



COLORADO
Department of Education

Division of Capital Construction

A Guide to Maximizing the Life of your Roof through Preventive Roof 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.”

Roofs are at the top of the “damage chain” in education buildings. With a failing roof, the damage is immediate and the results can be catastrophic. When a roof leaks, it results in structural damage to walls and floors, as well as damage to insulation, and mechanical and electrical systems. Another major concern is roof-water leakage seeping into walls and other areas, creating mold. The effects can be extensive because a roof leak may not show up right away.

Every building manager has to deal with roof issues but, for the most part, in commercial buildings, the similar age and condition of the roofs make management relatively easy. For facilities managers in education institutions, though, the problems are complicated by the fact that there may be many different types of roofs of different ages. Many schools and universities have been around for years — some more than 100 years — and in many cases, the original buildings are still in use. Different roof types also present problems. Some are pitched, some are flat, some are built-up, and some are single-ply. Some have gutters at eaves and some have internal gutters.

Each roof requires different maintenance procedures and skills. But all roofs have one thing in common — good roof maintenance eliminates headaches and is less expensive in the long run. Preventive maintenance and, just as important, predictive maintenance can help schools avoid emergencies and reduce damage dramatically. An established preventive maintenance program protects the district'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 and certifications
- 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 (appendix A). 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. Cables, conduit, pipes, etc, should be properly supported and not allowed to lay directly on the roof.
- 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 and roof membranes.

- 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.

Also listed are some exercises to practice on different types of roof surfaces. This is not a complete list, however, these factors, if not taken care of are among the most common factors in the early deterioration of a roof.

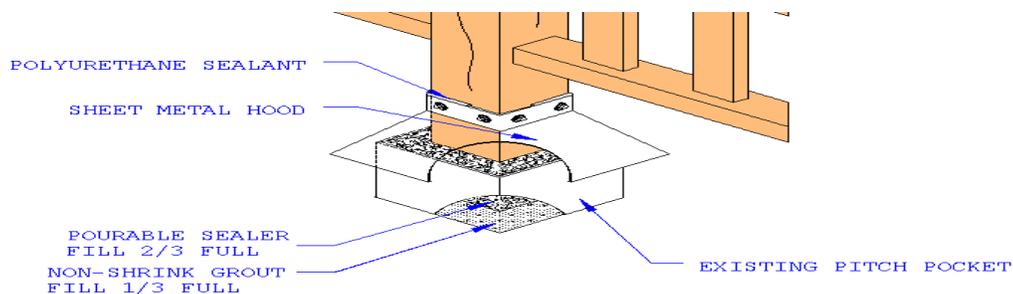
Asphalt Shingles

- 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. 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 is starting to collect moss or algae, install some zinc or lead control strips.
- Check all flashings and make sure that they are not deteriorated and there are no holes in them.

- Keep algae off of the roof surface. Install zinc control strips along the hips and ridges if necessary.
- Dab some roof cement under any loose shingle tabs. One dab on either side should do.
- Replace any damaged shingles.
- Keep all gutters free of debris. Make sure that the downspouts are draining properly by water testing them.
- Trim back any overhanging tree branches.
- Check the open valley metal for rust. Wire brush the rust then prime and paint the metal. If rust is prevalent, it should be removed using a Rust Oxidation and Corrosion Remover. Paint the valley afterward.
- 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 then reapply polyurethane caulking.
- 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.

Built-Up and Modified Bitumen Roofs

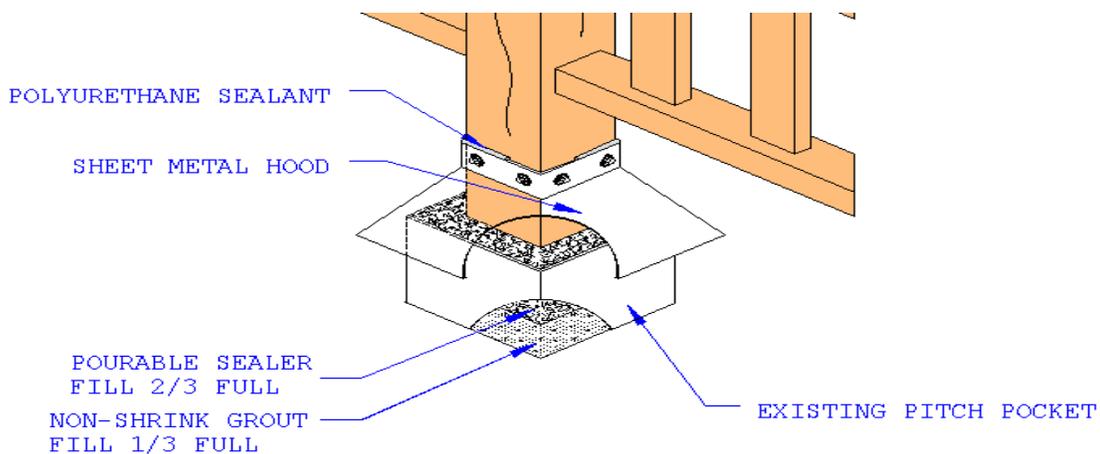
- Clean all debris from the surface of the roof. This includes debris that has gathered behind HVAC units, pipes and pitch pans, and any other roof penetrations. Debris has a tendency to hold water, and water will expedite roof deterioration, especially if your roof is asphalt based such as a built-up 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 inches 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.



- Keep all gutters 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 polyurethane caulking.
- 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.

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, and 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.



- Keep all gutters 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 polyurethane caulking.
- 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 polyurethane caulking.
- 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.

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 students and staff
- 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.

Maintaining the Investment

Roofs, like any facility component, require attention after they're installed. It's imperative that the roofing contractor continues as a partner after the last piece of work is done.

The contractor should have a dedicated maintenance and repair crew to handle warranty issues quickly. Work with someone that has the experience you need, but that will also be there over the long haul. They should be able to get to you within a day, better yet hours, to provide any required service.

While it's not the contractor's responsibility, the school district should review the manufacturer's warranty for roof inspection. The warranty should require the manufacturer to inspect the roof system on a periodic basis and report on the system's condition, including any recommended maintenance items, to the owner.

The school district should institute a preventive maintenance program immediately, and that the manufacturer and contractor can assist with this effort. Industry studies show that proactive maintenance completed on a yearly basis will extend the average life of any roofing system.

Facility personnel who do their homework regarding a roofing contractor's experience, business health and standing, personnel and certification regarding the types of roofs and systems that are used will have a more positive and successful project. There are many things a roofing contractor should deliver, and owners have the right to expect and receive just what they need to make the best investment possible.

From the time the first contracts are drawn up until after the project is closed, school administrators should ensure that the contractor and the manufacturer are on the same page as to what needs to be done to ensure that upon completion of the project the roof is certifiable and warranted. Many manufacturers have certification programs for contractors wishing to install their product. This should be a factor when deciding which contractor and what type of roof to go on the facility.

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 \$0.00

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 \$1.16

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 Materials

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

"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

"Maintenance of Membrane Roofing Systems", The Roofing Industry Educational Institute, 303-790-7200

"Manual of Roof Maintenance and Repair", National Roofing Contractors Association and Asphalt Roofing Manufacturers Association, 708-299-9070

"Maintenance Manual", Benchmark, Inc., 319-393-9100
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 roofing professionals. 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.

Sources

State of the Art Roof Preventive Maintenance

By Curt Liscum

<http://www.benchmark-inc.com/articles/Perspective%20Articles/archive005.html>

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<http://www.roofhelp.com/preventativemaintenance.htm>

The Perfect Patch

Dec 1, 2003 12:00 PM, Joseph F. Gaither

http://asumag.com/mag/university_perfect_patch/

SAT for School Roofing by Travis Wallace

<http://www.peterli.com/archive/spm/1652.shtm>

Roofing Customer

Service by Janet Wiens, staff writer

College Planning & Management, November 2004

<http://www.peterli.com/archive/cpm/863.shtm>

Appendix A

Roof Inspection Checklist

This is only a sample form covering the most common issues on a wide-range of roofing systems.

General Roof Conditions	
Item	Remarks
Debris on Roof	
Drainage	
Physical Damage	
Attic Conditions	
Structural	
Other	
Flat / Membrane Roof	
Item	Remarks
Condition of Coating	
Granular Loss	
Punctures	
Cracks / Alligatoring	
Blisters / Fishmouths	
Ponding	
Other	
Sloped Roof	
Item	Remarks
Roof Material	
Condition of Surface	
Deformed Edges	
Shingles: Buckled	
Shingles: Curled	
Shingles: Missing Tabs	
Shingles: Granular Loss	
Shingles: Other	
Metal: Corrosion	
Metal: Fasteners	
Metal: Other	
Roof Features	
Item	Remarks
Fascia	
Soffit	
Flashing	
Gutters / Drains etc.	
Skylights	
Chimneys / Vents	
Fall Arrest Anchors	
Control Zone Access	
Drains / Vents	
Other	

Ceiling Conditions	
Item	Remarks
Cracks	
Water Staining	
Water Leaks	
Seasonal Change	
Other	
Exterior Wall Surfaces	
Item	Remarks
Deformed Finish	
Surface Deterioration	
Staining	
Other	
Interior Wall Surfaces	
Item	Remarks
Cracks	
Water Staining	
Water Leaks	
Deformed Finish	
Seasonal Change	
Window Leaks	
Door Alignment	
Window Alignment	
Other	
Preventative Maintenance	
Debris Removal	
Caulking	
Painting the valley	
Resealing/shaping roof deformities	
Summary/Comments	
(Highlight areas of concern and any rapid degradation in roof system)	