MAINTENANCE GUIDEBOOK V
ROOF AND WATERPROOFING MAINTENANCE

CHAPTER FOUR - INSPECTION

SECTION A GENERAL

Roof and waterproofing systems are comprised of many parts that work together to provide a watertight barrier between the exterior and interior of the building. The partial or complete failure of any one component may result in failure of the entire system.

The visual inspection of the roof and waterproofing systems includes an evaluation of:

- Interior components of the building associated with the roof and waterproofing systems such as ceiling, and walls;
- Exterior components, including the facade, parapets, fascias, and drainage;
- The roof surface, including flashing, drainage, penetrations, parapets, and edge details;
- Waterproofing system, including sealant joints, mortar joints, building expansion joints, exposed flashing, and surface drainage.

Typical roof components are illustrated in Figures 4-1 and 4-2.

The inspection and repair of roof and waterproofing systems should be accomplished by trained personnel knowledgeable in:

- The basic make-up of the system being inspected;
- Identifying the various defects;
- Making recommendations to accomplish the necessary repairs;
- Recognizing when repairs are beyond the HA's ability.

SECTION B PREPARATION FOR INSPECTION

Prior to inspection, the Inspector should review the Historical Data File, especially the most recent inspection report and any related work orders. Leaks reported since the last inspection should be noted on the inspection roof plan. The Inspector should take the following items with him or her for conducting the inspection:

- Blank inspection report form;
- Roof plan with leak locations noted;
- Copy of last inspection report;

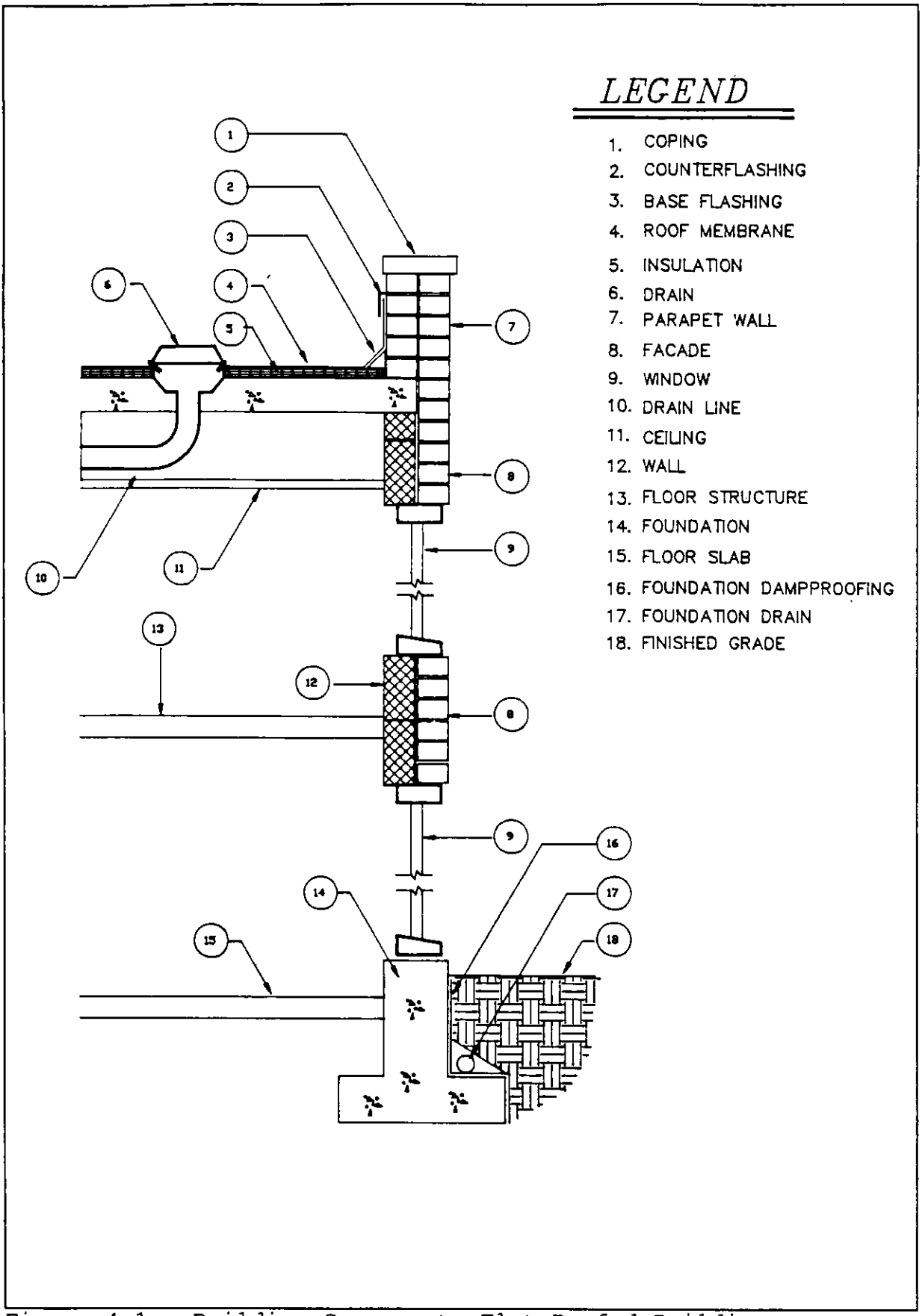
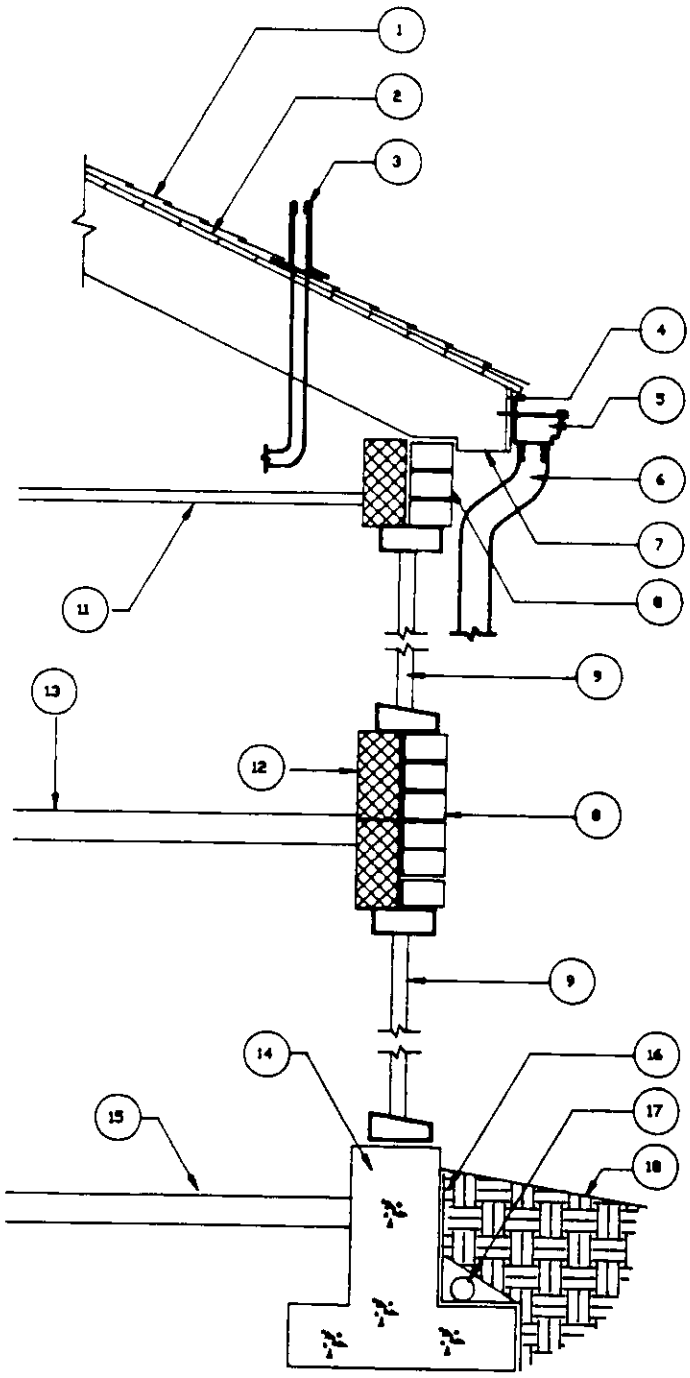


Figure 4-1: Building Components–Flat-Roofed Buildings



LEGEND

1. SHINGLE ROOFING
2. ROOF DECK
3. PIPE PENETRATION
4. FASCIA
5. GUTTER
6. DOWNSPOUT
7. SOFFIT
8. FACADE
9. WINDOW
10. NOT USED
11. CEILING
12. WALL
13. FLOOR STRUCTURE
14. FOUNDATION
15. FLOOR SLAB
16. FOUNDATION DAMPPROOFING
17. FOUNDATION DRAIN
18. FINISHED GRADE

Figure 4-2: Building Components–Sloped-Roofed Buildings

- Clipboard, ruler, colored pencil or pen;
- Aerosol can of bright marking paint;
- Sharp knife;
- Measuring tape;
- Flashlight;
- Small trowel to scrape sealant and gravel;
- Large trash bag to collect roof-top debris;
- Level;
- Camera and film—optional;
- Pocket whisk broom—optional.

SECTION C SYSTEMATIC INSPECTION OF THE STRUCTURE, ROOFING, AND WATERPROOFING SYSTEMS

The following are the recommended procedures for inspecting roof and waterproofing systems, whether the systems are inspected at the same time or separately. Each inspection should follow a prescribed routine which enables the inspector to examine each visible component. Inspection guides are included in Appendix B. These guides can be used as is, or tailored to meet specific HA requirements. A typical inspection will consist of four phases:

- Visual inspection of building interior;
- Visual inspection of building exterior;
- Visual inspection of roof or waterproofing system and components;
- Analysis and recommendations.

The basic components of each phase are illustrated in Figures 4-3 and 4-4.

Under certain circumstances, a fifth phase, consisting of specialized testing, may be required to determine the causes of leaks and the extent of the damage observed during the routine inspection.

SECTION D THE FIRST PHASE: INTERIOR INSPECTION

Visually inspect the interior of the structure related to the roof or waterproofing systems. The following elements should be inspected:

- Check structural system for deterioration, reflective cracking, efflorescence (white powder) on walls, ceilings, underside of roof deck, and at foundation walls.
- Check for water stains on ceilings, piping, ducts, walls, and supporting members.
    - Note the exact locations of water damage by measurement to building components that can be located on roof or exterior of building. At least two measurements should be taken from convenient points such as eaves, edges, valleys, or other identifiable locations.

- Inspect interior area above damage for potential source of leak. Where water can be seen dripping through the sheathing, locating the source is relatively simple, provided there is no insulation under the roof membrane. On steeply sloped roofs where water or moisture appears on the ceiling, the rafters immediately above the moist spot should be inspected for some distance. The drip line will probably show on the rafter, and the point of water entry can be located with measurements. Some typical sources for interior leaks are:
  - Water leaking through deck penetrations;
  - Water tracking along pipes or structural members and dripping off at changes in direction or elevation;
  - Saturated insulation on water and drain-line piping;
  - Condensation below HVAC ducts. (Note that stains below HVAC ducts may result from condensation or from pipe defects.)
- When the source is not readily apparent, inspect penetrations such as vent pipes, where such leaks may develop. Note these locations with measurements, and record. Discussions with tenants may be helpful in determining whether or not the leak occurs every time it rains, only during hard-driving rains, or some time after a rain has ended.

SECTION E THE SECOND PHASE: EXTERIOR INSPECTION

Transfer measurements of potential leak sources from interior inspection to exterior of building and mark locations with a lumber crayon. Visually inspect the exterior of the building. Elements that may be inspected include, but are not limited to:

- Facade—check for cracks, water stains, open sealant joints, pointing defects, loose or deteriorated brick, clogged weep holes.
- Parapet—check for cracks, water stains, pointing defects, open sealant joints. Such defects may be caused by base-flashing defects. Mark defect locations on the plan so the roof area near the defect can be inspected.
- Windows and door openings—check for defective sealant around window and doors, deteriorated wood and metal trim, rusted lintels, clogged window weeps and door-head flashing.
- Foundation—grading at foundation should slope away from building with no depressions in the grade against the building.
- Drainage—check for adequate support and for damage to gutters and downspouts. Leaks observed during the interior inspection can result from clogged gutters and downspouts. Also, melting snow and ice on roofs above ice dams at eaves or gutters can cause water penetration.
- Note exterior defects in relation to leaks observed during interior inspection to determine if exterior conditions are resulting in the interior damage.

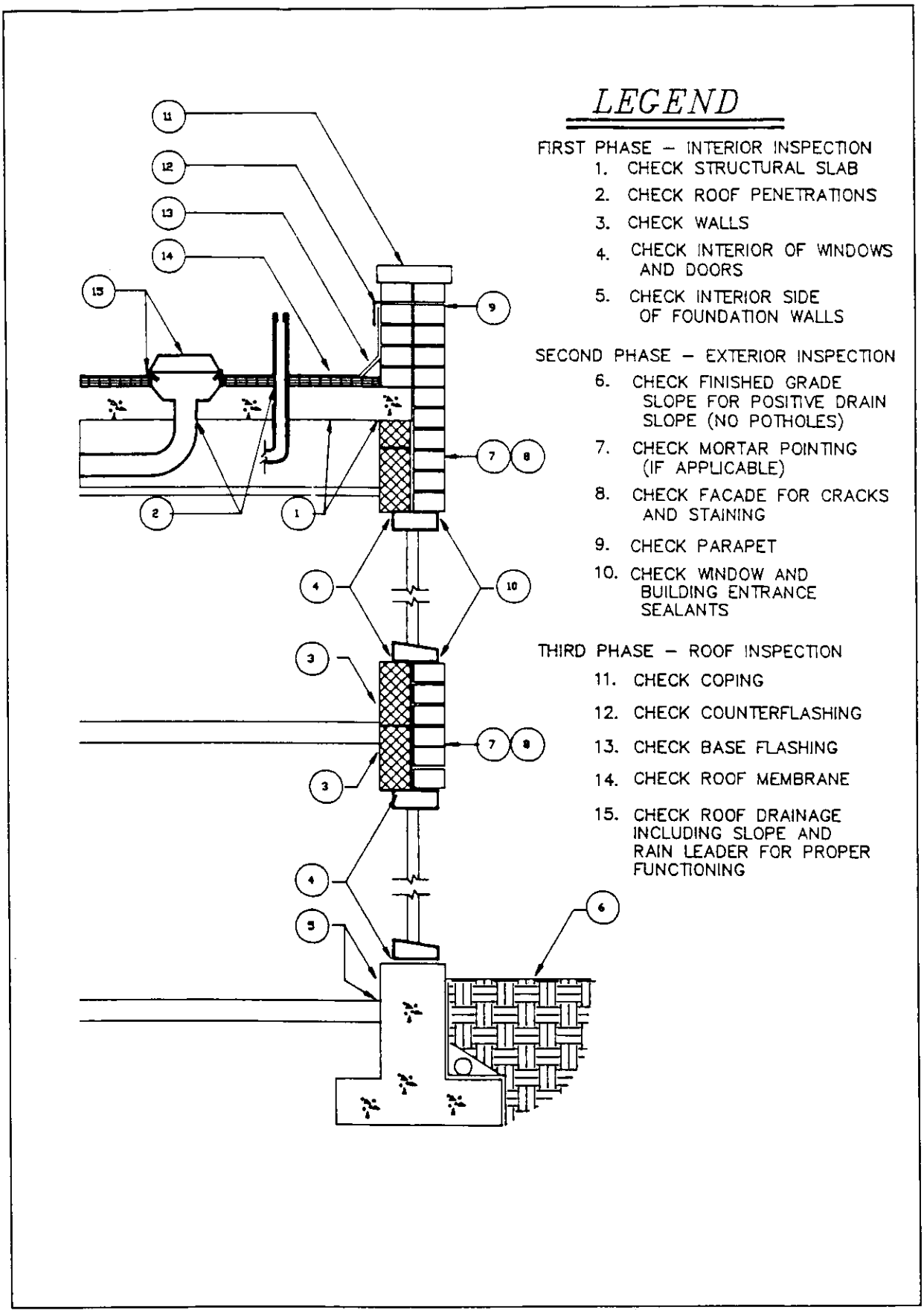
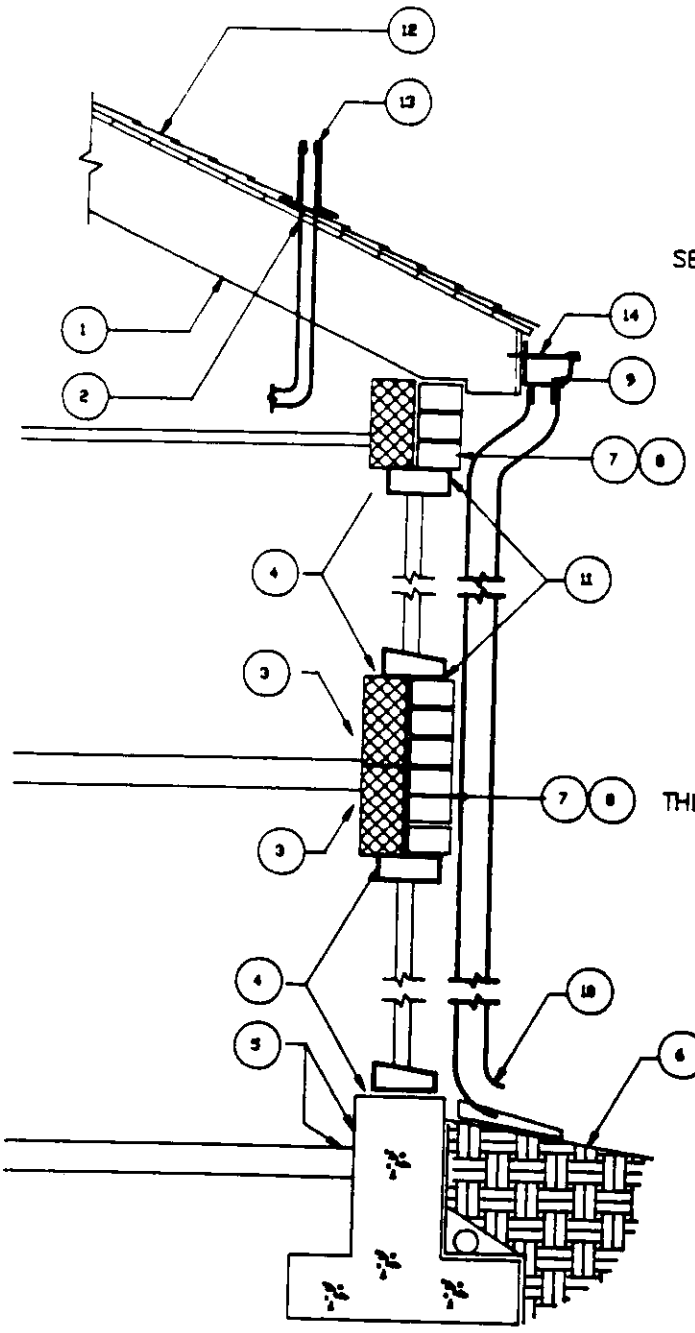


Figure 4-3: Components of a Visual Inspection



LEGEND

FIRST PHASE – INTERIOR INSPECTION

1. CHECK UNDERSIDE OF ROOF
2. CHECK ROOF PENETRATIONS
3. CHECK WALLS
4. CHECK INTERIOR OF WINDOWS AND DOORS
5. CHECK INTERIOR SIDE OF FOUNDATION WALLS

SECOND PHASE – EXTERIOR INSPECTION

6. CHECK FINISHED GRADE SLOPE FOR POSITIVE DRAIN SLOPE (NO POTHOLES)
7. CHECK MORTAR POINTING (IF APPLICABLE)
8. CHECK FACADE FOR CRACKS AND STAINING
9. CHECK GUTTER AND DOWNSPOUT ATTACHMENT
10. CHECK DOWNSPOUT DISCHARGE AT GRADE (SPLASH BLOCK) OR DRAIN BOOT
11. CHECK WINDOW AND BUILDING ENTRANCE SEALANTS

THIRD PHASE – ROOF INSPECTION

12. CHECK SHINGLES
13. CHECK PENETRATION FLASHING
14. CHECK GUTTER FOR DEBRIS, ETC.

Figure 4-4: Components of a Visual Inspection–Sloped Roofs

SECTION F THE THIRD PHASE: ROOF INSPECTION

This section is subdivided to provide inspection procedures for each typical roof component. Part 8 of this section is a list of typical deficiencies related to specific roof-membrane types.

It is recommended that the HA Inspectors familiarize themselves with the roof manufacturer's standard details prior to inspecting the roof. The National Roofing Contractors Association's *Roofing and Waterproofing Manual* also contains extensive illustrations of proper roof installations.

1. ROOF SURFACE

Inspection of the roof surface includes all penetrations, flashings, walls, and any other items that affect the watertight integrity of the roof system. Carefully inspect areas above interior damage reported by residents or noted during the interior survey. Debris, clogged drains, ponded water, and materials left on the roof indicate the need to improve the level of maintenance.

2. FLASHING INSPECTION

Many problems mistakenly attributed to roofing are actually flashing-related. When leaks occur, the flashing should be one of the first areas inspected. Typical flashing components are shown in Figure 4-5. The following are general guidelines for conducting flashing inspections:

- Check flashing height. Eight inches is the generally recommended minimum height for base flashing since water ponding on the roof during heavy rains can overtop low flashing.
- Carefully inspect the roofing materials near the flashings for signs of breaks or moisture.
- Look for punctures, broken laps or seams, separation of flashing from vertical surfaces, and signs of weather deterioration. Flashings exposed to direct sun deteriorate more rapidly than those not facing the sun.
- Check to see that roofing felts and base flashing sheets are tightly adhered to the cant strip or adjacent wall surface. Loose base flashing can be detected by gently tapping the flashing by hand mid-way between the roof and the vertical surface.
- Check for discoloration and other evidence of water entry on the inside and outside of walls and parapets. Areas in question should be clearly marked for repair.
- Check for wrinkling in the base flashing. This is a sign of differential movement between the roof and the wall or that the base flashing is inadequately nailed.
- Check metal counterflashing for deterioration and see that it is properly wedged into place or is securely fastened to a receiver, whichever is applicable.
- Check that the sealant at the top edge of surface-mounted counterflashing is well bonded to the wall and the counterflashing. Sealant should be concave and shaped to drain water away from

the wall.

- Check that counterflashing is securely set in a reglet. Loose counterflashing should be reset and missing or too-shallowly set counterflashing should be replaced with new counterflashing.
- Check condition of wall above counterflashing to determine whether there are open joints, or cracks that could allow water infiltration into wall and behind base flashing. Open mortar joints should be resealed. Weep holes, which allow water to exit the wall, should not be sealed. If necessary, repoint the joints with mortar.

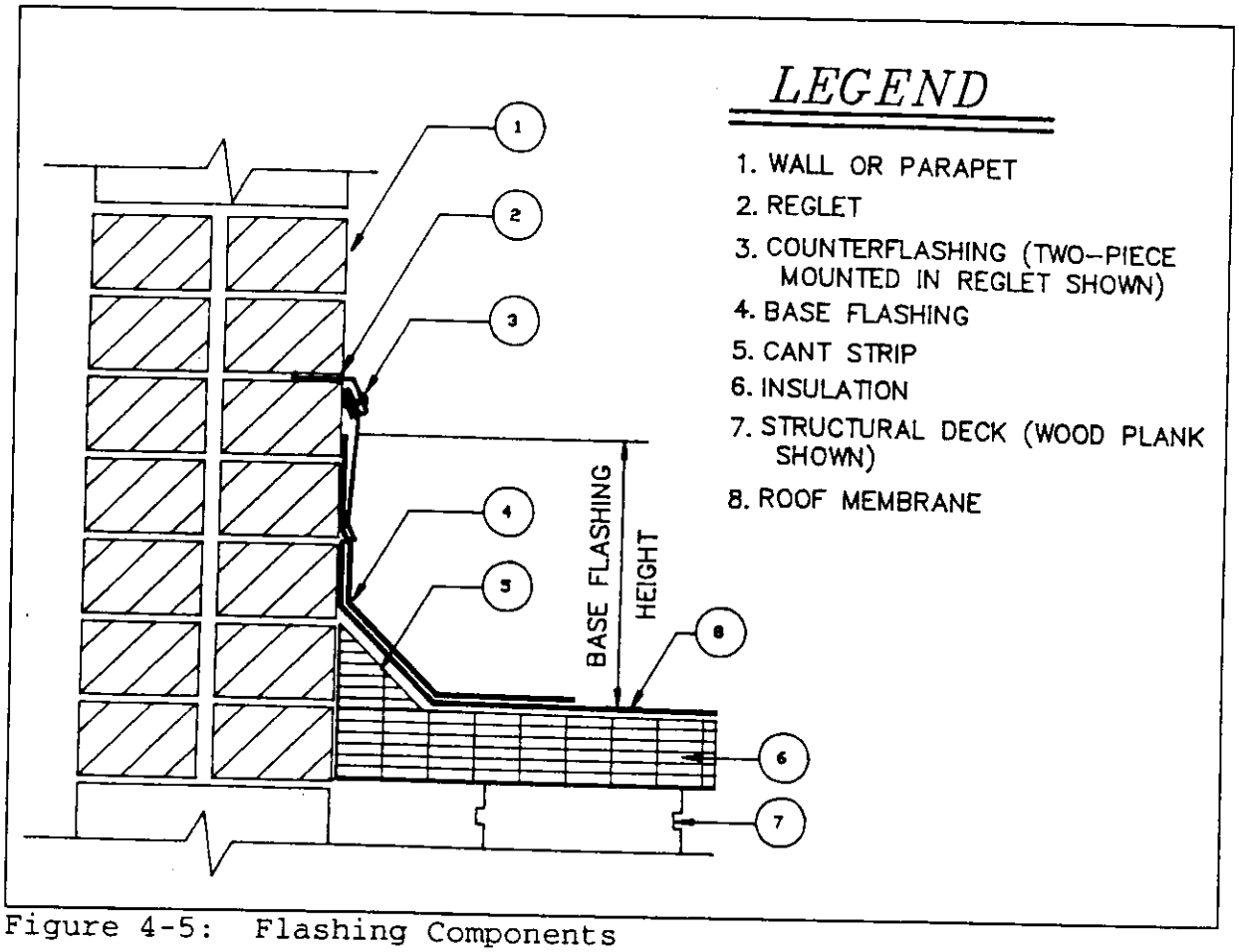


Figure 4-5: Flashing Components

3. DRAINAGE INSPECTION

General components of roof drainage systems are shown in Figures 4-6 and 4-7. The following is a suggested drainage inspection checklist:

- Check that the flat roof-deck slope is unobstructed and permits free drainage. Look for sagging and depressed areas, standing water, washed-out slag, or water-stained areas. Plant growth, foreign objects, and debris should be removed.
- Check rain leaders and strainers to see that they are in place and in good condition. Look for broken and clogged drains, strainers, and damaged gravel stops.

- Check for ponding water. Standing water may indicate that the drain is set too high or not in the correct location.
- Look for defective drain flashing. Determine if the roof membrane is securely clamped within the drain ring.
- Check that the roof membrane does not block or reduce the effective size of the drain pipe opening. Membrane inside clamping ring should be cut to within one inch of the clamping ring.
- Check gutter attachment to the edge of roof to determine whether it is adequately supported. Note whether gutter is clear of debris, gutter joints are sealed watertight, and if there are holes in the gutter. Verify that the gutters are level or slope downward to the downspout and that the downspout is firmly secured to the outlet tube.
- Check that the downspout is free-draining at grade, adequately connected to a ground drain pipe or that the splash blocks are properly located, and water is discharged to an area with good slope away from the building.

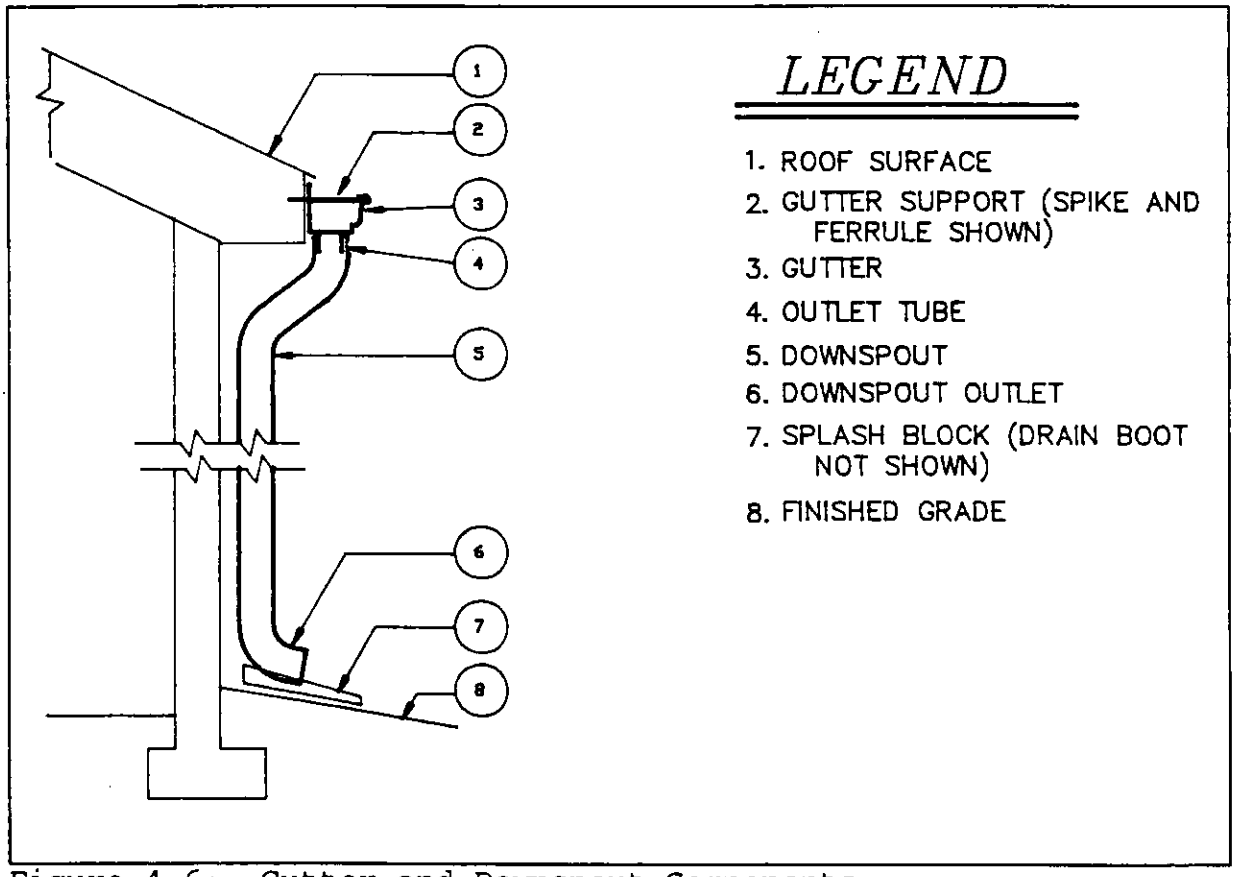


Figure 4-6: Gutter and Downspout Components

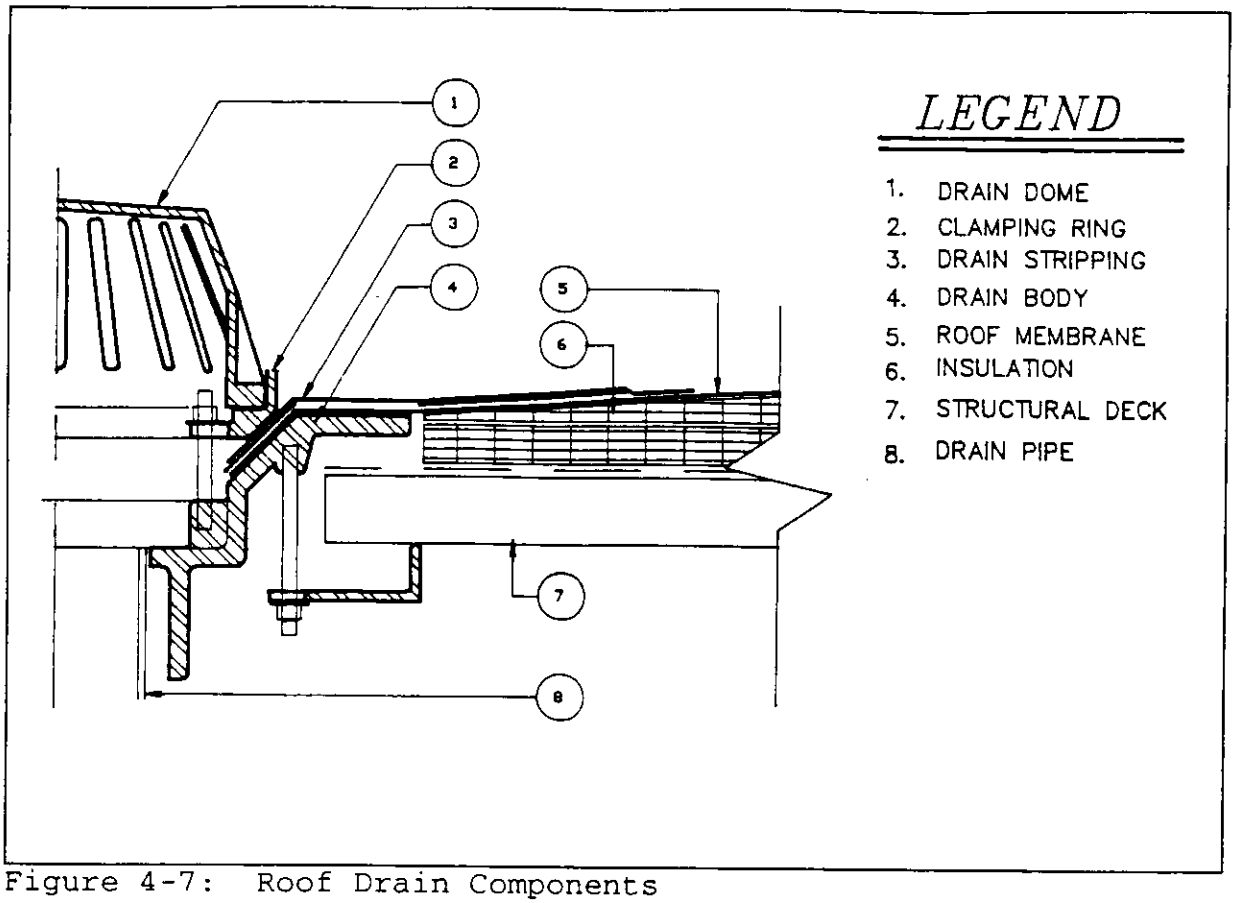


Figure 4-7: Roof Drain Components

4. ROOF EDGE INSPECTION

Gravel stops and metal roof-edge strips embedded in the roof membrane often leak because the metal and roofing materials expand at different rates and thus separate. The separations appear as splits between the roof membrane and the metal. This type of gravel-stop installation is shown in Figure 4-8. Roof-edge details should be inspected for:

- Damaged, missing, unattached, or deteriorated overhanging material and fascia boards;
- Split or cracked stripping felts;
- Open or broken joints between metal pieces.

5. COPING INSPECTION

- Determine whether the coping on the parapet wall is masonry, membrane, or metal. If metal, note the type and thickness/gauge/weight and update in the Historical Data File if necessary.
- Check for open mortar and sealant joints which require repair.
- Check that the roof membrane continues over the top of the parapet below the coping. If not, determine if the counterflashing is adequate.
- If the coping is metal, note the condition of the finish. Check for peeling paint, rust, corrosion, and

holes.

- Check whether exposed fastener heads are sealed watertight.

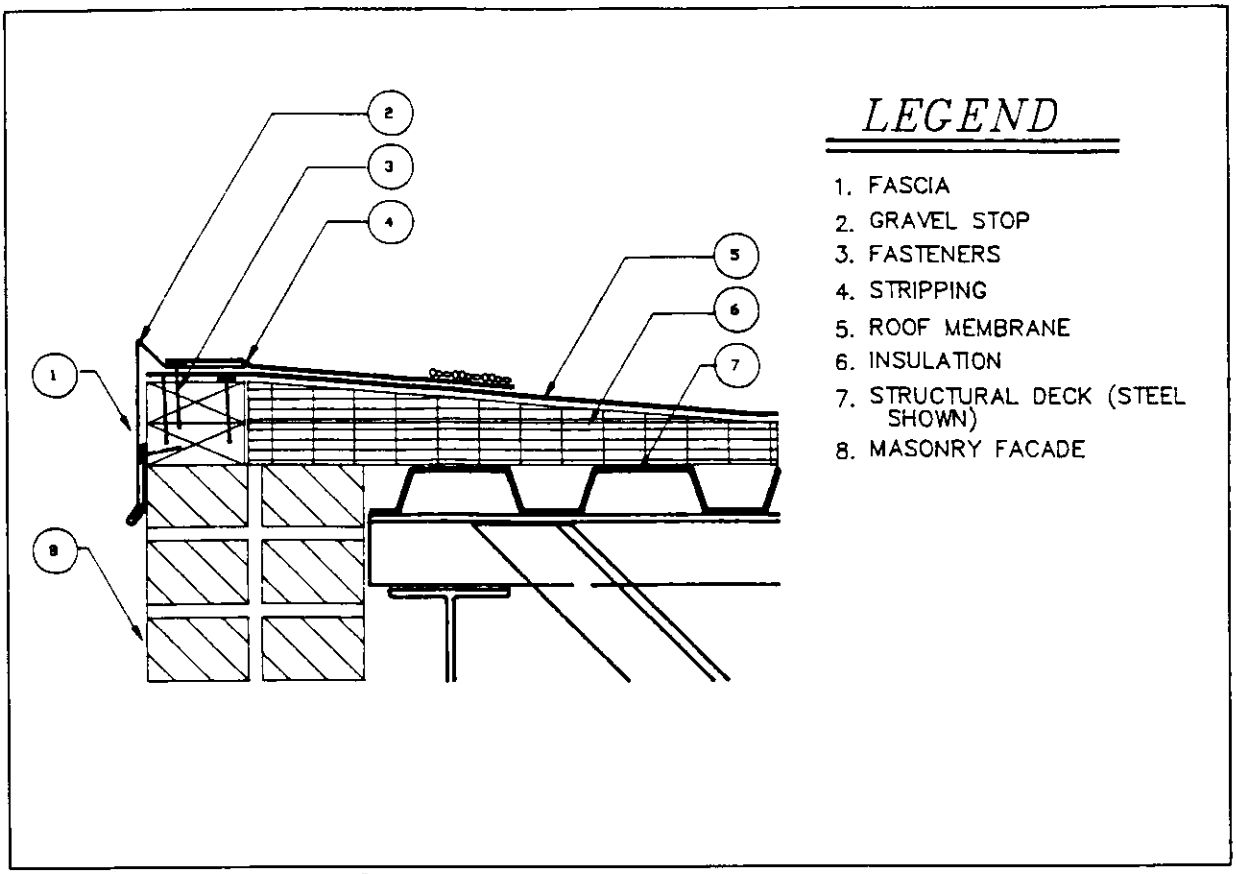


Figure 4-8: Gravel Stop Components

6. MEMBRANE INSPECTION

- Determine the roofing membrane material—bituminous, elastomeric, asphaltic shingle. Verify and update the Historical Data File if necessary.
- Check the Historical Data File to see if the roof is a re-cover.
- If there are patches, note their condition, especially the tie-ins with the existing roof membrane.
- List observations including, but not limited to, debris and clogged drains.
- Examine surface of roof for compliance with original specifications. The aggregate on built-up roof should fully cover the felts and flood coat. There should not be any bare spots. In ballasted systems, the ballast should be well distributed. In fully-adhered or mechanically-fastened systems, fasteners should not be backing out. Note any exposed felts, open seams, loose fasteners, or other areas of deterioration which need to be repaired.
- Check the condition of walkway pads, pavers, and the roof adjacent to them.
- Check for ponding and, if any, note its location, extent, and depth on roof plan.
- Emphasize the need for preventive maintenance if necessary, including, but not limited to, removal

of debris and foreign objects that can damage the membrane, redistribution of ballast, coating of a smooth-surfaced membrane, and re-embedment of aggregate at exposed felts on built-up roofs.

7. ROOF-TOP EQUIPMENT SUPPORT INSPECTION

Equipment typically encountered on roofs includes fans, heat pumps, and large and small HVAC equipment. These items are mounted on curbs, post-and-beam frames or, sometimes directly on the roof membrane. Inspect the supports to ensure that they are flashed water-tight. The following items should be considered as part of this inspection.

- Check supports for corrosion, and note the condition of painted surfaces.
- Check base flashing and attachment of membrane to supports. Note any deteriorated, loose, or open base flashing.
- If there are rain shields on supports, check that they are securely fastened and sealed water-tight.
- Check if there is any new equipment and note whether it has been installed in accordance with roofing manufacturers' recommendations. Also, note any equipment that has been removed.
- Check if unauthorized antennae or other objects have been installed on roof and need to be removed.

8. INSPECTION PROCEDURES BY MEMBRANE TYPE

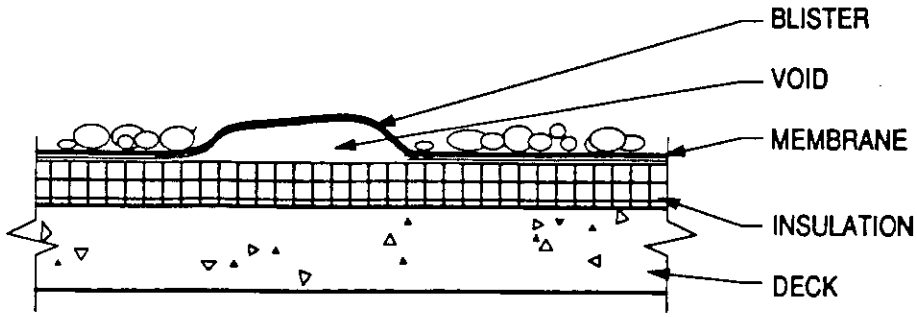
The following list is intended to supplement the general inspection guidelines listed above (see the Glossary for definitions of deficiencies). Note the locations and extent of deficiencies on the inspection roof plan. Illustrations of typical built-up roof deficiencies are shown in Figure 4-9.

a. Built-Up Roof

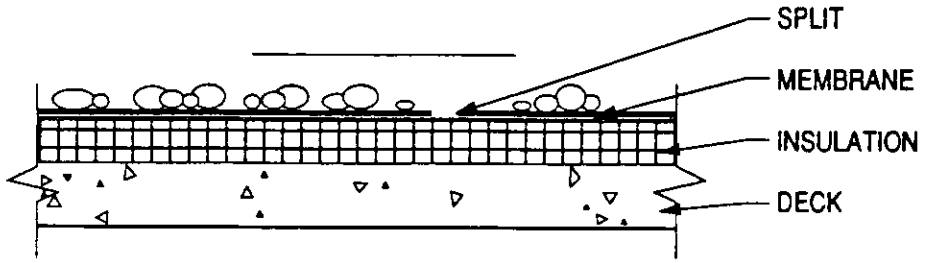
Built-up roof membranes are constructed of layers of roofing felt with bitumen between the felts to provide the waterproofing. The roof can be either smooth-surfaced (usually painted with aluminum roofing paint), or surfaced with gravel or slag embedded in a flood coat of bitumen. Check built-up roofs for the following deficiencies:

- Blisters: note the size and whether they are broken or unbroken. Mark unbroken blisters with highly visible paint so that others on the roof can avoid walking on blisters.
- Slippage and ridges;
- Splits, holes, fishmouths;
- Loss of top surface or coating, exposed and deteriorated felts, alligatoring (see Figure 4-9), lack of adhesion between plies.

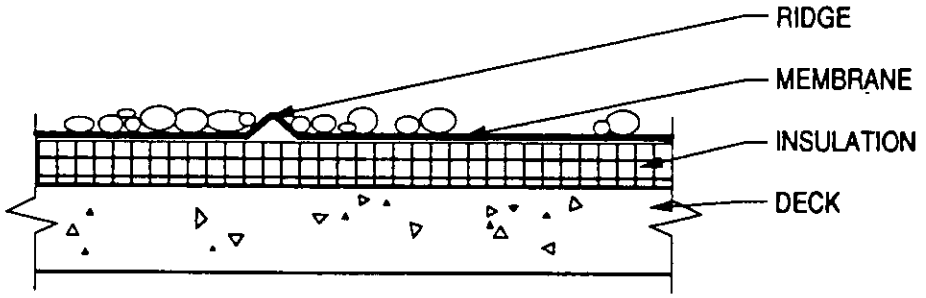
BUILT-UP ROOF DEFICIENCIES



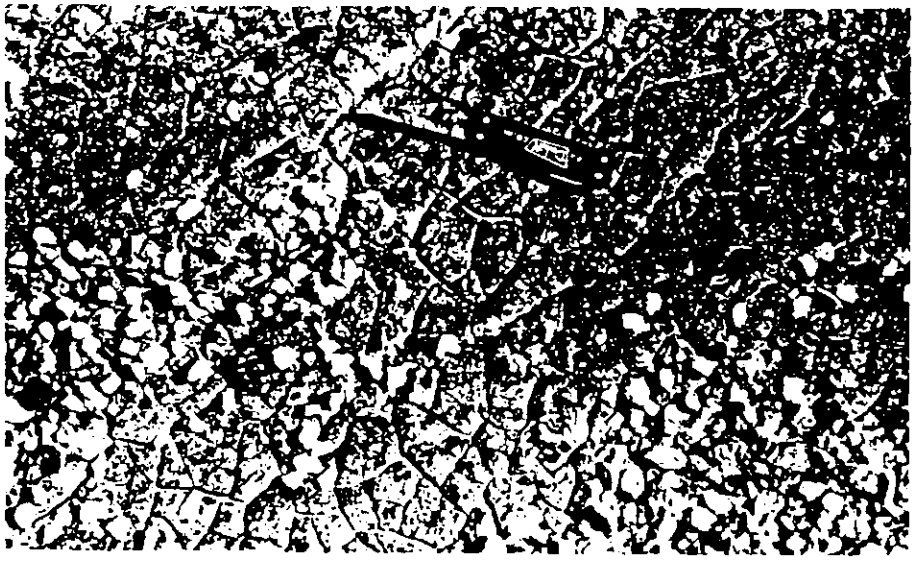
GRAPHIC REPRESENTATION OF A MEMBRANE BLISTER



GRAPHIC REPRESENTATION OF A MEMBRANE SPLIT



GRAPHIC REPRESENTATION OF RIDGES IN A MEMBRANE



Alligatored flood coat

Figure 4-9: Built-Up Roof Deficiencies

b. Modified Bitumen Roofing

Modified-bitumen roofing is either mineral or smooth-surfaced roofing material, typically applied in three-foot strips with bitumen visible at the seams. The material appears similar to roll roofing, except that the membrane is much thicker. Check modified-bitumen roofing for the following deficiencies:

- Open seams, membrane, and base flashing;
- Worn mineral or other type of surfacing.

c. Roll Roofing

Roll roofing is roofing felts that have been treated with asphalt and surfaced on one side with small mineral aggregate. Although this material is not typically used, it may be present on some maintenance or storage buildings. Check for the following:

- Open or improperly cemented, nailed, or lapped seams;
- Poor surface conditions, including worn or lost surfacing, weathered edges, and holes.

d. Metal Roofing

There are various metal roofing systems. The first step in inspecting a metal roof is to identify the type of metal used so that appropriate materials can be specified for the repairs. Then check for the following conditions:

- Deterioration of painted surfaces;
- Rust;
- Small holes, cuts, and punctures;
- Loose seams;
- Open solder joints;
- Inadequate flashing height;
- Erosion, especially on copper roofing. Check areas where there are concentrated drainage flows, valleys, crickets, or changes in roof elevation for thin or worn metal sections. (If the metal is worn, the surface can be painted to protect it from further wear. If an area is thin, a metal patch should be installed. If the thin area is large, the metal should be replaced.)

d. Slate, Tile, and Other Rigid Roofing

Typical slate roof components are shown in Figure 4-10. Check for the following:

- Broken, missing, and loose tile;
- Unsealed fastener heads;

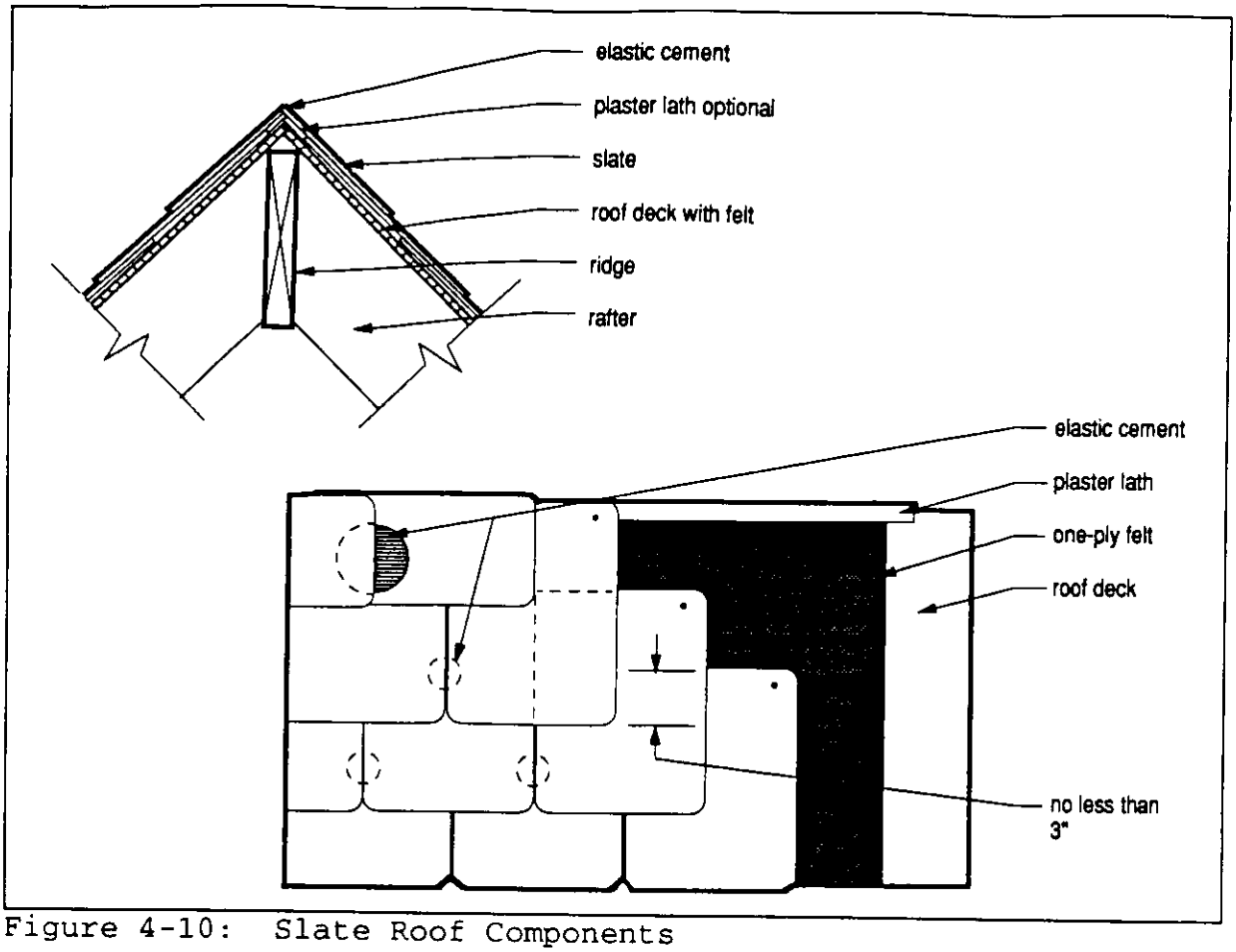


Figure 4-10: Slate Roof Components

- Inadequate head laps;
- Rotted nailers;
- Deteriorated underlayment (visible where tiles are missing);
- Deteriorated fasteners (look at loose tiles);
- Metal flashing—see criteria for metal roofs. Check erosion in drainage channels, along valleys, and at drip lines.

f. Asphalt Shingles

Check for the following:

- Loss of mineral surfacing;
- Splitting and surface cracking;
- Wind damage at "free" tabs;
- Improper overhang or lack of drip edge at rake and eave, resulting in rotting of wood sheathing;
- Curling or cupping, brittleness;
- Evidence of leaks at projections like vent pipes.

SECTION G THE FOURTH PHASE: WATERPROOFING INSPECTION

1. GENERAL

The Inspector should start with a sample inspection of exterior wall finishes, including mortar joints, sealant joints at window and door perimeters, window stiles, and building expansion joints. This inspection should provide enough information to determine whether a detailed inspection is required. When there is interior damage potentially associated with the waterproofing system, the wall areas above and near the interior damage should be carefully inspected. For leaks at and below-grade, the ground surface drainage at the wall exterior, the foundation waterproofing, and the footing drain, if any, should be inspected.

2. WATERPROOFING INSPECTION

a. Foundation

Check foundation walls for efflorescence, flouring of plaster, water stains, cracks, and spalls. If there are water stains on the walls, note their extent and location on a sketch elevation of the wall. Check the basement floor for ponded water or watermarks, and check floor drains to be sure they are clear. If there is a sump pump, lift the float to engage the pump to be sure it operates.

Most foundation leaks can be corrected by eliminating depressions (pot holes), by sloping the finished grade away from the foundation, and by connecting the downspouts to closed conduits. During the exterior inspection, note the following items related to the foundation waterproofing:

- Depressions and slope of finished grade;
- Location of roof drainage discharge and how (whether) it is directed away from the building.

b. Brick Masonry Facades

Inspect the facade for the following deficiencies:

- Open mortar joints;
- Clogged weep holes;
- Open or deteriorated sealant at soft joints;
- Exposed reinforcing;
- Efflorescence (white powdery substance on the face of a wall);
- Stains or discolorations;
- Cracked brick units. Note whether they are isolated breaks or part of a larger crack extending through several courses of the masonry. (Cracks resulting from differential

settlement or from shrinking and swelling soils require an engineering study.)

- Spalled bricks. Note whether they are single bricks or part of a larger area of deterioration.

If any of these conditions are observed, make a sketch of the facade and mark the locations and extent of the deficiency.

SECTION H THE FIFTH PHASE: ANALYSIS AND RECOMMENDATIONS

After all the data is collected, recommendations for any maintenance, repair, or replacement should be made. Maintenance and repair that are within the capabilities of the HA should be accomplished shortly after the inspection, preferably when the weather is good. Otherwise, the use of contract labor should be considered. When there is structural damage, a structural engineer should be contacted for assistance.

SECTION I THE SIXTH PHASE: ADDITIONAL TESTING

At times additional testing is required to confirm the suspected leak sources and to assess the extent of damage, such as wet insulation. Pinpointing the source or cause of leaks can often be accomplished by in-house HA staff by water-testing. Procedures for locating leaks are outlined in the following sections. Identifying the extent of wet insulation, however, requires the use of specialized nondestructive testing equipment which is not typically owned by HAs. The basic technologies are discussed in Chapter Three.

SECTION J LOCATING LEAKS

Leaks should be located and corrective action taken as soon as possible. Early action will limit the extent of damage to the roof and the building interiors. Leaks should be noted on the inspection plan. The procedures for locating leaks are included in the various guidelines for interior, exterior, and roof-surface inspections. If leak sources are not readily apparent from visual inspection, try to locate the leak source by water-testing as described in the next section.

SECTION K WATER-TESTING

1. WATER-TESTING FOUNDATIONS

Dig a small pit against the foundation wall above the area of suspected waterproofing failure. Pit dimensions should be approximately two feet square by one foot deep. Visually inspect the exposed damp-proofing or waterproofing and record observations. Fill the pit with water, and keep the hose on just enough to maintain the water level. Allow the water to pond for at least one hour and

continually monitor the interior of the structure for leak. A Delmhorst Moisture Meter or similar meter can often be helpful in tests when the interior damage may be the result of increased moisture content of the wall rather than actual leaking of water. If the test is unsuccessful, water test the wall, and then any doors or windows above the leaking foundation. Lack of a proper waterproofing termination or through-wall flashing could be the source of leaks. Another possible source is rising damp. This phenomenon, which results from ground water rising in masonry foundation walls by capillary action, would not be apparent from water testing. (Delmhorst Moisture Meters are manufactured by Delmhorst Instrument Company, 50 Indian Lane East Towaco, New Jersey 07082, Telephone 800/222-0638.)

2. WATER-TESTING WATERPROOFED WALLS

Start water-testing by spraying water at the lowest point of the wall that could possibly contribute to the leak; do not test the wall below the interior leak. For an extended test, a sprinkler can be useful. After allowing sufficient time for water to penetrate the wall, spray the wall at a higher elevation. When water penetrates the structure, note the location being tested and stop the test. Clean-up and remove water from the interior area. For leaks associated with wind- driven rain, water-testing may not be effective. Therefore, results obtained from water-testing walls may not always be conclusive.

3. WATER-TESTING ROOFS

Isolate the roof area above the leak, plug the roof drain with a removable plug, and flood the isolated roof area. Have an assistant continually monitor the building interior at the leak location for the entry of water or moisture. The assistant should notify the tester when the leak starts. If no leak occurs after approximately one hour of flood testing, remove the drain plug. Then move the hose and spray the flashings near the leak, one at a time. The approach should be to water-test from the lowest point to the highest point of the roof. When the interior leak starts, note the area being tested, shutoff the water, and clear the roof of water. Provide buckets and rags at the interior leak location to collect the water penetrating from the water-test.

4. LENGTH OF TESTS

One hour is typically sufficient time for water-tests to produce results. If a leak occurs in less time, the test should be stopped immediately and the water leak cleaned up. The main factors contributing to the length of time are the severity of the leak and the mass and porosity of material which the water must penetrate to appear on the interior.

5. VERIFY RESULTS

Moving water quickly from one location to another during testing can lead to inaccurate results. If there is doubt about the result of a test, allow water to stop leaking and repeat it. Since the leak path is already established, retesting should produce results much more quickly than the original test. It is important to note that successful water-testing is a systematic and methodical means that requires practice and patience.

6. EXERCISE CAUTION

Prior to water-testing roof systems, the live-load capacity of the roof should be checked to ensure that the water to be ponded on the roof will not overload the structure. (Water weighs approximately 5 pounds per square foot per inch of depth). A water test may result in additional damage in the interior of the building. Therefore, the inspector should evaluate the potential for interior damage to the structure, private property, and equipment when determining to water-test, and should take precautions to protect the interior elements (for instance, move furniture and cover items with plastic).

Water-testing may not be successful on re-cover roofs because water can travel between the original and re-cover roof for great distances before leaking into the building at a deck crack or penetration. Water can collect on the original roof membrane and not leak into the building until well after the Inspector has left the property.

7. EQUIPMENT

The following equipment is required or useful for water-testing:

- Hose;
- Spray nozzle, sprinkler, or soaker hose as required;
- Bucket, rags, and shop vacuum (if available) to catch water;
- Drain plugs;
- Plastic sheeting and duct tape to isolate water-test areas;
- Flashlight;
- Hose bib key, if needed;
- Delmhorst or other comparable moisture meter (if available);
- Tape measure to identify location of leak. Measure leak location from anything that can be seen at the exterior of the building, such as a vent pipe or a fan housing.

END OF CHAPTER FOUR