



A view across Charleston rooftops near the time of the Civil War. (www.loc.gov)

R3 RESILIENCE GUIDANCE: ROOF SYSTEM

ROOF IMPROVEMENT GOALS

Regular roof maintenance is an important factor in the long-term protection of all buildings and structures. A poorly maintained roof has a higher likelihood of major damage from water intrusion, wind, or a seismic event.

MAINTENANCE AND PERMITTING

A building permit may be required for any of these suggested work items. (*Refer to Resilience Guidance: Permit Review, page R1.5.*) Also, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center. Additional resources and codes can be found on the last page of this topic section.

The roof system provides the first line of defense against weather events, since it is the primary protection from rain, wind, and the sun's heat. It is a vital part of the building's outer envelope. While it is easy to think of a roof as a single surface material, roofs are made up of a number of components that must work together to protect the building and its occupants. The outer-most surface is the covering, which is usually shingles, tiles, or metal. Below this layer is a barrier called an underlayment; the next layer is panels of decking, typically plywood. Flashing is tucked into the edges and around chimneys, dormers, and other venting elements. The structural system that supports the roof is typically wood joists, beams, and sometimes trusses.

Each roof component will wear at different rates over time, and the deterioration can be accelerated by water seepage, sun exposure, or pests. Furthermore, if there is existing deterioration weakening these components, storms can cause more extreme damage. Regular maintenance and small improvements can work together to reduce damage and climate threats.

Maintaining the roof or improving a roof's water barriers can reduce:

- Potential leaks from stormwater
- Structural damage from high winds and earthquakes
- Heat gain at the interior of a building

Learning how to protect properties from climate threats by identifying existing roof vulnerabilities and addressing problems through small, incremental improvements can improve resilience. Conditions will vary based upon the original construction and current condition, and may require multiple approaches.





This roof needs shingle replacement and evaluation for structural repair. Overhead trees limbs should be trimmed so they are not touching the roof.

ROOF MAINTENANCE TO IMPROVE RESILIENCE

There are a number of ways roof maintenance can improve resilience.

- **Weather-tightness:** Weather-tight roofing preserves a building and provides shelter from stormwater, wind, and the sun's heat. Small holes are pathways for stormwater entry into a building, potentially resulting in damage to finishes, wood rot, and mold growth.
- **Structural soundness:** A structurally-sound roof can resist wind uplift and windborne debris impact. Well-secured components are less likely to become airborne or topple in an earthquake, and can prevent water intrusion.
- **Heat absorption:** Sunlight hitting a roof surface can significantly increase temperatures inside the building. In locations without trees to shade the roof surface, the color and/or reflectivity of a roof can reduce indoor air temperatures. *(Refer to [Trees](#), page R2.9.)*

KEY TIPS:

- Inspect roofing components every six months to allow time for repairs prior to hurricane season
- Look at the roof from the ground and ask friendly neighbors to allow access to their yards for a better vantage point and/or use a drone if available
- Tree limbs should be trimmed to avoid contact with the roof surface
- Complete maintenance issues, hire a worker or a contractor, or retain an architect or engineer for more complex projects
- Do not delay action, since problems identified sooner can be less costly to repair and may prevent more extensive deterioration
- Gutters and downspouts should be cleared of leaves and debris at least twice a year, and observed during a rainstorm to make sure they are functioning properly and not overflowing *(refer to [Gutters and Downspouts](#), page R3.4)*
- Flat roofs or low-sloped roofs should be inspected immediately following a rainfall to see if there is standing water

PROPERTY INSURANCE

In addition to increasing resilience, some improvements may allow owners to reduce their property insurance premiums. To be eligible for these reductions, certification from an architect or engineer indicating that improvements meet specific wind resistance requirements may be required.



Leaves need to be cleared from the roof and gutters. A professional service may be needed to access the roof safely.



Individual shingles are missing and others are in a deteriorated condition.



Metal hangers can be used to secure dislodged slates or replace individual slates.



Lightning rods look like spikes sticking up from the roof surface.

LIGHTNING PROTECTION

Lightning commonly accompanies severe storms. Metal roof buildings and those that are far from neighbors are more vulnerable. If a building is struck by lightning, the current is carried throughout the structure, creating a surge that can damage plugged-in appliances and electronics or start a fire. Lightning protection systems include rods that attract lightning and safely carry it into the ground through conductors.



A roof may have one pitch or multiple pitches. All roof valleys, ridges, chimney or window joints, and eaves require proper flashing to prevent stormwater leaks.

SLOPED ROOFING

Sloped roofs are typically covered by overlapping rectangular shingles made from slate, tile, metal, or asphalt. Metal sloped roofs can be standing seam or formed sheet metal. The overlapping individual shingles or metal panels direct stormwater to the bottom edge of the roof, known as the eave, where it is collected in a gutter and flows down to the ground in downspouts. *(Refer to Roof Soffits and Overhangs, page R3.6, and Gutters and Downspouts, page R3.4.) If shingles are damaged or worn, or metal is punctured or rusted, stormwater can find a path through the outer surface resulting in a roof leak.* Leaks may or may not be visible in the attic or ceiling spaces until the damage is severe. Another condition to note is the presence of moss, mold, or algae growing on the shingle surface. This can be a sign that shingles are becoming thinner as they wear down from age and are developing holes and absorbing water. Weakened shingles can detach and slide down the roof slope, and gaps at the bottom of shingles can allow strong winds to pull shingles off of the roof.

KEY TIPS:

- Refasten or replace nails that are popping up with secure fasteners
- Replace deteriorated or missing individual shingles, with in-kind material
- Repair isolated metal punctures or rust, preferably with in-kind material
- Refasten or solder slipping metal sheets, panels, open seams, or joints
- Consider roof replacement when over 20% of shingles are split, cracked, missing, or deteriorated, or 20% of the metal roof sections are rusted or punctured; this will also require replacement flashing *(refer to Roof Joint Protection, page R3.7, and Roof Replacement, page R3.10)*
- Use nails or foam insulation when replacing clay or concrete tile roofs to minimize edge uplift from strong winds
- Remove moss, mold, or algae from roof surface; clean and treat surface to prevent future growth
- Use a licensed contractor to make any repairs or remediate asbestos shingles, which are a hazardous material

FLAT ROOFING

Roofs with a shallow slope are referred to as flat roofs. A watertight surface and membrane is gently sloped toward a drain using tapered insulation installed under the roof surface material. Membrane materials include built-up roofing, single-ply roofing, modified bitumen roofing, and metal roofing. Flat metal roofs found on historic porches are made of small, rectangular pieces of copper, seamed and soldered together. **To prevent leaks, the membrane or metal flat roofing must be continuous and without splits, punctures, or surface cracking.**

KEY TIPS:

- Repair or reseal seams, splits, punctures, or surface cracking as soon as possible
- Apply a light-colored or reflective coating to reduce interior heat gain
- Avoid installing gravel, which can become airborne projectiles in heavy winds
- Build up roof insulation under the roof surface if there are puddles or ponding, and patch membrane or metal roof surface
- Consider roof replacement when over 20% of the surface is deteriorated; this will also require replacement flashing and tapered insulation to allow drainage and keep the interior cooler (refer to [Roof Joint Protection, page R3.7](#), and [Roof Replacement, page R3.10](#))
- Consider installing solar collectors that can provide energy and can shade the roof surface, using certified installers (refer to [Solar Collectors, page R3.8](#))



Rubber roofing can crack, eventually forming leaks. Significant cracking of this roof suggests replacement might be prudent. Selecting a lighter color can reduce heat absorption.



A system of gutters and downspouts can direct rainwater away from the building if kept clear of debris.

GUTTERS AND DOWNSPOUTS

Gutters and downspouts that are in good repair and clear of clogs can reduce water damage to building walls, foundations, and piers. They are located near or along the bottom edge of a roof slope to collect rainwater from the roof surface. If buildings were not designed with gutters, they can be added. In addition to collecting stormwater, gutters can collect leaves and debris, causing them to become clogged and ineffective, resulting in stormwater overflowing the edge. Downspouts are generally surface-mounted to building walls to transport stormwater from the gutter to the ground or to an underground drainage system via a cast iron boot. Stormwater discharged onto the ground should be directed away from building foundations, piers, and crawlspaces to minimize masonry damage. (Refer to [Site Grading, page R2.5](#), and [Managing Moisture, page R5.3](#).) Gutters and downspouts can be damaged by flying debris or pulled away from the building in strong winds.

KEY TIPS:

- Regularly clear gutters and downspouts of leaves and debris that might cause a clog
- Maintain fasteners and verify they are secured to the building
- Ensure that gutters are sloped towards the downspout
- Install a system to deposit stormwater into an on-site mechanism, such as a rain barrel
- Direct stormwater away from the building with a splash block or downspout extension to prevent water from pooling next to the foundation (refer to [Site Grading, page R2.5](#))

CHIMNEYS

Chimneys can be weak spots during a storm if water seeps through unprotected caps or open joints. A damaged chimney is also more vulnerable to toppling in high winds and earthquakes. Toppled chimneys or chimney parts can crash through the roof and cause major water damage and potentially damage the roof structure.

Tall, skinny chimneys and those that are leaning or have open joints are more prone to toppling. Regular maintenance can prevent mortar loss between bricks or stucco deterioration that is important to stabilize a chimney. *(Refer to section R5: Exterior Masonry.)*

KEY TIPS:

- Re-secure or replace chimney cap to reduce air loss and potential vermin
- Parge or coat chimney top so water does not seep into bricks from above
- Repoint damaged or weathered mortar joints between bricks
- Replace damaged bricks and stucco
- Brace tall, skinny, or leaning chimneys
- Rebuild severely damaged chimney above the roof line, preferably in-kind
- Reline crumbling chimney flue
- Replace damaged metal flashing at base of chimney: metal flashing can provide a longer-term repair; caulk or roof tar can provide a quick, temporary repair *(refer to Roof Joint Protection, page R3.7)*
- Inspect/repair or install crickets (sloped metal flashing) behind the chimney



Mortar joints between bricks may need to be repaired to prevent weak spots and potential structural failure. Stepped flashing is found at the base of the chimney along the roof slope.



Projecting features may need reinforced tie-downs and seals.

ROOF PROJECTIONS

Roof projections include historic features that extend above a roofline, such as dormer windows and cupolas, as well as modern interventions like plumbing vents, skylights, roof hatches, television dishes, antenna, mechanical equipment, solar panels, and lightning rods. *(Refer to Lightning Protection, sidebar page R3.3.)* Features projecting through and above a roof pose the potential for roof leaks and damage from high winds that can dislodge components, or they can be damaged by windborne debris impact.

KEY TIPS:

- Remove abandoned rooftop projections that are not historic features, like old television antennae or satellite dishes, to reduce the number of roof penetrations and attachment locations; patch roof and fastener locations with a compatible material to ensure long-term durability
- Securely anchor roof projections from wind uplift and prevent them from becoming airborne in high winds
- Replace damaged metal flashing at base of projections: metal flashing can provide a longer-term repair; caulk or roof tar can provide a quick, temporary repair *(refer to Roof Joint Protection, page R3.7)*
- Replace older skylights and roof hatches with hurricane-rated skylights and hatches that can withstand high winds



ATTIC VENTS

Attic vents can be located on a roof, on a ridge vent or hatch vent, or on a projecting eave or gable end. *(Refer to Roof Soffits and Overhangs, below.)* Attic vents allow trapped hot air to escape, reducing interior temperatures in summer months. While vents allow air to escape, they also provide a path for hurricane-strength winds to enter an attic, which can cause structural damage to the roof framing. Hurricane-rated attic vents can provide the highest level of protection, but it is also possible to temporarily protect vent openings with plywood panels in advance of a high-wind storm.

KEY TIPS:

- Prepare gable-end vent protection, such as pre-cut plywood panels, for installation in advance of a storm
- Replace existing attic vents with hurricane-rated vents, preferably to match existing appearance and building style
- Reinforce gable ends over four feet in height to reduce the possibility of collapse in high winds *(refer to Hurricane-Rated Connectors, page R3.9, and Wood Cladding, page R4.3)*
- Reinforce roof structure with hurricane-rated connectors



Any openings, including attic vents, will need temporary storm protection.



The roof eave projects beyond the building wall below. Eaves can be open, with exposed rafter tails, or boxed with vented spaces (as in this example).



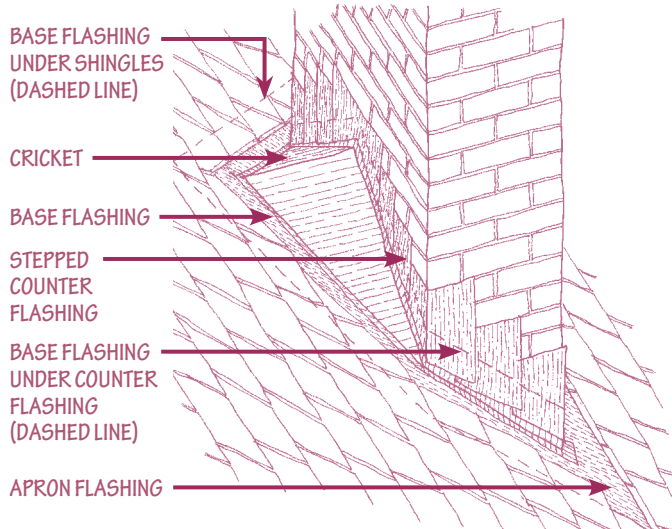
Overhangs on most buildings extend up to 16-inches from the building wall.

ROOF SOFFITS AND OVERHANGS

The underside of a roof may have extended eaves or an enclosed soffit. Deep overhangs provide shade to reduce a building's interior heat gain. However, if the connections are insufficient or deteriorated, strong winds can separate the eaves from the roof and the building through uplift, damaging the structure and potentially creating a path for stormwater to enter the building.

KEY TIPS:

- Ensure there is a strong connection between the roof structure or overhang to the main building structure
- Reinforce the structure of roof soffits and overhangs with hurricane-rated connectors *(refer to Hurricane-Rated Connectors, page R3.9)*



Flashing is composed of many pieces of sheet metal that are layered to prevent water from entering between joints. The specific types and configuration should be customized to the unique conditions of each roof.

ROOF FLASHING TYPES

Metal flashing is the best long-term protection for openings and joints on a roof. Tar and caulk are temporary solutions that should only be used until metal flashing can be installed.

- **Ridge Flashing:** Installed as a cap at the high edge of two roof slopes
- **Valley Flashing:** Located at the intersection between two roof slopes to direct water to gutter
- **Drip Edge Flashing:** Installed along the roof eave to direct water into gutters and protect roof edges
- **Vent Pipe Flashing:** Installed around vent pipes, often with upward slope under shingles and downward slope exposed
- **Chimney Flashing:** Typically made up of base flashing and counter flashing; may include a cricket at upper slope and base flashing; or apron flashing at downward slope
- **Base Flashing:** Installed under roof shingles and over underlayment where vertical walls intersect the roof surface
- **Step Flashing:** “L-shaped” flashing bent under shingles and extending up an intersecting wall surface
- **Counter Flashing:** Covers the top edge of base flashing or step flashing; top edge should be installed in a cut masonry joint, known as a reglet
- **Apron Flashing:** Base flashing located along the roof at the base of a wall or vertical intersections of chimneys, skylights, and dormers



Dormer windows have flashing at the top edge, along the roof slope, and below the window.

ROOF JOINT PROTECTION

Roof joints can occur at roof edges, chimneys, and roof projections. Roof joints tend to be protected with roof tar, caulk, and/or flashing, which are thin pieces of metal installed to prevent stormwater from entering a structure through a joint. Roof tar and caulk should be considered a short-term protective measure that will require regular removal and re-application.

Metal flashing is often found in sloped roofing layered under shingles at valleys, and bent to extend up chimneys or other roof projections. The top leg of the metal flashing may be protected by roof tar, sealant, or an additional piece of metal flashing known as counter flashing, which provides longer term protection than roof tar or caulk.

KEY TIPS:

- Re-secure loose sections of flashing
- Replace missing or deteriorated flashing
- Replace damaged or missing tar or caulk at the top of base flashing
- Aluminum flashing, which is the least expensive metal flashing, is prone to deterioration (discolored spotting and small holes)
- Copper flashing, one of the costliest options, tends to be one of the most durable
- Replacing the base flashing that is located below or between shingles may be difficult or impossible without removing large areas of shingles or roofing; installing flashing with a similar or longer lifespan than replacement roofing at the outset is recommended





The visibility of solar panels can be reduced if the color is close to the roof surface color. Verify that attachments are appropriate for the roof materials and securely fastened to reduce the likelihood of uplift in severe winds.



Solar roof tiles can more closely mimic shingle patterns.

SOLAR PANEL TAX CREDITS

Tax credits can reduce the cost of solar panels for property owners. The federal Energy Star website has information about efficient products, rebates, and tax credits for solar panels. (Refer to www.energystar.gov.) In addition, contact the South Carolina Energy Office for information if installing solar panels. (Refer to www.solar.sc.gov.)

SOLAR COLLECTORS

Solar collectors provide a renewable energy source that can reduce electricity costs for a property owner to power air conditioning, heating, hot water, and electricity. Solar water heaters supply hot water for building use, reducing fuel or electricity needed to power a traditional hot water heater.

Solar panels are usually panels mounted a few inches above a roof surface, but films or tiles applied directly to the roof surface are emerging as an alternative. (Refer to *Historic Preservation Considerations*, page R3.11, for guidance related to historic buildings.) In addition to producing electricity, solar panels have the added benefit of shading roof surfaces. A qualified structural engineer will need to be consulted to design an installation to meet the required load, wind load, and uplift requirements.

KEY TIPS:

- Install solar panels on a well-maintained roofs
- Install a solar water heater on a well-maintained roof to produce hot water, securely fastening tank to roof framing to prevent toppling
- Maintain connectors to prevent uplift in high winds
- Confirm with installer that the attachment connectors are appropriate for the roof surface; traditional standing seam, slate, and tile roof surfaces require specialized attachments, and consultation with an independent expert, like an architect, or a second opinion may be warranted prior to installation (refer to *Historic Preservation Considerations*, page R3.11, for guidance related to historic buildings)
- Install battery storage for solar panels to provide service during a power outage



Exposed roof framing in the attic can have pest and moisture problems.



Loose insulation should be measured to monitor depth. (energy.gov)

ATTIC

Inspecting the attic can help identify problems with a roof system. Water staining, a dark patch, or white bloom can be signs of a leak. Cracked, sagging, or missing framing members can identify a structural problem. Dampness or mildew can indicate poor ventilation. Addressing attic vulnerabilities can improve the life of a roof and reduce indoor air temperatures.

KEY TIPS:

- If the attic is accessible, review condition at least once a year, particularly around projections like chimneys, which are prone to joint leaks
- Repair roof leaks
- Install insulation on the attic floor to reduce heat and air conditioning loss below (refer to *Insulation Matrix*, page R8.6)
- Install a whole-house attic fan in un-insulated buildings; note potential for humidity and mold issues for insulated buildings (refer to *Heating and Air Conditioning*, page R7.4)
- Replace damaged or insufficient roof structure
- Reinforce roof structure with hurricane-rated connectors
- Reinforce gable ends over four feet in height to reduce possibility of collapse in high winds (refer to *Hurricane-Rated Connectors*, below)
- Evaluate options for a spray polyurethane foam (SPF) to the underside of the roof deck at the joints between plywood panels, and on both sides of framing members (rafters) (refer to *Historic Preservation Considerations*, page R3.11, and *Insulation Matrix*, page R8.6)

HURRICANE-RATED CONNECTORS

Many buildings in Charleston have wood framing for the roof and floors even if the walls are masonry. Wood-framed portions of a structure are more likely to be damaged by the effects of a significant storm. In some historic buildings, the connections between wood elements are nailed together, older buildings may have pegged or mortised joints. **The movement of a building in high winds or earthquakes may loosen connection joints and compromise its structural integrity, increasing the potential for damage from strong, sustained winds or wind gusts.** Adding hurricane-rated connections between structural elements can help a building resist wind forces and keep a building intact during hurricanes and other extreme storms. (Refer to *Wood Cladding*, page R.4.) At the roof level, hurricane-rated connectors should span across roof ridges and attach rafters to the walls and framing below. **To provide access to complete this work, roof replacement may be required and an architect or engineer should be consulted for guidance.** (Refer to *Historic Preservation Considerations*, page R3.11.)

METAL CONNECTORS

The type of metal used for the connectors should be based upon the building's location and conditions. Galvanized metal straps, connectors, nails, and screws are less likely to rust than steel. However, in areas exposed to saltwater or spray, stainless steel connectors may be warranted. They are more expensive, but the cost of removing wall surfaces to replace rusted or corroded connectors should be considered.



A structural engineer or architect should select and design the hurricane-rated connector layout best suited for the building conditions. The installation requires access to structural elements, like masonry walls and wood framing, necessitating removal of interior finishes.



Light-colored roofing material can help reduce interior air temperatures.

REPAIR VERSUS REPLACEMENT FOR HISTORIC BUILDINGS

One of the attractions of Charleston is the physical aesthetic and economic value of older and historic properties that will benefit future generations. *To preserve the authenticity of Charleston's heritage, the City strongly encourages the retention of historic materials or repair/replacement in-kind whenever work on a property is considered.* For those properties that are designated historic or within a regulated district, these practices are enforced by the BAR. (Refer to Board of Architectural Review (BAR), sidebar page R1.3.)

Recommended repairs are focused on specific areas of deterioration in order to maintain the stability and weather resistance of a building, rather than wholesale replacement of a historic building material. Careful attention to detail might be required as part of the effort. Regular maintenance with timely repairs can minimize large repair costs associated with ongoing deterioration.

ROOF REPLACEMENT

All materials deteriorate over time, and at some point it will be necessary to replace the roof surface. The useful life of a roof will vary based upon the materials and installation details. A full roof replacement provides an opportunity to significantly improve resilience as noted below.

- **Water Intrusion:** An adhesive roof membrane can be installed on sheathing as a secondary water barrier or a sprayed-on sealer applied; joint-tape systems can be applied between sheathing members; and flashing can be replaced at all penetrations and transitions (refer to *Insulation Matrix*, page R8.6, and *Roof Joint Protection*, page R3.7)
- **Wind:** Roof, eave, and gable-end framing can be enhanced and secured; hurricane straps can be added to the roof structure; sheathing can be securely fastened to the framing; hurricane-rated skylights and hatches can be installed (refer to *Hurricane-Rated Connectors*, page R3.9, and *Roof Projections*, page R3.5)
- **Earthquake:** Chimneys can be repointed and secured (refer to *Chimneys*, page R3.5)
- **Heat:** Attic or roof insulation can be installed; light colored or solar-reflective roofing can be installed; solar panels may be considered to offset energy usage (refer to *Solar Collectors*, page R3.8)

Property owners are encouraged to consider the long-term benefits of resilience upgrades and how that can reduce continued, costly repairs over time. Consultation with an architect or qualified contractor early in the design process can help a property owner understand current vulnerabilities and the range of resilience options appropriate for the unique conditions of a roof system.



BAR

Refer to the BAR Jurisdiction Chart and Map or speak with City staff to determine if a property has additional permit or review requirements.

BAR Policy Statements:

- *Roofing*
- *Solar Panels*
- *Materials and Demolition*
- *Hurricane Protection Panels*

HISTORIC PRESERVATION CONSIDERATIONS

Properties located in a historic district or design review district may require additional City review whether a permit is required or not. Contact the Permit Center, or the BAR or DRB staff, to speak with someone directly. Information provided below indicates best practices toward maintaining the historic character of a property when changes are made to the roof or roof features.

ROOFING MATERIAL

- Repair or replace in-kind and localize repairs rather than full replacement
- Match the shape and pattern of the historic material when repairing or replacing the roofing material
- Select compatible flashing material and fasteners with a lifespan and material similar to the new roofing

GUTTER AND DOWNSPOUTS

- Retain the original gutter and downspout system and appearance
- Replace gutters with new material of similar size, shape texture, and pattern if replacement with original material is not possible
- Install plain half-round, painted K-style or ogee gutters if none exist
- Paint downspouts to match the adjacent wall color

CHIMNEYS

- Retain and properly maintain historic chimneys, chimney caps, and detailing even in instances where the interior of the chimney has been removed
- Install a minimally visible, dark-colored, projecting chimney damper or cap
- Install flue extensions that are clay tile, unpainted galvanized metal, or painted black

ROOF PROJECTIONS

- Replace existing or install a new skylight or roof hatch with components that are relatively flat, minimally visible, and sympathetic to and compatible with the existing roof materials

ATTIC VENTS

- Select hurricane-rated attic vents appropriate to the building style

JOINT PROTECTION

- Install any new or replacement flashing with a life span longer than, or equal to, the life span of the roof material
- Install flashing compatible with all roof materials

ATTIC

- Application of spray foam on historic attic framing should be done with caution; install foam so that the application is reversible
- Obscuring historic framing and sheathing with foam hinders the ability for visual damage inspections
- Spray foam applied throughout an attic can create a micro-climate that promotes moisture and condensation, resulting in deterioration of framing



HISTORIC PRESERVATION CONSIDERATIONS (CONTINUED)

SOLAR COLLECTORS

- Locate on rear roof slopes, behind architectural features or parapets, or other locations of limited visibility such as accessory buildings
- Ensure that significant, character-defining features are not removed, damaged, altered, or obstructed
- Limit the fastening system to areas that will least impact fragile historic roofing materials
- Consider custom details to limit physical and visual impacts to the historic structure
- Consider installation alternatives, such as positioning panels on auxiliary structures, free-standing installations, and locating panels on secondary roof forms, all with restricted visibility from the public right of way
- Select solar collectors that are low-profile, or no more than 8” above the roof surface, and can be installed at a pitch consistent with the existing roof
- Paint conduits and attachment mechanisms to be compatible with the existing material, including roof, siding, etc.
- Install solar collectors in a manner that is reversible
- Confirm with installer that the attachment connectors are appropriate for the roof surface; traditional standing seam, slate, and tile roof surfaces require specialized attachments, and consultation with an independent expert, like an architect, or a second opinion may be warranted
- Locate battery storage in a minimally visible location



ROOF REPLACEMENT

- Select replacement roofing material that is compatible with the appearance of historic roofing

ROOF SYSTEM IMPROVEMENT CHECKLIST

The Roof System Improvement Checklist on the following pages identifies maintenance information and other related potential resilience improvements. Information on the relative costs, expertise, and vulnerabilities addressed are keyed with icons described at right.

Level of Risk and Professional Help: The Checklist identifies work that can be completed by property owners or tenants who are able to safely and comfortably use hand tools or power equipment, as needed. Any lifting, bending, or exertion beyond a person’s abilities should be undertaken by professionals.

Vulnerabilities: The icons below are used throughout this guide. Completion of the proposed improvements can increase a building’s resilience from the following vulnerabilities:

-  Flood
-  Wind
-  Earthquake
-  Heat
-  Good maintenance

Cost: The relative cost of the proposed improvement is denoted by symbols below. The cost will vary based on the conditions and extent of the impacted area.

- ¢ Minimal supplies under \$100
- \$ \$100-\$1,000
- \$\$ \$1,000-\$5,000
- \$\$\$ \$5,000 and above



















“Off-the-Shelf” Solution Available: An item that is relatively available for purchase and easy to install by a property owner or contractor.



















ROOF SYSTEM IMPROVEMENT CHECKLIST

ACTION / PROJECT <i>PERMITS: A building permit may be required for any of these suggested work items. Additionally, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center.</i>	RESILIENCE BENEFIT	COST	DO-IT-YOURSELF	CONTRACTOR MAY BE REQUIRED	ARCHITECT OR ENGINEER MAY BE REQUIRED	"OFF-THE-SHELF" SOLUTION AVAILABLE
ROOF MAINTENANCE TO IMPROVE RESILIENCE						Page R3.2
<input type="checkbox"/> Trim overhanging tree limbs		¢-\$	●	●		
<input type="checkbox"/> Clear gutters and downspouts at least twice a year; inspect during a rainstorm		¢-\$	●	●		
<input type="checkbox"/> Contact an architect or engineer to review/repair structural problem like a sagging or bowing roof		\$\$\$\$		●	●	
SLOPED ROOFING						Page R3.3
<input type="checkbox"/> Refasten or replace nails that are popping up with secure fasteners		\$\$-\$	●	●		
<input type="checkbox"/> Replace deteriorated or missing individual shingles; repair isolated metal punctures or rusting		\$\$-\$	●	●		
<input type="checkbox"/> Refasten or solder slipping metal sheet, panel, open seam, or joint		\$		●		
<input type="checkbox"/> Remove moss, mold, or algae from roof surface; clean and treat surface to prevent future growth		¢-\$	●			●
FLAT ROOFING						Page R3.4
<input type="checkbox"/> Repair or reseal seams, splits, punctures, or surface cracking as soon as possible		\$\$-\$		●		
<input type="checkbox"/> Apply light-colored or reflective coating		\$	●	●		●
<input type="checkbox"/> Avoid installing gravel that can become airborne		¢-\$		●		
<input type="checkbox"/> Build up roof insulation under the roof surface and slope to drain		\$\$		●		
GUTTERS AND DOWNSPOUTS						Page R3.4
<input type="checkbox"/> Clear gutters and downspouts of debris		¢-\$	●	●		
<input type="checkbox"/> Maintain fasteners and verify they are secured to the building and gutters are sloped toward the downspout		¢-\$	●	●		
<input type="checkbox"/> Install a system to deposit stormwater into an on-site mechanism, such as a rain barrel		¢	●			●
<input type="checkbox"/> Direct stormwater away from the building with a splash block or downspout extension		¢	●			●



RESILIENCE GUIDANCE: ROOF SYSTEM

ACTION / PROJECT <i>PERMITS: A building permit may be required for any of these suggested work items. Additionally, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center.</i>	RESILIENCE BENEFIT	COST	DO-IT-YOURSELF	CONTRACTOR MAY BE REQUIRED	ARCHITECT OR ENGINEER MAY BE REQUIRED	"OFF-THE-SHELF" SOLUTION AVAILABLE
CHIMNEYS Page R3.5						
<input type="checkbox"/> Re-secure or replace chimney cap		¢-\$	●	●		●
<input type="checkbox"/> Parge or coat top of chimney		¢-\$	●	●		
<input type="checkbox"/> Repoint damaged or weathered mortar		\$-\$-\$		●		
<input type="checkbox"/> Replace damaged bricks and stucco		\$-\$-\$		●		
<input type="checkbox"/> Brace tall, skinny, or leaning chimneys		\$-\$-\$	●	●		
<input type="checkbox"/> Rebuild severely damaged chimney		\$-\$-\$		●	●	
<input type="checkbox"/> Reline crumbling chimney flue		\$-\$-\$		●		
<input type="checkbox"/> Replace damaged/missing metal flashing		¢-\$	●	●		
ROOF PROJECTIONS Page R3.5						
<input type="checkbox"/> Remove abandoned rooftop projections and patch roof and fastener locations		¢-\$	●	●		
<input type="checkbox"/> Securely anchor roof projections		¢-\$	●	●		
<input type="checkbox"/> Replace damaged metal flashing		\$-\$-\$	●	●		
<input type="checkbox"/> Replace older skylights and roof hatches with hurricane-rated skylights and hatches		\$-\$-\$		●	●	
ATTIC VENTS Page R3.6						
<input type="checkbox"/> Prepare gable-end vent protection, such as pre-cut panels, for installation in advance of a storm		¢	●			
<input type="checkbox"/> Replace existing attic vents with hurricane-rated vents		\$	●	●		●
<input type="checkbox"/> Reinforce gable ends over four feet in height to reduce possibility of collapse in high winds		\$-\$	●	●		
<input type="checkbox"/> Reinforce roof structure with hurricane-rated connectors		\$-\$-\$		●	●	
ROOF SOFFITS AND OVERHANGS Page R3.6						
<input type="checkbox"/> Secure roof structure or overhang to main building structure		\$-\$-\$-\$		●	●	
<input type="checkbox"/> Reinforce roof soffits and overhangs with hurricane-rated connectors		\$-\$-\$-\$		●	●	

ACTION / PROJECT <i>PERMITS: A building permit may be required for any of these suggested work items. Additionally, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center.</i>	RESILIENCE BENEFIT	COST	DO-IT-YOURSELF	CONTRACTOR MAY BE REQUIRED	ARCHITECT OR ENGINEER MAY BE REQUIRED	"OFF-THE-SHELF" SOLUTION AVAILABLE
ROOF JOINT PROTECTION Page R3.7						
<input type="checkbox"/> Re-secure loose sections of flashing		\$\$\$	●	●		
<input type="checkbox"/> Replace missing or deteriorated flashing		\$\$\$	●	●		
<input type="checkbox"/> Temporarily seal gaps at top of base flashing with roof tar or caulk		¢-\$	●	●		
<input type="checkbox"/> Replace flashing and counter flashing		\$\$\$\$		●	●	
SOLAR COLLECTORS Page R3.8						
<input type="checkbox"/> Install solar panels on a well-maintained roofs		\$\$\$		●		
<input type="checkbox"/> Install a solar water heater on a well-maintained roof, securely fasten		\$\$		●		
<input type="checkbox"/> Maintain connectors		¢-\$	●	●		
<input type="checkbox"/> Confirm attachment connectors are appropriate for the roof surface		\$			●	
ATTIC Page R3.9						
<input type="checkbox"/> Repair roof leaks		\$\$\$	●	●		
<input type="checkbox"/> Install insulation on attic floor		\$\$\$	●	●		●
<input type="checkbox"/> Install a whole-house attic fan in un-insulated buildings		\$\$\$	●	●		●
<input type="checkbox"/> Replace damaged or insufficient roof structure		\$\$\$\$		●	●	
<input type="checkbox"/> Install structural hurricane-rated connectors		\$\$\$\$		●	●	
<input type="checkbox"/> Reinforce gable ends over four feet in height		\$\$		●	●	
<input type="checkbox"/> Evaluate appropriateness of spray polyurethane foam (SPF)		\$\$\$		●	●	
HURRICANE-RATED CONNECTORS Page R3.9						
<input type="checkbox"/> Install structural hurricane-rated connectors		\$\$\$		●		
ROOF REPLACEMENT Page R3.10						
<input type="checkbox"/> Replace roof in-kind		\$\$\$		●		
<input type="checkbox"/> Replace roof with resilience upgrades		\$\$\$		●	●	

ROOF SYSTEM RESOURCES

City of Charleston

BAR Policy Statements
Climate Adaptation Planning + Analytics (CAPA) Heat Watch, 2021
Homeowner Rehabilitation
Sustainability Checklist
charleston-sc.gov

Federal Emergency Management Agency (FEMA)

Building Codes Toolkit for Homeowners and Occupants, FEMA P-2325
Wind Retrofit Guide for Residential Buildings, FEMA P-804
fema.gov

National Park Service

Preservation Brief 4: Roofing for Historic Buildings
Preservation Brief 41: The Seismic Rehabilitation of Historic Buildings
Preservation Brief 50: Lightning Protection for Historic Structures
nps.gov

U.S. Department of Energy

Building American Solution Center Gutters and Downspouts
Cool Roofs
Cooling with a Whole House Fan
Homeowner's Guide to Going Solar
energy.gov

U.S. Department of Environmental Protection

EnergyStar Attic Air Sealing Project
energystar.gov



REGULATIONS TO REVIEW

- International Existing Building Code
- South Carolina Building Code
- South Carolina Residential Code
- City of Charleston Code of Ordinances (Zoning, BAR, DRB)
- City of Charleston Climate and Geographic Design Criteria

This is not a comprehensive list and is intended only to provide additional resources to consider when planning a project. Contact the Permit Center for detailed information.

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