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ROOFER: Steep Roofing Inventory Procedures and Inspection and Distress Manual for Asphalt Shingle Roofs

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This report gives instructions for using ROOFER procedures for establishing a steep roofing inventory and evaluating the condition of asphalt shingle roofs. ROOFER is an engineered management system designed to help facility managers more efficiently manage their roofing assets and make the best use of roof maintenance and repair dollars.

This document includes the standardized information the user needs to divide steep roofs into manageable sections and collect and maintain inventory information. Visual inspection survey procedures, which include distress descriptions, severity levels, measurement criteria and photographs of shingle and flashing distresses, are presented. Procedures for distress density calculations are also provided. Roof inspectors can use this information to objectively determine condition indexes that reflect (1) the ability of the shingles and flashings to perform their function, (2) needed level of repair, and (3) waterproof integrity.

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Foreword

This study was conducted for the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE) under Reimbursable Project ZS8, "Final Phase for ROOFER Condition Evaluation Process for Asphalt Shingles." The technical monitor was Dave Bohl, CEMP-ET.

The work was performed by the Materials and Structures Branch (CF-M) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was David M. Bailey. Dr. Ilker R. Adiguzel was Chief, CEERD-CF-M, at the beginning of this effort. Mark Slaughter is currently Acting Chief, CEERD-CF-M and L. Michael Golish is Chief, CEERD-CF. The technical editor was Vicki A. Reinhart, Information Technology Laboratory – CERL.

Special acknowledgement is due to the following who participated as members of the development field validating team:

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The Director of CERL is Dr. Michael J. O'Connor.

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Detail drawings on pages 38, 43, 47, 51, 57, 61, and 67, are reprinted courtesy of the Asphalt Roofing Manufacturers Association.

1 Introduction

Background

The U.S. Army has approximately 200 million square feet of asphalt shingle roofing. Army installations spend a significant portion of their infrastructure maintenance dollars replacing these roofs. Historically, Army Directorates of Public Works (DPWs), like other facility managers, have lacked systematic procedures for evaluating and managing their inventory of roofs to make the best use of limited maintenance funds.

The U.S. Army Construction Engineering Research Laboratory (CERL), with the assistance of other organizations, developed ROOFER, an Engineered Management System initially designed for bituminous built-up roofs (Bailey et al. 1989; Bailey, Brotherson, and Tobiasson 1989) and single ply roofs (Bailey et al. 1993). The ROOFER procedures used in conjunction with a microcomputer application called MicroROOFER (Bailey et al. 1990), provide building managers with a decision-support tool for assessing roof condition, selecting repair strategies, and establishing planning and budgeting needs for accomplishing the necessary work.

The current phase of ROOFER development addresses steep roofing assets surfaced with asphalt shingles.

Objectives

The objective of this work was to develop an inventory procedure for steep roofing systems and condition index procedures based on visual inspection of the flashing and shingle components of asphalt shingle roofs as part of the program to apply ROOFER to additional types of roofing systems. The objective of this report is to provide roof inspectors with a standard reference for collecting physical and historical roofing system data, conducting inspections, and calculating a flashing condition index (FCI) and shingle condition index (SCI).

Approach

The concepts and theory behind the condition index methodology, and the process used to develop and field-validate the distress definitions and deduct value curves are described elsewhere (Shahin, Bailey, and Brotherson 1987a). The procedures for determining membrane and flashing condition indexes for built-up roofs (BUR), as described in Shahin, Bailey, and Brotherson (1987b) provide the basis for the current work. A rating team of experts was employed and field tests were conducted at several sites (military and nonmilitary), replicating the successful development process used in the earlier work cited.

Using This Manual

Chapter 2 contains the inventory procedure for steep roofing systems. Chapter 3 provides the inspection and condition evaluation procedures for asphalt shingle roofs. Distresses for flashings and shingles are presented in Chapters 4 and 5, respectively. These two chapters include descriptions of distresses, severity levels, defect definitions, photographs, and measurement criteria. Inspectors should study this manual and carry a copy for reference during inspections.

Results of roof inspections are to be used in conjunction with the calculation procedures in Chapter 3 to determine the FCI and SCI and their corresponding condition ratings (Figure 1). Deduct value curves are in Appendix A, field measurement methodologies are in Appendix B, and samples of roof inspection sheets are in Appendix C. These flashing and shingle component condition indexes are combined to calculate a roof condition index (RCI) and provide an overall roof assessment.

Mode of Technology Transfer

This report serves as the ROOFER inspection manual for asphalt shingle roofs. The capabilities for storing collected information and performing automated calculations, data analyses, and reporting have been incorporated into the Micro-ROOFER software program. CERL and Corps of Engineers Districts can provide assistance to Army installations in implementing the ROOFER program.

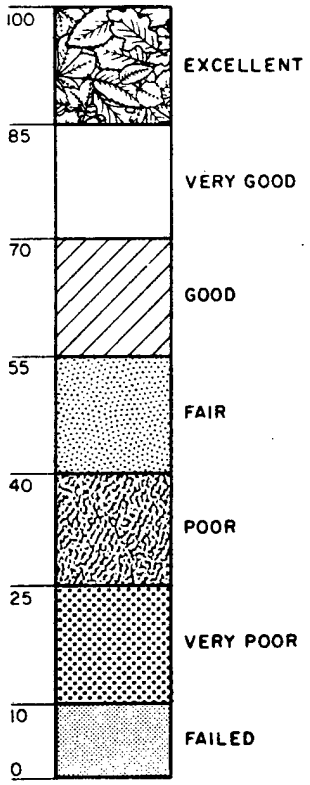


Figure 1. Flashing and Shingle Condition Indexes (FCI and SCI) and ratings.

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

SI conversion factors		
1 in.	=	2.54 cm
1 ft	=	0.305 m
1 yd	=	0.9144 m
1 sq in.	=	6.452 cm^2
1 sq ft	=	0.093 m^2
1 sq yd	=	0.836 m^2
1 lb	=	0.453 kg
°F	=	(°C x 1.8) + 32

2 Steep Roofing Inventory Procedures

The roofing inventory is the foundation of ROOFER. The inventory provides the information needed by engineering personnel to manage roofing assets. A well maintained inventory, when combined with condition evaluation data (discussed in Chapters 3, 4, and 5), provides a construction history for each roof and a record of performance that can be used to determine repair and replacement strategies.

Roof Network Identification

A roof network, as defined within the ROOFER system, consists of all the building roofs maintained by an installation or facility manager. This network is generally divided into the following manageable components:

Building

A building consists of one distinct structure that may include several wings or sections, but generally has one building number or designation. Buildings connected by covered walks or enclosed passageways should be considered separately unless they are designated by the same building number. Facility complexes with only one building number or designation should be given subdesignations for easier identification.

Roof Sections

Building roofs are managed by units called "roof sections" for which all repair and replacement decisions can be made. To achieve this, each roof section is inspected and evaluated independently of other roof sections. As a rule, a building having a steep roofing system of approximately 10,000 SF or less should be managed as one section. Roofing on dormers and similar projections should be included with the main roof section. As an example, all exposed roof areas on the building shown in Figure 2 would comprise one roof section.

For buildings with larger roof areas, the roof may be divided into two or more sections, and each section inspected and rated independently. Using this approach, a roof section in poor condition does not detract from the assessment of a

roof section on the same building that is performing well. It may be possible to replace only those sections that have reached the end of their service life while making the necessary repairs to the remaining roof sections.

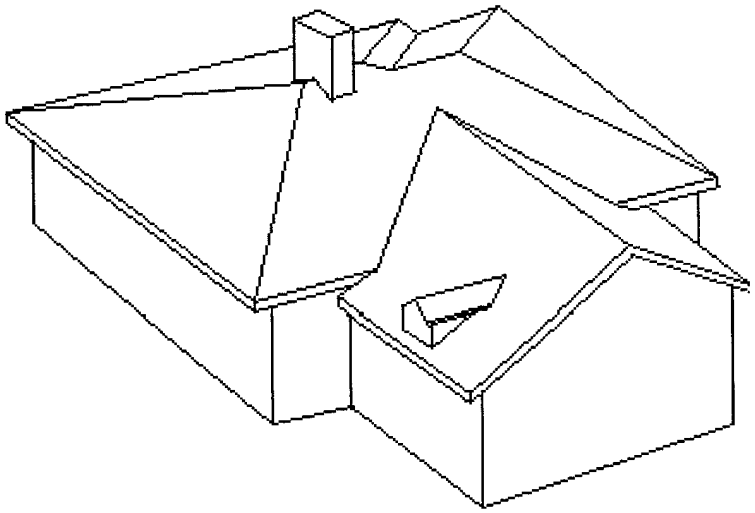


Figure 2. Example of a building roof comprising a roof section.

Roof sections are assigned letter designations (A, B, C, etc.). For roofing systems that require subdivisions, sections are generally delineated by:

- different weather exposure (i.e., north side and south side of a gabled roof)
- perimeter details such as firewalls, expansion joints, valleys, hips, or ridges
- different roof slopes or levels
- areas having different roof covering types, different amounts of rooftop equipment, or significantly different conditions below the roof
- areas that were constructed at different times.

If a roof is physically divided into many small areas, strong consideration should be given to combining these areas with a larger adjacent roof area to comprise one roof section.

Data Collection

The information needed to successfully manage a roof network must be stored in a way that makes the data accessible and usable. The data collection system described in this report affords easy input into the MicroROOFER computer application. Once stored, the information about each building and roof section can be used to perform analyses and develop reports needed to effectively manage large networks of building roofs or individual roof projects.

The physical and historical information about buildings and roof sections which is recorded on standardized forms, comes from a variety of sources. At installations that have complete building records, most of the data can be taken from as-built drawings, record drawings, and specifications. Because these drawings and specifications often do not show actual conditions, it is important that information collected during the visual inspection be as complete as possible. Missing data will make analysis and planning difficult. Although this phase does require time and effort, once accomplished, it only requires updating as changes to a roof system occur.

Building Identification Sheet

The Building Identification Sheet (Figure 3) provides general information such as building name, number, location, and occupancy. It also lists each roof section and its area, and the date the building was originally constructed. Although some of the information is not directly related to the roofing system, it does provide essential data for managing the network. A building roof plan, which shows overall dimensions and identifies each roof section, should also be drawn on the sheet. The plan can be drawn to a scale that will fit in the space provided. For large buildings, a scale of 1 in. = 30 ft or 1 in. = 60 ft will probably be required to show the entire roof.

Roof Section Identification Worksheet

The three-page Roof Section Identification Worksheet (Figure 4) simplifies the task of collecting the inventory data for a roof section and ensures uniformity in reporting terminology. Most of the items are self-explanatory and the collection process uses standard checklists to identify the various system components. Data can be obtained from specifications, drawings, and visual inspection.

Descriptions of the collected inventory data follow:

General

Section 11 — Type. Slope configurations for the roofing system.

Section 12 — Perimeter. The length (in feet) of the perimeter of the roof section categorized into the listed construction "edges."

Section 13 — Access. The method used to gain access to the roof. Note whether the ladder is inside or outside the building and if it is permanently attached to

the building. If it is not, a portable ladder may be necessary for inspection. If access is gained from an adjacent roof section, identify the section.

BUILDING IDENTIFICATION SHEET | AGENCY / INST. NO.: |X|X|X|X|X|

DATE: 7 / 2 / 99 | AGENCY / INST.: Example

BUILDING NAME: Residence - 1201 Vine

BUILDING NUMBER: 1253 | DESIGN CATEGORY CODE: |7|1|1|1|1|1|

TYPE CONST.: |P| | FACILITY NUMBER: | |1|2|5|3|

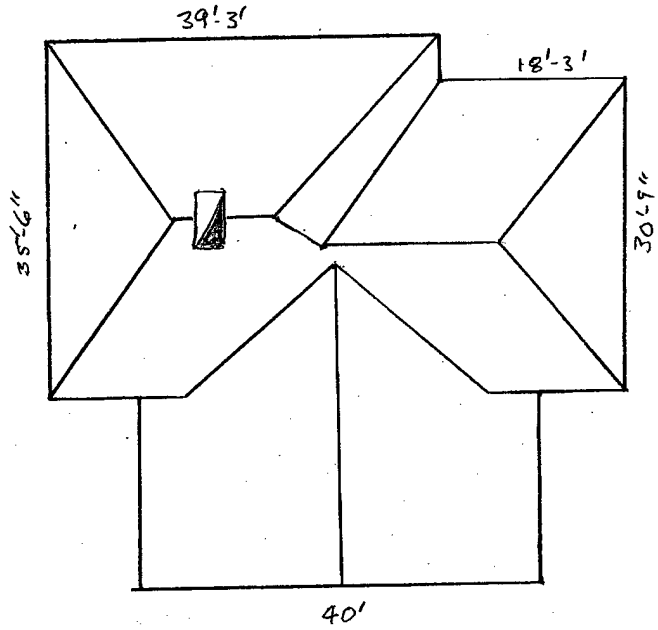
LOCATION: 1201 Vine Street

USE: Family Housing | YEAR BUILT: 1991

ROOF SECTIONS:

A	2813 SF	F	SF	K	SF	P	SF
B	SF	G	SF	L	SF	Q	SF
C	SF	H	SF	M	SF	R	SF
D	SF	I	SF	N	SF	S	SF
E	SF	J	SF	O	SF	T	SF

REMARKS:



BUILDING ROOF PLAN SCALE:

Figure 3. Completed Building Identification Sheet.

ROOF SECTION IDENTIFICATION WORKSHEET			AGENCY/INST.: Example
DATE: Jun/ 1999	BLDG. NO.: 1253	SECTION ID: A	AREA: 2813 SF
OCCUPANCY:	YEAR ORIG. CONST.: _____		YEAR LAST REPLACED: _____

10 GENERAL

11 TYPE (check all):

X GABLE
X HIP
__ GAMBREL
__ SHED
__ DOME
__ BARREL
__ OTHER

12 PERIMETER (check all):

PARAPET	____ LF	FIREWALL	____ LF	RIDGE	69 LF
ROOF EDGE	234 LF	HIP	116 LF	OTHER	____ LF
ADJACENT WALL	____ LF	VALLEY	70 LF		

13 ACCESS (check one):

INTERNAL LADDER
__ Permanent
__ Temporary

EXTERNAL LADDER
__ Permanent
X Temporary

__ PENTHOUSE
__ ACCESSED FROM ADJ. SECTION (Sec.ID___)
__ OTHER

20 STRUCTURAL FRAME

21 TYPE (check one):

STEEL
__ Beams,Girders,Cols.
__ Long Sp Deck, Beams
__ Trusses
__ Bar Joists with Beams & Cols.
__ Bar Joists with Bearing Walls
__ Bar Joists with Combination

CONCRETE
__ Beams
__ Flat Slab

WOOD
__ Laminated Beams
X Trusses
__ Joists
__ Panels

SPECIAL
__ Dome
__ Space Frame
__ OTHER
__ UNKNOWN

30 ROOF DECK

31 STRUCTURAL DECK (check one):

NONCOMBUSTIBLE

__ STEEL
__ CONCRETE, LWT. PRECAST

CONCRETE, STD
__ Precast
__ Cast-in-Place

CEMENT FIBER
__ Bulb-Tees
__ Clipped

__ GYPSUM, PRECAST

COMBUSTIBLE

__ WOOD BOARDS
X PLYWOOD
__ WOOD FIBER
__ OTHER
__ UNKNOWN

Figure 4. Completed Roof Section Identification Worksheet.

32 ATTACHMENT SURFACE (if applicable):

__ WOOD FIBER
__ PLYWOOD
__ WOOD BOARDS
__ WOOD BATTENS
__ METAL PURLINS
__ OTHER
__ UNKNOWN

33 SLOPE (primary): 4 **IN 12**

34 DRAINAGE (check all):

__ INTERIOR DRAINS
__ INTERIOR GUTTERS
X GUTTERS & DOWNSPOUTS
__ SCUPPERS
__ ADJACENT ROOF SECTIONS
__ SCUPPERS W/LEADER & DOWNSPOUTS
__ OVERFLOW SCUPPERS
__ ROOF EDGE
__ OTHER

40 UNDERLAYMENT

41 TYPE(check all):

__ FULLY-ADHERED ICE & WATER MAT
X ASPHALT SATURATED SHEET
__ OTHER
__ UNKNOWN
__ NONE

50 ROOF COVERING

51 TYPE (check one):

ASPHALT SHINGLE
X Three-Tab
__ Multi-Tab
__ Strip (no cutout)
__ Laminated
__ Lock-Down
__ Foil-Faced

__ ASPHALT ROLLED

SYNTHETIC ROOFING
__ Plastic
__ Wood Fiber
__ Metal Shingles
__ Fiber Cement

__ WOOD SHAKES

__ WOOD SHINGLES

__ SLATE

__ METAL PANEL

CONCRETE TILE
__ Pan and Cover
__ S-Shaped
__ Flat

CLAY TILE
__ Pan and Cover
__ S-Shaped
__ Flat

__ OTHER

52 SHINGLE REINFORCEMENT (for Asphalt Shingle only)(check one):

__ ORGANIC
X FIBROUS GLASS
__ OTHER
__ UNKNOWN

Figure 4 (continued). Completed Roof Section Identification Worksheet.

53 ATTACHMENT (check one):

X NAILS
__ STAPLES
__ FASTENER AND TIE
__ WIRE CLIPS
__ LOOSE-LAID (Tile)
__ SCREW (Tile)
__ MORTAR (Tile)
__ ADHESIVE-HOT
__ ADHESIVE-COLD
__ OTHER
__ UNKNOWN

60 FLASHINGS

61 TYPES (check all):

VALLEY
X Open
__ Closed
__ Woven
X STEP
X APRON
__ CHANNEL (TILE)
X FLASHED PENETRATIONS
__ PITCH PANS
X EDGE METAL
__ OTHER

62 ACCESSORIES (check all):

__ SNOW GUARDS
__ WALKWAYS

63 OVERLAY:

IS ROOF OVERLAYED N (Y/N) __ # OF LAYERS

70 REMARKS

Figure 4 (continued). Completed Roof Section Identification Worksheet.

Structural Frame

Section 21 — Type. The structural framing system that supports the roof section.

Roof Deck

Section 31 — Structural Deck. The roof deck construction supporting the roof covering.

Section 32 — Attachment Surface. For roof coverings not attached directly to the structural deck, the intermediate structure or substrate to which attachment is made.

Section 33 - Slope. The predominant slope of the roof section. The roof plan will generally indicate the slope (e.g., 4 in. in 12). If the slope is not noted on the roof plan, the section drawings may indicate the slope. If such information is not available, field measurement will be required (use the method in Appendix B).

Section 34 - Drainage. The existing means of removing rainwater from the roof section. ROOF EDGE indicates that the roof water flows over the building edge to the ground or to a lower roof area without gutters or scuppers. Check the roof section for gutters, downspouts, and interior drains.

Underlayment

Section 41 — Type. The material course placed beneath the roof covering to provide additional protection to the deck, shed water, and provide a secondary weather protection.

Roof Covering

Section 51 — Type. Type of roof covering material and construction.

Section 52 — Shingle Reinforcement. For asphalt shingles, the base material that provides the matrix to support the asphalt, surfacing, and other components.

Section 53 — Attachment. The method used for attachment of the roof covering units (shingle, tiles, panels, etc.).

Flashings

Section 61 — Type. Types of flashing details existing on the roof section. Check all types that are present. Check the roof section plan on the Roof Inspection Worksheet to be sure that all of the existing flashing, including penetrations, pitch pans, and pipe supports are shown.

Section 62 — Accessories. The presence of snow guards or walkways on the roof.

Section 34 — Overlay. The existence of underlying layers of previous roofing systems.

Remarks

Additional information that will be useful to planners in scheduling maintenance or replacement.

Roof Section Identification Sheet

The inventory data for a roof section can be entered directly into a Micro-ROOFER computer database or compiled onto a Roof Section Identification Sheet (Figure 5). The sheet has seven major divisions and organizes the data onto one page.

Roof Inspection Worksheet

Each roof section should have a roof plan drawn to a scale that fits on the Roof Inspection Worksheet (Figure 6). The plan should show all physical roof features, including perimeter conditions (e.g., roof edge, ridge, valley, parapet wall), rooftop equipment, and projections through the roof. The standard symbols shown in Figure 7 should be used to identify these items.

Actual measured dimensions for the following lengths should be determined for each exposure and shown on the roof plan.

- eave to ridge
- valley length
- rake length
- ridge length
- hip length
- vertical flashing length.

ROOF SECTION IDENTIFICATION			AGENCY/INST.: Example
DATE: JUN/1999	BLDG NO: 1253	SECTION ID: A	AREA: 2813 SF
OCCUPANCY: Housing	YEAR ORIG. CONST.: 1991		YEAR LAST REPLACED: —

10 GENERAL

11 TYPE: Gable, Hip

12 PERIMETER:

PARAPET	___ LF	FIREWALL	___ LF	RIDGE	69 LF
ROOF EDGE	234 LF	HIP	116 LF	OTHER	___ LF
ADJACENT WALL	___ LF	VALLEY	70 LF		

13 ACCESS: External Ladder: Temporary

20 STRUCTURAL FRAME

21 TYPE: Wood Trusses

30 ROOF DECK

31 STRUCTURAL DECK: Plywood

32 ATTACHMENT SURFACE:	33 SLOPE:	34 DRAINAGE:
–	4 IN 12	Gutters & Downspouts

40 UNDERLAYMENT

41 TYPE: Asphalt Saturated Sheet

50 ROOF COVERING

51 TYPE: Asphalt Shingle Three-Tab

52 SHINGLE REINFORCEMENT: Fibrous Glass

53 ATTACHMENT: Nails

60 FLASHINGS

61 TYPES:	62 ACCESSORIES:	63 OVERLAY: Y/N
Valley-Open Step Flashed Pen Apron Edge Metal		N # OF LAYERS

70 REMARKS:

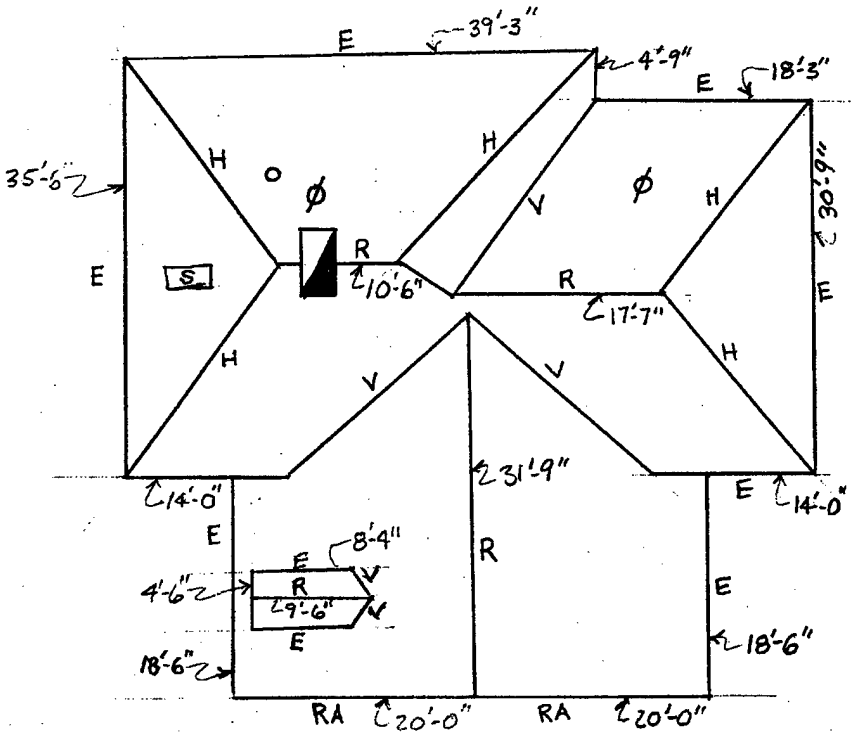
Figure 5. Completed Roof Section Identification Sheet.

ROOF INSPECTION WORKSHEET | AGENCY/INSTALLATION:

BUILDING _____ PERIMETER FLASHING _____ DATE _____
SECTION _____ OTHER FLASHINGS _____ NAME _____

SF -STEP FLASHING	MA -METAL APRON	AD -AGE DET.	EF -EXPOSED FAST.
MC -METAL CAP	FP -FLASHED PENET.	HS -HOLE/MISSING SHINGLE	ST -STAINS/FUNGUS
EM -EDGE METAL	RV -RIDGE/HIP VENT	TB -UNSEALED TABS	DV -DEBRIS & VEG.
VF -VALLEY FLASHING	PP -PITCH PAN	LR -LUMPS/RIDGES	PA -PATCHING
RH -RIDGE/H SHINGLE	IG -INT. GUTTER		EQ -EQUIP. SUPPORTS

ID #	DISTRESS	SEVERITY	DEFECT	QUANTITY



NORTH

SCALE: _____

Figure 6. Roof Inspection Worksheet with roof section plan.

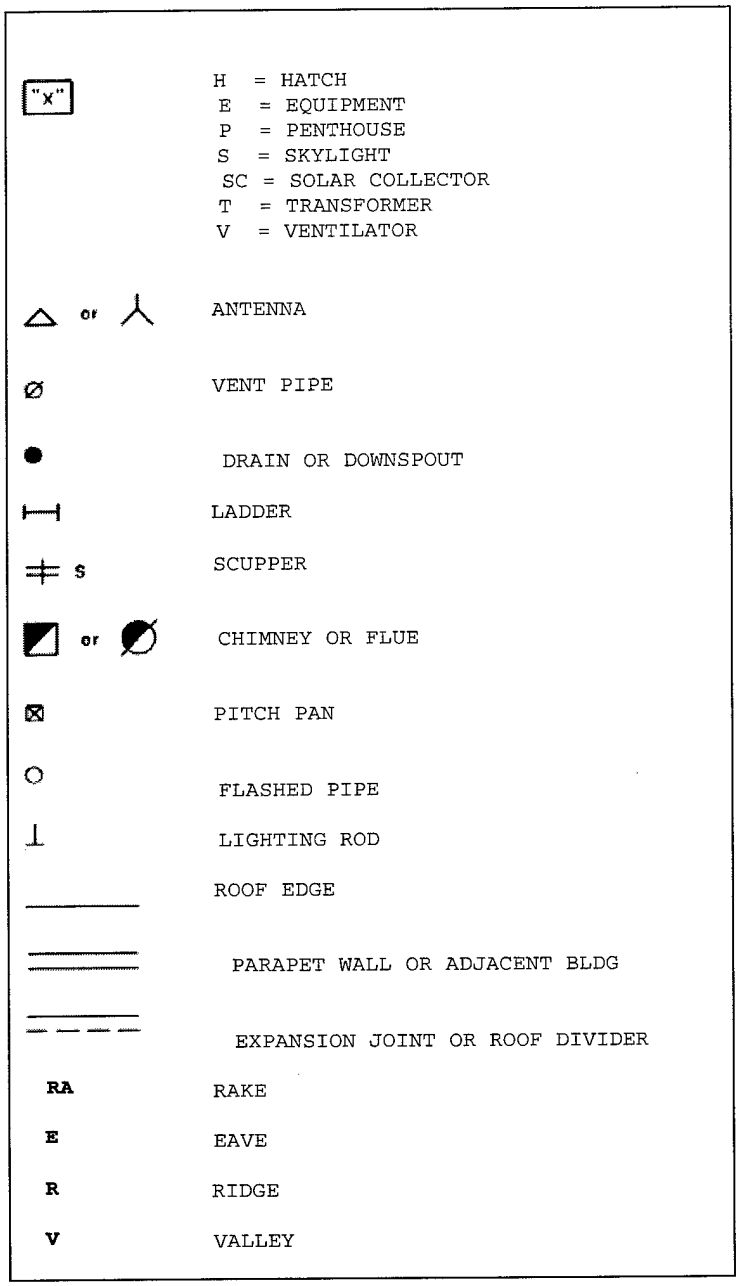


Figure 7. Standard symbols for the roof section plans.

Slopes (inches of rise per foot of horizontal distance) should be measured for each exposure (see Appendix B). A master Roof Inspection Worksheet with an unmarked roof section plan should be filed so copies can be used to conduct condition evaluation inspections. A blank Roof Inspection Worksheet is included in Appendix C.

Calculating Roof Section Area

The roof section area used in the condition rating procedure is the actual exposed area — not the projected horizontal area. The latter area can be determined from a roof section plan having horizontal dimensions and then can be converted to the actual area by adjusting for roof slope (see Appendix B).

3 Procedures for Roof Inspection and Calculation of Indexes

As defined by the concepts and theories in previous technical reports (Shahin, Bailey, and Brotherson 1987a, 1987b; Bailey et al. 1993), the condition indexes reflect the (1) ability of the roof covering and its flashing components to perform their functions, (2) needed level of maintenance, and (3) waterproof integrity. The flashing and shingles of asphalt shingle roofs are evaluated to determine the FCI and the SCI. A thorough visual inspection must be conducted to identify the distress type, severity, and amount of each defect present. A distress type may have several different defects for a given severity level. The inspection must be carefully organized and planned to provide the necessary information for determining the flashing and shingle conditions. This chapter presents the overall process for visually inspecting asphalt shingle roofs and computing FCIs and SCIs, as shown in Figure 8.

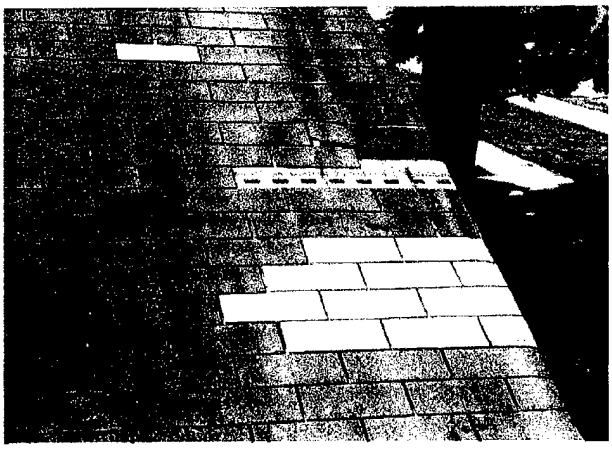
Inspection Procedure

A team of two people should perform the roof inspection: an inspector and a recorder. The inspector surveys the roof, identifying distresses and determining severity levels, specific defects, and quantities. The recorder records the data on the Roof Inspection Worksheet and assists in measuring distress quantities when required. The recorder must also serve as the safety observer for the team.

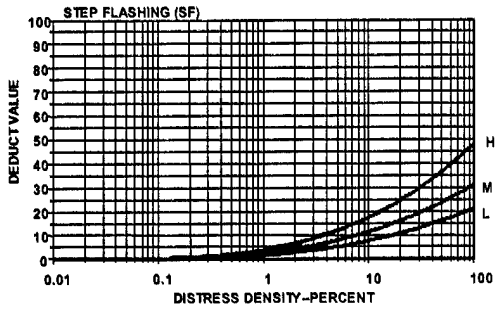
Supplies

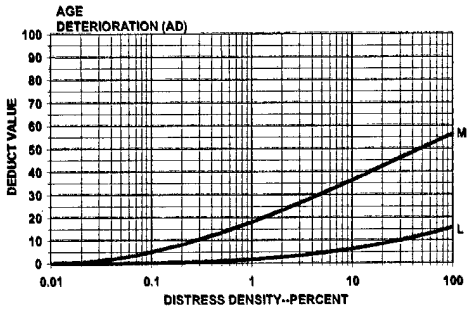
The following supplies are required to perform the inspection and can be carried in a satchel when on the rooftop:

- roofer inspection and distress manual (this document)
- pencil and clipboard
- asphalt shingle Roof Inspection Worksheets
- small, 3 in. pointing trowel
- lumber crayon
- stiff-bristle whisk broom

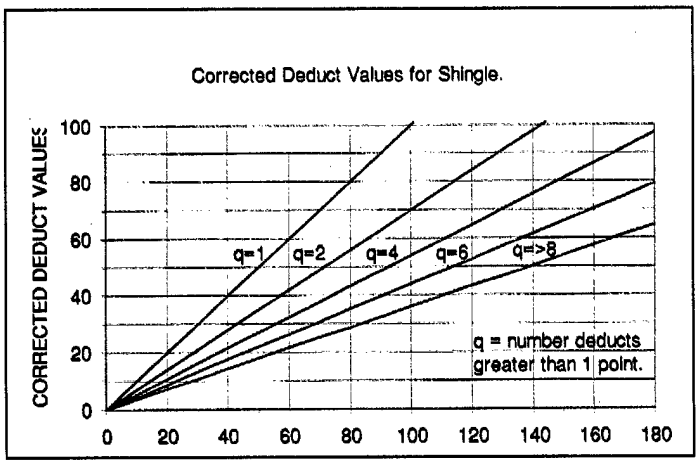


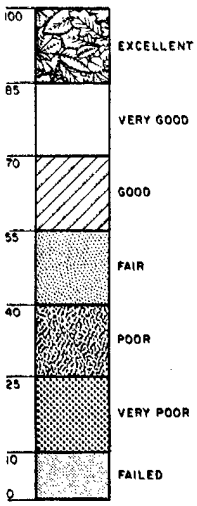
Step 1. Inspect roof. Determine distress types, severity levels and defects. Determine quantities and calculate densities.





Step 2. Determine deduct values.





Step 3. Compute corrected deduct value.

Step 4. Compute condition index.

Figure 8. Steps of rating procedure.

- pocket knife
- measuring tapes (12 ft and 100 ft recommended)
- large plastic bag (for collecting rooftop debris).
- binoculars
- slope meter.

General Inspection Guidelines

The following is a list of general guidelines for the roof inspection:

- Walk the outside of the building and look for water stains, efflorescence, missing mortar, spalled brick, and gutter and downspout problems. Note any findings in the Remarks Section on the reverse side of the Roof Inspection Worksheet. A blank copy of that sheet is provided in Appendix C.

- Walk the interior of the building and examine the ceiling for water marks or other evidence of problems. Note rusting or other signs of water penetration in the Remarks Section. Building occupants can often provide valuable information.

- If accessible, inspect attic space to verify the type of deck and identify existing problems.

- When on the rooftop be careful not to damage the roof. Do not step on unsupported flashings or shingles exhibiting age deterioration such as cupping, curling, or brittleness.

- If snow, frost, or visible moisture are present on the roof, postpone the inspection until the roof is clear and dry.

- If sunlight or high temperatures have softened the shingle asphalt so that foot traffic causes displacement of granules, postpone the inspection until more moderate conditions prevail.

- Wherever possible, measure lengths and areas to determine distress quantities. Estimating instead of measuring compromises the rating accuracy. Pacing to find lengths, measuring shingle exposures and counting rows, or other numerical estimating methods are preferable to "eyeball" estimates.

- If more than one severity level of a distress exists in a localized area, rate the entire area at the highest severity level present.

- Note in the Remarks Section any existing problems that are not included in the lists of flashing and shingle distresses.

Survey Preparation

It may be necessary for the survey team to contact the building superintendent or custodian for assistance in gaining access to the roof. When accessing the roof, the inspectors should assess conditions and determine if they can safely walk on the roof surface. If the roof cannot be walked safely (i.e., slopes greater than 5 in. in 12 in.), alternative inspection methods should be used. These include use of a man lift or chicken ladders, or looking through binoculars from a secured ladder. The inspectors should always be aware of and abide by all safety requirements of governing authorities.

Before beginning the inspection, the roof section plan should be developed (or verified, if a plan already exists). Locate all penetrations, projections, rooftop equipment, and perimeter conditions on the plan. Measure and record dimensions on the roof plan. Measure and record the total perimeter flashing length (i.e. step flashing, edge metal, ridge, hip, and valley) in the appropriate space on the heading of the Roof Inspection Worksheet. Also determine and record on the worksheet the length of curb flashing around rooftop penetrations (i.e., metal apron, step flashing).

Distress Survey

Inspectors must be able to identify the various distresses and defects accurately and follow the inspection procedure closely to obtain meaningful, consistent, and repeatable results.

When performing the inspection, identify each distress as it is encountered. Determine the severity level, the specific defect present, and measure the quantity using the criteria defined in Chapters 3 and 4. A description of the valley flashing distresses and specific defects is shown in Figure 9. Enter this information in the columns on the right side of the Roof Inspection Worksheet (Figure 10). Each distress encountered is assigned an identification number, starting with 1 and numbering consecutively. The identification number should be recorded in column 1 of the inspection worksheet. Record the location of each distress on the roof plan using the identification number as shown in Figure 10. If the Roof Inspection Worksheet becomes filled during the inspection, continue recording on a second worksheet An abbreviated copy of the distress/defect identifier list (Figure 11) can be attached to the bottom of a long (8 by 14 in.) clipboard so it is ex-

posed below the Roof Inspection Worksheet, as a ready reference during inspections.

Perform the distress survey on each roof section using the following steps:

1. Inspect the perimeter. Establish a starting point at one corner of the roof section. Walk the perimeter, examining the step flashing, metal cap flashing, and edge metal. Fill in the worksheet as the inspection proceeds.

2. After inspecting the perimeter, walk the roof area using an established pattern, inspecting all other flashings. This includes ridges, hips, step flashing, metal aprons, flashed penetrations, valley flashings, etc.

VALLEY FLASHING (VF)

Description: Roof valley flashings are formed when two sloping roof sections intersect to form a "V". Water from both sections of roof runs through the valley making it especially vulnerable to deterioration and leakage. Valley flashings for asphalt shingles may be of three types: open valleys lined with sheet metal or mineral-surfaced asphalt roll (composition) material; closed cut valleys having shingles on one side of the valley cut on an angle parallel with the valley; and woven valleys lined with interwoven asphalt shingles from the adjoining roof sections. All three types of valley flashings should have underlying asphalt roll material.

Severity Levels:

Low: Any of the following defects:
1. Loss of protective coating or corrosion on metal open valley flashing.
2. No fabricated "V" crimp (vertical ridge) in center of metal open valley flashing.

Medium: Any of the following defects:
1. Loss of surfacing with exposure of felts in valley flashing.
2. Unsealed laps in open composition valley flashing.
3. Cracks, splits or holes in valley flashing not extending down to underlayment.
4. Loose or missing valley shingles with no underlayment or substrate exposed.
5. Edges of valley shingles are sealed (in open or closed valleys).
6. Exposed fasteners within 12 inches of centerline of closed or woven valley.

High: Any of the following defects:
1. Splits or holes in valley flashing with underlayment or substrate exposed.
2. Loose or missing valley shingles with underlayment or substrate exposed.
3. Exposed fasteners within 12 inches of centerline of open valley.

Measurement: Measure length (ft) of valley flashing having the above conditions. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distress as one.

Density:

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of valley flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.

Figure 9. Description of valley flashing distress.

ROOF INSPECTION WORKSHEET

AGENCY/INSTALLATION: EXAMPLE

BUILDING 1253
SECTION A

PERIMETER FLASHING 489
OTHER FLASHINGS 38

DATE 7/2/99
NAME Jones

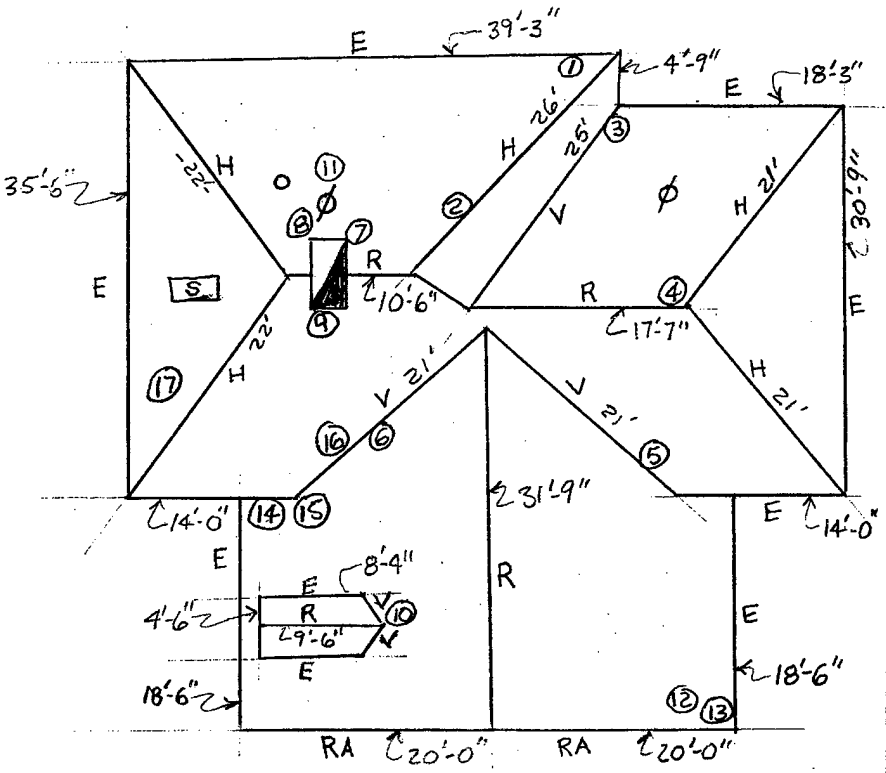
SF -STEP FLASHING
MC -METAL CAP
EM -EDGE METAL
VF -VALLEY FLASHING
RH -RIDGE/H SHINGLE

MA -METAL APRON
FP -FLASHED PENET.
RV -RIDGE/HIP VENT
PP -PITCH PAN
IG -INT. GUTTER

AD -AGE DET.
HS -HOLE/MISSING SHINGLE
TB -UNSEALED TABS
LR -LUMPS/RIDGES

EF -EXPOSED FAST.
ST -STAINS/FUNGUS
DV -DEBRIS & VEG.
PA -PATCHING
EQ -EQUIP. SUPPORTS

ID #	DISTRESS	SEVERITY	DEFECT	QUANTITY
1	EM	M	1	10
2	RH	M	3	1
3	VF	L	2	25
4	RH	H	4	1
5	VF	L	2	21
6	VF	L	2	15
7	SF	M	4	12
8	MA	M	2	2
9	MA	M	2	2
10	RH	M	4	1
11	ST	L	1	20
12	DV	M	3	16
13	HS	M	1	6
14	DV	M	1	9
15	PA	M	1	8
16	VF	M	5	6
17	AD	L	2	150



SCALE: _____

Figure 10. Completed Roof Inspection Worksheet.

FLASHING DISTRESSES

SF
Low:
1. Loss of coating, corrosion
2. Overlayed shingles not step flashed
3. Coverage < 1 unit/course

Medium
1. Vert. leg < 4" high
2. Deformed/wide gaps in vert. leg
3. Loose or displaced
4. Vert. joints sealed
5. Continuous "L" flashing

High
1. Holes
2. No vert. flashing exists
3. Top of vert. leg exposed

MC
Low
1. Loss of coating, corrosion
2. Metal cap deformed
3. Ctrfl. deformed
4. Ctrfl. sealed to step fl.
5. Exposed fasteners on horiz. surface

Medium
1. Holes on vert. surface
2. Loose fasteners, failed/open joints

High
1. Metal cap fl. missing/displaced
2. Holes on horiz. surface
3. Missing joint covers
4. Top sealant missing/not functioning
5. Ctrfl./cladding not extended over fl.

EM
Medium
1. Missing/displaced (where installed)

VF
Low
1. Loss coating/corrosion (metal valley)
2. No "V" crimp (metal valley)

Medium
1. Loss of surfacing/exposed felts
2. Unsealed laps (composition valley)
3. Holes/splits, substrate not exposed
4. Loose/miss. shingles, substr. not exp.
5. Shingles egdes sealed (open/closed)
6. Exp. fasteners<12" of ctr (closed/wov.)

High
1. Holes/splits, substrate exposed
2. Loose/miss. shingles, substr. exposed
3. Exposed fastener<12" of ctr (open)

RH
Medium
1. Holes/splits, substrate not exposed
2. Misalign shingle, substr. not exposed
3. Miss. shingle, substrate not exposed
4. Exposed fastener, has not backed out

High
1. Holes/splits, substrate exposed
2. Misalign shingle, substrate exposed
3. Missing shingle, substrate exposed
4. Exposed fastener, has backed out

MA
Low
1. Loss of coating, corrosion
2. Flashing height < 4"

Medium
1. No upslope cricket (apron width > 2")
2. Exposed fastener

High
1. Upslope flange edge is exposed
2. Downslope flange sealed/no overlap
3. Holes/splits/cracks
4. Metal flashing open at vert. corner
5. No apron flashing exists

FP
Low
1. Loss of coating, corrosion
2. Flashing sleeve deformed
3. Flue flashing height < 5"

Medium
1. Exposed fastener
2. Sleeve or umbrella is open/missing

High
1. Upslope flange edge is exposed
2. Downslope flange sealed/no overlap
3. Top of sleeve not sealed
4. Sleeve cracked/broken/corroded thru
5. No flashing sleeve present

RV
Medium
1. Missing components

High
1. Missing or loose vent section
2. Holes, splits in vent
3. Missing cap shingle on vent

PP
Medium
1. Pitch pan rim not level

High
1. Holes/splits in metal
2. Sealing material is below rim
3. Sealing material cracked/separated
4. Edge of upslope flange is exposed
5. Downslope flange is not exposed

IG
Low
1. Entire length rated low severity

High
1. Clogged gutter or drain
2. Holes/open seams in gutter

SHINGLE DISTRESSES

AD
Low
1. Loss surfacing, felt/mat not exposed
2. Erosion of material at shingle edge

Medium
1. Corners turned (curling/clawing)
2. Loss of surfacing, felt/mat exposed
3. Loss/delamination of foil

HS
Medium
1. Holes/splits, substrate not exposed
2. Misalign shingle, substr. not exposed
3. Missing shingle, substrate not exposed

High
1. Holes/splits, substrate exposed
2. Misalign shingle, substrate exposed
3. Missing shingle, substrate exposed
4. Exposed fastener has backed out

TB
Medium
1. Tab not sealed down
2. Lock-down shingle not interlocked

LR
Low
1. Lumps/ridges, not caused by deck
2. Lumps/ridges/sags caused by deck

EF
Medium
1. Exposed fastener, not backed out

ST
Low
1. Stains/rust/fungus/mildew

DV
Medium
1. Foreign objects/vegetation
2. Grease/solvent drippings, no degrad.
3. Branches making contact with roof

High
1. Grease/solvent drippings, degrad.
2. Vegetation roots, penetrate shingles

PA
Low
1. Replacement shingle, diff. from orig.

Medium
1. Replacement patch, dissimilar matls.

High
1. Replacement patch, high sev. distress

EQ
Low
1. All rated low severity

Medium
1. Equip. bolted thru shingles, sealed

High
1. Damage to shingles
2. Equip. bolted thru shingles, not sealed

Figure 11. Abbreviated list of distress/defect identifiers.

3. Inspect the roof shingles. Establish a starting point at one corner of the roof section. Using 10- to 15-ft wide strips, walk back and forth across the roof section surveying the entire area.

4. For each separate roof exposure, check individual tabs on random courses for proper seal down. If loose tabs are found, investigate to establish the location and amount of each affected area.

5. When specific defects occur uniformly on a large area, the following representative sampling technique can be used. Select a portion of the roof (e.g., 1000 sq ft of shingles or 20 lineal ft of flashing) and measure the distress in the sample area. Then by extrapolation, estimate the quantity of that distress for the total portion of the shingles or flashing affected. Record the distress information as a single entry with one identification number on the Roof Inspection Worksheet. The boundaries of the overall area or length, as represented by the sampling, should be shown on the roof section plan.

FCI and SCI Calculations

The FCI and SCI of a roof section are determined from the information recorded on the Roof Inspection Worksheet. The condition indexes can be calculated by entering the distress information into the Micro ROOFER program. The indexes can also be determined manually using the Roof Section Rating Form (Figure 12) with the following procedure. A blank copy of the form is provided in Appendix C.

Determine Deduct Values

Use information from the Roof Inspection Worksheet to complete the heading section of the Roof Section Rating Form. Transfer the quantities for each combination of distress type and severity level to the Roof Section Rating Form. Flashing distresses are tabulated on the left side of the page and shingle distresses on the right. Total the quantities for each severity of each distress, calculate each density using the equations in Chapters 4 and 5, and determine deduct values (DV) from the deduct value curves in Appendix A.

Determine Corrected Deduct Values

Tabulate flashing deduct values in descending order as shown on page 34 using the data obtained from Figure 12. Determine the sum of the flashing deduct val-

ues (ΣDV) and the sum of the number of distresses with deduct values greater than 1 (DV <1 = q), then use these two values and the appropriate graph in Appendix A to determine corrected deduct values (CDV) for the flashing distresses. Circle the maximum value of CDV as shown.

ROOF SECTION RATING FORM

BUILDING 1253	SECTION A	DATE 7/2/99	CALC. BY RL
PER. FLASHING 489 FT OTHER FLASHING 38 FT	FLASHING TOTAL 527 FT	AREA 2813 SQ FT	CHKD. BY DB

FLASHING

DISTRESS TYPES

SF -STEP FLASHING
MC -METAL CAP
EM -EDGE METAL
VF -VALLEY FLASHING
RH -RIDGE/H SHINGLE
MA -METAL APRON
FP -FLASHED PENETRATION
RV -RIDGE/HIP VENT
PP -PITCH PAN
IG -INTERIOR GUTTER

DIS	SEV	QUANTITIES	TOT	DEN	DV
EM	m	10	10	1.90	1
RH	m	1+1	2	.38	1
VF	L	25+21+15	61	11.6	7
RH	H	1	1	.19	1
SF	m	12	12	2.28	5
MA	m	2+2	4	.76	4
VF	m	6	6	1.14	5

CORRECTED DEDUCT VALUE (CDV) 12

FCI = 100 - CDV = 88

FLASHING RATING Excellent

SHINGLE

DISTRESS TYPES

AD -AGE DETERIORATION
HS -HOLE/MISS SHINGLE
TB -UNSEALED TAB
LR -LUMPS/RIDGES
EF -EXPOSED FASTENERS
ST -STAINS/FUNGUS
DV -DEBRIS & VEG.
PA -PATCHING
EQ -EQUIP. SUPPORTS

DIS	SEV	QUANTITIES	TOT	DEN	DV
ST	L	20	20	.71	3
DV	M	16+9	25	.89	3
HS	m	6	6	.21	6
PA	m	8	8	.28	3
AD	L	150	150	5.33	5

CORRECTED DEDUCT VALUE (CDV) 9

SCI = 100 - CDV = 91

SHINGLE RATING Excellent

Figure 12. Completed Roof Inspection Rating Form.

Flashing

Distress data from the completed Roof Section Rating Form (Figure 12).

DV	ΣDV	q	$CDV_{flashing}$
7	7	1	7
5	12	2	8
5	17	3	9
4	21	4	10
1	22	4	11
1	23	4	11
1	24	4	12

$$\text{Maximum } CDV_{flashing} = 12$$

Repeat this process using the appropriate graph in Appendix A to determine the maximum corrected deduct value for the shingles.

Shingles

Distress data from the completed Roof Section Rating Form (Figure 10).

DV	ΣDV	q	$CDV_{shingles}$
6	6	1	6
5	11	2	7
3	14	3	9
3	17	4	9
3	20	5	9

$$\text{Maximum } CDV_{shingles} = 9$$

Compute Flashing and Shingle Condition Indexes

Calculate flashing and shingle condition indexes using the following equations:

$$FCI = 100 - \text{Max. } CDV_{flashing}$$

$$SCI = 100 - \text{Max. } CDV_{shingles}$$

Determine the corresponding descriptive condition ratings from Figure 1 for both indexes. For this data, FCI = 88 and SCI = 91, giving both the flashings and shingles an excellent rating.

Roof Condition Index Calculation

Each individual index (FCI, SCI) reflects the component's ability to provide its intended service and indicates repair/replacement needs. Since the components must interact to function as a roof system, they are dependent on each other. The indexes, in total, provide an assessment of the condition of an asphalt shingle roof section. By combining these indexes, a roof condition index (RCI) can be calculated. This single index is useful for evaluating the overall condition of a roof section and for comparing conditions between roof sections. The RCI allows the user to rank individual roof sections in accordance with their ability to perform.

This relationship is defined by the following equation:

RCI = (0.7 x lowest condition index) + (0.3 x remaining condition index)

The above equation gives the greatest weight to the component with the lowest condition index and then modifies it by adding "value" from the remaining index.

The following example illustrates how this relationship works:

Example: FCI = 88; SCI = 91

$$RCI = (0.7 \times 88) + (0.3 \times 91)$$

$$= 62 + 27$$

$$= 89$$

A completed RCI Calculation Sheet is shown in Figure 13.

RCI CALCULATION SHEET	AGENCY/INST.: Example		
DATE: 7/2/99	BLDG NO: 1253	SECTION ID: A	AREA: 2813 SF

ROOF SECTION WITH STEEP ROOFING

	VALUE	LOWEST	OTHER
SCI	91		91
FCI	88	88	
		X 0.70	X 0.30
		(A) 61.6	(B) 27.3
		(A+B) RCI	89

RATINGS

86 - 100	EXCELLENT
71 - 85	VERY GOOD
56 - 70	GOOD
41 - 55	FAIR
26 - 40	POOR
11 - 25	VERY POOR
0 - 10	FAILED

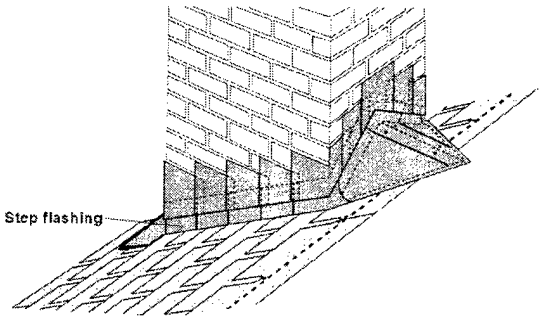
Figure 13. Completed RCI Calculation Sheet.

4 Flashing Distresses

Step Flashing (SF) 38
Metal Cap Flashing (MC) 43
Edge Metal (EM) 47
Valley Flashing (VF) 51
Ridge/Hip Shingles (RH) 57
Metal Apron Flashing (MA) 61
Flashed Penetrations (FP) 67
Ridge/Hip Vents (RV) 73
Pitch Pans (PP) 75
Interior Gutters (IG) 79

Step Flashing (SF)

Description



Step Flashing

Individual pieces of metal flashing material used to flash vertical walls, chimneys, dormers, and other projections. The pieces range from 7 to 10 in. long and have a 90-degree bend with a horizontal and a vertical leg. The pieces are individually placed at the end of each course of shingles where the roof meets a vertical surface. They are overlapped and "stepped up" the slope, and are fastened through the horizontal surface to the deck. Step flashing should be used only to flash a vertical surface that runs up a slope and not across the slope.

Severity Levels

Low

Any of the following indicate a low-severity distress:

1. Loss of protective coating or corrosion of step flashing.
2. Overlayed roof system shingles are not step flashed.
3. Coverage of less than one step flashing unit per shingle course exists.

Medium

Any of the following indicate a medium-severity distress:

1. Vertical leg of step flashing is less than 4 in. high.
2. Bent, deformed, or wide gaps in vertical leg of step flashing.
3. Loose or displaced step flashing.
4. Vertical joints between step flashing pieces have been sealed closed.
5. Continuous "L" flashing exists instead of incremental step flashing.

High

Any of the following indicate a high-severity distress:

1. Holes exist in step flashing.
2. No vertical flashing exists.
3. Top edge of step flashing is exposed, allowing water to penetrate behind flashing.

Measurement

Measure length (ft) of step flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

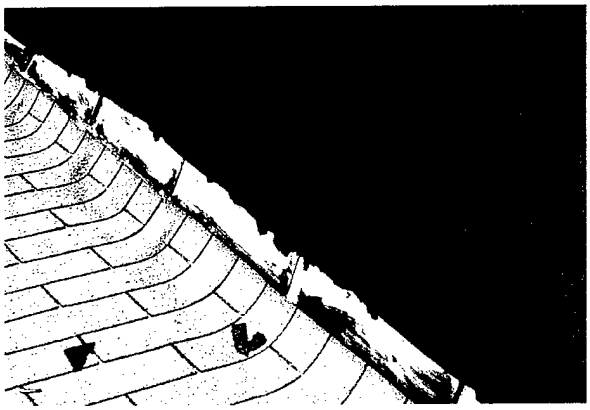
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

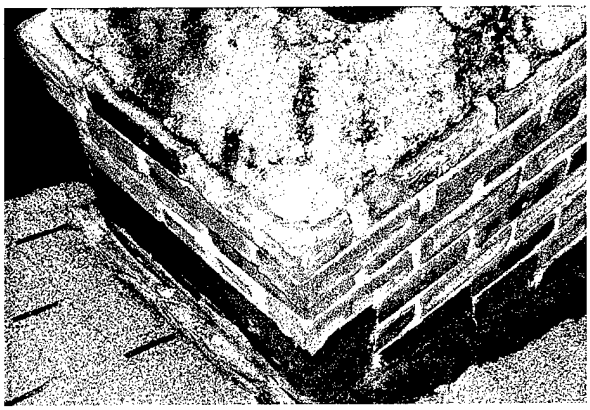
where A = length of step flashing defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



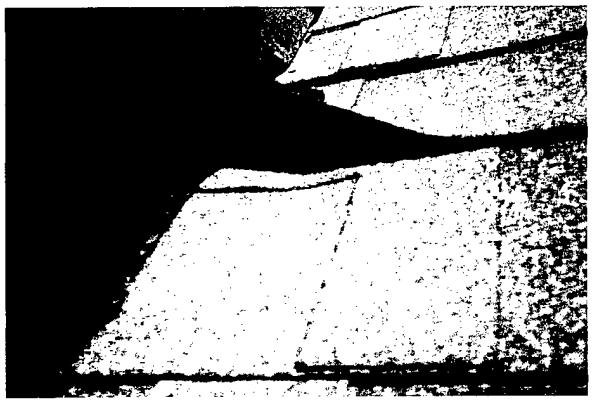
SF-L-2.



SF-M-4.

SF-M-5.

SF-H-2.

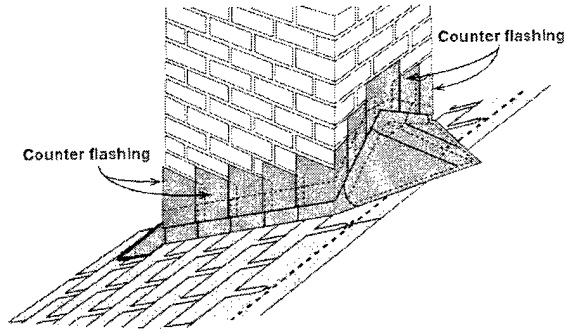


SF-H-2.

SF-H-3.

Metal Cap Flashing (MC)

Description



Metal Cap Flashing

Metal cap flashing includes counterflashing and any sheet metal coping cap that serves as part of the counterflashing or cover over a detail such as roof area divider, equipment curb, expansion joint, step flashing, ridge, or hip. Metal cap flashing protects the top termination of the vertical flashing (step flashing or metal apron flashing) and sheds water away from it. It should be free to expand and contract. Properly lapped exterior siding or cladding can perform the function of metal cap flashing.

Severity Levels

Low

Any of the following indicate a low-severity distress:

1. Loss of protective coating or corrosion.
2. Metal coping cap is deformed, allowing water to pond on the top.
3. Counterflashing is deformed but still functioning.
4. Counterflashing has been sealed to the step flashing.
5. Exposed fasteners on horizontal surfaces of metal cap flashing.

Medium

Any of the following indicate a medium-severity distress:

1. Corrosion holes are present in the metal on a vertical surface.
2. Metal coping cap has loose fasteners, failure of soldered or sealed joints, open joints, or loss of attachment.

High

Any of the following indicate a high-severity distress:

1. Metal coping cap or counterflashing was not installed, or is missing or displaced from its original position, allowing water to channel behind it.
2. Corrosion holes are present in the metal on a horizontal surface.
3. Metal coping cap has missing joint covers (where originally installed).
4. Sealant at reglet or top of counterflashing is missing or no longer functioning, allowing water to channel behind counterflashing.
5. Counterflashing, exterior siding, or cladding does not extend over top of step flashing or apron flashing.

Measurement

Measure length (ft) of metal cap flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

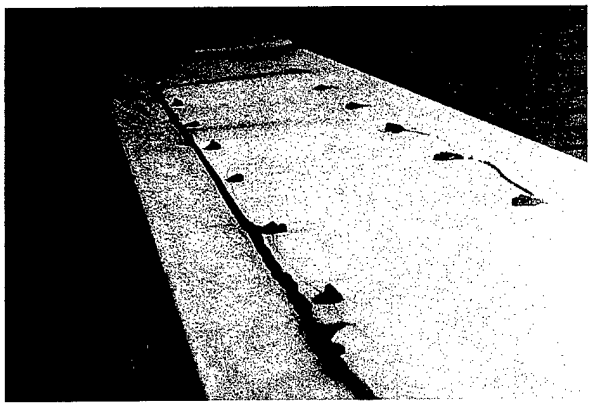
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of metal cap flashing defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.

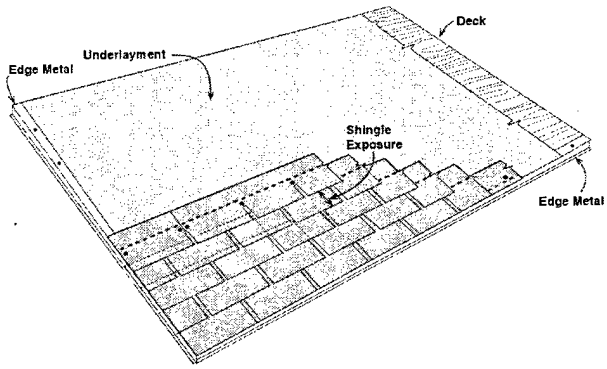


MC-L-5.

Edge Metal (EM)

Description

Formed edge of metal, often referred to as drip edge, placed along eaves and rakes and covered by shingles. The edge metal allows water to drip away from vertical surfaces and protects underlying building components.



Edge Metal

Note: In some cases edge metal may not have been installed. If no edge metal exists for the roof section and there is no evidence that edge metal was originally installed, do not count its absence as a distress.

Severity Levels

Low

Not applicable.

Medium

The following indicates a medium-severity distress:

1. Missing or displaced section of edge metal (where originally installed).

High

Not applicable.

Measurement

Measure length (ft) of edge metal flashing having the condition described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

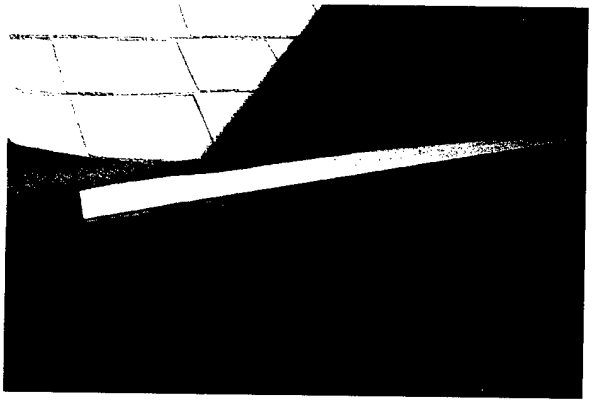
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of edge metal defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



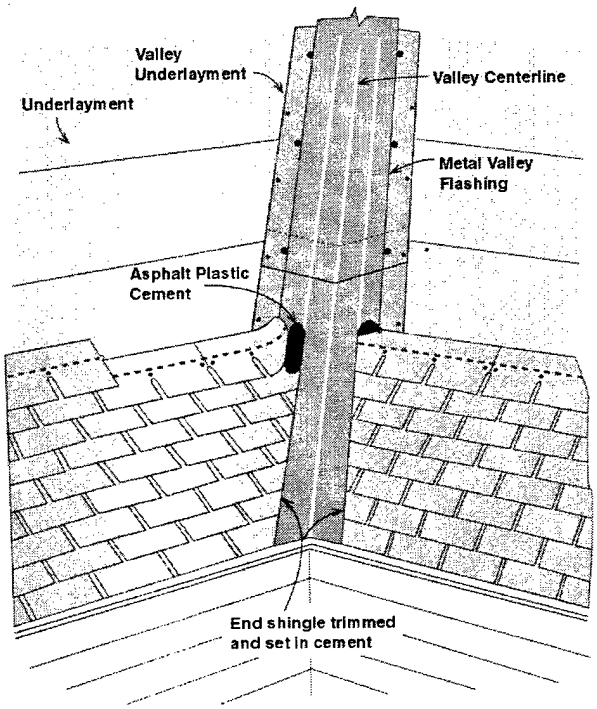
EM-M-1.

EM-M-1.

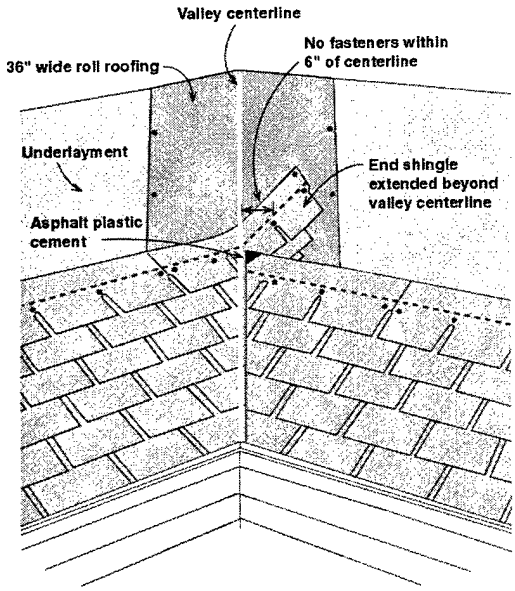
Valley Flashing (VF)

Description

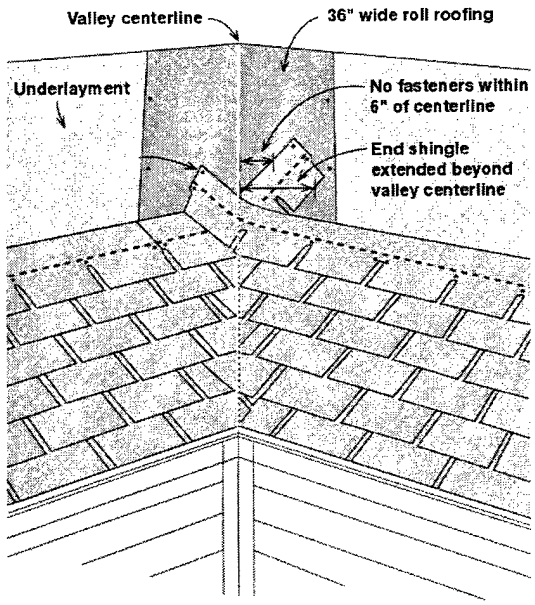
Roof valley flashings are formed when two sloping roof sections intersect to form a "V". Water from both sections of roof runs through the valley making it especially vulnerable to deterioration and leakage. Valley flashings for asphalt shingles may be of three types: (1) open valleys lined with sheet metal or mineral-surfaced asphalt roll (composition) material, (2) closed cut valleys having shingles on one side of the valley cut on an angle parallel with the valley, and (3) woven valleys lined with interwoven asphalt shingles from the adjoining roof sections. All three types of valley flashings should have underlying asphalt roll material.



Valley Flashing - Open



Valley Flashing - Closed



Valley Flashing - Woven

Severity Levels

Low

Any of the following indicate a low-severity distress:

1. Loss of protective coating or corrosion on metal open valley flashing.
2. No fabricated "V" crimp (vertical ridge) in center of metal open valley flashing.

Medium

Any of the following indicate a medium-severity distress:

1. Loss of surfacing with exposure of felts in valley flashing.
2. Unsealed laps in open composition valley flashing.
3. Holes, splits, or cracks in valley flashing not extending down to the underlayment.
4. Loose or missing valley shingles with no underlayment or substrate exposed.
5. Edges of valley shingles are sealed (in open or closed valleys).
6. Exposed fasteners within 12 in. of centerline of closed or woven valley.

High

Any of the following indicate a high-severity distress:

1. Holes or splits in valley flashing with underlayment or substrate exposed.
2. Loose or missing valley shingles with underlayment or substrate exposed.
3. Exposed fastener within 12 in. of centerline of open valley.

Measurement

Measure length (ft) of valley flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

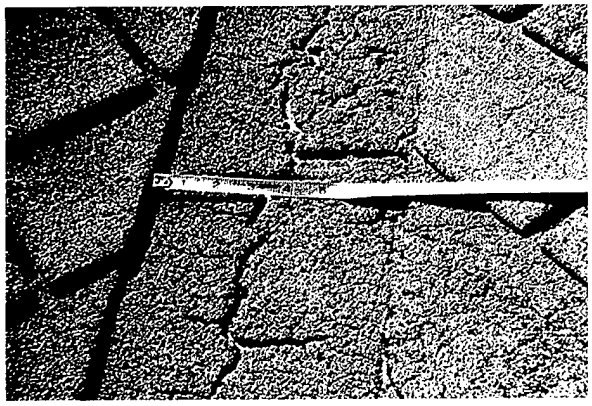
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

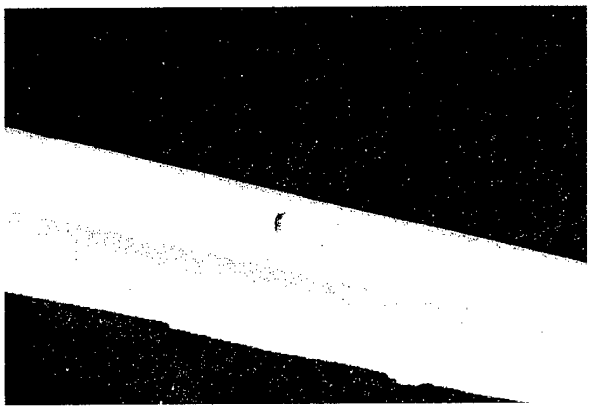
where A = length of valley flashing defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



VF-H-1.

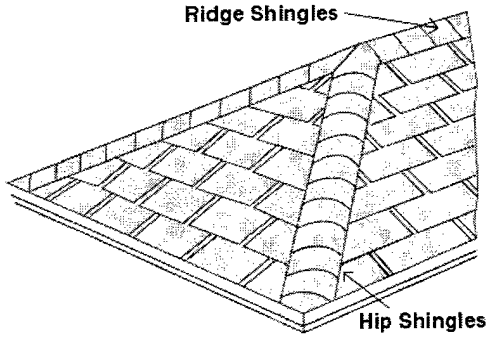


VF-H-1.

Ridge/Hip Shingles (RH)

Description

Portions of shingles (usually one tab width) that are cut from a full 3-tab shingle and laid perpendicular to the hip or ridge, providing a finished watershedding cap. Note: Ridge and Hip Shingles are treated as flashings because they provide protection of the roofing system at the terminations of adjoining roof planes.



Ridge/Hip Shingles

Severity Levels

Low

Not applicable

Medium

Any of the following indicate medium-severity distress:

1. Holes, splits, or cracks not extending down to the underlayment or substrate.
2. Misaligned shingle resulting in partial loss of coverage but no exposed underlayment or substrate.
3. Missing shingle, but no exposed underlayment or substrate.
4. Exposed fastener that has not backed out.

High

Any of the following indicate high-severity distress:

1. Holes or splits that extend down to the underlayment or substrate.
2. Misaligned shingle resulting in exposed underlayment or substrate.
3. Missing shingle resulting in exposed underlayment or substrate.
4. Exposed fastener that has backed out.

Measurement

Measure the lineal feet of exposure of ridge or hip shingle tabs having the conditions described above. Round total quantity to next higher whole foot. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of ridge or hip shingles having defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.

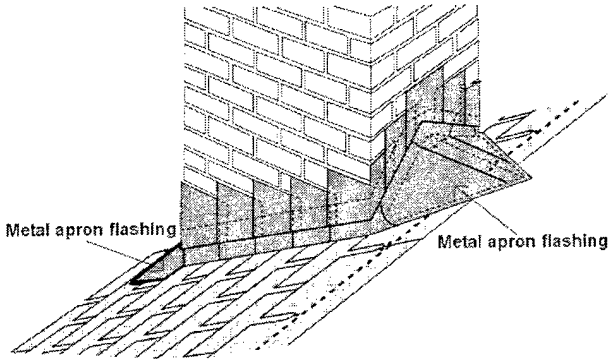
RH-M-3.

RH-M-4.

RH-H-3.

Metal Apron Flashing (MA)

Description



Metal Apron Flashing

Roof-to-wall sheet metal flashing used at the upslope and downslope sides of chimneys, dormers, curbs, and other projections. Apron flashing should be placed at the downslope side of the projection with the edge of the deck flange exposed. The metal apron at the upslope side of the projection should have the edge of the deck flange covered by overlying shingles. A projection that is wider than 2 ft should have a saddle-shaped cricket that diverts water around the projection.

Severity Levels

Low

Any of the following indicate a low-severity distress:

1. Loss of protective coating or corrosion.
2. Vertical flashing height is less than 4 in. high.

Medium

Any of the following indicate a medium-severity distress:

1. Absence of cricket on upslope side of penetration that is wider than 2 ft.
2. Exposed fastener in flashing.

High

Any of the following indicate a high-severity distress:

1. Edge of deck flange on upslope side of penetration is exposed or visible.
2. Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.
3. Holes, splits, or cracks in metal flashing.
4. Metal flashing is open at vertical corner.
5. No apron flashing exists.

Measurement

Measure length (ft) of metal apron flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

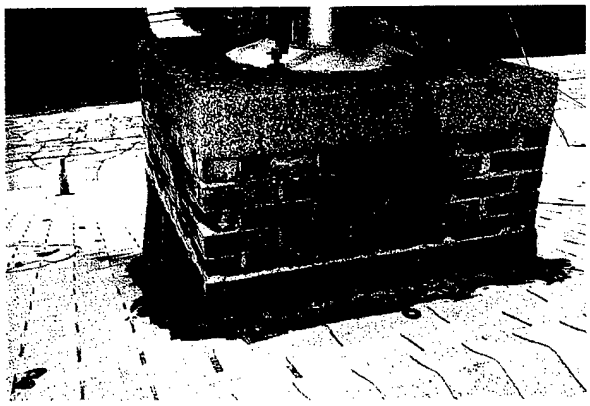
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

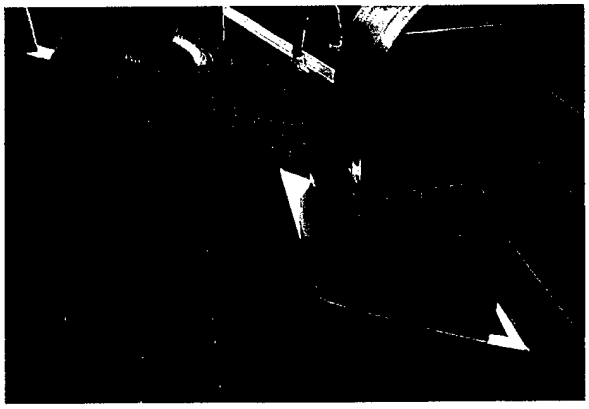
where A = length of flashing defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



MA-M-1.



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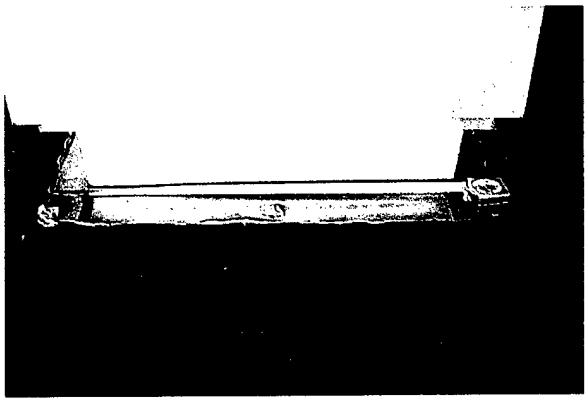

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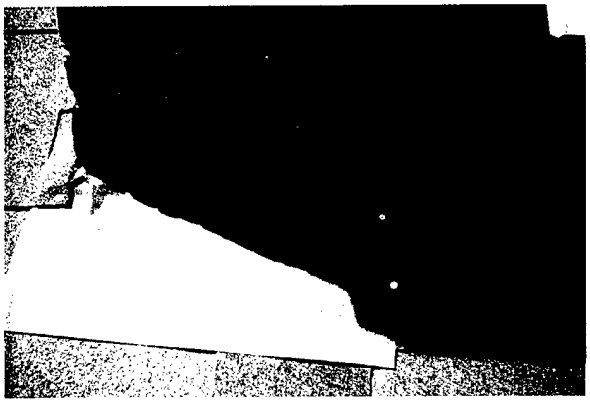
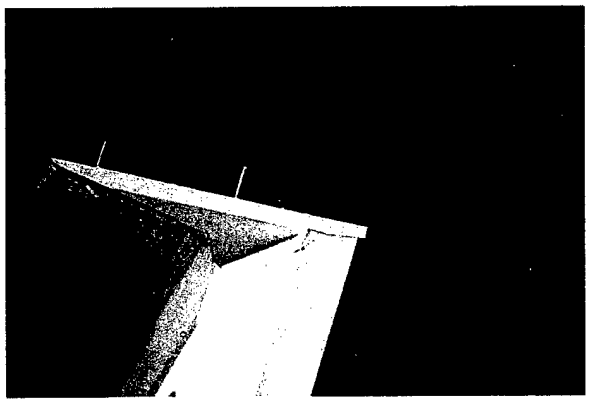
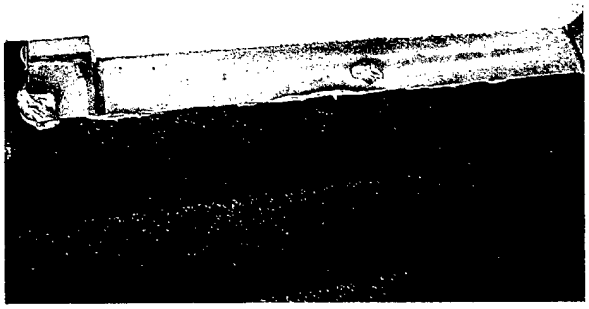


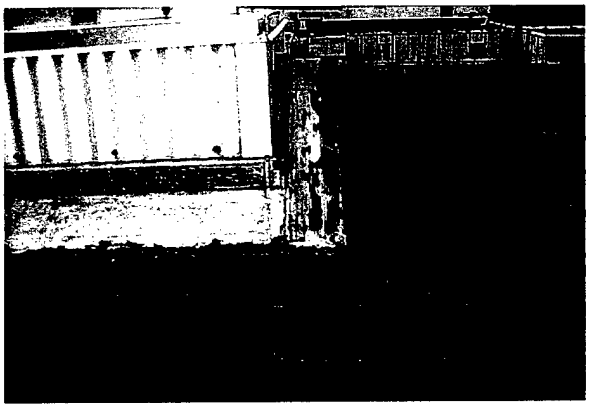
MA-M-2.



MA-H-1.

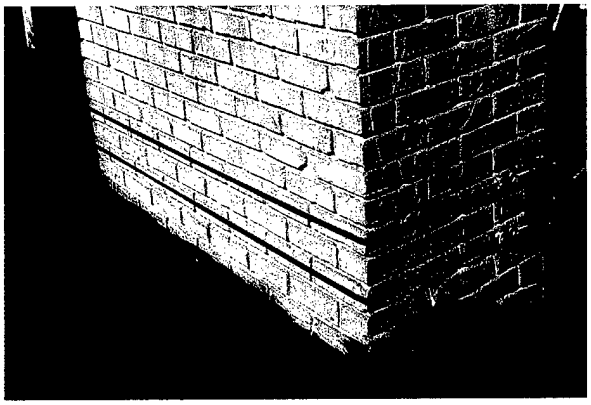


MA-H-1.



MA-H-2.

MA-H-5.

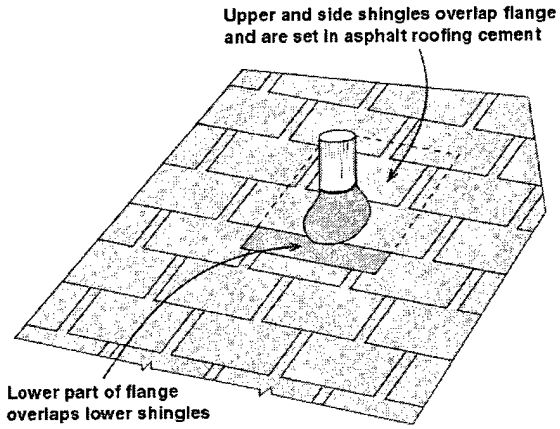


MA-H-5.

Flashed Penetrations (FP)

Description

Flashings for open pipes, plumbing vent stacks, attic vents, flues, ducts, continuous pipes, guy wires, and other roof penetrations that require a deck flange integrated into the shingles.



Flashed Penetration

Severity Levels

Low

Any of the following indicate a low-severity distress:

1. Loss of protective coating or corrosion.
2. Flashing sleeve is deformed.
3. Top of flue flashing is less than 5 in. above the roof surface on the upslope side.

Medium

Any of the following indicate a medium-severity distress:

1. Exposed fastener in flashing.
2. The sleeve or umbrella is open or no umbrella is present (where required).

High

Any of the following indicate a high-severity distress:

1. Edge of deck flange on upslope side of penetration is exposed or visible.
2. Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.
3. Top of flashing sleeve is not sealed or has not been rolled down into existing plumbing vent stack.
4. Flashing sleeve is cracked, broken, or corroded through.
5. No flashing sleeve is present.

Measurement

Count each distressed flashed penetration as 1 ft at the highest severity level present.

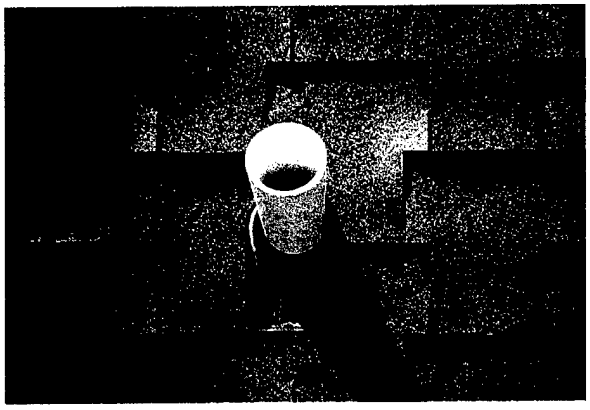
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of flashed penetrations defects (ft)

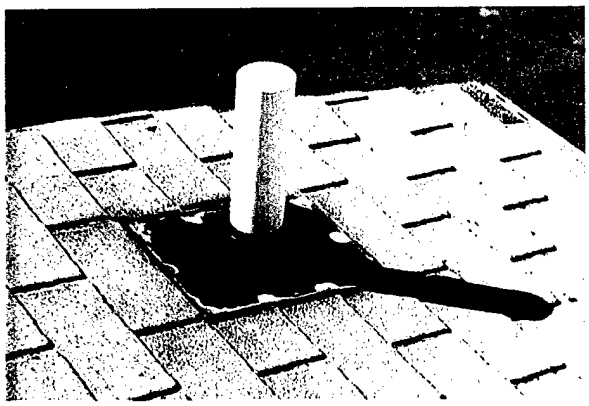
B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.

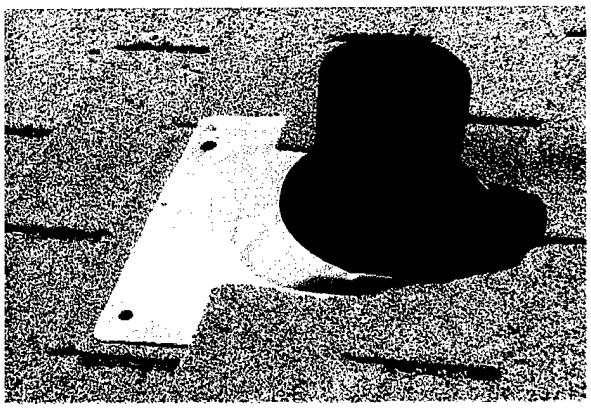


FP-L-1.

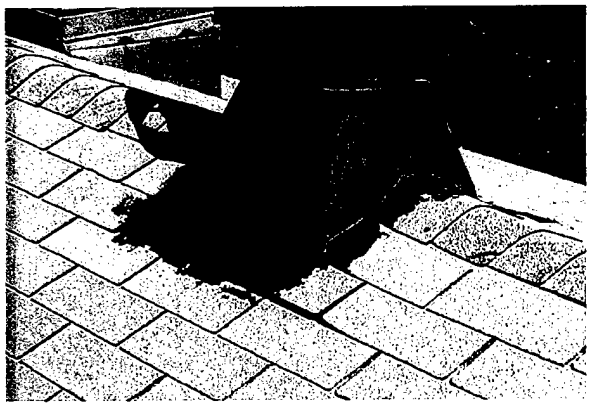
FP-L-2.



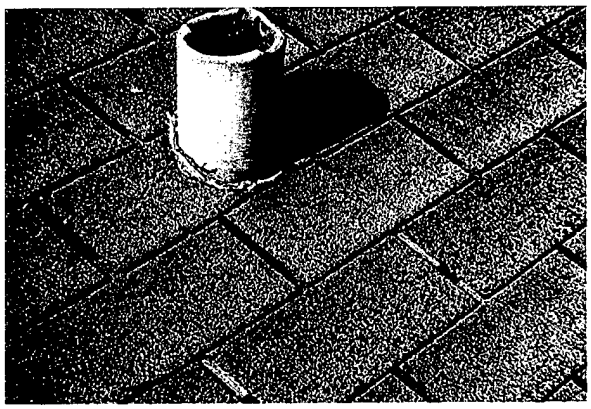
FP-H-1.



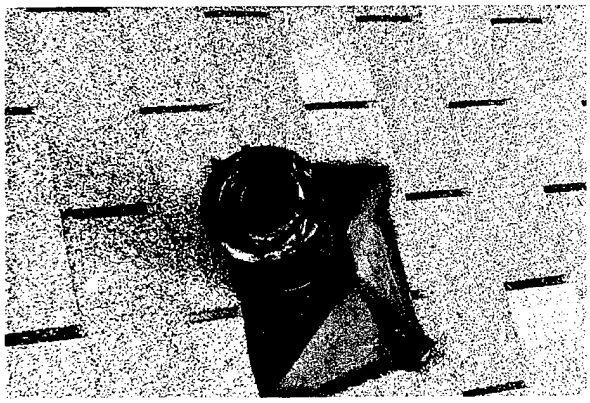
FP-M-1.



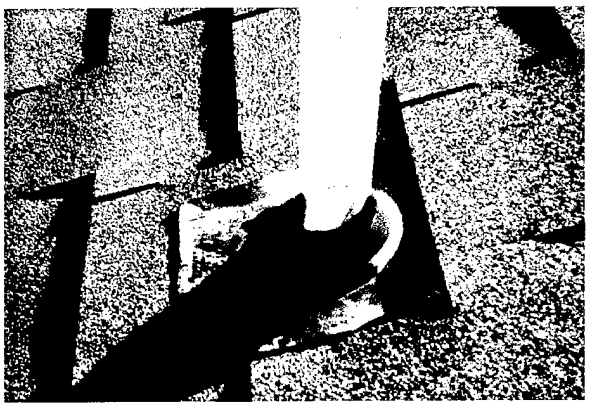
FP-H-2.



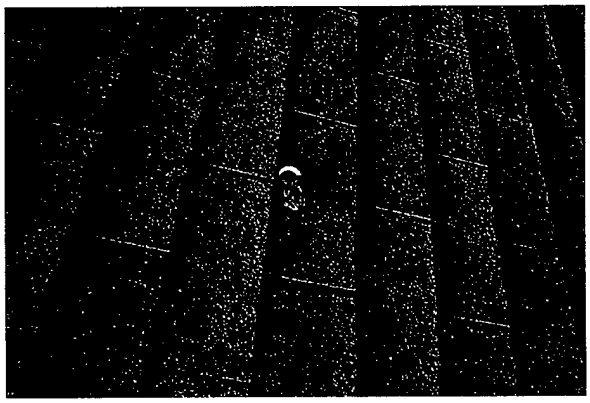
FP-H-2.



FP-H-3.



FP-H-4.



FP-H-5.

FP-H-5.

Ridge/Hip Vents (RV)

Description

Any device installed on and along the roof ridge or hip for the purpose of ventilating the underside of the roof deck.

Severity Levels

Low

Not applicable.

Medium

The following indicates a medium-severity distress:

1. Missing component of vent assembly (i.e., end caps, baffles, etc.).

High

Any of the following indicate a high-severity distress:

1. Missing or loose section of ridge or hip vent.
2. Holes, splits, or cracks in ridge or hip vent.
3. Missing cap shingle on roof vent.

Measurement

Measure length (ft) of ridge/hip vent flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of ridge/hip vent flashing defects (ft).

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.

Pitch Pans (PP)

Description

A pitch pan is a flanged sleeve with an open bottom that is placed around a roof penetration and filled with a bituminous, polymeric, or grout sealant to seal the area around the penetration.

Severity Levels

Low

Not applicable.

Medium

The following indicates a medium-severity distress:

1. Top rim of pitch pan is not level on all sides.

High

Any of the following indicate a high-severity distress:

1. Holes, splits, or cracks in metal.
2. Sealing material is below metal rim.
3. Sealing material has cracked or separated from pan or penetration.
4. Edge of deck flange on upslope side of penetration is exposed.
5. Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.

Measurement

Count each distressed pitch pan once at the highest severity level present.

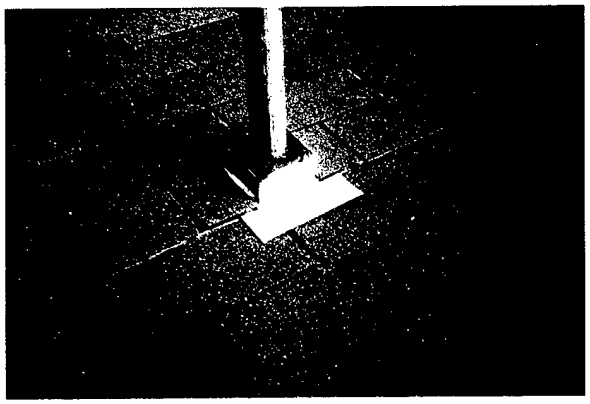
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = number of distressed pitch pans

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



PP-M-1.

Interior Gutters (IG)

Description

An interior gutter is a built-in trough of metal or other material that collects water from the roof and carries it to a drain or downspout.

Severity Levels

Low

The following indicates a low-severity distress:

1. Entire length of interior gutter is rated low severity, as a minimum, due to the maintenance problems and high potential for leak damage associated with its presence.

Medium

Not applicable.

High

Any of the following indicate a high-severity distress:

1. Clogged gutter or drain.
2. Holes or open seams in interior gutter.

Measurement

Measure entire length of gutter having the conditions described above. For clogged gutters, count lineal feet of clogging material. For clogged drain, count as 1 ft. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

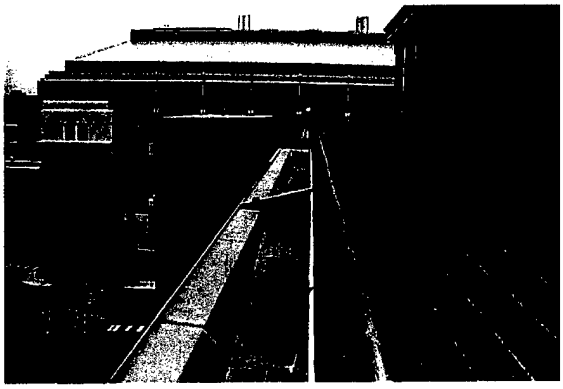
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of gutter defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as step flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights).

Note: A problem density is calculated for each existing severity level.



IG-L-1.

5 Shingle Distresses

Age Deterioration (AD) 84

Holes/Splits/Missing Shingles (HS) 89

Unsealed/Unlocked Tab (TB) 95

Lumps/Ridges/Sags (LR) 99

Exposed Fasteners (EF) 103

Stains/Rust/Fungus/Mildew (ST) 107

Debris and Vegetation (DV) 111

Patching (PA) 115

Improper Equipment Supports (EQ) 119

Age Deterioration (AD)

Description

Age deterioration includes clawing and curling of the shingles, and exposure of the shingle felt/mat due to excessive loss of granules, all of which indicate brittleness. Normally, these are not localized problems but are general conditions found on large areas of the roof, such as individual roof exposures, or the entire roof. The occurrence of these problems indicate aging and reduced service life. Clawing is the turning under of the tab corners of the shingle and curling is the turning up of the tab corners.

Severity Levels

Low

Any of the following defects indicates a low-severity distress:

1. Loss of granular surfacing on shingle, but the reinforcing felt or mat is not exposed.
2. Erosion of material around the edge of the shingle, normally found less than ¼ inch back from the edge.

Medium

Any of the following defects indicates a medium-severity distress:

1. Corners of the shingle are turned under or up (that is, clawing or curling).
2. Loss of granular surfacing on shingle that results in bare spots and exposes reinforcing felt or mat.
3. Loss or delamination of foil on foil-surfaced shingle.

High

Not applicable.

Measurement

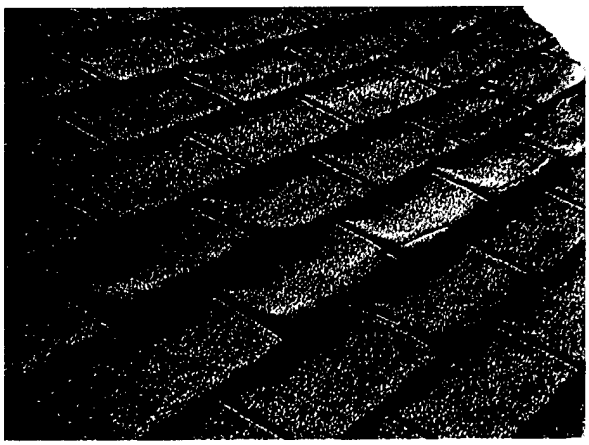
Measure the exposed area (sq ft) of shingles having the above conditions.

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

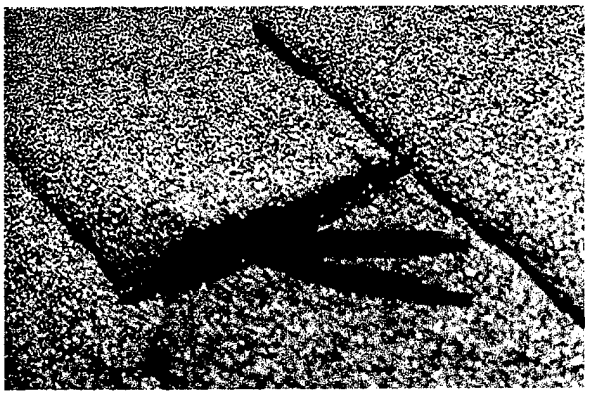
Density

where A = total exposed are of shingles (sq ft) having age deterioration defects.
B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.

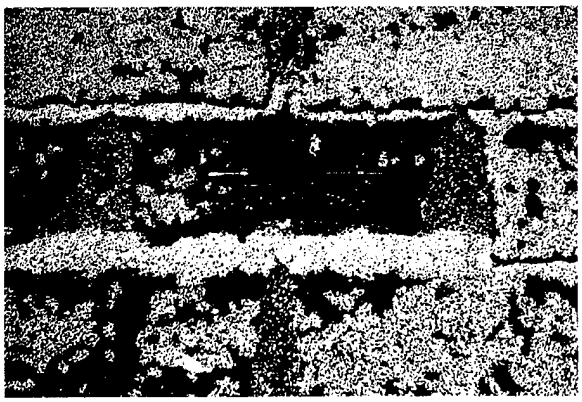


AD-M-1



AD-M-1

AD-M-2



AD-M-2

Holes/Splits/Missing Shingles (HS)

Description

This category of distresses is characterized by holes, splits, cracks, or visible tears in the shingle reinforcing felt or mat, or missing shingles or tabs.

Severity Levels

Low

Not applicable.

Medium

Any of the following defects indicates a medium-severity distress:

1. Holes, splits, or cracks that do not extend down to the underlayment or substrate.
2. Misaligned shingle resulting in partial loss of coverage but no exposed underlayment or substrate.
3. Missing shingle, but no exposed underlayment or substrate.

High

Any of the following defects indicates a high-severity distress:

1. Holes or splits that extend down to the underlayment or substrate.
2. Misaligned shingle resulting in exposed underlayment or substrate.
3. Missing shingle, resulting in exposed underlayment or substrate.
4. Exposed fastener that has backed out. (Note: if fastener has not backed out, count as exposed fastener distress, EF, not a hole.)

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

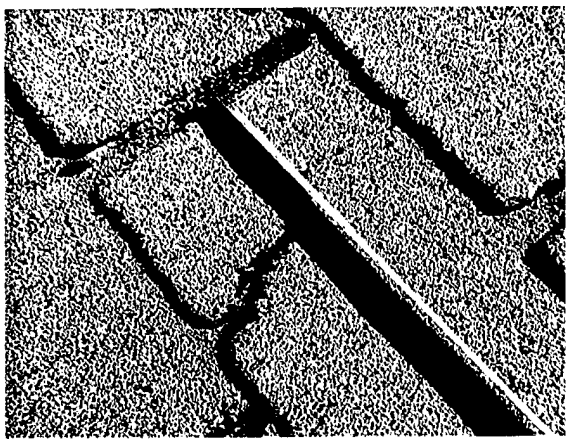
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total exposed area of shingles (sq ft) having holes/splits/missing shingle defects.

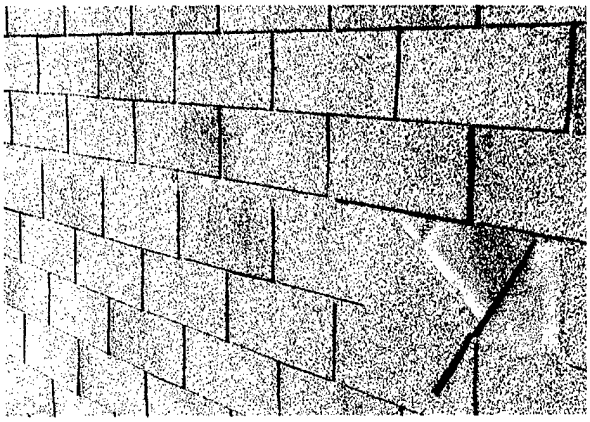
B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.

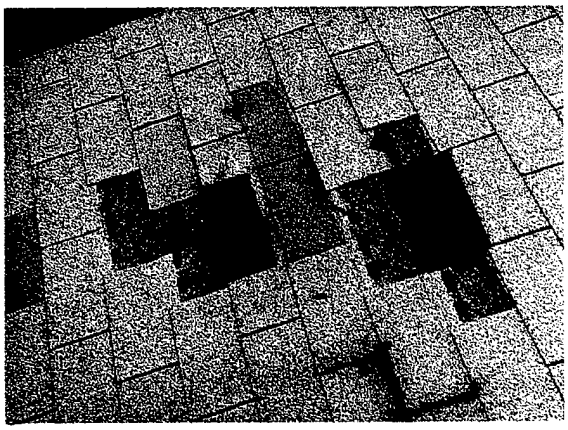


HS-M-1

HS-M-1



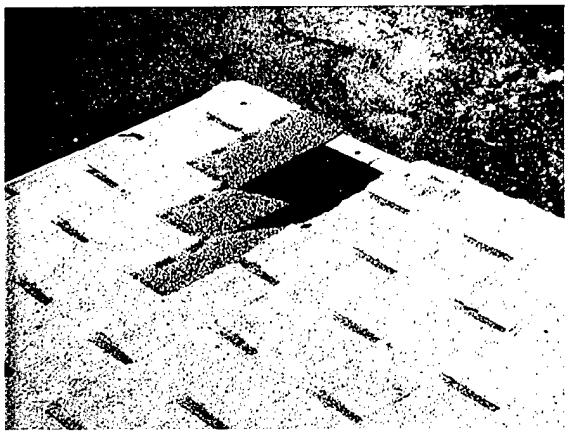
HS-M-2



HS-M-3

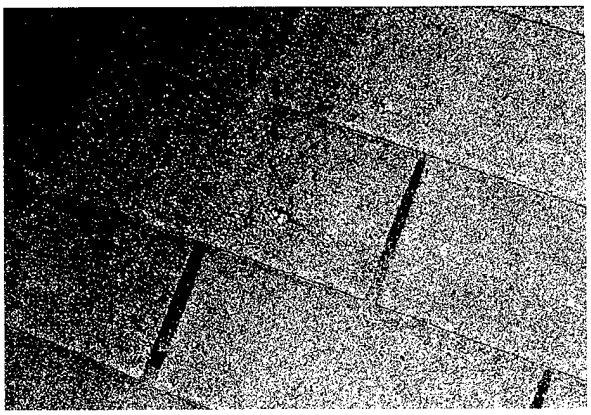
HS-M-3

HS-H-1



HS-H-3

HS-H-3



HS-H-4

Unsealed/Unlocked Tab (TB)

Description

For a seal-down shingle, a lack of adhesion between the tab of a shingle and underlying shingles indicates an unsealed condition. Displacement or damage to a lock-down shingle that results in the loss of its interlocking mechanism indicates an unlocked condition.

Note: For seal-down shingles, use a trowel or fingers and gently try to lift tab. Any adherence of the shingle tab to underlying shingles should be judged as adequate. Test several adjacent shingles in three or four randomly selected areas of the roof. If any shingles are found to be unsealed, use sampling method to determine the quantity of the affected area.

Severity Levels

Low

Not applicable.

Medium

Any of the following defects indicates a medium-severity distress:

1. The tab of a shingle, that is designed to be sealed down is unsealed.
2. A lock-down shingle is not interlocked.

High

Not applicable.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

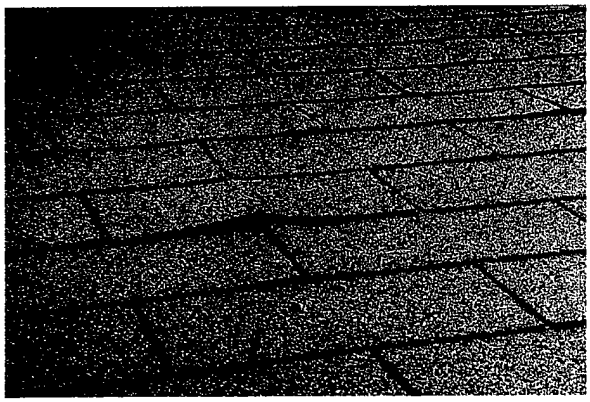
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

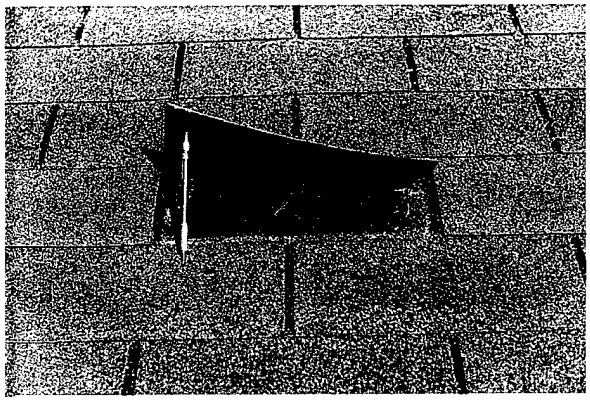
where A = total exposed area of shingles (sq ft) having unsealed/unlocked defects

B = total area of roof section being rated (sq ft).

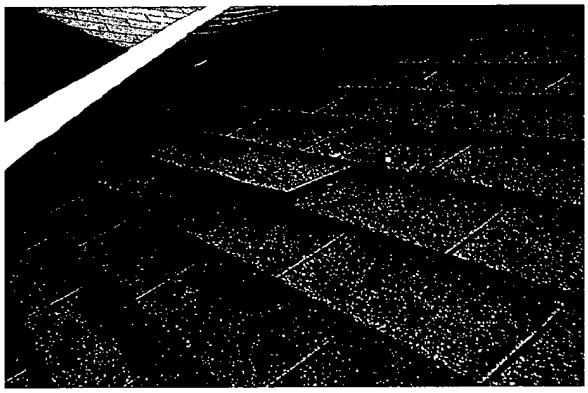
Note: A problem density is calculated for each existing severity level.



TB-M-1



TB-M-1



TB-M-1

TB-M-2

Lumps/Ridges/Sags (LR)

Description

Lumps, ridges, or sags are present on the surface of the roof.

Note: If other problems exist in the areas that exhibit lumping, sagging, or ridging, record them under the appropriate distresses.

Severity Levels

Low

Any of the following defects indicates a low-severity distress:

1. Lumps or ridges that do not appear to be caused by unevenness in the supporting substrate or underlying flashing component (i.e., wrinkles in underlying felt).
2. Lumps, ridges, or sags caused by unevenness in the supporting substrate or underlying flashing component.

Medium

Not applicable.

High

Not applicable.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

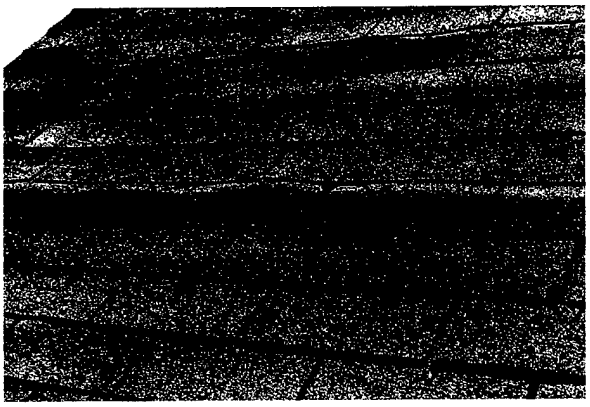
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

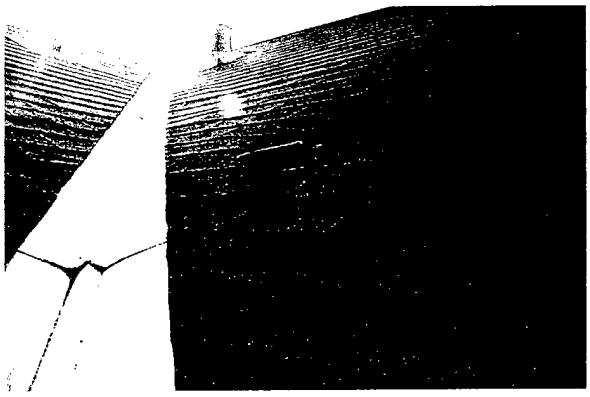
where A = total exposed area of shingles (sq ft) having lumps/ridges/sags defects

B = total area of roof section being rated (sq ft).

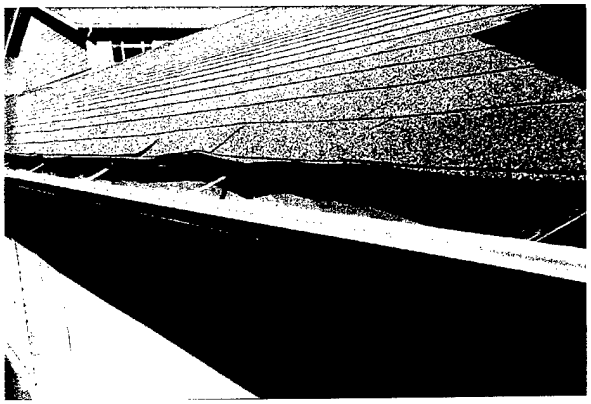
Note: A problem density is calculated for each existing severity level.



LR-L-1



LR-L-2



LR-L-2

Exposed Fasteners (EF)

Description

Shingle fasteners are visible in the field of the roof.

Note: If a shingle fastener has backed out, count it as a hole (HS).

Severity Levels

Low

Not applicable.

Medium

1. A fastener is exposed but has not backed out.

High

Not applicable.

Measurement

Measure the number of exposed fasteners. Individual exposed fasteners count as 1 sq ft minimum. If more than one exposed fastener is found in an area of 1 sq ft, count the distressed are as 1 sq ft.

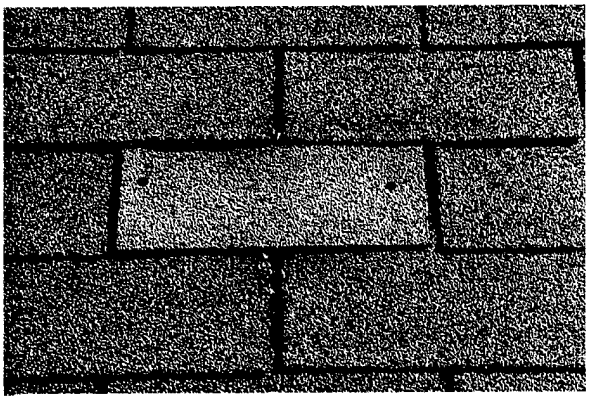
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

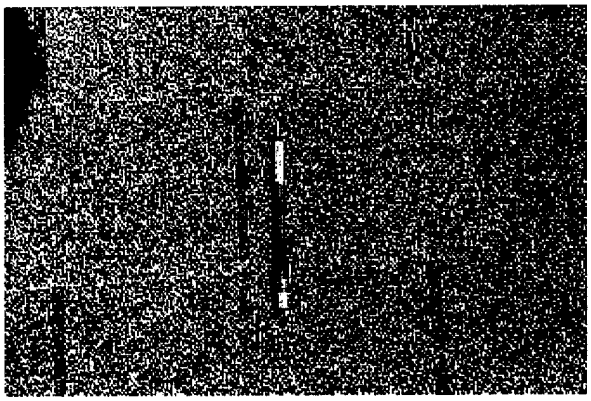
where A = total area of exposed fasteners (sq ft) having defects

B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.



EF-M-1



EF-M-1

Stains/Rust/Fungus/Mildew (ST)

Description

The shingle surface shows evidence of stains, rust fungus, or mildew.

Note: If the appearance is unacceptable, corrective treatments can be applied, such as cleaning with trisodium hypochlorate or installing zinc strips.

Severity Levels

Low

1. Evidence of stains, rust, fungus, or mildew.

Medium

Not applicable.

High

Not applicable.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

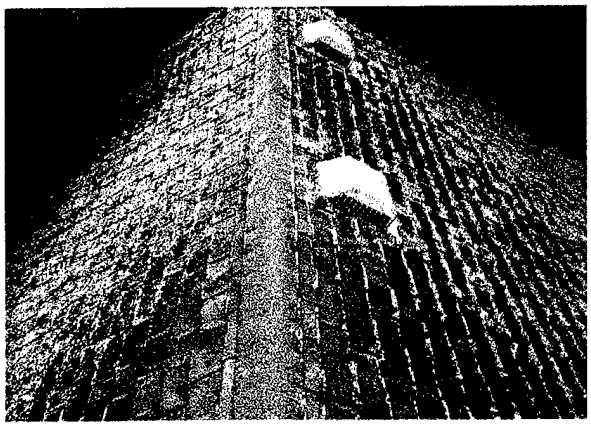
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total exposed area of shingles (sq ft) having stains/rust/fungus/mildew defects

B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.



ST-L-1

Debris and Vegetation (DV)

Description

This category includes any of the following items:

- foreign objects on the roof that could damage or puncture the shingles or flashings
- the growth of vegetation on the roof
- accumulation of solvent or oil drippings on the roof.

Note: If other problems exist in the areas that have debris and vegetation, record additional problems under the appropriate distress categories.

Severity Levels

Low

Not applicable.

Medium

Any of the following defects:

1. Collection of foreign objects or vegetation on the field of the roof.
2. Grease, solvent, or oil drippings on the roof but no apparent degradation of the roofing system.
3. Evidence of branches making contact with roof shingles.

High

Any of the following defects indicates a high-severity distress:

1. Grease, solvent, or oil drippings on the roof that have caused degradation of the roofing shingles.
2. Vegetation roots that have penetrated the roof shingles.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

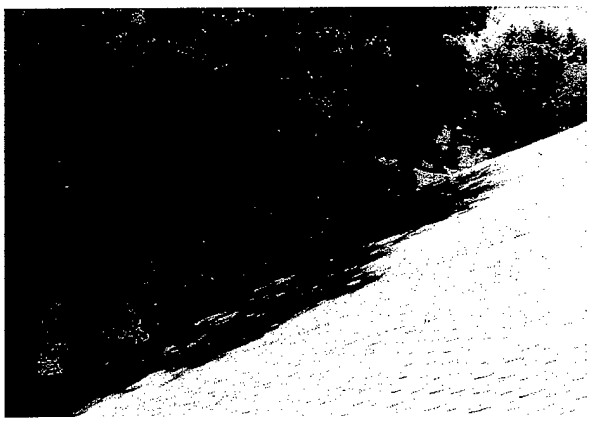
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total exposed roof area (sq ft) having debris and vegetation defects

B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.

DV-M-1



DV-M-3

DV-H-2

Patching (PA)

Description

Roof repairs were previously made using dissimilar materials such as mastics or shingles of a different color or design.

Severity Levels

Low

1. Replacement shingle does not match appearance or composition of original adjacent shingles.

Medium

1. Shingle replacement patch is composed of dissimilar materials such as mastic, roofing felts, or coatings.

High

1. Shingle replacement patch composed of dissimilar materials, that have other high severity distresses (i.e., holes, splits, and cracks).

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

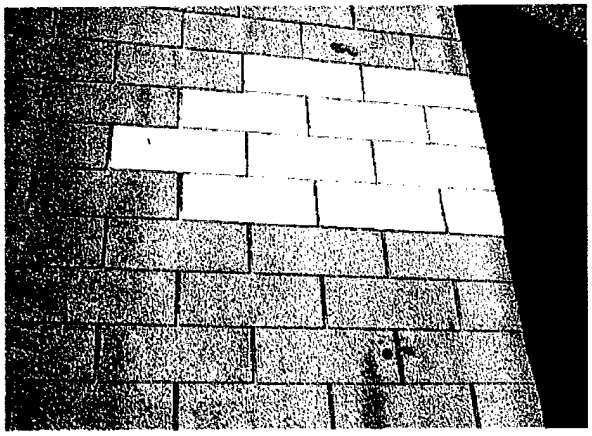
Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total exposed roof area (sq ft) having patching defects

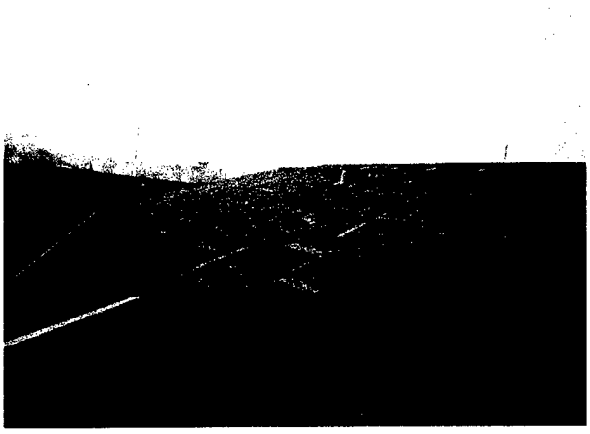
B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.

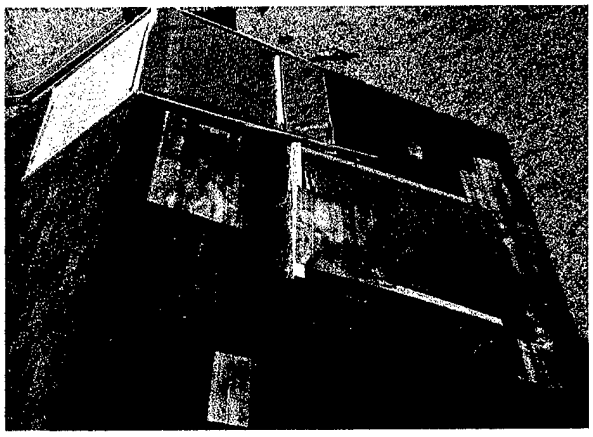


PA-L-1

PA-M-1



PA-M-1



PA-M-1

PA-H-1.

Improper Equipment Supports (EQ)

Description

This distress category includes pipe, conduit, and mechanical equipment supports (wood sleepers, channels, etc.) that are placed directly on the roof surface with no protective pad or placed at an insufficient height to allow for maintaining the roofing system below the equipment. Repairing this type of distress may require replacing the surrounding roofing system.

Terminations for guy wires are to be rated as flashed penetration (FP) distresses (see Chapter 4, page 67).

Severity Levels

Low

1. All improper equipment supports are rated low severity as a minimum due to the maintenance problems associated with them.

Medium

1. The equipment is bolted through the shingles and the bolts appear to be sealed.

High

Any of the following defects indicates a high-severity distress:

1. The support has caused movement or damage to the shingles.
2. The equipment is bolted through the shingles and the bolts do not appear to be sealed.

Measurement

Measure square feet of each improper equipment support. The minimum dimension for length and width of a support shall be 1 foot.

Density

$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total area of improper equipment supports (sq ft)

B = total area of roof section being rated (sq ft).

Note: A problem density is calculated for each existing severity level.

References

Bailey, D. M., D. Brotherson, and W. Tobiasson, *ROOFER: A Management Tool for Maintaining Built-up Roofs*, CERL Technical Manuscript M-90/02/ADA214032 (CERL, October 1989).

Bailey, D.M., D.E. Brotherson, W. Tobiasson, S. Foltz and A. Knehans, *ROOFER: Membrane and Flashing Condition Indexes for Single-Ply Membrane Roofs - Inspection and Distress Manual*, CERL Technical Report FM-93/11/ADA272573 [CERL], April 1993).

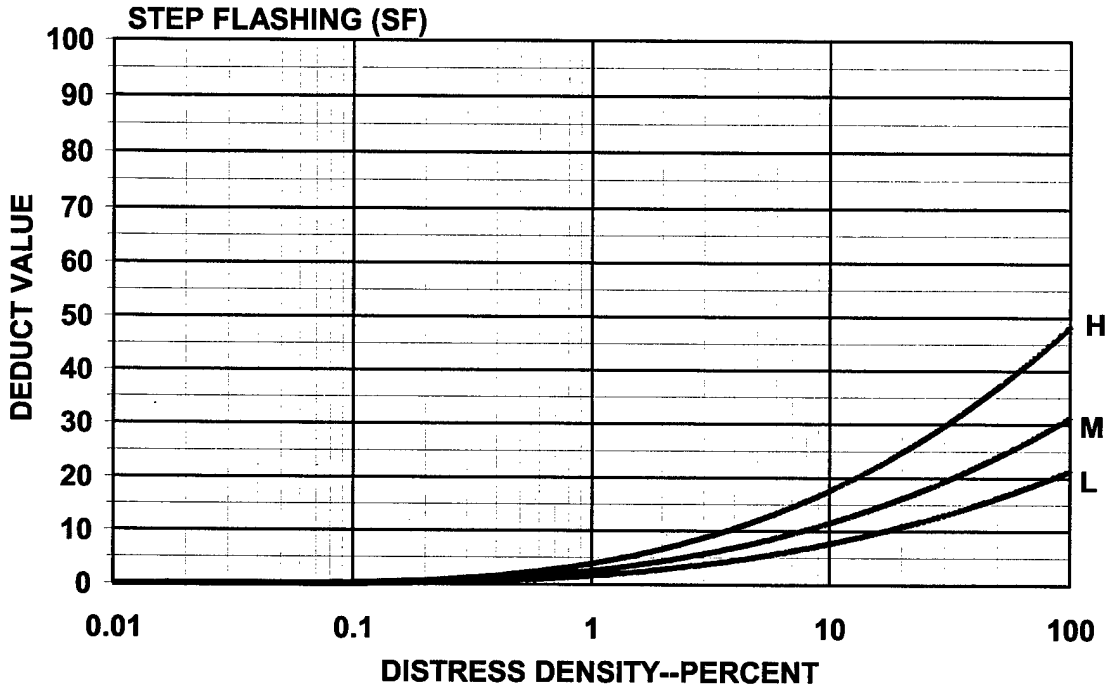
Bailey, D. M., D. Brotherson, W. Tobiasson, and A. Knehans, *ROOFER: An Engineered Management System (EMS) For Bituminous Built-Up Roofs*, CERL Technical Report M-90/04/-ADA218529 (U.S. Army Construction Engineering Research Laboratory [CERL], December 1989).

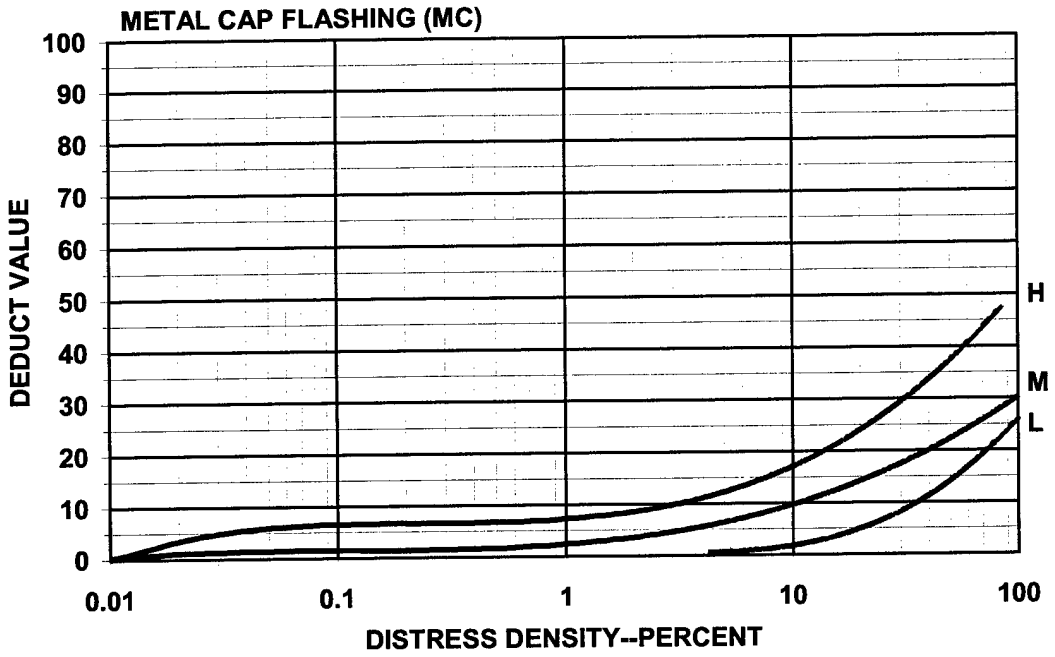
Bailey, D. M., B. Young, S. Hansen, and J. Elston, *Micro ROOFER User's Guide*, CERL ADP Report M-90/12 (CERL, April 1990).

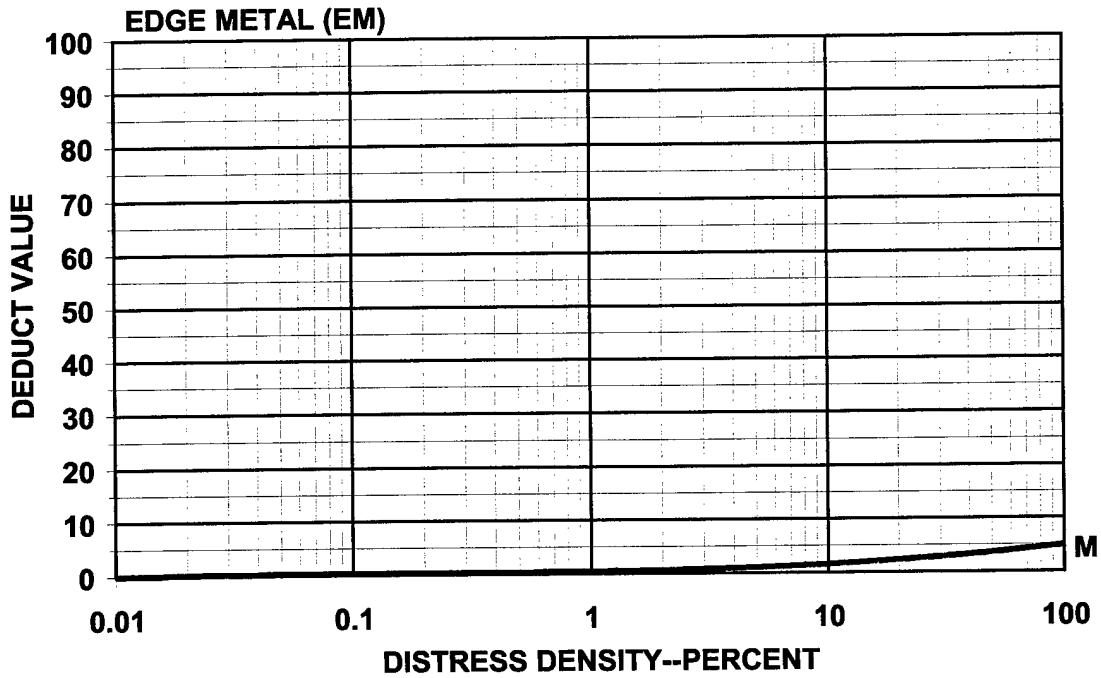
Shahin, M. Y., D. Bailey, and D. Brotherson, *Membrane and Flashing Condition Indexes for Built-Up Roofs Volume I: Development of the Procedure*, Technical Report M-87/13/ADA190367 (CERL, September 1987a).

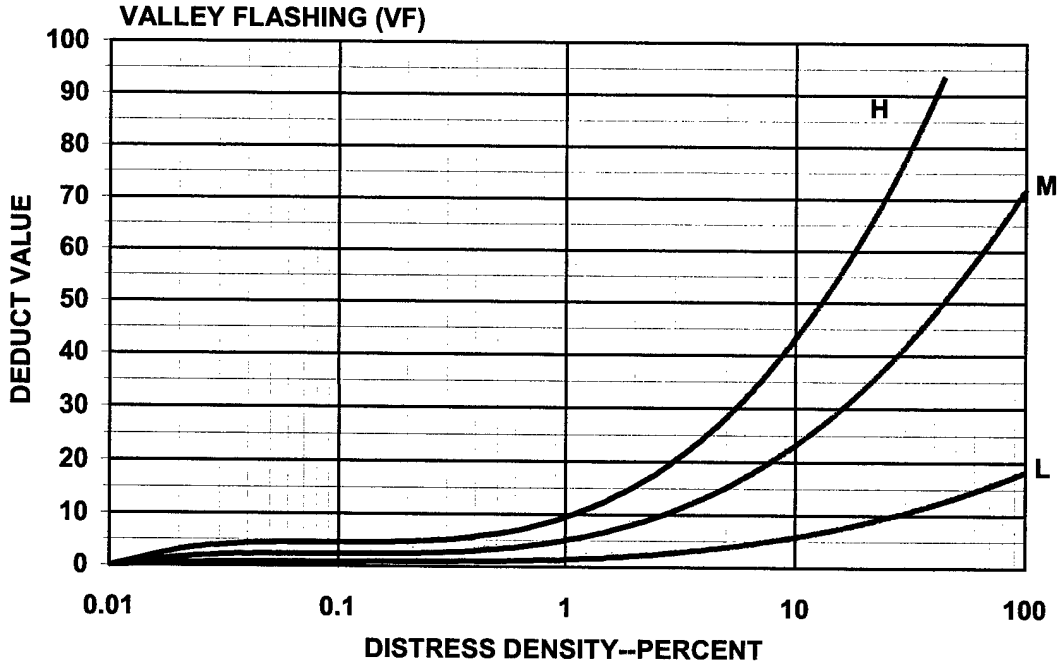
Shahin, M. Y., D. Bailey, and D. Brotherson, *Membrane and Flashing Condition Indexes for Built-Up Roofs Volume II: Inspection and Distress Manual*, Technical Report M-87/13/ADA190368 (CERL, September 1987b).

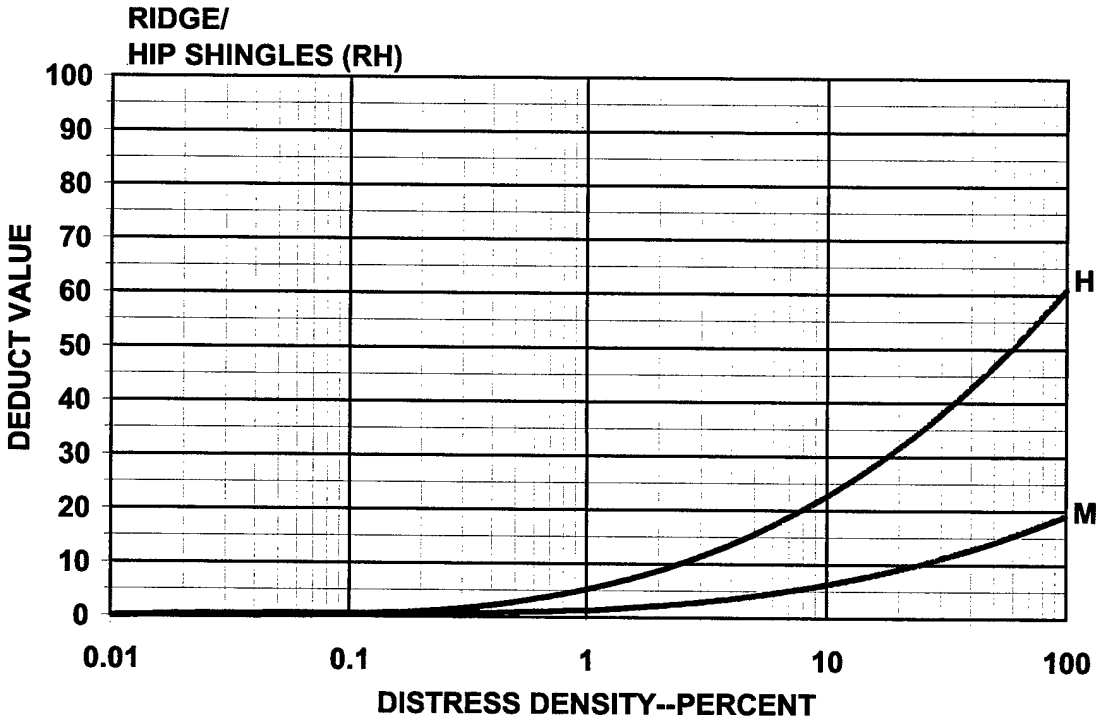
Appendix A: Deduct Value Curves

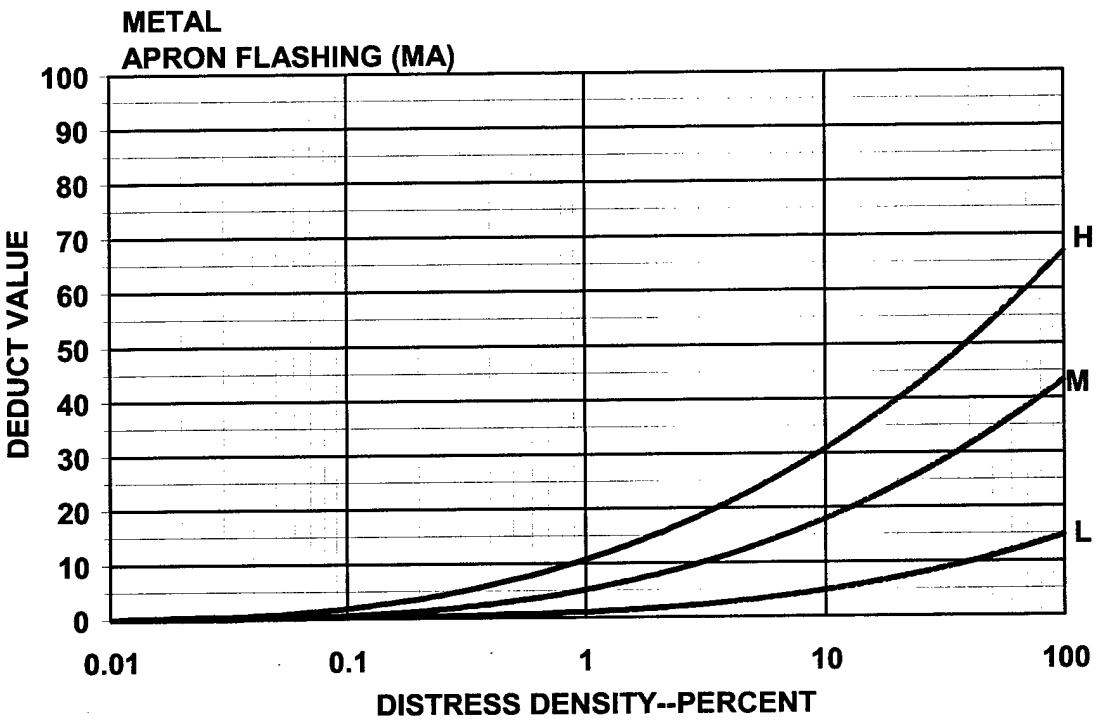


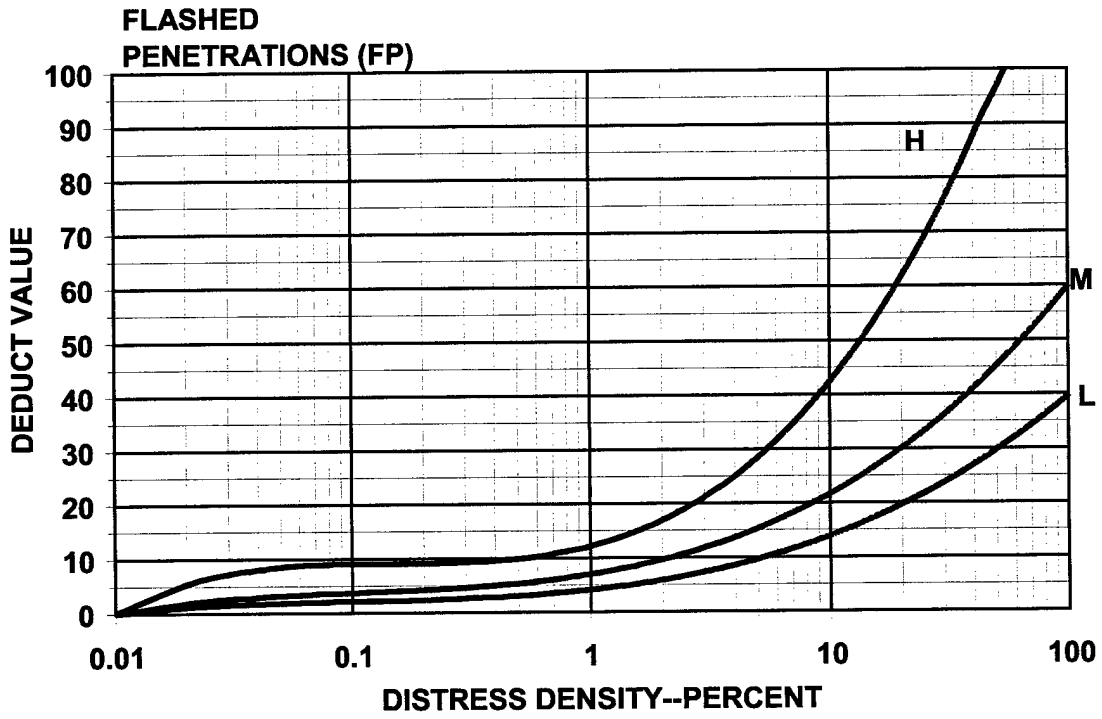

METAL CAP FLASHING (MC)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

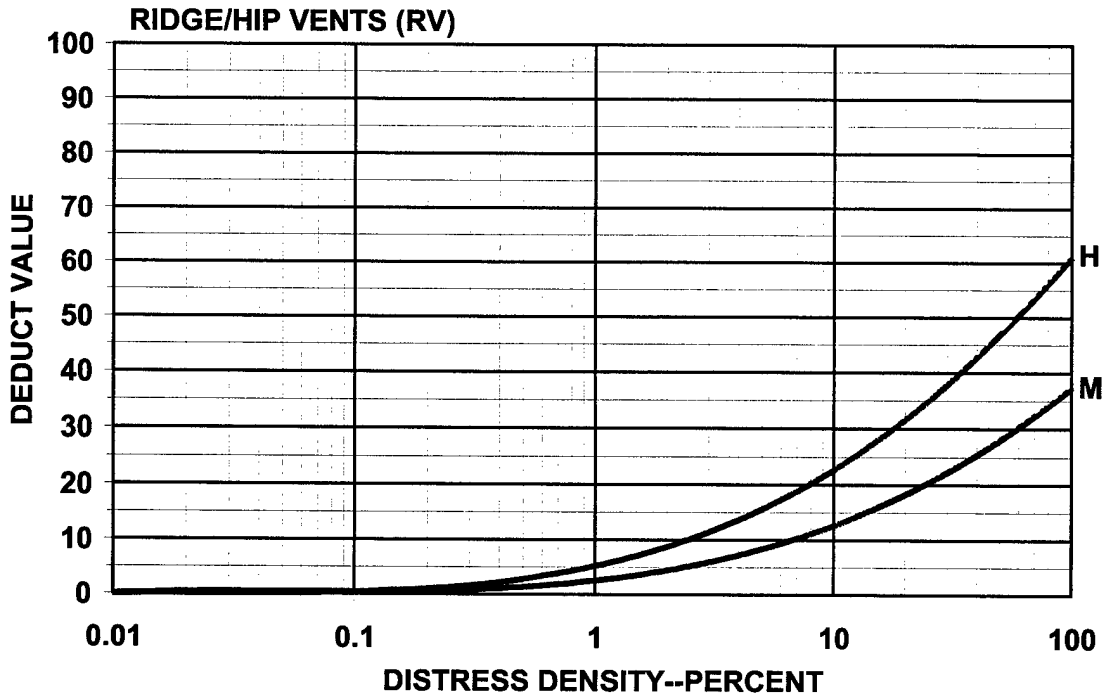

EDGE METAL (EM)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
M
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

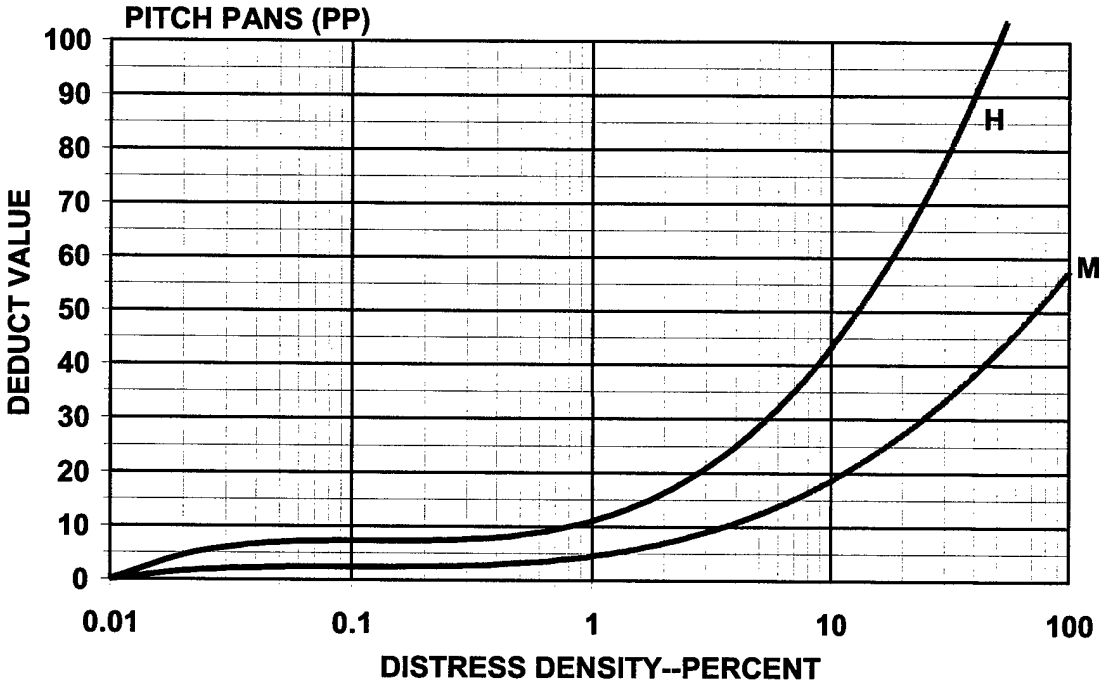

VALLEY FLASHING (VF)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

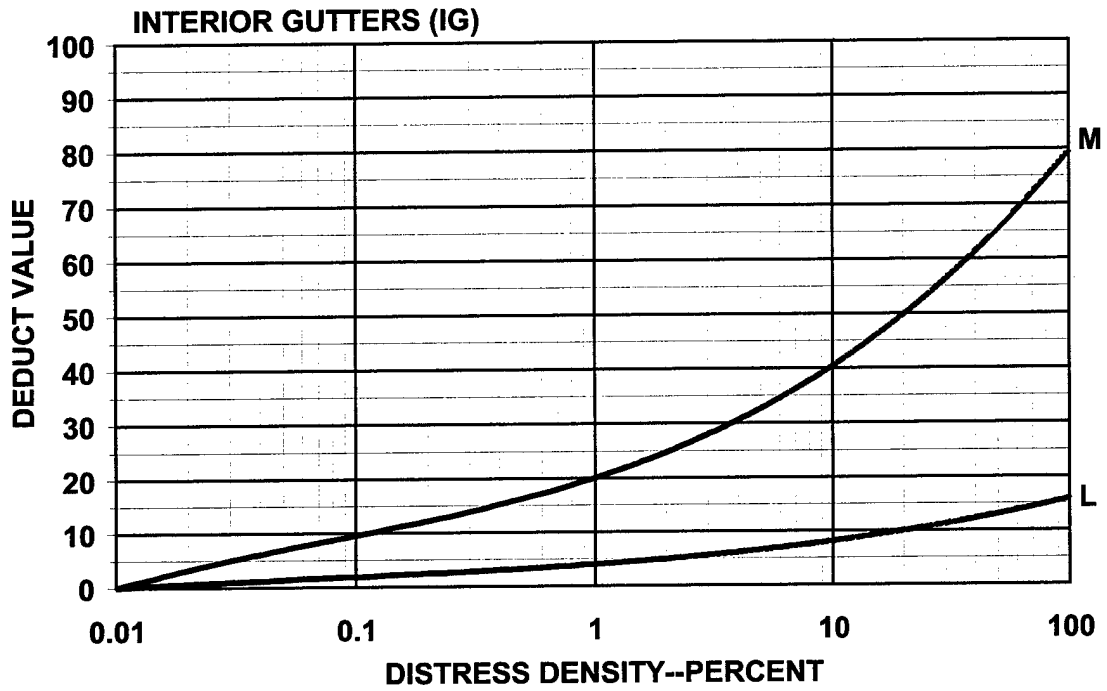

RIDGE/
HIP SHINGLES (RH)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT


METAL
APRON FLASHING (MA)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

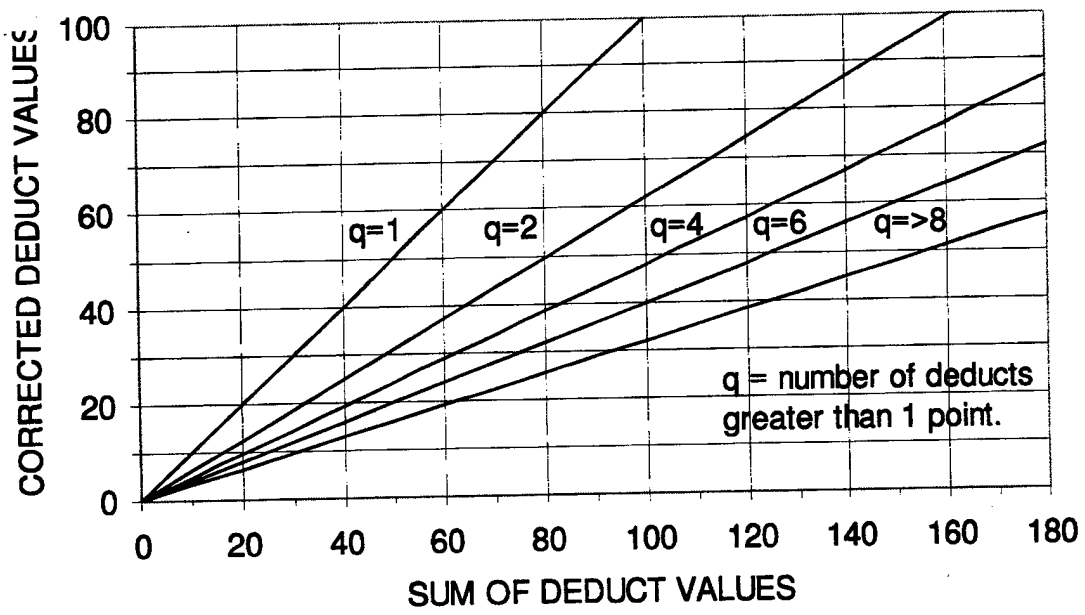

FLASHED
PENETRATIONS (FP)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

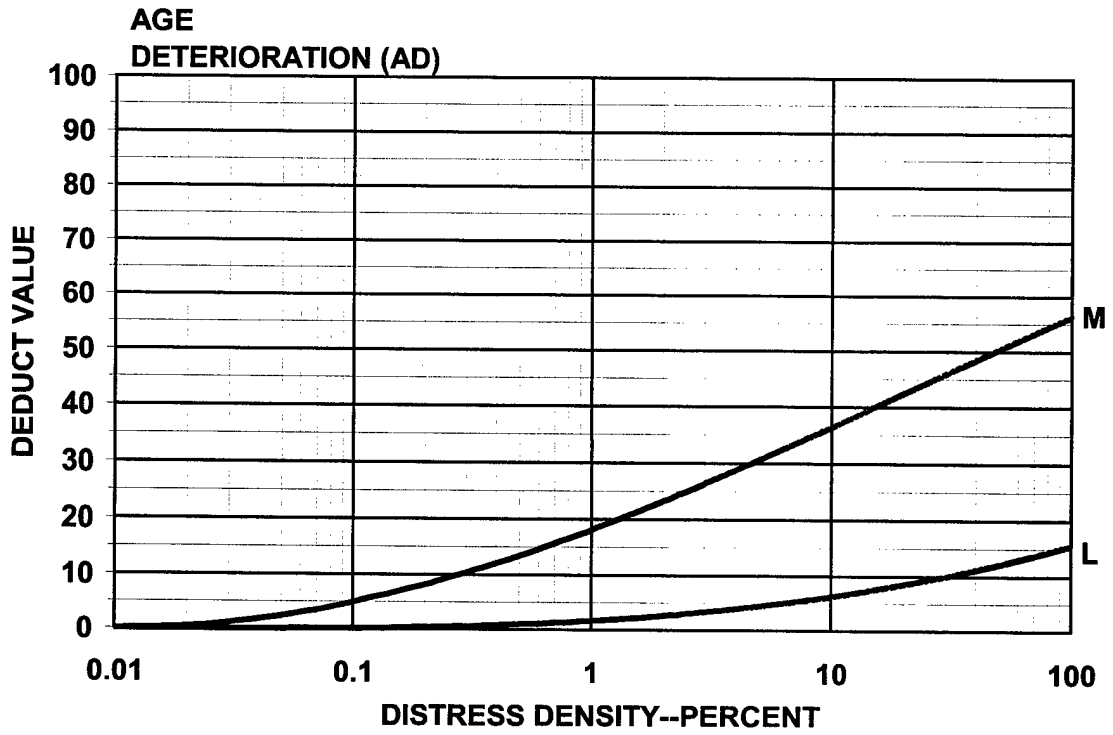

RIDGE/HIP VENTS (RV)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT
H
M

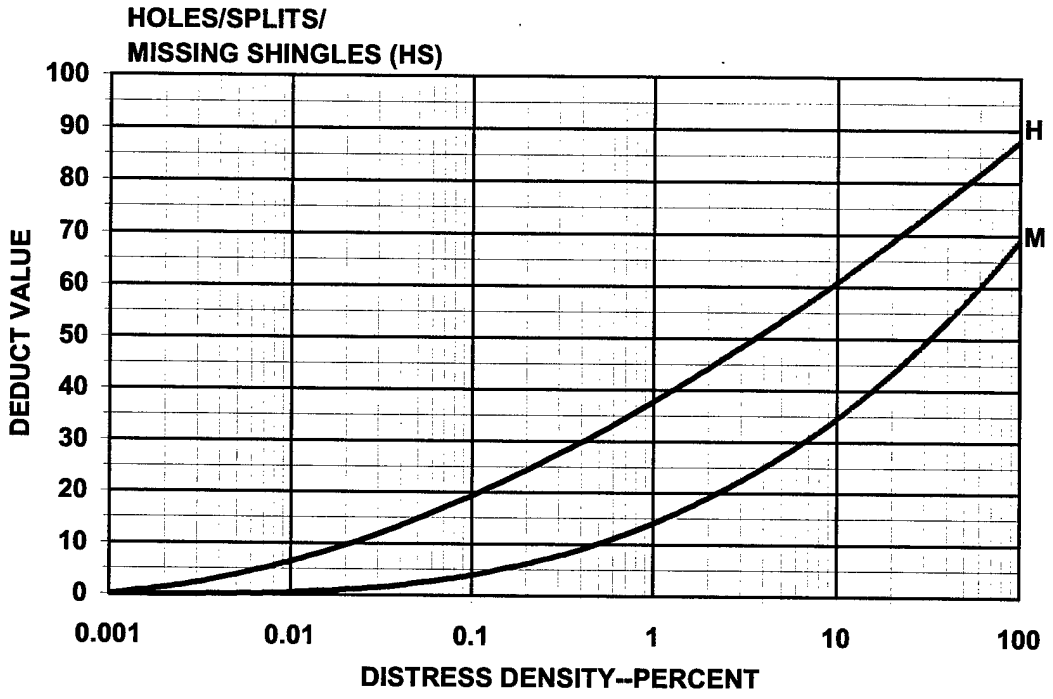

PITCH PANS (PP)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT
H
M

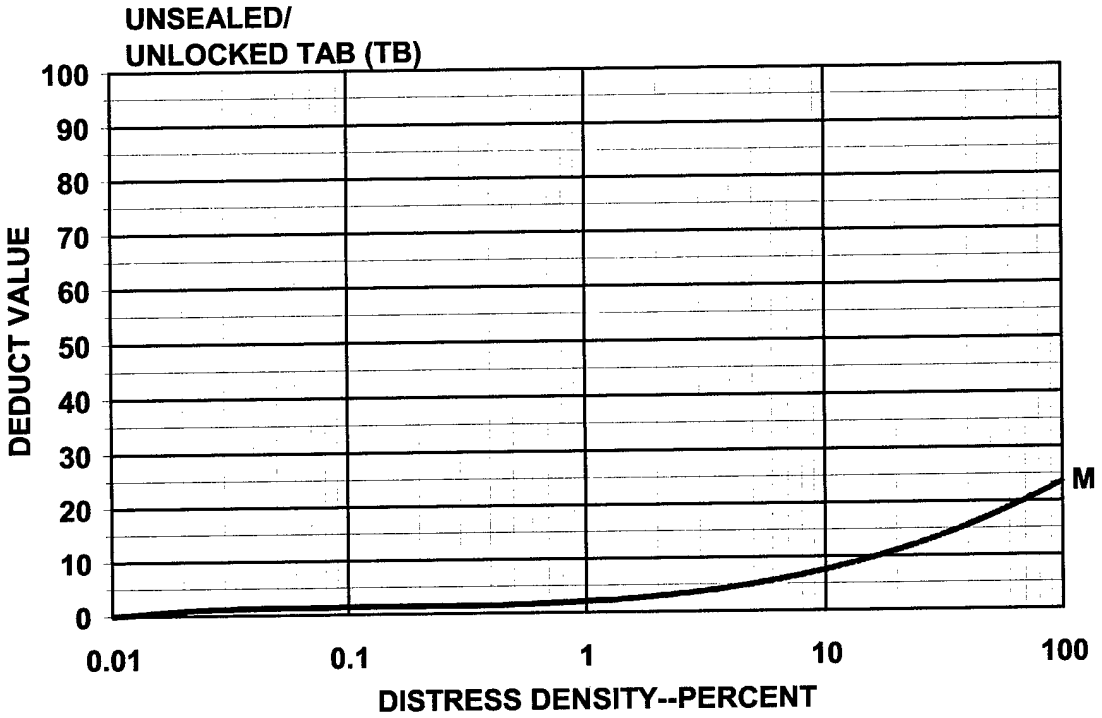


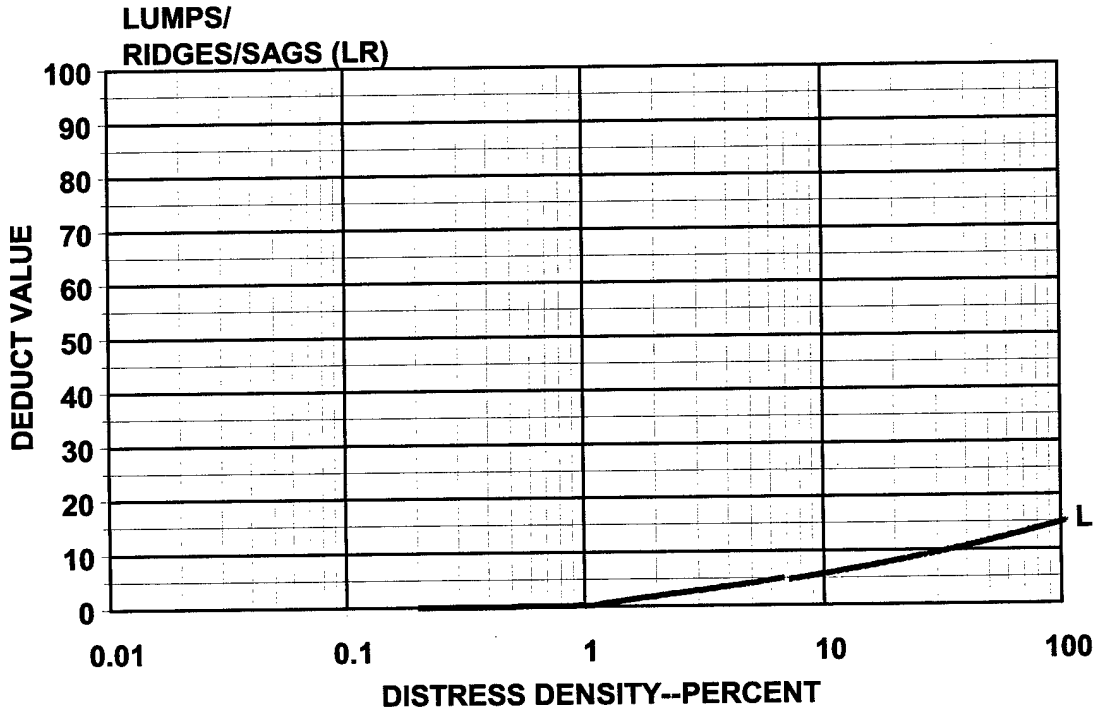
Corrected Deduct Values for Flashing.

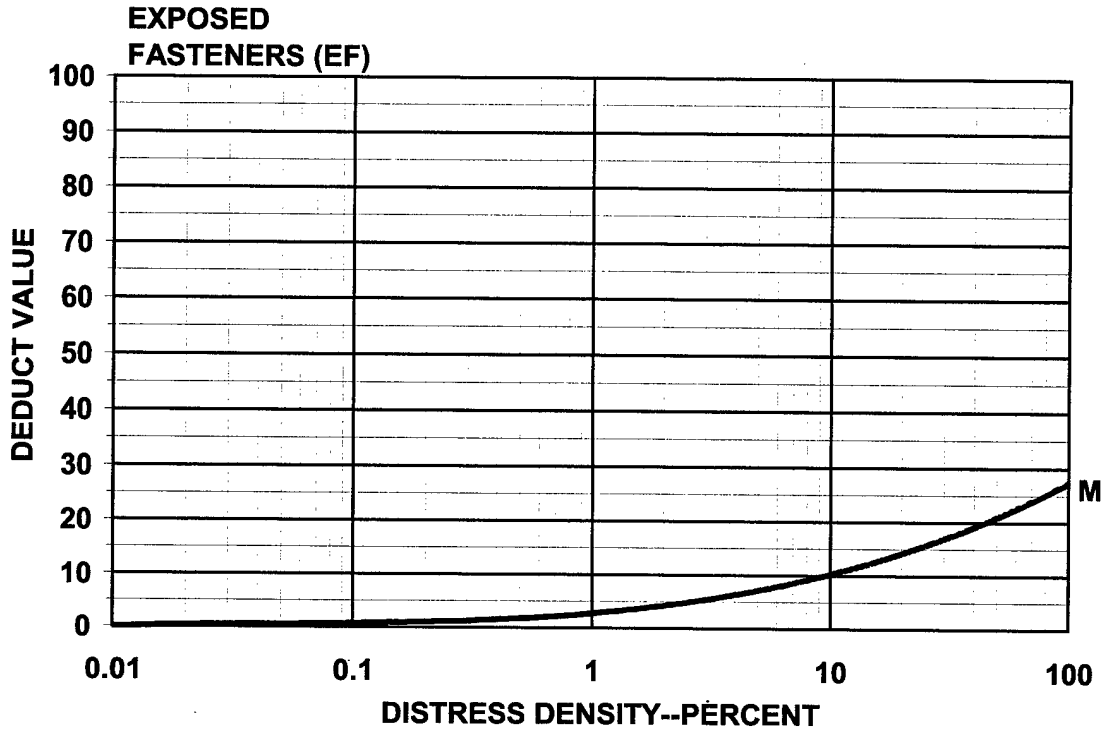


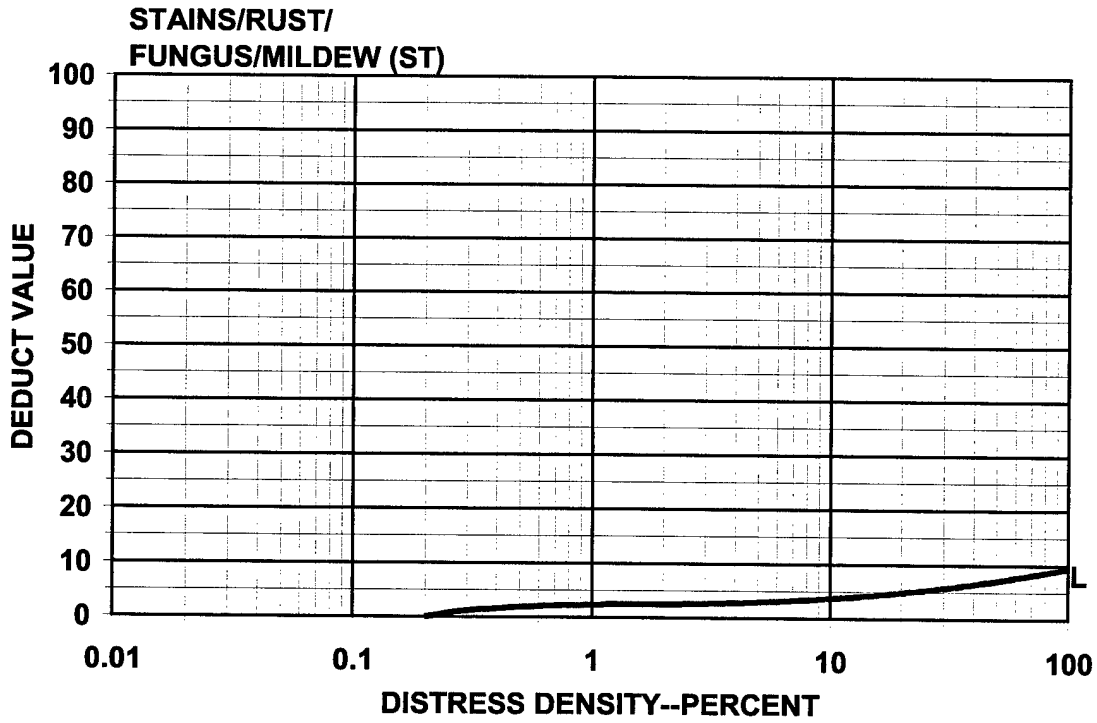

AGE
DETERIORATION (AD)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

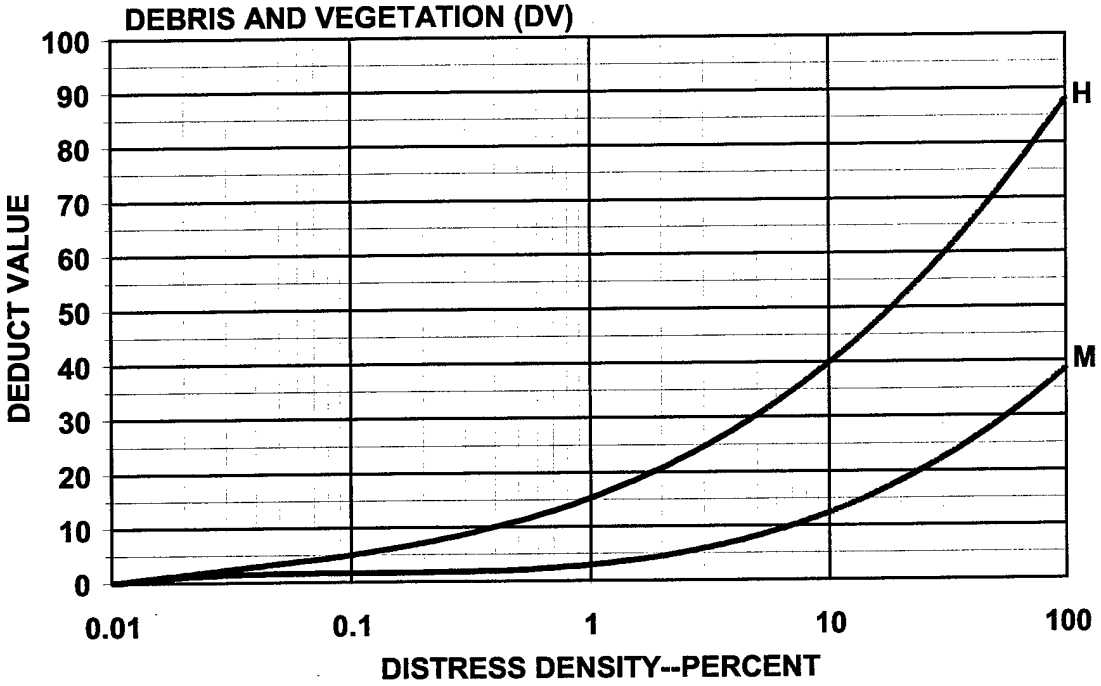

HOLES/SPLITS/
MISSING SHINGLES (HS)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
0.001
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

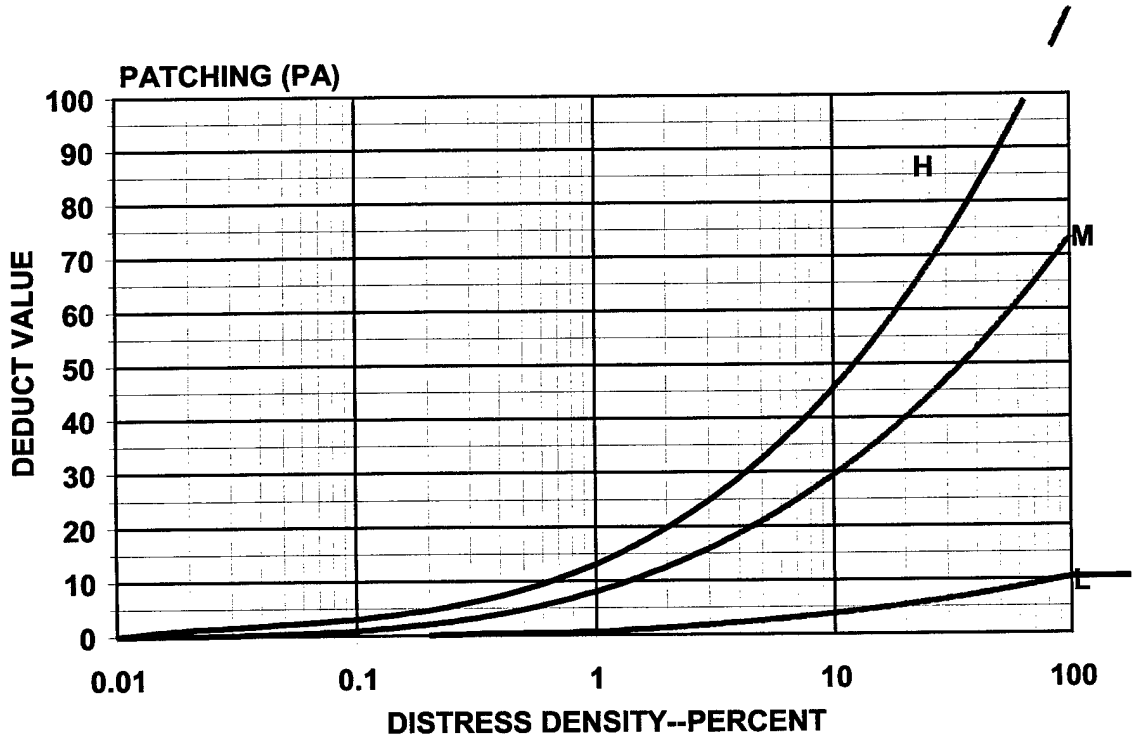

UNSEALED/
UNLOCKED TAB (TB)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
M
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

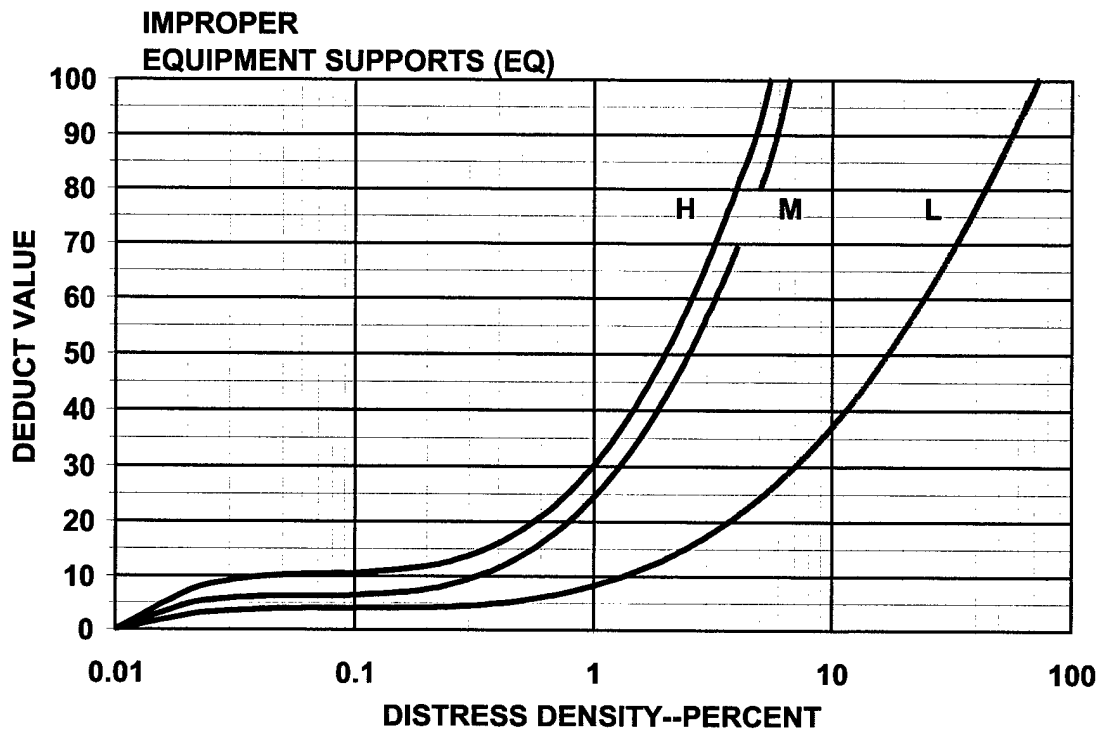

LUMPS/
RIDGES/SAGS (LR)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT


EXPOSED
FASTENERS (EF)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
M
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT

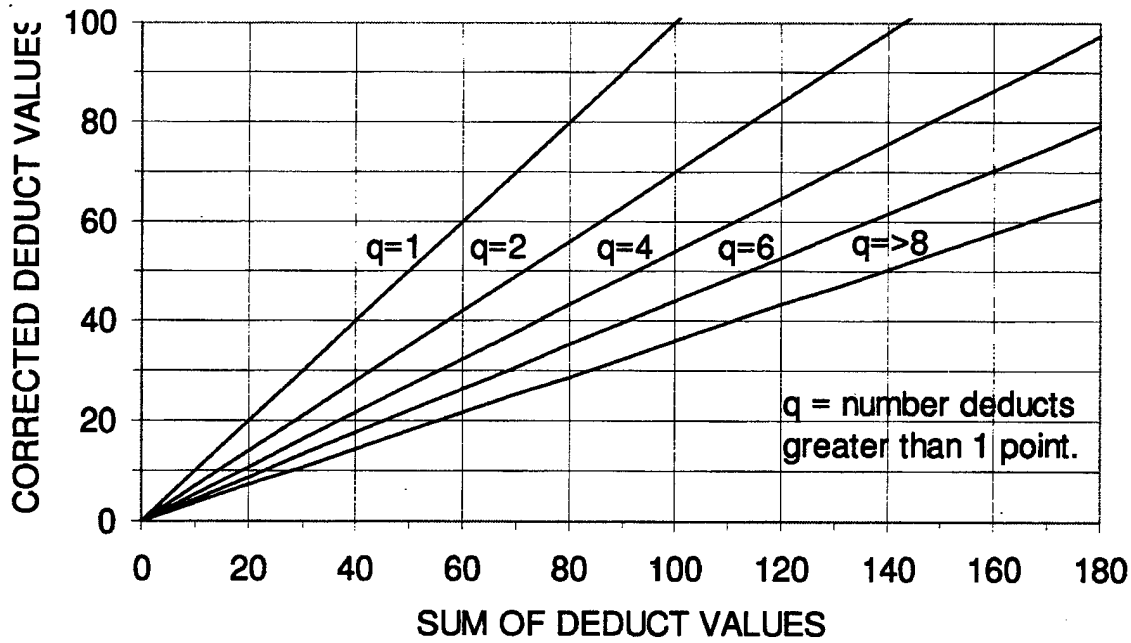

STAINS/RUST/
FUNGUS/MILDEW (ST)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT


DEBRIS AND VEGETATION (DV)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT


PATCHING (PA)
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY--PERCENT



Corrected Deduct Values for Shingle.



Appendix B: Field Measurement Method

This estimation procedure is reprinted courtesy of the Asphalt Roofing Manufacturers Association.

Estimating How Much Roofing is Required

Chapter V

Estimating How Much Roofing is Required

Various types of asphalt roofing materials and accessories are required to complete a typical roofing job, including shingles or roll roofing, underlayment, starter strips, drip edges, valley flashings and hip and ridge shingles. Before the job begins, estimates of the required quantities of each material, based on calculations derived from the dimensions of the roof, must be made.

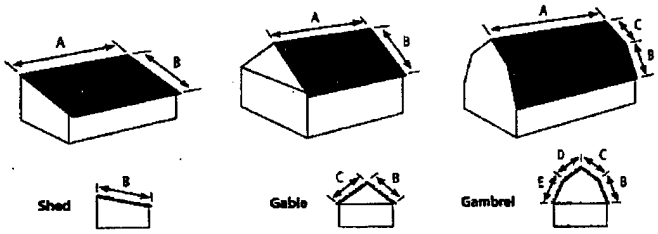
Fairly simple calculations are all that are required. Certain measurement and calculation methods also may be used that simplify the process even further. These are described in the following sections along with suggestions on how to take measurements without getting onto the roof.

Estimating Area (Simple Roofs)

Roofs come in a variety of shapes and styles but virtually every kind of roof is comprised of plane surfaces that can be subdivided into simple geometric shapes — squares, rectangles, trapezoids and triangles. Thus, roofing area calculations simplify to area calculations for these basic shapes.

The simplest type of roof is one without any projecting dormers or intersecting wings. Each of the illustrated roofs is comprised of one or more rectangles. (See Figure 13.) The area of the entire roof in each case is the sum of the areas of each rectangle.

Figure 13
Examples of simple roofs



For the shed roof which has only one rectangle, the area is found by simply multiplying the rake line by the eaves line, or B x A. The gable roof is comprised of two rectangular planes and its area is found by multiplying the sum of the rake lines by the eaves line,

Estimating Area (Simple Roofs)

(continued)

or A(B + C). For the gambrel roof, four rake lines are involved and the total area calculation is found by multiplying the sum of the rake lines by the eaves line, or A(B + C + D + E).

Estimating Area (Complex Roofs)

The more complex roofs include those with intersecting wings or dormer projections through the various roof planes. Area calculations for these roofs use the same basic approach taken for simple roofs but involve a number of subdivisions of the roof surface that are calculated separately, then added together to obtain the total roof area.

If plans of the building are available, use them to obtain the required roof dimensions from which area calculations can be made. Otherwise, direct measurements may have to be taken on the roof.

However, another alternative exists that enables the estimator to indirectly measure the areas. It involves calculating the projected horizontal areas of the roof, then combining these areas with the roof slope or slopes to obtain the true areas. Both the roof slope and the horizontal projection of the various roof surfaces are determined directly as described in this chapter. Tables are also included in the following sections for converting the indirect measurements and calculations to actual lengths and actual roof areas.

Ⓐ Roof Pitch and Slope

The degree of incline a roof possesses is usually expressed as its "pitch" or "slope." Pitch is the ratio of the rise of the roof to the span of the roof. (See Figure 14.) Slope is the ratio of rise in inches to horizontal run in feet (run equals half the span). For example, if the span of a roof is 24' and the rise is 8', the pitch is 8/24 or 1/3. Expressed as a slope, the same roof is said to rise 8" per foot of horizontal run [Slope (inches per foot) = Rise (in inches) ÷ Run (in feet)]. If the rise of the same roof span were 6', the pitch would be 1/4 and its slope would be 6" per foot of run. Whether a particular roof incline is expressed in pitch or slope, the results of area calculations will be the same.

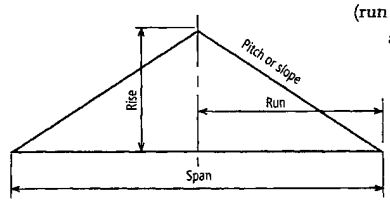


Figure 14
Pitch and slope relationships

It is not necessary to go onto a roof to measure pitch or slope. It can be closely approximated from the ground with the aid of a pitch card (available from many manufacturers) or a carpenter's folding rule as follows: Stand away from the building and form the rule into a triangle with the 6" joint at the apex and the 12" joint at one side of the horizontal base line. Holding the rule at arm's length, line up the sides of the

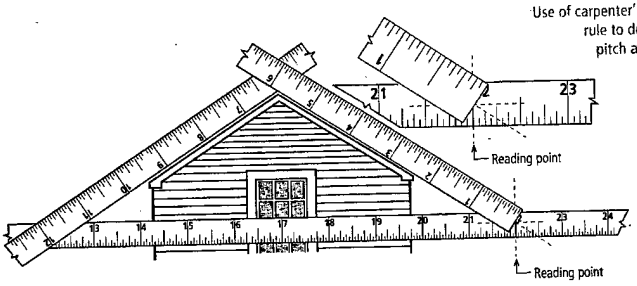
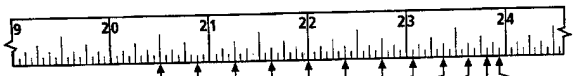


Figure 15
Use of carpenter's folding rule to determine pitch and slope

triangle with the roof as shown in Figure 15, being sure to keep the base of the triangle horizontal. Then, with the zero point of the rule aligned with the center of the base, read the intersection of the zero point with the base. In the example shown in Figure 15, this occurs at the 22" mark. Next, locate the "rule reading" in Figure 16 nearest to the one read in the field and directly under it read the pitch and slope of the roof. For the example, the pitch is read as ⅓, the slope as 8" per foot.

Figure 16
Reading point conversions to pitch and slope



Rule reading	20 1/2	20 7/8	21 1/4	21 5/8	22	22 3/8	22 3/4	23 1/6	23 3/8	23 5/8	23 13/16	23 15/16
Pitch (fraction)	1/2	11/24	5/12	3/8	1/3	7/24	1/4	5/24	1/6	1/8	1/12	1/24
Slope (inches per foot)	12	11	10	9	8	7	6	5	4	3	2	1

Ⓑ Projected Horizontal Area

No matter how complicated a roof may be, its projection onto a horizontal plane will easily define the total horizontal surface the roof covers. Figure 17 illustrates a typical roof complicated by valleys, dormers and ridges at different elevations. The lower half of the figure shows the projection of the roof onto a horizontal plane. In the projection, inclined surfaces appear flat and intersecting surfaces appear as lines.

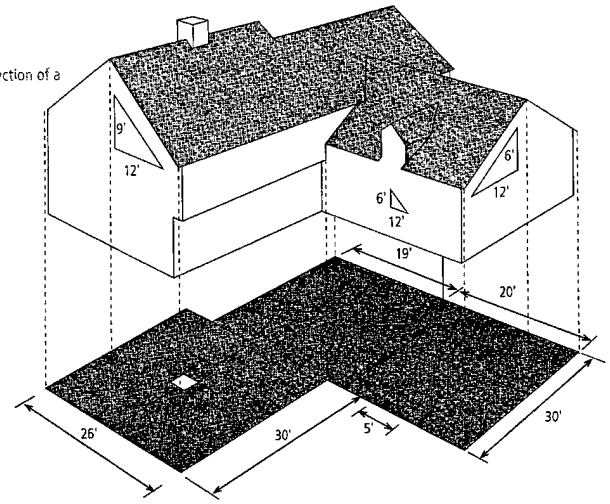
Measurements for the horizontal projection of the roof can be made from the plans, from the ground or from inside the attic. Once the measurements are made, the horizontal area covered by the roof can be drawn to scale and calculated. Sample calculations for the roof in Figure 17, using the dimensions and slopes indicated, appear on the following page.

Because the actual area is a function of the slope, calculations must be grouped in terms of roof slope and those of different slopes are not combined until the true roof areas have been determined.

Estimating Area (Complex Roofs)

(continued)

Figure 17
Horizontal projection of a complex roof



① Calculate the horizontal area under the *9" slope* roof.

② From this gross figure, deductions must be made for the area of the chimney and for the triangular area of the ell roof that overlaps and is sloped differently from the main roof:

③ Calculate the net projected area of the main roof.

④ Calculate the horizontal area under the *6" slope* roof:

① **Calculation for Horizontal Area Under a 9" Slope Roof**

(26 x 30) = 780	
+ (19 x 30) = 570	
Total	= 1350 ft.²

② **Calculation for Deduction of Differently Sloped Areas**

4 x 4 = 16 ⓐ	
+ (16 x 5) ÷ 2 = 40 ⓑ	
Total	= 56 ft.²

ⓐ Chimney Area
ⓑ Ell roof (triangular area)

③ **Calculation for Net Projected Area of Main Roof**

1,350 ft.² – 56 ft.² = 1,294 ft.²

④ **Calculation for Horizontal Area Under 6" Slope Roof**

20 x 30 = 600	
+ (16 x 5) ÷ 2 = 40	
Total	= 640 ft.²

Ⓒ Duplications

Portions of higher roof surfaces often project over roof surfaces below them but the horizontal projections do not show the overlap. Such duplicated areas should be added to the total horizontal area. Thus, one final correction must be made to account for these overlapped or duplicated areas before the total projected horizontal area is obtained.

In the example, there is an overlap: ① on the 6" slope roof where the dormer eaves overhang the ell roof; ② on the 9" slope roof where the main roof eaves overhang the ell section; and ③ where the main roof eaves overhang the smaller section of the main roof in the rear of the building. In each case, if the eaves extend 4" beyond the structure, the duplication calculations are:

① Two eaves overhangs:
$2(5 \times 4/12) = 3\frac{1}{3}$ ft.^{2}

② Two eaves overhangs:
$2(7 \times 4/12) = 4\frac{2}{3}$ ft.^{2}

③ Overhang covers only half of the 19' wide section:
$9.5 \times 4/12 = 3\frac{1}{16}$ ft.^{2}

Item ① should be added to the area of the 6" slope roof and items ② and ③ to the 9" slope roof. Thus, for the 6" slope roof, the adjusted total is 640 + 3 = 643 ft.^{2} and for the 9" slope roof, 1,294 + 8 = 1,302 ft.^{2} (fractions are rounded off to the nearest foot).

Ⓓ Conversion to Actual Area

Now that the total projected horizontal areas for each roof slope have been calculated, the results can be converted to actual areas with the aid of Table 3. (To calculate the Actual Area, multiply the Horizontal Area by the Area/Rake Factor.)

① For the *9" slope* roof:
1,302 ft.^{2} x 1.250 = 1,627.5 ft.^{2}

② For the *6" slope* roof:
643 ft.^{2} x 1.118 = 718.8 ft.^{2}

After the horizontal areas have been converted to actual areas, the results can be added to obtain the total area of roof to be covered:

1,628 ft.^{2} + 719 ft.^{2} = 2,347 ft.^{2}

Table 3: Area/Rake Conversion*

Slope (inches per foot)	Area/Rake Factor
4	1.054
5	1.083
6	1.118
7	1.157
8	1.202
9	1.250
10	1.302
11	1.356
12	1.414

*To use the table, simply multiply the projected horizontal area by the conversion factor for the appropriate roof slope. The result is the actual area of the roof.

Appendix C: Samples of Roof Inspection Sheets

BUILDING IDENTIFICATION SHEET	AGENCY / INST. NO.:
DATE: ____/____/_____	AGENCY / INST.:
BUILDING NAME:	
BUILDING NUMBER:	DESIGN CATEGORY CODE:
TYPE CONST.:	FACILITY NUMBER:
LOCATION:	
USE:	YEAR BUILT: _____

ROOF SECTIONS:

A	_____SF	F	_____SF	K	_____SF	P	_____SF
B	_____SF	G	_____SF	L	_____SF	Q	_____SF
C	_____SF	H	_____SF	M	_____SF	R	_____SF
D	_____SF	I	_____SF	N	_____SF	S	_____SF
E	_____SF	J	_____SF	O	_____SF	T	_____SF

REMARKS:

BUILDING ROOF PLAN SCALE:

ROOF SECTION IDENTIFICATION			AGENCY/INST.:
DATE: ___/_____	BLDG NO:	SECTION ID:	AREA: _____SF
OCCUPANCY:	YEAR ORIG. CONST.:	YEAR LAST REPLACED:	

10 GENERAL

11 TYPE:

12 PERIMETER:

PARAPET	____LF	FIREWALL	____LF	RIDGE	____LF
ROOF EDGE	____LF	HIP	____LF	OTHER	____LF
ADJACENT WALL	____LF	VALLEY	____LF		

13 ACCESS:

20 STRUCTURAL FRAME

21 TYPE:

30 ROOF DECK

31 STRUCTURAL DECK:

32 ATTACHMENT SURFACE:	33 SLOPE: _____ IN 12	34 DRAINAGE:

40 UNDERLAYMENT

41 TYPE:

50 ROOF COVERING

51 TYPE:

52 SHINGLE REINFORCEMENT:

53 ATTACHMENT:

60 FLASHINGS

61 TYPES:	62 ACCESSORIES:	63 OVERLAY: Y/N ____ # OF LAYERS

70 REMARKS:

ROOF SECTION IDENTIFICATION WORKSHEET			AGENCY/INST.:
DATE: ___/_____	BLDG. NO.:	SECTION ID:	AREA: _____SF
OCCUPANCY:	YEAR ORIG. CONST.: _____		YEAR LAST REPLACED: _____

10 GENERAL

11 TYPE (check all):

__ GABLE
__ HIP
__ GAMBREL
__ SHED
__ DOME
__ BARREL
__ OTHER

12 PERIMETER (check all):

PARAPET _____LF
ROOF EDGE _____LF
ADJACENT WALL _____LF
FIREWALL _____LF
HIP _____LF
VALLEY _____LF
RIDGE _____LF
OTHER _____LF

13 ACCESS (check one):

INTERNAL LADDER
__ Permanent
__ Temporary

EXTERNAL LADDER
__ Permanent
__ Temporary

__ PENTHOUSE
__ ACCESSED FROM ADJ. SECTION (Sec.ID___)
__ OTHER

20 STRUCTURAL FRAME

21 TYPE (check one):

STEEL
__ Beams,Girders,Cols.
__ Long Sp Deck, Beams
__ Trusses
__ Bar Joists with Beams & Cols.
__ Bar Joists with Bearing Walls
__ Bar Joists with Combination

CONCRETE
__ Beams
__ Flat Slab

WOOD
__ Laminated Beams
__ Trusses
__ Joists
__ Panels

SPECIAL
__ Dome
__ Space Frame
__ OTHER
__ UNKNOWN

30 ROOF DECK

31 STRUCTURAL DECK (check one):

NONCOMBUSTIBLE

__ STEEL
__ CONCRETE, LWT. PRECAST

CONCRETE, STD
__ Precast
__ Cast-in-Place

CEMENT FIBER
__ Bulb-Tees
__ Clipped

__ GYPSUM, PRECAST

COMBUSTIBLE

__ WOOD BOARDS
__ PLYWOOD
__ WOOD FIBER
__ OTHER
__ UNKNOWN

32 ATTACHMENT SURFACE (if applicable):

__ WOOD FIBER
__ PLYWOOD
__ WOOD BOARDS
__ WOOD BATTENS
__ METAL PURLINS
__ OTHER
__ UNKNOWN

33 SLOPE (primary): _____ IN 12

34 DRAINAGE (check all):

__ INTERIOR DRAINS
__ INTERIOR GUTTERS
__ GUTTERS & DOWNSPOUTS
__ SCUPPERS
__ ADJACENT ROOF SECTIONS
__ SCUPPERS W/LEADER & DOWNSPOUTS
__ OVERFLOW SCUPPERS
__ ROOF EDGE
__ OTHER

40 UNDERLAYMENT

41 TYPE(check all):

__ FULLY-ADHERED ICE & WATER MAT
__ ASPHALT SATURATED SHEET
__ OTHER
__ UNKNOWN
__ NONE

50 ROOF COVERING

51 TYPE (check one):

ASPHALT SHINGLE
__ Three-Tab
__ Multi-Tab
__ Strip (no cutout)
__ Laminated
__ Lock-Down
__ Foil-Faced

__ ASPHALT ROLLED

SYNTHETIC ROOFING
__ Plastic
__ Wood Fiber
__ Metal Shingles
__ Fiber Cement

__ WOOD SHAKES

__ WOOD SHINGLES

__ SLATE

__ METAL PANEL

CONCRETE TILE
__ Pan and Cover
__ S-Shaped
__ Flat

CLAY TILE
__ Pan and Cover
__ S-Shaped
__ Flat

__ OTHER

52 SHINGLE REINFORCEMENT (for Asphalt Shingle only)(check one):

__ ORGANIC
__ FIBROUS GLASS
__ OTHER
__ UNKNOWN

53 ATTACHMENT (check one):

__ NAILS
__ STAPLES
__ FASTENER AND TIE
__ WIRE CLIPS
__ LOOSE-LAID (Tile)
__ SCREW (Tile)
__ MORTAR (Tile)
__ ADHESIVE-HOT
__ ADHESIVE-COLD
__ OTHER
__ UNKNOWN

60 FLASHINGS

61 TYPES (check all):

VALLEY
__ Open
__ Closed
__ Woven
__ STEP
__ APRON
__ CHANNEL (TILE)
__ FLASHED PENETRATIONS
__ PITCH PANS
__ EDGE METAL
__ OTHER

62 ACCESSORIES (check all):

__ SNOW GUARDS
__ WALKWAYS

63 OVERLAY:

IS ROOF OVERLAYED ___(Y/N)
__ # OF LAYERS

70 REMARKS

ROOF INSPECTION WORKSHEET

AGENCY/INSTALLATION:

BUILDING _____ PERIMETER FLASHING _____ DATE _____

SECTION _____ OTHER FLASHINGS _____ NAME _____

SF -STEP FLASHING	MA -METAL APRON	AD -AGE DET.	EF -EXPOSED FAST.
MC -METAL CAP	FP -FLASHED PENET	HS -HOLE/MISSING SHINGLE	ST -STAINS/FUNGUS
EM -EDGE METAL	RV -RIDGE/HIP VENT		DV -DEBRIS & VEG.
VF -VALLEY FLASHING	PP -PITCH PAN	TB -UNSEALED TABS	PA -PATCHING
RH -RIDGE/H SHINGLE	IG -INT. GUTTER	LR -LUMPS/RIDGES	EQ -EQUIP SUPPORTS

ID #	DISTRESS	SEVERITY	DEFECT	QUANTITY

NORTH

SCALE: _____

16 ROOF SECTION RATING FORM

BUILDING ________	SECTION ________	DATE ________	CALC. BY
PER. FLASHING ________FT OTHER FLASHING ________FT	FLASHING TOTAL ________FT	AREA ________SQ FT	CHKD. BY

FLASHING

DISTRESS TYPES

SF -STEP FLASHING
MC -METAL CAP
EM -EDGE METAL
VF -VALLEY FLASHING
RH -RIDGE/H SHINGLE
MA -METAL APRON
FP-FLASHED PENETRATION
RV -RIDGE/HIP VENT
PP -PITCH PAN
IG -INTERIOR GUTTER

DIS	SEV	QUANTITIES	TOT	DEN	DV

CORRECTED DEDUCT VALUE (CDV) ________

FCI = 100 - CDV = ________

FLASHING RATING ________

SHINGLE

DISTRESS TYPES

AD-AGE DETERIORATION
HS-HOLE/MISS SHINGLE
TB -UNSEALED TAB
LR -LUMPS/RIDGES
EF-EXPOSED FASTENERS
ST -STAINS/FUNGUS
DV -DEBRIS & VEG.
PA -PATCHING
EQ -EQUIP SUPPORTS

DIS	SEV	QUANTITIES	TOT	DEN	DV

CORRECTED DEDUCT VALUE (CDV) ________

SCI = 100 - CDV = ________

SHINGLE RATING ________

RCI CALCULATION SHEET	AGENCY/INST.:		
DATE: ___/___/_____	BLDG NO:	SECTION ID:	AREA: _____SF

ROOF SECTION WITH STEEP ROOFING

	VALUE	LOWEST	OTHER
SCI			
FCI			
		X 0.70	X 0.30
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13. ABSTRACT *(Maximum 200 words)*

This report gives instructions for using ROOFER procedures for establishing a steep roofing inventory and evaluating the condition of asphalt shingle roofs. ROOFER is an engineered management system designed to help facility managers more efficiently manage their roofing assets and make the best use of roof maintenance and repair dollars.

This document includes the standardized information the user needs to divide steep roofs into manageable sections and collect and maintain inventory information. Visual inspection survey procedures, which include distress descriptions, severity levels, measurement criteria and photographs of shingle and flashing distresses, are presented. Procedures for distress density calculations are also provided. Roof inspectors can use this information to objectively determine condition indexes that reflect (1) the ability of the shingles and flashings to perform their function, (2) needed level of repair, and (3) waterproof integrity.

14. SUBJECT TERMS
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