintenance |
|----------------------|---|
| Initial Construction | \$3.00 |
| Annual PM | \$0.00 |
| Reroofing | \$5.00 |
| Annual PM | \$0.00 |
| Reroofing | \$5.00 |
| Annual PM | <u>\$0.00</u> |

Total for 45 years of service \$13.00 or \$0.29 per year

| Activity | Estimated Costs /sf/year With Preventative Maintenance |
|----------------------|---|
| Initial Construction | \$3.00 |
| Annual PM | \$1.16 |
| Reroofing | \$5.00 |
| Annual PM | <u>\$1.16</u> |

Total for 40 years of service \$10.32 or \$0.26 per year a **10% Cost Savings**

Using a very conservative simplistic approach, one can see that investing money into annual preventive maintenance **saves money**. The part of this equation that is difficult to assign a monetary value to is secondary benefits previously discussed, including reduced building damage, product damage and downtime.

SIDEBARS

Roof Preventive Maintenance Reference Material

Available references for establishing and operating a roof preventive maintenance program.

1. "Manual of Roof Inspection, Maintenance, and Emergency Repair for Existing Single-Ply Roofing Systems", [Single Ply Roofing Institute](#) and [National Roofing Contractors Association](#), 708-299-9070
2. "Maintenance of Membrane Roofing Systems", [The Roofing Industry Educational Institute](#), 303-790-7200

3. "Manual of Roof Maintenance and Repair", [National Roofing Contractors Association](#) and [Asphalt Roofing Manufacturers Association](#), 708-299-9070

Service Agreements

A service agreement is a maintenance or service contract between an owner and roofing contractor. These agreements generally cover a specified period of time and can have renewable options. Typically covered is the periodic inspection and routine maintenance of a roof system. Most of these agreements are initiated at the time the roof system is being installed.

The advantage to this type of service is that the roof will be periodically inspected and repaired by a roofing professional. The disadvantage is that the owner is lulled into a false sense of security, and neglects to perform the monthly housekeeping surveys. Documentation and long term maintenance requirements are sometimes very limited with these service agreements. In addition, we have found that the installing roofing contractors may be reluctant to identify maintenance items that are caused from improper workmanship during the construction of the roof system.

Built-Up and Modified Bitumen Roofs

- Clean all debris from the surface of the roof. This includes debris that has gathered behind HVAC units, pipes and pitch pans, and any other roof penetrations. Debris has a tendency to hold water, and water will expedite roof deterioration, especially if your roof is asphalt based such as a built-up roof or asphalt shingles.
- If your roof has a gravel surfacing and there are some bare spots present, clean the bare spot thoroughly using a broom and a wire brush if necessary. Be sure to remove all loose dirt generated from brushing and sweeping. Blow on the area if need be. Spread a thin layer of asphalt roof cement (mastic) over the bare area about 1/8 inch thick. Gather some loose gravel from other areas of the roof and embed it in the roof cement.
- Check all flashings and make sure that they are not deteriorated and there are no holes in them.
- Check the edge metal. Make sure that it isn't separating at the seams. If it is, then the repairs need to be made as soon as possible. This can usually be done easily by yourself or by any local [qualified contractor](#).
- Check for blisters in the roof. DO NOT STEP ON OR PUNCTURE THEM. Call a local [qualified contractor](#) to patch them.
- Clean out and refill any pitch pockets where the filler is cracked and/or shrinking. Click [here](#) to see how.
- Keep all gutter free of debris. Make sure that the downspouts are draining properly by water testing them.
- Water test any sump drains twice per year. Once in the spring and once in the fall before winter sets in. If they don't drain properly, call a plumber and get them working properly. Drains will often leak if they are holding water.

- Trim back any overhanging tree branches.
- Check all caulking and sealants on flashings and copings. Scrape and remove any caulking that is weather cracked and damaged. Clean the area thoroughly. Use a wire brush if necessary. Reapply a polyurethane caulking such Vulkem, NP-1, or equivalent.
- Check the mortar on chimneys and parapet walls, both in between the brick and on top. If it's damaged or deteriorated, have it tuck-pointed. Any mason can perform this work.

Wood Shakes and Shingles

- Clean all debris from the surface of the roof. This includes debris that has gathered behind HVAC units, pipes and pitch pans, and any other roof penetrations. If your roof is starting to collect moss or algae, install some zinc or lead control strips.
- Keep all fungus and algae from the surface. Install [zinc control strips](#) along the hips and ridges if necessary.
- Check all flashings and make sure that they are not deteriorated and there are no holes in them.
- Keep all gutter free of debris. Make sure that the downspouts are draining properly by water testing them.
- Trim back any overhanging tree branches.
- Check all caulking and sealants. Scrape and remove any caulking that is weather cracked and damaged. Clean the area thoroughly. Use a wire brush if necessary. Reapply a polyurethane caulking such Vulkem, NP-1, or equivalent.
- Check the mortar on the chimney, both in between the brick and on top. If it's damaged or deteriorated, have it tuck-pointed. Any mason can perform this work.
- Check the open valley metal for rust. Wire brush the rust then prime and paint the metal. If rust is prevalent, it can be removed using Rust-Away® Oxidation and Corrosion Remover. Manufactured by Hocking International, 2121 Hoover Ave., National City, CA 91950. Ph: 619/474-8457 Fax: 619/477-5630. This stuff works very well.

Single-Ply Roofs

- Remove all debris from the roof surface. This includes vegetation, dirt, loose nails and screws, unused equipment, etc. With a single-ply roof, you have only one layer of protection, so if a nail head gets stepped on and penetrates that one thin layer, then eventually there will be a leak.
- Check the seams. If they are coming apart, then they need to be patched as soon as possible.
- Check all flashings and make sure that they are not deteriorated and there are no holes in them.
- Check the edge metal. Make sure that it isn't separating at the seams. If it is, then the repairs need to be made as soon as possible. This can usually be done easily by yourself or by any local [qualified contractor](#).
- Check for bubbles and blisters in the roof. DO NOT STEP ON OR PUNCTURE THEM. Call a local [qualified contractor](#) to patch them.
- Clean out and refill any pitch pockets where the filler is cracked and/or shrinking. Click [here](#) to see how.
- Keep all gutter free of debris. Make sure that the downspouts are draining properly by water testing them.
- Water test any sump drains twice per year. Once in the spring and once in the fall before winter sets in. If they don't drain properly, call a plumber and get them working properly. Drains will often leak if they are holding water.
- Trim back any overhanging tree branches.

- Check all caulking and sealants on flashings and copings. Scrape and remove any caulking that is weather cracked and damaged. Clean the area thoroughly. Use a wire brush if necessary. Reapply a polyurethane caulking such Vulkem, NP-1, or equivalent.
- Check the mortar on chimneys and parapet walls, both in between the brick and on top. If it's damaged or deteriorated, have it tuck-pointed. Any mason can perform this work.

Sprayed Polyurethane Foam (SPF)

- Clean all debris from the surface of the roof. This includes debris that has gathered behind HVAC units, pipes and pitch pans, and any other roof penetrations. Debris has a tendency to hold water, and water will expedite roof deterioration.
- Keep an eye on any blisters you see. If they get large enough that they split open, you will need to contact a foam contractor to repair them but they still should not leak.
- Any yellow exposed foam should be covered with polyurethane caulking.
- Any splits, punctures, or other forms of damage to the roof should be repaired using polyurethane caulking.
- Trim back any overhanging tree branches.
- Clean out all drains and water-test to ensure they aren't plugged.
- Check all caulking and sealants. Scrape and remove any caulking that is weather cracked and damaged. Clean the area thoroughly. Use a wire brush if necessary. Reapply a polyurethane caulking such Vulkem, NP-1, or equivalent.
- Check the mortar on chimneys and parapet walls, both in between the brick and on top. If it's damaged or deteriorated, have it tuck-pointed. Any mason can perform this work.

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