

MAINTENANCE GUIDEBOOK V

ROOF AND WATERPROOFING MAINTENANCE

CHAPTER FIVE - MAINTENANCE AND REPAIR

SECTION A INTRODUCTION

This chapter discusses the basic requirements for maintaining roof and waterproofing systems and methods for repairing deficiencies. The repairs, except as noted, should be within the capabilities of most local HA maintenance staff.

SECTION B MAINTENANCE

1. DRAINAGE

All foreign matter including slag, vegetation, and debris, should be removed from drains, gutters, downspouts, scuppers, conductor heads, and at-grade downspouts to storm drain connections under a preventive-maintenance program.

a. Ponding

Roof areas where water ponds in excess of one inch in depth after 48 hours should be corrected by the addition of roof drains or tapered insulation, or by lowering the existing roof drains. Such repairs, however, may be beyond the capabilities of in-house HA maintenance staff and may need to be contracted. Prior to contracting for repairs, a Scope of Work should be developed by a knowledgeable HA staff member or an Architect or Engineer, depending on the complexity of the work to be performed.

2. SMALL REPAIRS

Small repairs to roof components are considered a part of the preventive and regular maintenance program. (Roof repair methods are described in Sections D-I by membrane type.) In performing any repairs, the HA staff should be aware of warranty requirements. Most warranties require that the manufacturer be notified in advance and that the repairs be made by an approved contractor.

3. FOOT TRAFFIC

Foot traffic on roofs should be kept to a minimum. If equipment on the roof requires frequent maintenance, install walk pads, following roof-membrane manufacturers' recommendations for installation, to protect the roof from damage. Residents frequently seek access to the roof for a number of activities, ranging from sunbathing through antenna installation, and most do not understand the damage that foot traffic and puncturing of the membrane can cause. HA staff may need to educate residents about the effects of their actions in order to gain their cooperation in limiting roof-top foot traffic. Although the HA's policy on keeping roof doors and hatchways locked will require balancing fire fighters' needs for access through the roof against property damage due to residents' access to the roof, HAs should consider controlling access to the roof by keeping doors and hatchways locked.

SECTION C EMERGENCY REPAIRS

Depending on the extent of the defect, emergency repairs should be as simple as possible to allow them to be performed safely by HA maintenance staff without any delay. These repairs should be considered temporary, and permanent repairs should be made later, usually by a professional roofing contractor, as soon as weather permits.

1. MATERIALS, TOOLS, AND EQUIPMENT FOR EMERGENCY REPAIRS

The following materials, tools, and equipment are suggested for emergency repairs:

- Roofing fabric, cotton, or glass fiber;
- Wet/dry roofing cement (non-asbestos);
- Roll of EPDM or 6-mil polyethylene sheeting with adhesive glues or tape;
- Bentonite (an absorptive clay useful in creating dams);
- Ballast material—sandbags, concrete blocks, wood planks;
- Wood blocks;
- Screw driver, sharp knife, scissors, and straight-claw hammer;
- Trowel for roofing cement;
- Cleaning products (409 or similar cleaner for cleaning sheet membranes);
- Brush for adhesive;
- Dry, clean rags;
- Capped nails for fastening flashing;
- Push broom;
- Water pump and hose.

2. TWO PERSONS FOR EMERGENCY REPAIRS

Emergency repairs should be performed by a minimum of two persons to ensure safety. Electricity and water are a hazardous combination; always exercise caution when performing emergency repairs in the presence of "hot" wires or equipment under electrical current, such as air conditioners or heat-pump condensers.

3. BEFORE GETTING ONTO THE ROOF

It is wise to accomplish several tasks even before getting up onto the roof:

- Identify approximate location of leak;
- Remove residents from apartments where potentially harmful conditions exist;
- Shut off electrical service when there is a chance that downed electrical wires may be encountered.

4. INSPECTION PROCEDURE DURING EMERGENCY REPAIRS

The following inspection procedure is recommended during emergency repairs:

- Inspect roof from the access point for downed tree limbs and electrical lines. As noted above, water and electricity are a potentially deadly combination.
- Check for potential structural overloading resulting from water, snow, and ice.
- Check all roof drains, scuppers, gutters, and downspouts. Clear strainers to allow free draining. DO NOT remove strainers and reach into a drain pipe, since the sudden cleaning may cause dangerous suction. Remove additional water with brooms, squeegees, or pumps.

5. CAUSES OF LEAKS REQUIRING EMERGENCY REPAIRS

a. Water Overtopping Base Flashings, Pitch Pockets

Check leaks after water is drawn down by clearing drainage system. If leak has stopped, return to roof in good weather, perform inspection (see Special Inspection), and make required repairs.

b. Punctures at Fallen Limbs, Toppled Equipment

- Examine roof for punctures, remove penetrating object, and patch membrane as well as possible;
- Return in good weather and install permanent, durable repair.

c. Wind Damage

- Examine roof for membrane blow-off;
- Install battens, sand bags, concrete blocks, or take other measures to prevent more extensive wind damage to the roof membranes. CAUTION: Exercise care when placing ballast or heavy objects on roofs to hold down tarps and other materials, since additional weight may overload an already damaged roof structure. On wood and steel decks, batten strips can be fastened directly through the membrane. Tarps or other covers may have to be applied and ballasted to seal areas where the membrane has been lost.
- Wind effects usually are most severe at corners and perimeters. Look there for missing fascia metal, displaced coping, or other perimeter damage.
- Refasten loose coping, gravel stops, and other perimeter flashing. If necessary, install tarps, battens, or sand bags to prevent further damage to the roof and to stem leaks to the interior of the building.

6. FOLLOW-UP SPECIAL INSPECTION

Roof areas should be inspected after severe storms, and any necessary repairs should be completed without delay.

7. WET REPAIRS

The following is the recommended procedure for making wet repairs:

- Dry out the surface as much as possible, since "wet-patch" materials have a better chance of success when applied to dry surfaces. If necessary, dam off the area to be repaired. Use 2x4s bedded in plastic cement or sand, sand bags, or bentonite.
- Wipe the affected surface clean with rags, and dry with compressed air, fans, or hot-air guns. Use caution when using electrical devices in wet areas to avoid electrocution.
 - Built-up and Modified Bitumen Roofs: Prepare surface and repair built-up roofs in accordance with two-ply cement and fabric-patch specification outlined below.
 - Single-Ply Roofs: Solvent-clean elastomeric membranes and follow manufacturer's instructions for installation of patch materials. For loose-laid single-ply membranes, a simple repair can consist of placing a wood block below the membrane at the puncture and covering the block and hole with an upside-down bucket. Weight the bucket with a sand bag to prevent blow-off.
 - Steeply-Sloped Roofs and Metal Roofs: Install tarps and secure with battens.

SECTION D REPAIR OF BUILT-UP ROOF MEMBRANES

Built-up roofing membranes are the most common membrane type on HA properties. The repair materials and procedures listed below apply to gravel-surfaced and smooth-surfaced coal-tar and asphalt-bitumen built-up roofs.

1. BASIC MATERIALS

The basic materials used in built-up roof membrane repairs are:

- Roof Cement (Asphalt): ASTM D 4586, Type I, roof cement, asphalt, wet and dry, non-asbestos.
- Roof Cement (Coal Tar): ASTM D 4022, non-asbestos, coal-tar based roof cement.
- Fabric (Cotton): ASTM D 173, asphalt-saturated cotton fabric, 3.5 ounces per square yard.
- Fabric (Glass): ASTM D 1668, Type I, asphalt-saturated woven glass fiber, 3.0 ounces per square yard.
- Asphalt (for Built-up): ASTM D 312, Type III, Steep. Do not heat above 500°F; point of application temperature is 375° to 425°F.
- Asphalt (for Modified Bitumen): ASTM D 312, Type IV, Special Steep. Do not heat to temperatures greater than 500°F; point-of-application temperature is 400°F.
- Coal Tar Bitumen: ASTM D 450, Type III. Maximum kettle temperature 425°F; point of application temperature 350-450°F.
- Modified Bitumen: 160 mils thick, fiberglass or polyester reinforcing.
- Felt (Fiberglass, Type IV or VI): ASTM D 2178, continuous-strand glass-fiber coated with weathering grade asphalt.

2. METHODS AND TECHNIQUES

- Tie maintenance and repair work into sound, clean (free of all surface contaminants), and dry membrane. There should be no loose felts, gravel/slag surfacing or other debris at patch area.
- Use compatible materials on all work (for instance, coal-tar based materials for coal-tar roofs and asphalt-based materials for asphalt-based roofs).
- Place debris removed from roof, gutters, and downspouts into a trash container off the roof.
- Most patches used in repair procedures are cold-applied, two-ply cement and fabric patches. These patches do not require special equipment—kettles or torches—and can be performed by in-house HA maintenance staff. Use two-ply cement and fabric patches to repair areas less than four square feet, and if equipment for making hot repairs on larger areas is not available. Use hot patches—three-ply hot-asphalt patch or membrane patch with modified bitumen—for areas greater than four square feet if equipment and properly trained personnel are available. Generally, a hot-patch is more suitable and will last longer, especially for larger repairs (greater

than two square feet).

a. Two-Ply Cement and Fabric Patch

Remove surface material and most of the flood coat from membrane a minimum of 12 inches beyond the edge of the area to be patched. Prepare membrane by trimming away deteriorated felts. Use care not to damage the watertight felts below. Prime area with a thin coat of asphalt primer and allow to dry; or, work cement well into membrane. Apply a 1/16-inch thick bed of roofing cement. Place one layer of fabric in cement, lapping a minimum of 3 inches onto sound membrane. Apply second 1/16-inch bed of cement and final layer of fabric, covering the first layer and lapping 3 inches onto sound membrane. Seal the total patch and spudded area with 1/16-inch cement coating. In gravel-surfaced areas, do not lap cement onto surface material. Apply surface material to completely cover patch.

b. Three-Ply Hot Asphalt Patch

Prepare deteriorated membrane as described for two-ply cement-and-fabric patch above. Apply 3-ply hot asphalt and fiberglass felt patch using strips 6, 9, and 12 inches wider than the area to be patched. Apply the surface material in a flood coat of hot asphalt.

c. Membrane Patch with Modified Bitumen

Prepare deteriorated membrane as described above. Apply mop-on or torch-on modified bitumen patch, lapping adjacent sound membrane a minimum of 12 inches from edge of deteriorated membrane. Seal perimeter of patch with two-ply cement and fabric patch.

3. BARE SPOTS

Bare spots consist of areas where felts are exposed from loss of gravel surfacing, flood coat, or smooth-surface built-up roof coating. Causes of bare spots include bitumen flow in coal-tar built-up roofs, wind scour, foot traffic, chemical attack, ponding water, or other weathering effects. Repair procedures include:

- Sweep loose surface material (gravel or slag), dirt, and dust from top of exposed membrane or unbroken blister or ridge without damaging the watertight plies below. Coat surface of membrane with 1/8-inch thick layer of cement, and spread surface material over the wet-cemented surface.
- On smooth-surface membranes, repair as above, and apply coating to match adjacent areas.
- If bare spots are the result of foot traffic, install walk pads in accordance with roof membrane manufacturer's recommendations.

4. ALLIGATORING/CRACKING

The appearance of a pattern similar to "mud-cracking" or alligator hide on surface of roof is known as alligatoring (see Figure 4-9). This problem is common to smooth-surface built-up roofs. Excessive shrinkage of a bitumen flood coat can expose felts to the weather and stress and tear felts, allowing water intrusion. Repair, using the following procedures:

- Remove loose surface material, dirt, and dust from the top of the membrane with a broom, and coat with a material similar to that used on the remainder of the roof (clay-based emulsion or asphalt roof coating). Control thickness of application to avoid excessive coating build-up.
- When coating is severely alligatored, remove dust and dirt by sweeping or vacuuming without damaging watertight plies below. Apply one thin coat of asphalt primer, preferably by brushing. Avoid applying an excessive amount of primer. After primer is allowed to dry, apply clay-based emulsion or asphalt roof coating.

5. SURFACE SLIPPAGE

Surface slippage, or down-slope lateral movement of felt plies, generally occurs on slopes greater than 1/4 inch per foot. Causes can include the following:

- Felts were not back-nailed during application of the roof membrane;
- Wrong grade of asphalt was used for the roof slope;
- Too much asphalt was used between felts;
- Interply moppings were too thick;
- Construction was phased so that the base sheet was glaze-coated and the membrane was installed at a later date.

Repair procedures include:

- Clean roof drains and gravel stops of bitumen build-up that is inhibiting proper drainage of roof;
- Repair felts exposed by slippage with procedures similar to those described above;
- Areas of excessive slippage should be repaired by a professional roofing contractor.

6. BLISTERS

Blisters are round or elongated raised areas of the membrane which are filled with air and sometimes water (see Figure 4-9). Blisters are caused by moisture vapor in built-up roofs exposed to summer heat. Repair in the following way:

- Unbroken, sound blisters up to approximately one foot in diameter are best left alone. Mark perimeter of blisters with bright orange spray paint to prevent foot traffic across blister and for easy reference during subsequent inspections to see if blisters are growing.

- Bare spots on tops of blisters should be treated as described in Section D.3 above.
- Repair broken blisters as follows:
Remove the entire blister to its edges where the membrane is sound. Allow resulting depression to dry. Fill depression with fitted felt set in 1/8-inch-thick layers of roof cement. Apply two-ply cement and fabric patch over the filled area, extending onto the surrounding sound membrane.
- Cut away large blisters and repair per broken blister procedures.
- At large repairs, consider applying three-ply hot patch.

7. SPLITS

Splits are tears that extend through the membrane felts (see Figure 4-9). Splits vary in length from a few feet to the width of the roof and in width from a hair-line crack to more than an inch. Causes include the following:

- Membrane felts are too weak;
- Attachments among membrane, insulation, and decking are minimal;
- Differential movement;
- Structure undergoes expansion and contraction.

Repair procedure is the following:

- Identify cause of split in the membrane. If cause is not readily ascertained, or if the repair requires outside contract work, perform temporary repair with two-ply cement and fabric patch.
- Repair splits caused by differential movement by installing a curbed structural expansion joint.
- Repair splits caused by weak membrane or unsecured materials by reattaching the membrane, insulation, or other material to the deck with appropriate fasteners. Patch split and heads of fasteners with two-ply cement and fabric patch.

8. RIDGES

Ridges are long, narrow raised portions of the roof membrane (see Figure 4-9). Usually ridges occur directly above insulation-board joints and run perpendicular or parallel to the felts. They include all plies of the membrane and therefore are generally stiffer than blisters. Causes include excess moisture vapor build-up at insulation joints, slippage of membrane perpendicular to the roof slope, and a poorly attached membrane. Repair ridge in accordance with repair procedure listed for Bare Spots and Splits (see Sections D.3 and D.7). Note the repair on roof plan, and schedule periodic follow-up inspections.

9. HOLES

Holes are punctures through the roofing membrane. They come from a large number of sources, such as falling debris, vandalism, or damage during work on roofs. Repair by application of two-ply cement and fabric patch.

10. FISHMOUTHS

Fishmouths are half-cylindrical openings at the edges of felts and cap sheets. They are caused by excessive pulling of the felts during installation, application of felts with wet edges, or insufficient bitumen application. Repair by the following procedures:

- If the fishmouth is less than 2 inches deep, loose material may be cut away and discarded.
- For deeper fishmouths, cut away loose material until sound, well-bonded material is encountered, and apply two-ply cement and fabric patch.

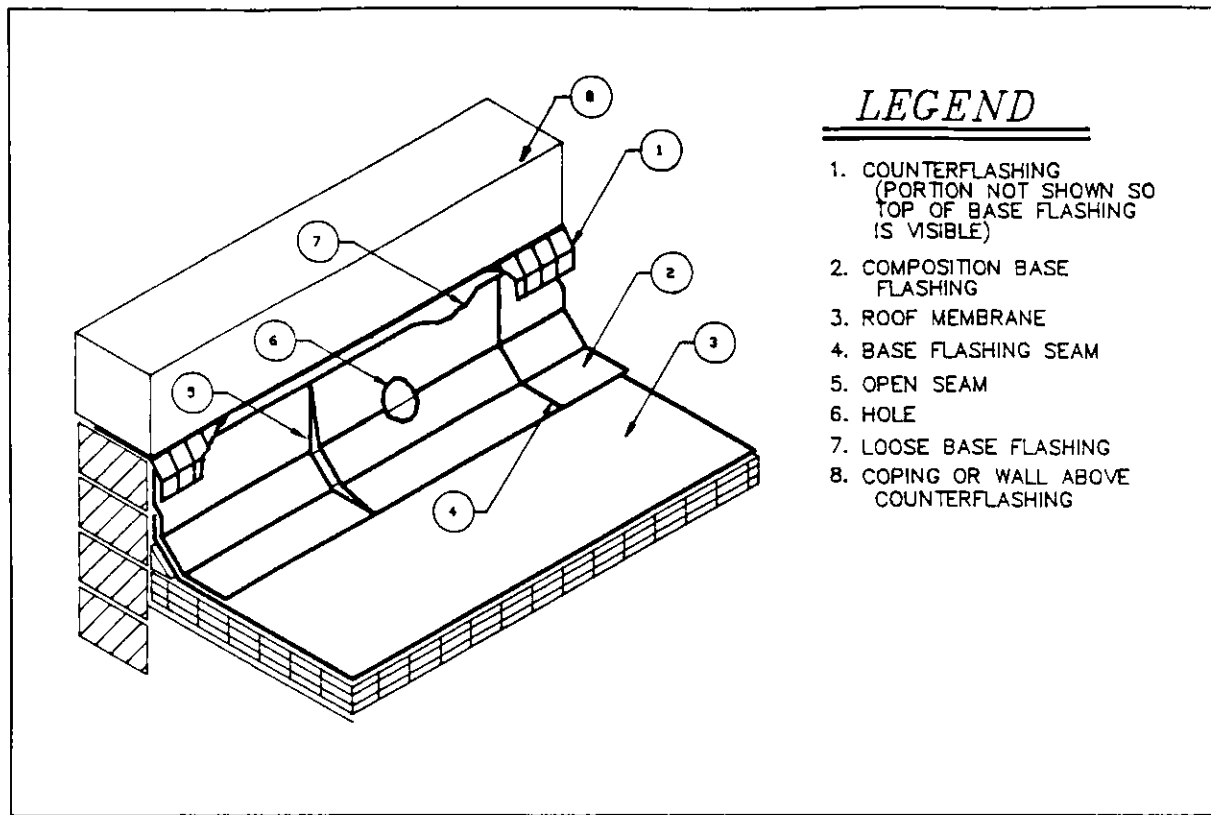
11. PATCH FAILURE

Patches are previous repairs in the membrane. Failures can be caused by improper repair and aging. Repair by the following procedure:

- Perimeter Repairs: Seal open areas with two-ply cement and fabric patch.
- Surface Repairs: Repair surface defect or splits in accordance with appropriate repair procedure described previously.

12. BASE FLASHING DEFICIENCIES

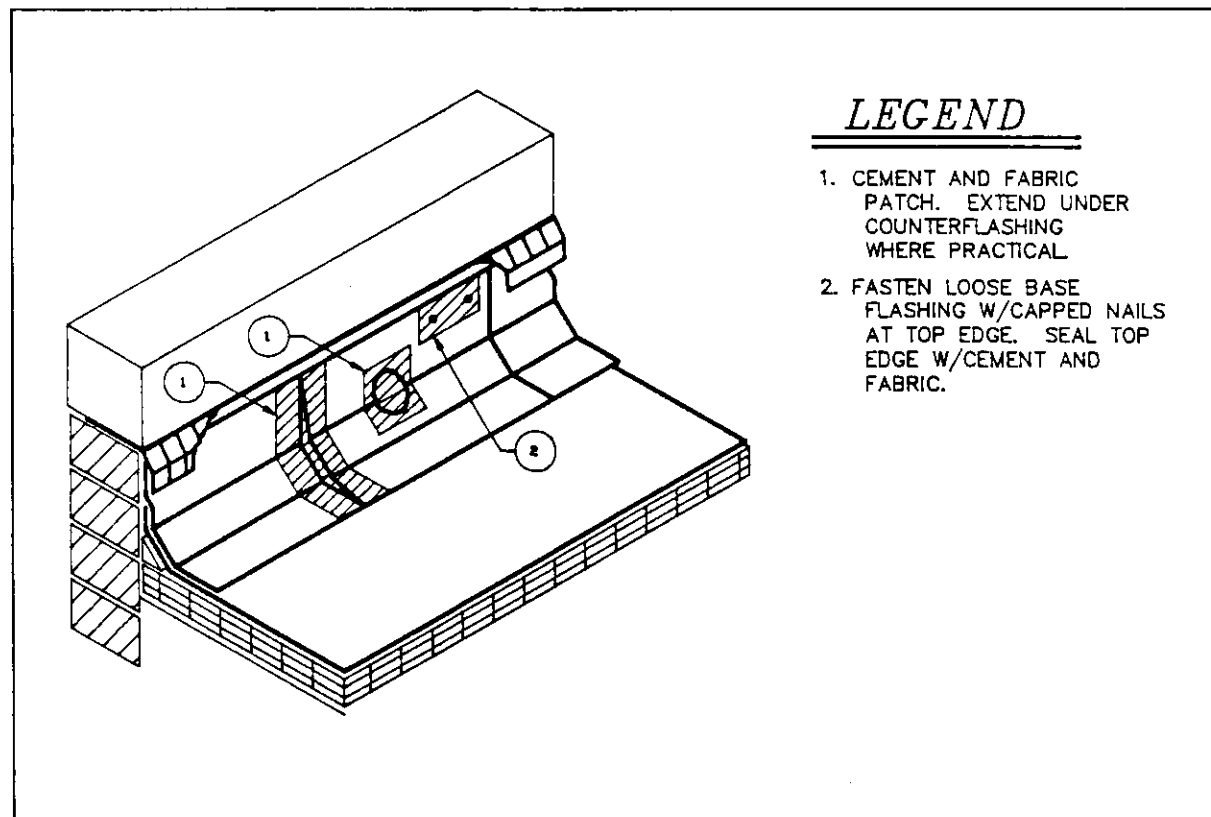
Base flashing consists of material providing the watertight transition between the roof and the wall, parapet, equipment curbs, equipment supports, and chimneys. Base flashing is constructed of asphalt-based composition-roofing material or metal (older installations). Base flashings should be a minimum of 8 inches high, securely fastened at the top and firmly adhered to wall and cant surfaces. The top 3 to 4 inches of the base flashing should be covered with counterflashing. Base flashing deficiencies consist of openings at the top of the flashing, a top edge of flashing which is too low, inadequate cover by counterflashing, open seams, holes, and poor securement to wall. Defective base flashing should be repaired. Causes include cracks or breaks in vertical joints of the metal base flashing, incompatible thermal movement between metal base flashing and roof membrane, punctures, broken laps at seams, separation or sagging from wall, disintegration of surface coating, and differential movement between roof deck and wall. Figures 5-1 through 5-4 show some of these deficient conditions with associated repairs.



LEGEND

1. COUNTERFLASHING
(PORTION NOT SHOWN SO
TOP OF BASE FLASHING
IS VISIBLE)
2. COMPOSITION BASE
FLASHING
3. ROOF MEMBRANE
4. BASE FLASHING SEAM
5. OPEN SEAM
6. HOLE
7. LOOSE BASE FLASHING
8. COPING OR WALL ABOVE
COUNTERFLASHING

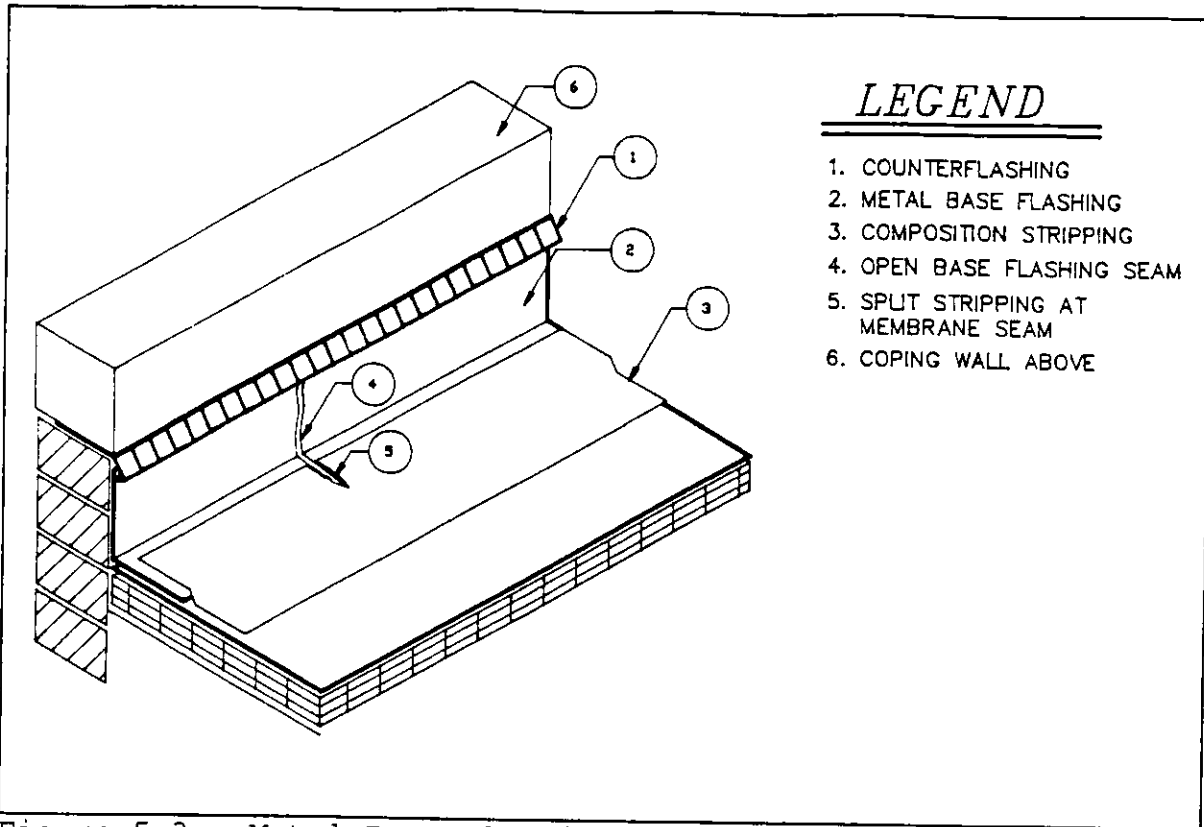
Figure 5-1: Composition Base-Flashing Open Seam



LEGEND

1. CEMENT AND FABRIC
PATCH. EXTEND UNDER
COUNTERFLASHING
WHERE PRACTICAL
2. FASTEN LOOSE BASE
FLASHING W/CAPPED NAILS
AT TOP EDGE. SEAL TOP
EDGE W/CEMENT AND
FABRIC.

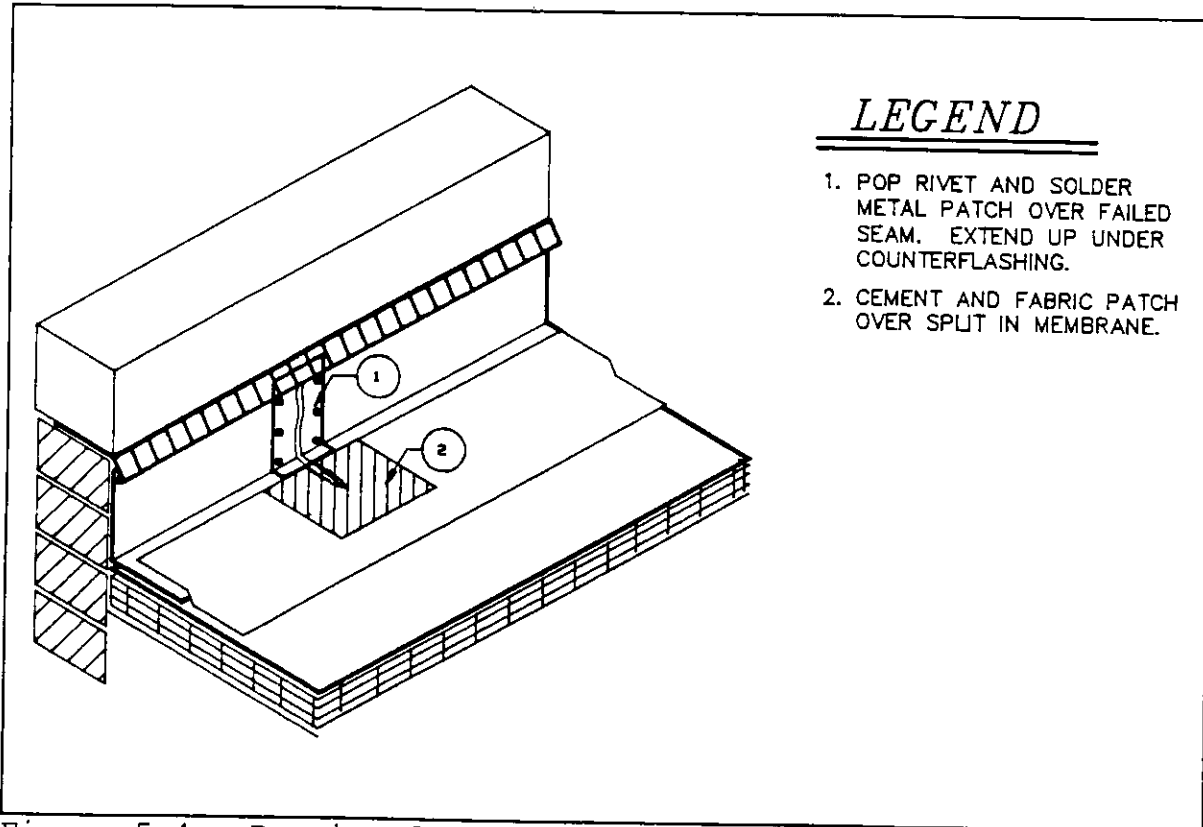
Figure 5-2: Repair of Composition Base-Flashing Open Seam



LEGEND

1. COUNTERFLASHING
2. METAL BASE FLASHING
3. COMPOSITION STRIPPING
4. OPEN BASE FLASHING SEAM
5. SPLIT STRIPPING AT MEMBRANE SEAM
6. COPING WALL ABOVE

Figure 5-3: Metal Base-Flashing Open Seam



LEGEND

1. POP RIVET AND SOLDER METAL PATCH OVER FAILED SEAM. EXTEND UP UNDER COUNTERFLASHING.
2. CEMENT AND FABRIC PATCH OVER SPLIT IN MEMBRANE.

Figure 5-4: Repair of Metal Base-Flashing Open Seam

Repair procedures include the following:

- Open Metal Base Flashing Seams (see Figures 5-3 and 5-4): Repair cracks and breaks in vertical seams by cleaning metal and resoldering, or install soldered metal patch over joint. If defect is close to coping or cap flashing, extend repair a minimum of 1 inch under flashing.
- Splits between Roof Membrane and Metal Base Flashing: Remove surface material and flood coat a minimum of 9 inches from the edge of base flashing and 6 inches beyond the extent of damage. Remove deteriorated stripping. Clean and solder open joints. Install two-ply cement and fabric patch overlapping the sound membrane 6 inches.
- Deterioration of Metal Base Flashing Coating: Clean, prime, and paint metal with rust inhibitive primer and two coats of good, exterior grade alkyd paint.
- Punctures: Install two-ply cement and fabric patch on composition base flashings. Temporarily repair punctures in metal base flashings with two-ply cement and fabric patch. Permanent soldered repairs may be beyond the capabilities of HA maintenance, and may require outside contract work.
- Broken Laps and Split Seams in Composition Base Flashing (see Figures 5-1 and 5-2): Seal all cracks, holes, and open seams in composition base flashing with two-ply cement and fabric patch. Terminate cement and fabric repair 1 inch under counterflashing or coping, if within 6 inches.
- Separation/Sagging at Wall: Small areas of sagging and separation can be left alone as long as they are properly counterflashed. At larger areas, embed loose base flashing in full coating of roofing cement applied to wall, and secure base flashing plies to wall with capped nails or nailins spaced 12 inches on center. Seal fastener heads and top of base flashing with cement and fabric.
- Deteriorated Surface Coating, Smooth-Surfaced Composition Base Flashing: Seal all cracks, holes, and open seams in base flashing, as noted above, prior to application of surface coating. Apply aluminum coating to all exposed existing base flashing.

13. METAL ROOF EDGES (GRAVEL STOPS)

Typical problems with metal gravel stops are splits in the roof membrane at the gravel-stop joints, separation of stripping from the gravel-stop flange, and deterioration of the gravel-stop metal. Splits and delaminations between the metal gravel stop and the roofing membrane are the result of differential thermal expansion. Deterioration is often the result of roof drainage across the gravel stop.

Repair procedures are the following:

- Splits at Seams: Remove surface material and flood coat a minimum of 9 inches from the edge of the gravel stop and 6 inches from the gravel-stop joint. Cut away deteriorated stripping. Clean and solder open joints. Refasten loose sections of gravel stop with corrosion-resistant nails, 3 inches on center, staggered. Install two-ply cement and fabric patch, lapping the gravel stop 3

- inches and sound roof membrane 6 inches.
- **Repair Stripping:** Spud surface material and flood coat a minimum of 9 inches from the edge of the gravel stop. Remove deteriorated stripping. Refasten loose edges of gravel stop with corrosion-resistant nails, spaced 3 inches on center, staggered. Install two-ply cement and fabric patch, lapping the gravel stop 3 inches and the sound roof membrane 6 inches.
 - **Replace Deteriorated Gravel Stop Section:**
 - Remove surface material and stripping to a minimum of 9 inches from the face of the deteriorated gravel stop.
 - Remove and dispose of the deteriorated gravel stop.
 - Install new gravel stop of same material and profile. Set it in a 1/8-inch-thick bed of roof cement and secure it with compatible, corrosion-resistant nails, spaced 3 inches on center, staggered. Lap joints 3 inches. The bottom edge of the fascia (vertical leg of gravel stop) should be hooked to a securely fastened continuous cleat.
 - Strip in with two plies of cement and fabric and apply surface material.
 - **Clean, Prime and Paint:** If gravel stop is painted, clean, prime and paint deteriorated surfaces. Wire brush loose rust and paint down to bare metal and apply rust-inhibitive primer recommended by the manufacturer for the metal being primed. Allow to dry, then apply first and second paint coats.

SECTION E MODIFIED-BITUMEN ROOF MEMBRANES

Modified-bitumen roofing, due to its ease of installation, is gaining in popularity on low-slope roofs. The material is either torch-applied or set in hot asphalt and is similar in appearance to smooth or mineral-surfaced roofs, except it is much thicker. The additional thickness of membrane is visible at the exposed seams. Torch repairs to modified-bitumen membranes are normally contracted out to a professional roofing contractor.

1. BASIC REPAIR MATERIALS AND SPECIAL TOOLS

The following are the basic repair tools for modified-bitumen membrane repairs:

- Mastic as approved by membrane manufacturer;
- Membrane, same as installed material;
- Heat-welding torch;
- Cement and fabric. (See Built-up Roofing material list at Section D.1.)

2 OPEN SEAMS

One of the main drawbacks of modified-bitumen systems is the frequent failure of both membrane and base-flashing seams. This can lead to extensive leaks in single-ply systems. Lap-seam failure can result from thermal stress and improper material application. Lap-seam repair should be done with the following procedure:

Slice failed lap seam with a hook-blade knife; clean and dry lap area. Torch unbonded lap to seam the existing material. Roll with heavy-weighted hand roller to bond as best as possible prior to stripping in. Cut stripping ply with rounded corners measuring 10 inches wide and four inches longer than the lap seam to be repaired. Prepare membrane surface by sweeping and applying asphalt primer. Allow primer to cure. Center stripping ply over seam and torch-apply. Heat to produce flow of 3/8 to 5/8-inch outside the edge of the patch.

These repairs require contract work unless there are properly trained roofing professionals on the HA staff. Temporary repairs may be made with two-ply cement and fabric patches. Check compatibility of roofing cement and membrane with membrane manufacturer.

3. SURFACE DETERIORATION

Loss of mineral surfacing or smooth-surface coating on mineral-surfaced modified-bitumen membranes can lead to accelerated deterioration of the asphalt and reinforcements in the modified membrane. Causes of surface deterioration can include foot traffic and natural weathering. Repair procedures are as follows:

- **Mineral Surfacing Repair (Small Areas):** Sweep surface and salvage existing loose mineral surfacing. Apply a bed of approved mastic to the area to be resurfaced. Broadcast heavy coating of mineral surface material over mastic and press into place.
- **Mineral Surfacing Repair (Large Areas):** If there has been granule loss throughout the roof, sweep surface to remove all existing loose mineral and apply protective coating in accordance with membrane manufacturer's specifications.
- **Smooth Surface Repair:** Repair the exposed surface of the membrane, sweep clean, and apply protective coating in accordance with membrane manufacturer's specifications.

4. BASE FLASHING DEFICIENCIES

See Built-up Roofing section.

5. HOLES

Punctures through the roofing membrane can be caused by vandalism, foot traffic, falling tree limbs, or other similar events. For repair procedures, see seam-repair procedure in Section E.2.

6. BLISTERS

See Built-up Roofing section. Patch locations where blisters are removed with modified-bitumen roofing membrane.

SECTION F ROLL ROOFING

Roll roofing consists of asphalt-impregnated roofing felt coated with a mineral surfacing. The roof is installed in shingle style on sloping, nailable roof deck and is fastened with roofing nails. This type of roof is not common.

1. OPEN SEAMS

Open seams are caused by failure to cement seams or to use the proper kind of cement.

Use the following repair procedure:

- Cut all buckles and fishmouths which terminate at seams.
- Replace loose or missing nails.
- Sweep mineral surface material from the area to be repaired and salvage. Apply asphalt primer or work first layer of roofing cement well into the membrane.
- Extend roofing cement a minimum of 3 inches on either side of seam to be repaired. Embed 4-inch wide strip of cotton roofing fabric into the cement.
- Apply second coat of roofing cement and broadcast liberal amount of mineral surfacing into completed repair.

2. HOLES

Holes are punctures or tears in the roofing membrane, which may be the result of foot traffic, falling debris, and vandalism. Follow this repair procedure: sweep the area to be repaired of loose mineral surfacing material and apply two-ply cement and fabric patch.

SECTION G METAL ROOFS

There are numerous kinds of metal-roof systems available today. Metal roofs are generally limited to porches, cornices, penthouses, and other small structures. The metals used in these roofs are copper, lead coated copper, stainless steel, terne-coated stainless steel, terne plate, and galvanized steel. The most common types are standing-seam and flat-locked and soldered seam roofs. If an HA has a prefabricated metal roof, the system manufacturer should be contacted for maintenance requirements unless the information is already on file.

The metal roof repairs listed below are best made by skilled sheet-metal mechanics and professional roofing contractors. Therefore, the repairs will have to be contracted out.

1. BASIC MATERIALS

Materials for metal roof repairs include the following:

- Copper: ASTM B 152, C110 cold rolled, tempered, 16 or 20-ounce. Match existing materials.
- Lead-Coated Copper: ASTM B 101, Type I, Class A, coated one side, except coated both sides where both exposed; cold-rolled unless soft temper required for forming and performance; 16-ounce sheet before coating (0.0216 inch thick).
- Neoprene: Uncured neoprene, 60 mils thick; specific gravity (ASTM D 297) 1.50 + .05; tensile strength 1400 psi; density 0.50 psf. Use adhesives and sealants supplied by neoprene manufacturer.
- Paint System (for copper): Primer: Epoxy polyamide, highly corrosion and chemical-resistant lead silico-chromate primer, two-part mix, solids content 68 percent by weight, color-dull orange, recoat within 72 hours. Apply at the rate of 400 square feet per gallon or 2 mils dry-film thickness (Ply-Tile 520-R-17 Primer by MAB or equal). Finish Coat: Aliphatic Acrylic Urethane, two-part mix, solids content 59 percent by weight, color—Vista Green C60-63 Y. Apply at 350 square feet per gallon or 2.5 mils dry film thickness (Ply-Thane 880 Coating by MAB or equal). (Contact MAB, 600 Reed Road, Broomall, Pennsylvania (Phone 215/353-5100) for nearest distributor.)
- Solder: ASTM B 32, 50-50 percent block tin and pig lead (minimum) solder. Use rosin flux. Use 3 pound irons. Do not use torches or welding for metal roofs.
- Stainless Steel (SS): Type 304, ASTM A 167, with AISI 2D finish, dead soft, fully annealed, 0.018 inch thick, except as otherwise indicated.
- Terne Coated Stainless Steel (TCS): Type 304, ASTM A 167, dead soft stainless steel coated on both sides with terne alloy (80% lead and 20% tin); match thickness of material being patched, 0.015 inch thick minimum. (Terne Coated Stainless Steel by Follansbee).

2. METHODS AND TECHNIQUES

When performing inspection or repairs on metal roofs, workmen should wear rubber-soled shoes to prevent damage to the roof.

a. Solder Repair

Clean existing metal of all roofing cement, paint, coating, and rust to bright clean metal for one inch around small hole. Solder hole watertight.

b. Soldered Metal Patch

Clean existing metal of all roofing cement, paint, or other coating and rust to bright clean metal for two inches around damaged area. Cut metal for patch to 1/8-inch smaller than cleaned area. Pre-tin patch and cleaned surface at repair area. Solder patch watertight (Do not use torches or welding). Use pop rivets (same material as roof) on larger patches to aid in soldering operation. Clean excess rosin and neutralize flux.

c. Neoprene Repair

Clean all adhesive, cement, dirt, and oil from seams to be repaired. Center 2-inch wide bond breaker, polyethylene backer from neoprene or duct tape, over damaged seam. Apply a neoprene patch, with bonding adhesive applied to both surfaces. Lap the open seam a minimum of 4 inches on all sides. Roll patch with a hand roller until it is completely in contact with the metal roofing and does not bridge at any point. Seal the patch edges with polyurethane sealant and coat exposed surface of neoprene with Hypalon or equal.

d. Clean, Prime, and Paint

Wire brush rust down to bare metal and remove loose paint from metal roof panels. Patch open seams or damaged sections of metal roof using appropriate repair procedures (see Section G.2). Apply rust-inhibitive primer recommended by manufacturer for metal to be painted. Allow to dry and apply first and second finish coats of paint. Record paint information in Historical Data File.

e. Coating Eroded Surfaces (typical for copper roofing)

Repair holes and open seams in accordance with appropriate repair procedures. Clean, prime, and paint eroded areas with paint system for copper, following manufacturer's recommendations.

3. HOLES

Holes in metal roofs can result from corrosion, erosion, natural weathering of metal, foot traffic, impact of falling objects, or from other causes. Repair procedures include the following:

- Patch small hole (less than 1/8-inch diameter) in accordance with Solder Repair techniques described above.
- Patch large hole (greater than 1/8-inch diameter) in accordance with Soldered Metal Patch technique described above.

4. OPEN SEAMS

Open seams in flat-locked and soldered metal roofing result from expansion of the metal roof when it is exposed to the summer sun. Repair procedure is as follows:

- Patch open seam in metal roof in accordance with Soldered Metal Patch technique above.
- Only if soldered patches are unsuccessful or if damage results from lack of expansion joints and expansion joints cannot be added, repair in accordance with Neoprene Repair technique described above.

5. CORROSION AND EROSION

Corrosion occurs when aluminum or ferrous metal surfaces are exposed to weathering or when different metal materials are in contact. Erosion results from concentrated water flowing over the metal surfaces, such as valleys and crickets, and is confined to copper roofing materials. The repair procedure is as follows:

- Clean, prime, and paint painted metal surface where deterioration has started or paint is cracking, peeling, or otherwise in poor condition.
- Repair eroded metal surfaces in accordance with Coating Eroded Surface techniques described above.

6. FASTENER DEFICIENCIES

Fastener deficiencies arise when fasteners become loose. Corrosion develops when fasteners of incompatible metals are in contact, and when ferrous fasteners are exposed to the weather. Repair procedures are as follows:

- Loose Fasteners: Check all exposed fasteners for tightness. Tighten loose screws. If screws are stripped, replace them with new screws with neoprene washers. Use fasteners which are corrosion-resistant and compatible with the metal being fastened.
- Corroded Fasteners: Remove corroded fasteners and replace them with new corrosion-resistant

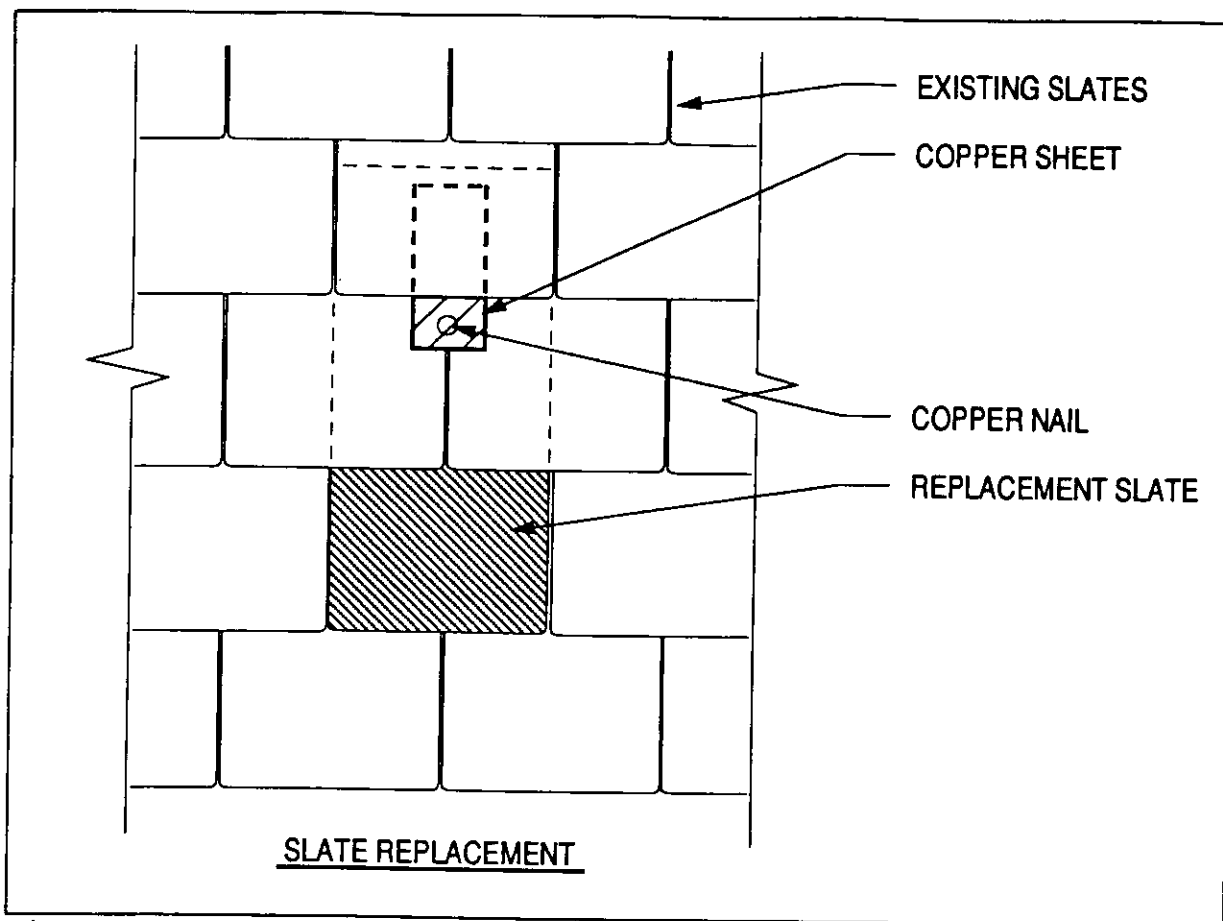


Figure 5-5: Slate Replacement Plan

fasteners compatible with metal to be fastened. Screws should be installed with neoprene washers. Where nail heads will remain exposed, cover with neat spots of polyurethane sealant.

SECTION H SLATE, TILE, AND OTHER RIGID ROOFING SHINGLES

Slate, tile, and cement-asbestos shingles are rigid roofing materials generally used on pitched or sloping roofs. These materials normally provide long service lives with little or no repair. However, being brittle and rigid, they are frequently susceptible to damage from hail, foot traffic, tree limbs, high winds, and thrown objects.

1. REPAIR OR REPLACEMENT OF MISSING, BROKEN, OR LOOSE TILES

If repair or replacement is necessary, fasten shingles with copper nails long enough to penetrate the substrate sheathing, or about 1/2-inch. Nails should just touch shingle slightly. DO NOT drive the nails "home" or draw down the shingle. Replace broken or missing slates which allow water to enter the building (slates which are broken or have large cracks extending over joint between slates underneath), using the following repair procedure.

a. Slate (and Other Flat, Rigid Shingles)

Carefully remove broken slate shingle, cut the nails with a ripper, and remove remaining small pieces of slate. Insert new slate, matching the existing slate in size and color. Using copper nails, fasten replacement slate through vertical joint of overlying course about 2 inches below the tail of the overlying course. Insert over this nail a 3x8 inch sheet of copper, bent slightly, to fit snugly under the slate above and cover the nail. (See Figure 5-5.)

b. Tile

Lift the tile up-slope of the tile to be replaced, and install a copper nail into the substrate. Insert copper wire into replacement tile fastener hole and twist wire to secure it to tile. Slide tile into place and wrap wire around new nail and twist to secure. (See Figure 5-6.)

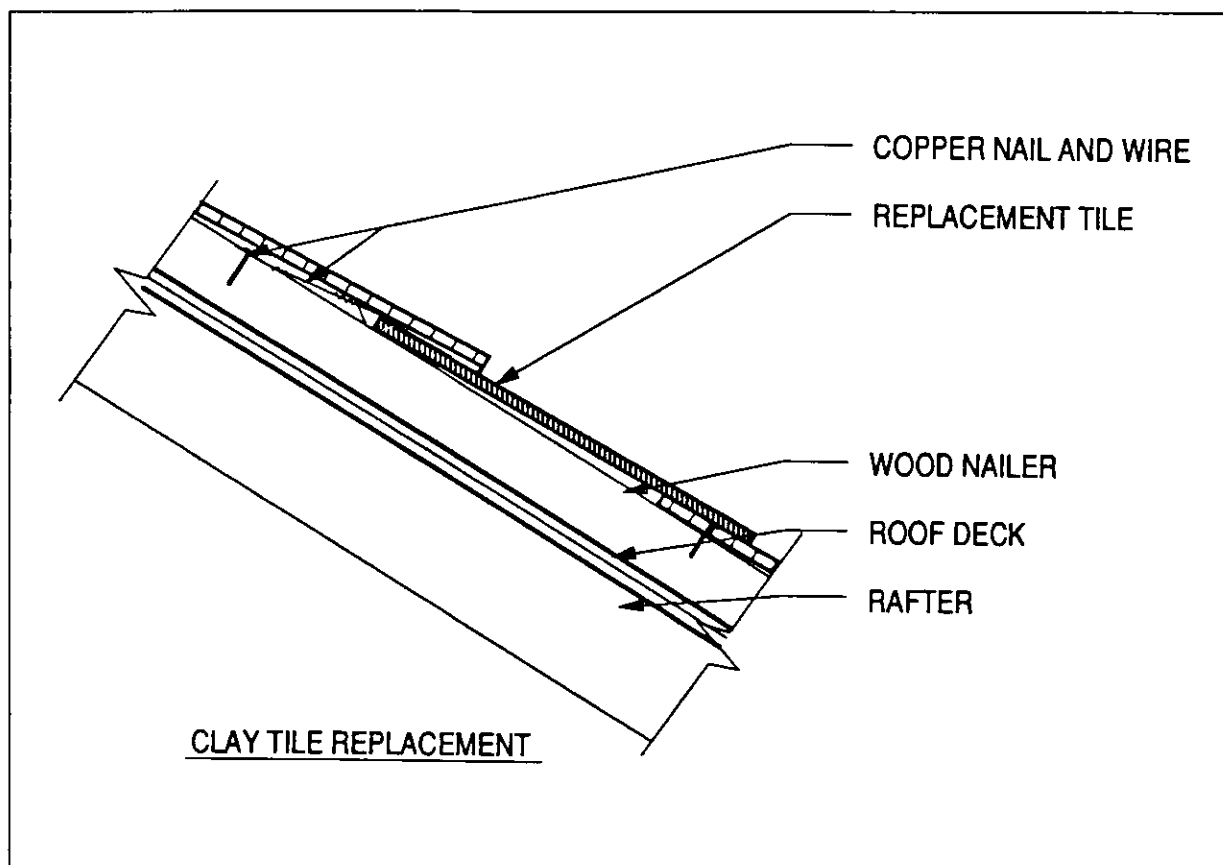


Figure 5-6: Tile Replacement Section

2. DETERIORATED FELT UNDERLAYMENT

The cause of deteriorated felt underlayment is usually extended exposure to weather at missing and broken tiles. Replace deteriorated felt underlayment encountered as follows.

- Small Areas (less than 2 SF): Cut away deteriorated felt underlayment, clean substrate and

- **Small Areas (less than 2 SF):** Cut away deteriorated felt underlayment, clean substrate and surrounding felt at tie-in. Prime substrate with a thin coat of asphalt primer and allow to dry or work roofing cement well into underlayment. Apply 1/16-inch thick bed of roof cement, embed one layer of fabric reinforcing and cover with a second 1/16-inch thick layer of roofing cement. Extend patch a minimum of 3 inches onto sound underlayment.
- **Large Areas (greater than 2 SF):** Cut out and remove deteriorated underlayment. Cut square with roof. Make two 3-inch long slices at top edge corners of sound underlayment to remain to create flap, and slide new felt up under the existing. Fasten new underlayment with one nail per two square feet, and seal edges of new underlayment and nail heads with roof cement. If more than one width of underlayment is installed, start installation at lowest point and install in shingle fashion lapping each width 3 inches.

SECTION I ASPHALT SHINGLES

Asphalt shingles are among the most common steeply-sloped roofing materials because of their low maintenance requirements, low initial cost, and ease of installation. The first indication of normal weathering is loss of mineral surfacing granules, slight at first, but accelerating as loss of granules exposes more of the asphalt coating. Other effects noticeable on aging shingle roofs are curling and cracking.

1. BASIC MATERIALS

The following are the three basic materials required for the repair of asphalt shingles:

- **Asphalt-Fiberglass Shingles:** UL Class A fire-resistance rating. Match color, dimension, and thickness of existing shingles. Use same shingle as originally installed, if possible.
- **Nails (Roofing):** Galvanized steel, annular or spiral threaded, 11-gage roofing nails.
- **Roof Cement:** See Built-up Roofing Repair Material.

2. SINGLE SHINGLE REPLACEMENT TECHNIQUE

Raise shingle above the damaged shingle, taking care not to damage the existing sound shingle. Remove nails with pry bar, chisel, or slate ripper. Slip new shingle into place. Holding up shingle above, nail replacement shingle into place. Apply dab of roof cement at tabs (3 to 4 one-inch diameter dabs). Cutting top corners of the replacement shingles at a 45 degree angle can ease the installation when sliding them under existing shingles.

3. FASTENING PROBLEMS

Some of the problems associated with improperly fastened shingles are lifting during normal winds, tearing at fasteners, and loss of shingles. Damage may also result from high winds lifting end tabs of properly fastened shingles. Some causes include nails installed too close to top of shingle; nails driven at an angle cutting the shingle; staples driven through shingles; insufficient fastener penetration into substrate. Correct these problems using the following repair procedures:

- **Missing or Loose Shingles:** Repair in accordance with Single Shingle Replacement Technique (Section 1.2 above).
- **Loose End Tabs:** Apply 1 1/2-inch diameter dab of roofing cement below loose tab and press tab into roofing cement.
- **Ridge Wind Damage:** Check that ridge shingles are lapped with, rather than against, direction of prevailing wind. Replace damaged ridge shingles, or if they are installed in the wrong direction (shingle ends against prevailing wind direction), replace the entire ridge.

4. SMALL ASPHALT SHINGLE AREA REPLACEMENT

Small area replacement is an effective means of restoring a partially deteriorated or damaged asphalt shingle roof that is otherwise in good condition. Shingles can be blown off by high winds, punctured by hail or other objects such as protruding nails. Use the following repair procedure:

- Remove all loose, deteriorated, and damaged shingles;
- Remove all loose and protruding nails;
- Remove and replace damaged underlayment (felt) similar to procedure outlined above. Cut out and replace damaged or deteriorated wood decking. Replace decking (sheathing) with material of same thickness so that deck will be even with adjoining area.
- Install replacement shingles. Install top row in accordance with Single Shingle Replacement Technique.

5. WOOD TRIM AND WOOD EAVE REPLACEMENT

Rotted wood can result in leaks into the interior of the building and deterioration of connected wood elements. Among the causes are gutter back-up or leaks, improper extension of shingles beyond edge of roof, lack of a metal drip edge, and ice dams. Use the following repair procedures:

- Remove and store gutters if applicable;
- Remove first three courses of shingles. Remove additional shingles to expose sound decking as necessary (see Single Shingle Replacement Techniques);
- Remove deteriorated wood decking and replace with new decking of same thickness;
- Cover new deck with felt underlayment;

- Install metal drip edge;
- Install replacement shingles in accordance with Small Area Replacement.

6. INADEQUATE VENTILATION

Cupping and curling of asphalt shingles is sometimes the result of inadequate ventilation between the building interior and the roof deck. Asphalt Roofing Manufacturers Association (ARMA) recommends a minimum of one square foot of ventilating area (grating) per 150 square feet of attic space. Check existing conditions and make provisions to increase ventilation where necessary to meet these requirements. Repair shingles as noted above.

7. REROOFING WITH ASPHALT SHINGLES

Excessively deteriorated shingles should be replaced. Guidelines for shingle roof installation have been developed by the National Roofing Contractors Association (NRCA) and the Asphalt Roofing Manufacturers Association (ARMA). Contact NRCA or ARMA at addresses listed in Appendix C.

SECTION J COUNTERFLASHING

Cap or counterflashing, usually metal, serves as a protecting cover for the base flashing. The counterflashing should extend over and completely cover all flashing strips, nails, and fasteners securing the top of base flashing by 3 to 4 inches. Some typical counterflashing installation methods are illustrated in Figures 5-7 through 5-9.

1. TWO-PIECE COUNTERFLASHING

Two-piece counterflashing consists of a removable "counterflashing" which is attached to a "receiver." The receiver is either inserted into a reglet in the wall above the base flashing or is the outer edge of a through-wall flashing. The seams in the counterflashing receiver should be soldered watertight. Typical deficiencies with two-piece counterflashing are failure of the connection between the two flashing sections, and deterioration at the joint where the receiver meets the wall.

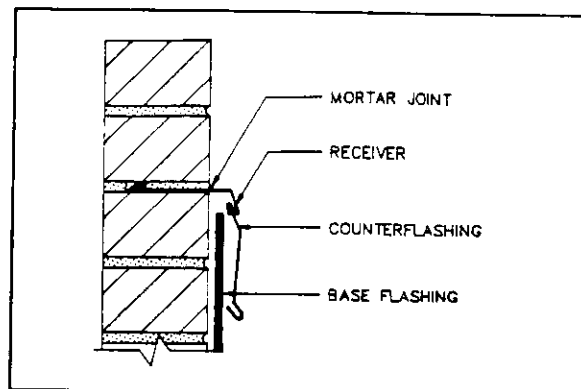


Figure 5-7: Reglet-Mounted Two-Piece Counterflashing

Causes include differential thermal movement between wall and counterflashing receiver, poor original installation, or lack of maintenance, for instance, counterflashing that is not reattached when it becomes loose. Repair procedure is:

- Reattach loose or fallen counterflashing to receiver with compatible, corrosion-resistant sheet-metal screws with neoprene washers, spaced 16 inches on center.
- Repoint deteriorated mortar joints above receiver (see Mortar Repointing repair below). **DO NOT** seal joint above receiver with sealant; this will prevent drainage of water from the wall.

2. REGLET-MOUNTED COUNTERFLASHING

Reglet-mounted counterflashing can be single-piece or two-piece counterflashing. Typical deficiencies with reglet-mounted counterflashing are deterioration of the reglet joint, too-shallow embedment into wall, and poor securement of flashing to wall.

Causes include differential thermal movement between wall and counterflashing receiver, poor original installation, and lack of maintenance, such as not resealing the joint between the wall and counterflashing. Use the following repair procedures:

- Secure or reset loose counterflashing in the reglet with lead wedges, and repoint with mortar.
- Replace missing counterflashing with new matching material, size, and profile of existing counterflashing.
- Replace counterflashing that is in a too-shallow reglet. Saw-cut reglet at 3/8-inch wide and 1 1/2-inch deep. Fabricate and install new two-piece counterflashing with 1 1/2-inch leg set into reglet. Secure with lead wedges and point with mortar.

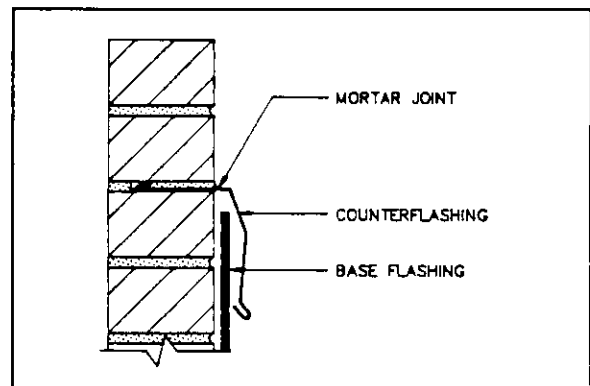


Figure 5-8: Reglet-Mounted One-Piece Counterflashing

3. SURFACE-MOUNTED (PHILADELPHIA) COUNTERFLASHING DEFICIENCIES

Surface-mounted metal counterflashing is secured to the wall with nails or other similar fasteners (there is no reglet), and sealed along the top edge with sealant. Surface-mounted counterflashing should not be used on masonry walls because any water penetrating the mortar joints can seep behind base flashing. Typical deficiencies with surface-mounted counterflashing are failure of sealant at the edge of flashing and leaks at fasteners that penetrate the base flashing.

Use the following repair procedure:

- Cut away all failed sealant, and clean surfaces to receive new sealant in accordance with sealant manufacturer's specifications. Install new, neat bead of weather-resistant sealant at the top of counterflashing. DO NOT smear excessive amounts of sealant onto surrounding wall or counterflashing surfaces. Tool surface of sealant to a concave shape that will allow water to drain away from wall.
- Secure loose counterflashing with nails spaced 12 inches on center. Seal tops of new and existing fasteners with neat dab of sealant.

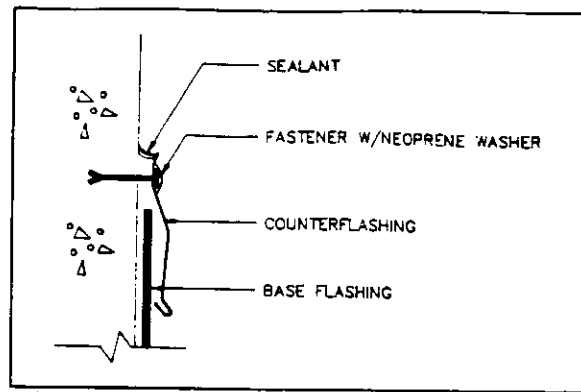


Figure 5-9: Surface-Mounted Counterflashing

4. CORROSION OF COUNTERFLASHING

Causes of corroded counterflashing include lack of protective paint on ferrous-metal counterflashing, and concentrated flows of water over copper counterflashing. Serious corrosion of counterflashing is an infrequent occurrence. Follow this repair procedure:

- Clean, prime, and paint in accordance with technique listed under Metal Roofing section.
- Coat eroded surfaces in accordance with technique listed under Metal Roofing section.

SECTION K VALLEYS

Roof valleys are formed when two sloping roof sections join to form a "V." Because water flow is concentrated in the valley, valley flashing should be adequately sized. Valleys are constructed of metal, roll roofing or shingles. The valley flashing discussion below addresses only metal valleys. Typical deficiencies associated with valley flashing are leaks at seams and holes, inadequate side laps under roofing materials, corrosion, and erosion.

1. HOLES AND PUNCTURES

Holes and punctures are caused by foot traffic, falling objects, and erosion, among other causes.

Repair in accordance with Soldering and Sheet Metal Patch techniques in the Metal Roofing section.

2. CORROSION AND EROSION

Two causes of corrosion and erosion are a lack of coating maintenance on ferrous-metal valleys and concentrated flow of water over copper valleys. Use the following repair procedure:

- Repair in accordance with Clean, Prime, and Paint and Coating Eroded Surfaces techniques in the Metal Roofing section.
- Reline: Heavily eroded valleys should be relined in accordance with Gutter Lining technique in the Drains, Gutters, and Downspouts section. It is not a good practice to coat metal flashing with roofing cement. The roofing cement accelerates erosion, inhibits future repairs, and generally fails after only a few thermal cycles.
- Replacement: Remove roofing materials adjacent to valleys in accordance with small area repairs. Fabricate and install valleys in accordance with Sheet Metal and Air Conditioning Contractors Association (SMACNA) and NRCA details.

3. LAP-JOINT LEAKS

Lap-joint leaks are caused by an inadequate lap between valley flashing sections, and debris on the valley or at the gutter, which causes water, snow, or ice to back up. Correct by cleaning debris or other materials inhibiting water flow in valley. Clean lap-joint surfaces and install a bead of sealant.

SECTION L PARAPETS

Although parapets are not a part of the roofing system, problems at parapets often directly affect the performance of the roof. The most common problems include inadequate slope of coping (top surface should be sloped to drain toward the highest roof section adjacent to the coping), poor quality or deteriorated mortar joints, failed masonry coping joints, non-watertight metal copings, lack of through-wall flashing below masonry coping, and deteriorated masonry coping stones.

1. COPING-JOINT LEAKS, GENERAL

Inadequately sealed coping joints can allow water to penetrate the roofing system. Confirm that there is through-wall flashing and that base flashing extends over top of parapet wall below coping. If there is through-wall flashing or the membrane base flashing extends over the top of the wall, there is less need for concern over the condition of the coping joints. The causes of coping-joint leaks are thermal expansion and contraction of coping materials, and poor original construction.

2. REPAIR PROCEDURES, METAL COPING

a. Joint Failure

Check to see that coping joints meet requirements of Sheet Metal and Air Conditioning Contractors National Association (SMACNA) if they are required to be watertight. Joints will either be lapped, butted with back-up and cover plates, lapped and soldered, or standing seamed.

- Repair broken solder joints in accordance with Soldered Metal Patch technique in the Metal Roofing section.
- Repair open sealant joints by cutting away all failed sealant and cleaning both sides of joint to receive new sealant. Install new polyurethane sealant.

b. Metal Coping Corrosion

Clean, prime, and paint in accordance with technique listed in the Metal Roofing section.

3. REPAIR PROCEDURES, MASONRY COPING

a. Joint Failure

Cut out failed mortar and sealant joints and install backer rod and sealant. Repoint bed joints with mortar.

b. Masonry Coping Deterioration

If there is no through-wall flashing, consider removing the coping, installing through-wall flashing, and replacing the coping stone with new material. If it is not practical to remove stone, consider covering coping with sheet-metal coping designed by an Architect or Engineer. Fabrication and installation should be performed by a professional roofing contractor.

4. DETERIORATED MORTAR JOINTS IN PARAPET WALLS

Causes of deteriorated mortar joints in parapet walls may include thermal movement, poor quality mortar, and trapped moisture. For repair, see Repointing technique in Waterproofing Repair section.

SECTION M DRAINS, GUTTERS, AND DOWNSPOUTS

1. LEAKS AT DRAINS

Leaks at drains normally result from failed roof-drain flashing, improperly fastened or broken clamping rings, condensation from uninsulated roof drains and piping, deteriorated piping, and poor pipe connections. Repair in the following ways:

- **Clamping Ring Repair:** Replace broken or missing roof-drain clamping ring, clamps, and bolts with cast-iron components. Extract stubs or drill and tap threads, if necessary, to fasten clamping ring bolts.
- **Restrip Roof Drain Flashing:** Spud and clean loose and deteriorated material and debris from roof drain stripping. Be careful not to damage lead flashing. Restrip with two-ply cement and fabric. Do not build dam around drain.
- **Replace Roof Drain Flashing:** Carefully remove roof-drain clamping ring, stripping, and lead flashing down to surface of original membrane. Prepare surface of existing membrane, strip into existing drain in accordance with membrane manufacturer's recommendations for new drain installations, and reinstall clamping ring. Drill and tap threads if necessary. Do not build a dam around drain. This work should be contracted out to a professional roofing contractor.
- **Replace broken or missing roof-drain domes, screens, or strainers** with cast-iron components, to match existing size.
- **Insulate roof-drain body and piping** with heavy density, 1-inch thick insulation with embossed aluminum foil and laminated PVC vapor barrier. Tape all joints.
- **Replace Failed Roof Drains:** This is specialty work and should be performed by a competent plumber familiar with roof-drain installation. **DO NOT** install plastic (PVC) drains or metal drains that do not have clamping rings.

2. GUTTER LEAKS

Gutter leaks are caused by failure of gutter seams due to inadequate expansion joints and thermal movement; loose, insufficient supports; improper slope; inadequate sizing; ice formations; or overloading due to clogged outlets. Repair procedures are as follows:

- Check gutters during heavy rain to see if they are overflowing. If they are, and the downspouts are clear, have sizing of system checked by a consultant.
- Repair holes and open seams in gutters in accordance with Soldering and Sheet Metal Patch techniques in the Metal Roofing section.
- Repair open gutter seam with neoprene (moving joint): Perform repair in accordance with Neoprene Repair technique described in the Metal Roofing section.
- Refasten loose gutter with compatible gutter spikes or appropriate brackets for existing gutter

style.

- Re-slope gutter: Remove and reinstall existing gutters that have reverse (negative) slope toward the outlet. Set to a 1/16-inch per foot minimum slope.
- Reline Gutters: Reline structurally sound gutters with numerous holes and open joints. Line deteriorated portion of gutter with cured EPDM set in bonding adhesive. Lap joints 4 inches.
- Clean, prime, and paint ferrous-metal gutters and downspouts on a regular basis in accordance with Clean, Prime, and Paint technique described in the Metal Roofing section.

3. DOWNSPOUT DEFICIENCIES

Often downspouts are either not secured to gutters or building walls or are inadequately secured. As a result, they slip down or become clogged or damaged. Sometimes they are removed by an unauthorized person. Such downspouts can result in improper roof drainage or water being discharged onto the building walls. Repair procedures include the following:

- Clean all debris from downspouts. Carefully and neatly disconnect downspouts if necessary. Use slip connector to make joint watertight after cleaning.
- Re-secure existing downspouts to masonry wall with compatible hangers and fasteners, 6 feet on center maximum. Refasten existing downspout to gutter outlet tubes with compatible pop rivets or compatible metal screws, then seal.
- Remove and replace damaged or missing downspout sections, including transitions, with new downspouts to match existing. Use four rivets at each joint, two in front and one on each side. Downspout sections shall penetrate lower sections and storm-drain boots 1 1/2-inches minimum. Use compatible hangars and fasteners to secure downspouts to wall.
- Install concrete splash block under downspout unless downspout is connected to a drain pipe.
- Clean drain pipe if clogged.

SECTION N MISCELLANEOUS PENETRATIONS AND ROOF-TOP EQUIPMENT

Industry-recommended flashing details for miscellaneous penetrations are contained in the NRCA Roofing and Waterproofing Manual for most common types of roof membranes. A copy of these details should be compared to the existing installations, and, where possible, the existing installations should be upgraded to meet the minimum requirements in the manual.

1. PITCH-PAN LEAKS

Leaks can occur at pitch pans due to shrinkage of the pitch-pan filler. Topping off of pitch-pan filler is a constant maintenance problem. Therefore, if at all possible, pitch pans should be eliminated from

the roof and replaced with sheet-metal piping enclosures or with boots with rain shields positively sealed to the penetrating object, using details in the NRCA Roofing and Waterproofing Manual.

Repair procedure is as follows:

- Fill existing pitch pans with roofing cement or pitch-pan filler, whichever is existing. Remove insulation from piping 2 inches above pitch-pan filler. Separate wires, pipes, and conduit (1/2-inch diameter, minimum). Clean item to be flashed to a bright, clean metal for a minimum of 2 inches above the pitch pan. Apply filler material and slope surface for positive drainage out of the pitch pan.
- Remove Pitch Pans: Cut off existing steel supports at roof deck and remove supports, framing, and pitch pans. Patch surface of membrane in accordance with appropriate repair procedure, depending on type of roof.

2. VENT PIPE LEAKS

Vent pipe leaks result from incomplete and open flashing, and from worn or deteriorated stripping.

Repair procedure is as follows:

- Tall Vent Pipes: Seal top of vent pipe flashing with two plies of cement and fabric or install a sheet-metal rain shield with band clamp and sealant joint.
- Normal/Short Vent Pipe Caps: Install watertight caps of copper, stainless steel, or lead, whichever is compatible with the vent pipe and existing boot flashing. Lap existing sound flashing a minimum of 2 inches. Turn cap down 1 inch into pipe.
- Restrip Vent Pipe Flashing: Remove deteriorated membrane, and patch in accordance with appropriate membrane-patching procedure.

3. EQUIPMENT-SUPPORT DEFICIENCIES

Improper equipment supports can result in accelerated deterioration of the roofing membrane and inhibit roof maintenance, inspection, repair, and drainage. Supports may be too low or rest directly on the roof membrane with no protective pad. If possible, remove equipment supports and install new support in accordance with membrane manufacturer and NRCA recommendations. Connect supports directly to roof deck, flash penetrations, and re-install equipment. The support should be designed by a structural engineer.

SECTION O INSULATION

Roof-top insulation is fabricated from a variety of materials, which all have differing insulating values, compatibility, and fastening requirements. There are two types of insulation, absorbent and nonabsorbent. When absorbent insulation becomes wet, it must be removed from the roof and replaced with dry insulation.

1. WET INSULATION

Wet insulation contributes to accelerated deterioration of roof membranes, loses its thermal insulating value, and adds to the dead load on the roof. Causes include failures and defects in the roofing membrane, flashings, and walls. Use the following repair procedure:

- Identify general areas of wet insulation by nondestructive testing, and mark locations on the roof.
- Cut out membrane and remove wet insulation. Extend areas marked on the roof as required to remove all wet insulation. Prepare surface of surrounding membrane for patch. Replace deteriorated membrane and patch in accordance with appropriate membrane-patching technique described previously.
- Outside assistance will be required for detection, removal, and replacement of wet insulation and patching damaged roof membrane.
- If more than 25 percent of the roof insulation is wet, the HA should consider replacement of the entire roofing system.

SECTION P DECK REPAIRS

In performing roof repairs, deteriorated deck is often encountered. Also, examination of the underside of roof decks may reveal areas of deterioration requiring repair that would otherwise have gone unnoticed. To perform deck repairs, see specific membrane type for cutting repair procedures related to cutting and patching membranes. When deck deterioration is encountered, a structural engineer should inspect the roof deck and provide repair recommendations.

1. WOOD DECK

Deteriorated wood deck, including supports, normally results from roof leaks; however, some wood-deck repairs may be required as a result of insect (termite or carpenter ant) damage.

The following repair procedure should be followed:

- Cut out deteriorated wood deck. Exercise care not to damage materials to remain.
- Nail new wood supports to the existing joist/rafter if required for proper support of the deck.
- Replace wood deck with new plywood or plank, matching size and thickness of the existing deck.

2. CONCRETE DECK

Deteriorated concrete deck can result from poor original construction, roof leaks, or a combination of both. Small surface deterioration encountered during roof repairs can be repaired by removing deteriorated concrete and patching with a sand-cement concrete mix. Large defects should be investigated by an engineer to determine scope of the required repair work.

3. GYPSUM DECK

Deteriorated gypsum deck most often results from roof leaks. Repair in the following way:

- Remove deteriorated gypsum and clean the exposed reinforcing.
- Install form at the underside of deck if deterioration extends through the deck.
- Place gypsum fill, and cure in accordance with manufacturer's recommendations.
- For small deteriorated area (less than 2 SF), lightweight concrete patching compound can be used instead of the gypsum fill material.

4. STEEL DECK

Deteriorated steel deck can result from either roof leaks or condensation forming at the roof deck.

Repair as follows:

- **Small Areas (less than 2 SF):** Repair by cutting out deteriorated decking back to sound, unruled metal. Install 20-gauge sheet-metal patch extending a minimum of 6 inches onto sound deck. Fasten with sheet-metal screws, with 2 to 3 screws per side of patch.
- **Large Area (exceeding 2 SF):** Cut out deteriorated deck back to nearest support. Install new deck matching gauge and profile of the existing deck material. New deck should extend across a minimum of two supports. Fasten to joist and adjacent sound deck in accordance with steel deck manufacturer's recommendations.

SECTION Q WATERPROOFING

1. REPOINTING

Mortar joints provide the bond between masonry units (bricks or concrete masonry units), and form a primary layer to protect the wall against water infiltration, although the joints are porous and water seepage is not fully excluded. Sound mortar joints reduce the amount of water penetrating the wall to an acceptable level. Mortar deterioration results from thermal movement, settlement, shrinking and swelling soil and water penetration.

The corrective action generally includes removal of cracked and deteriorated mortar from masonry joints to a minimum depth of 3/4-inch, or to sound mortar. Flush joints with clean water to remove all dirt and debris and to saturate the joint before applying mortar. Allow water to penetrate masonry at the joint to be repointed so that there is no standing water in joint at the time of repointing. Apply mortar in thin (1/4-inch) layers. Each layer should become "thumb-print" hard before applying next layer. Tool joints to match adjacent existing joints. Clean all excess mortar from the face of the stone within 24 hours.

Mortar and wall deteriorations resulting from shrinking and swelling subsoils require a different method of correction which exceeds the scope of this Guidebook.

2. SEALANT-JOINT REPAIR

Sealant joints are used in masonry walls to provide both horizontal and vertical expansion joints. The horizontal expansion joints, also known as "soft" joints, allow differential movement between the building structure and the brick masonry facade. The vertical expansion joints normally correspond to the building expansion joints. Sealant joints are also used to seal the perimeter of doors and windows. Failure of sealant joints often results in leaks directly into the building.

Sealant joints fail because of age and the resulting inelasticity of sealant material, improper installation (sealant must have the correct profile and depth-to-width ratio to perform properly in joints), improper surface preparation, and improper curing. Repair procedure is as follows:

- a. Full Joint Replacement:** Clean out joints immediately before installing joint sealants to comply with recommendations of joint-sealant manufacturer and the following requirements:
 - Remove all foreign material from joint substrates that could interfere with adhesion of the joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, mechanical abrasion, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from these cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 - Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - Install backer rod or bond-breaker tape in joints greater than 1/8-inch wide, and apply sealant

in strict compliance with manufacturer's specification. The correct ratio of joint width to sealant depth is 1:1, with a maximum sealant depth of 1/2 inch. Tool sealant joints to ensure good contact with sides and produce a slightly concave surface.

- b. **Partial Joint Failure Repair:** Cut away deteriorated sealant, clean sides of joint as noted above, install backer rod (or bond-breaker tape), apply sealant, and tool to produce a slightly concave surface.

END OF CHAPTER FIVE