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Roofing Maintenance Management System

US Army Corps
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ROOFER: Membrane and Flashing Condition Indexes for Single-Ply Membrane Roofs–Inspection and Distress Manual

by
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Because no procedures exist to inspect and evaluate the condition of single-ply membrane roofing systems within the ROOFER program, the U.S. Army Construction Engineering Research Laboratories (USACERL) has developed this inspection and distress manual for these roofing systems. Included is the standardized information needed to conduct the visual inspection survey, including names, descriptions, severity levels, measurement criteria, causes and photographs of membrane and flashing distresses. Procedures for distress density calculations are also provided. Roof inspectors can use this information to objectively determine the indexes that reflect the (1) ability of the membrane and flashing to perform their functions, (2) needed level of maintenance, and (3) waterproof integrity.

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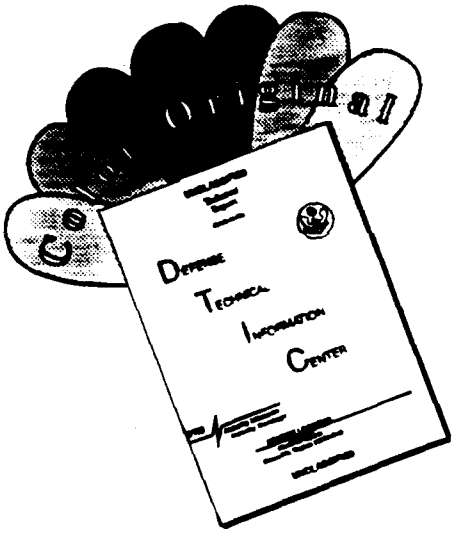

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Because no procedures exist to inspect and evaluate the condition of single-ply membrane roofing systems within the ROOFER program, the U.S. Army Construction Engineering Research Laboratories (USACERL) has developed this inspection and distress manual for these roofing systems. Included is the standardized information needed to conduct the visual inspection survey, including names, descriptions, severity levels, measurement criteria, causes and photographs of membrane and flashing distresses. Procedures for distress density calculations are also provided. Roof inspectors can use this information to objectively determine the indexes that reflect the (1) ability of the membrane and flashing to perform their functions, (2) needed level of maintenance, and (3) waterproof integrity.

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FOREWORD

This research was conducted for the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE) under Project 4A162784AT41, "Military Facilities Engineering Technology"; Task MB; Work Unit D92, "Roofing Maintenance Management System." The technical monitor was Al Knehans, CEHSC-FB-S.

The work was performed by the Engineering and Materials Division (FM), of the Infrastructure Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). David M. Bailey is the principal investigator. Dr. Paul Howdyshell is Chief, CECER-FM and Dr. Michael J. O'Connor is Chief, CECER-FL. The USACERL technical editor was Gloria J. Wienke, Information Management Office.

Donald E. Brotherson is Director of the Building Research Council, University of Illinois. Wayne Tobiasson is a Research Civil Engineer in the Experimental Engineering Division at the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL).

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COL Daniel Waldo, Jr., is Commander and Director of USACERL and Dr. L.R. Shaffer is Technical Director.

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1 INTRODUCTION

Background

The U.S. Army has over 300 million square feet* of low-slope roofing, the largest portion of this being bituminous built-up membranes. Army installations spend a large portion of their infrastructure maintenance dollars repairing and replacing these low-slope roofs. Historically, Army Directorates of Engineering and Housing (DEHs), 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 Laboratories (USACERL), with the assistance of the U.S Army Cold Regions Research and Engineering Laboratory (USACRREL) and the U.S. Army Engineering and Housing Support Center (USAEHSC), developed ROOFER, an Engineered Management System initially for bituminous built-up roofs (Bailey et al. 1989; Bailey, Brotherson, and Tobiasson 1989). The ROOFER procedures with a microcomputer application (Bailey et al. 1990) provide building managers with a decision support toc. for assessing roof condition, selecting repair strategies, and establishing planning and budgeting needs for accomplishing this work.

Since the early 1980s, the amount of single-ply membranes being used for roofing at Army installations has been steadily increasing. DEHs, Directorates of Public Works (DPWs), and other building managers need to be able to use the ROOFER program to evaluate single-ply roofing systems.

Objective

The objective of this work was to develop condition index procedures based on visual inspection of the flashing and membrane components of single-ply roofs as part of the program to extend ROOFER to other types of roofing systems. This report provides roof inspectors with a standard reference for conducting inspections and calculating the membrane condition index (MCI) and flashing condition index (FCI).

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 elsewhere (Shahin, Bailey, and Brotherson 1987b) provide the basis for this work. The same developmental process involving a rating team of experts and field tests at six sites (military and nonmilitary) was used for this effort.

*A metric conversion table is on page 80.

Single-ply flashing distresses are categorized by flashing type, as was done for BUR. Some single-ply membrane distresses are comparable to BUR distresses. For these similar flashing and membrane distresses, the corresponding BUR deduct value curves were determined by field ratings to be valid for single-ply roofing. Several distresses, different from those encountered by BUR, were identified for the single-ply membrane component. For those distresses, new defects were defined and deduct value curves were developed, field tested, and verified.

Using the Manual

Chapter 2 contains the inspection procedures. Distresses for flashings and membranes are presented in Chapters 3 and 4, respectively. These two chapters include descriptions of distresses, severity levels, defect definitions, photographs, measurement criteria, and causes. 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 2 to determine the MCI and FCI and their respective ratings (Figure 1). Deduct Value Curves are in Appendix A and samples of roof inspection sheets are in Appendix B. These membrane and flashing component condition indexes, combined with an insulation condition index (ICI) for insulated roofs, are used to determine a roof condition index (RCI) and provide an overall assessment of a roof. The methods for calculating the single-ply ICI and combining it with the MCI and FCI are the same as for BUR and are documented in USACERL Technical Report M-90/04, *ROOFER: An Engineered Management System for Bituminous Built-Up Roofs*.

Mode of Technology Transfer

This report serves as the ROOFER inspection manual for single-ply roofs. The capabilities for performing automated calculations and storing collected information will be incorporated into the Micro ROOFER software program. USAEHSC is the support agency that has the responsibility for assisting in implementing the ROOFER program at Army installations.

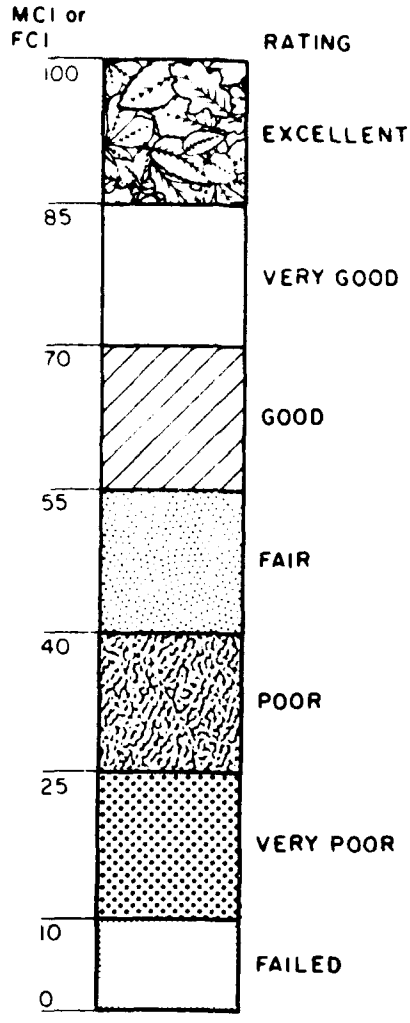


Figure 1. Membrane and Flashing Condition Indexes (MCI and FCI) and Ratings.

2 PROCEDURES FOR ROOF INSPECTION AND CALCULATION OF INDEXES

As defined by the concepts and theories in previous RCI research reports (Shahin, Bailey, and Brotherson 1987a, 1987b), the condition indexes reflect the (1) ability of the membrane and flashing to perform their functions, (2) needed level of maintenance and, (3) waterproof integrity. Determining the MCI and FCI requires measurement of all existing membrane and flashing distresses. A thorough visual inspection must be conducted to determine the distress type, severity, and amount of each defect present. A distress type (e.g., defective seams) may have several different defects (e.g., missing lap sealant, wrinkled seam) for a given severity level. The inspection must be carefully organized and planned to provide the necessary information for determining the membrane and flashing conditions.

This chapter presents the overall process for visually inspecting single-ply membrane roofs and computing membrane and flashing condition indexes as shown in Figure 2.

Roof Sections

The inspector should divide each building's roof into sections and rate each section independently to determine maintenance, repair, and replacement (MRR) needs. 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. Also it may be possible to replace only those sections that are not performing well.

Roof sections are assigned letter designations (A,B,C, and so on) and are generally delineated by:

- perimeter details such as firewalls, expansion joints, or area dividers,
- different roof levels,
- areas having different roofing systems, different amounts of rooftop equipment, or significantly different conditions below the roof, or
- areas that were constructed at different times.

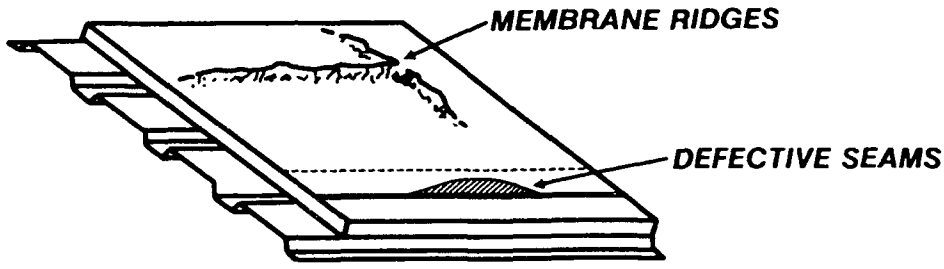
If a roof is physically divided into many small areas, it may be possible to combine several similar areas (e.g., canopies over entrances) into one section, provided the areas of similar age and construction. However, if areas have different structural systems or different environments below the roof, they should be treated as individual sections. Large areas without obvious delineations should be arbitrarily divided into areas of 25,000 to 40,000 sq ft.

Roof Plans

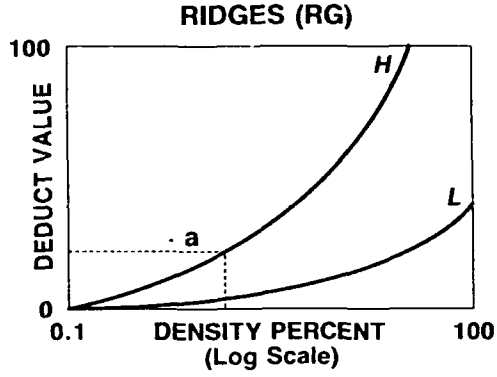
Each roof section should have a roof plan drawn to a scale that fits on the Roof Inspection Worksheet (Figure 3). A blank version of the worksheet is provided in Appendix B. The plan should show all physical roof features, including perimeter conditions (e.g., roof edge, expansion joint, parapet wall), rooftop equipment, projections through the roof, roof drains, walkways, sign supports, piping, and other features. The standard symbols shown in Figure 4 should be used to identify these items.

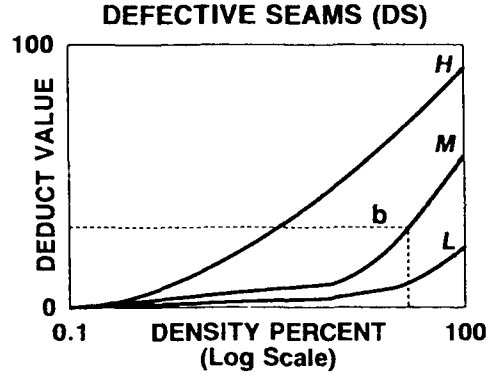
STEP 1: Divide Building Roof Into Sections and Develop Roof Plans.

STEP 2: Inspect Roof Section. Determine Distress Types, Severity Levels, and Defects & Measure Quantities.

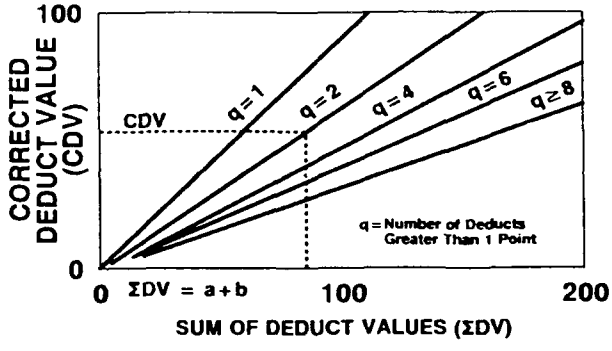


STEP 3: Determine Deduct Values.





STEP 4: Determine Corrected Deduct Values.



STEP 5: Compute Membrane and Flashing Condition Indexes.

STEP 6: Determine Membrane and Flashing Condition Ratings.

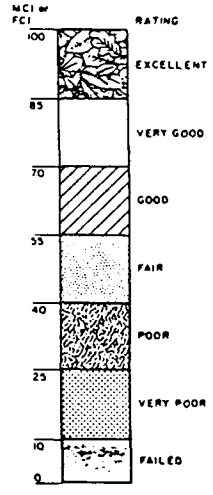


Figure 2. Six-Step Rating Procedure.

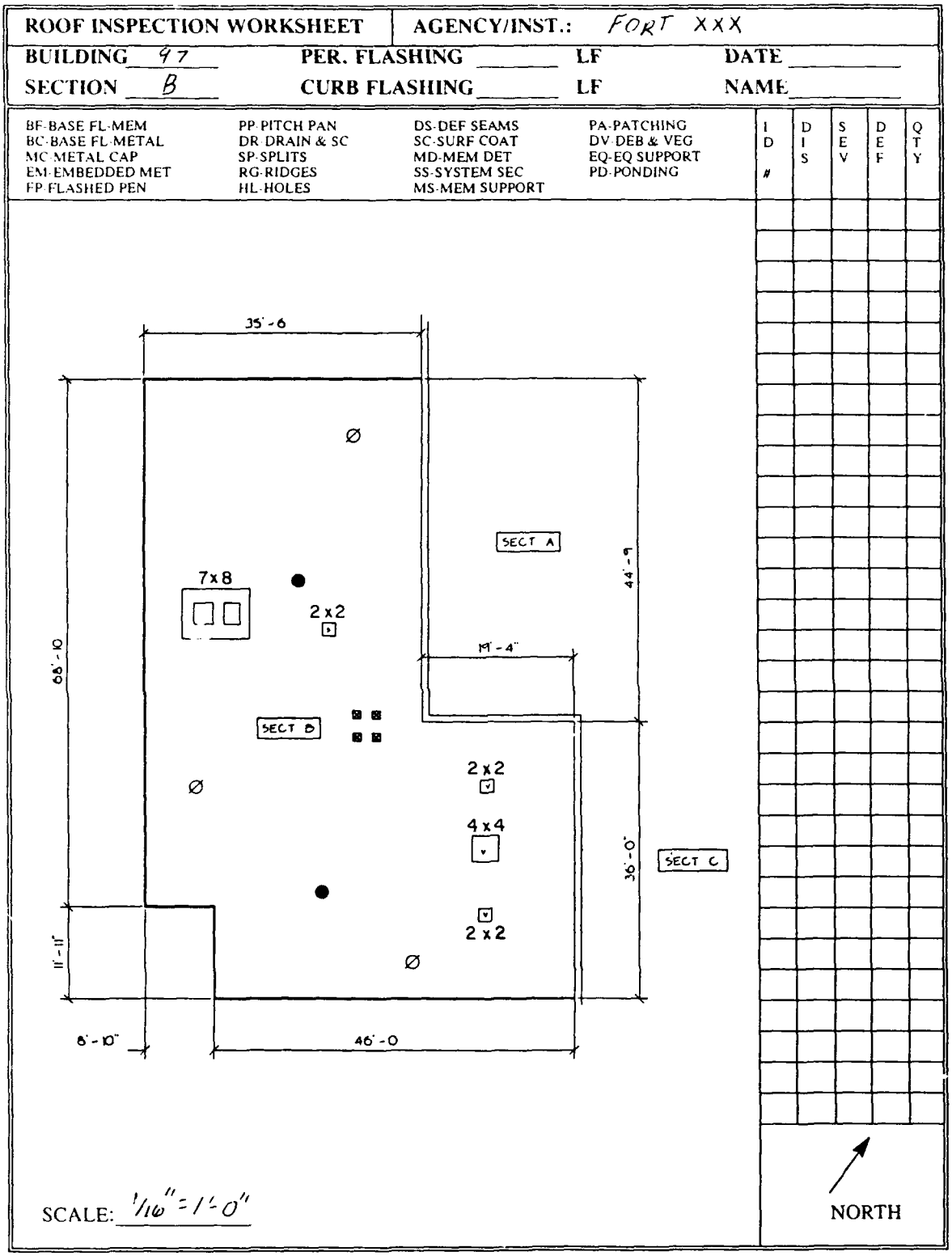


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Figure 3. Roof Inspection Worksheet Showing Example Roof Plan.

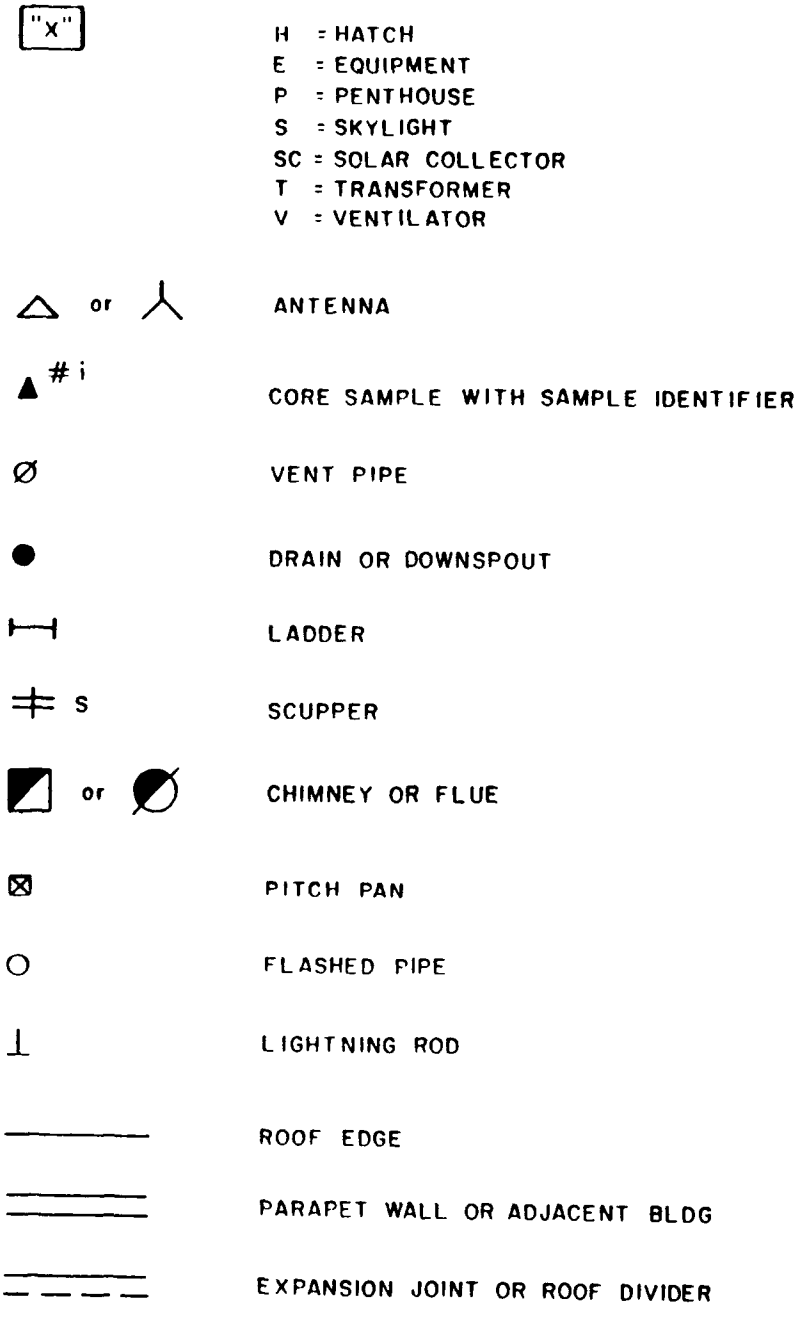


Figure 4. Standard Symbols for the Roof Section Plans.

Inspection Procedure

Survey Team

The roof inspection should be performed by a team of at least two people: an inspector and a recorder. The inspector surveys the roof, identifying distresses and determining appropriate severity levels, defects, and quantities. The recorder enters the data on the Roof Inspection Worksheet and assists in measuring distress quantities. The recorder also serves 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:

Inspection and Distress Manual (this document)
Pencil and clipboard
Single-ply Roof Inspection Worksheets
Small, 3-in. pointing trowel
Can of spray paint
Stiff bristle whisk broom
Pocket knife
Measuring tapes (12-ft and 100-ft recommended)
Large plastic bag (for collecting rooftop debris).

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. Once on the rooftop, the roof section plan should be developed (or verified, if a plan already exists). Before the survey begins, 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 (in lineal ft) in the appropriate space in the heading of the Roof Inspection Worksheet. Also determine and record on the worksheet the length of the base flashing on all curbed penetrations.

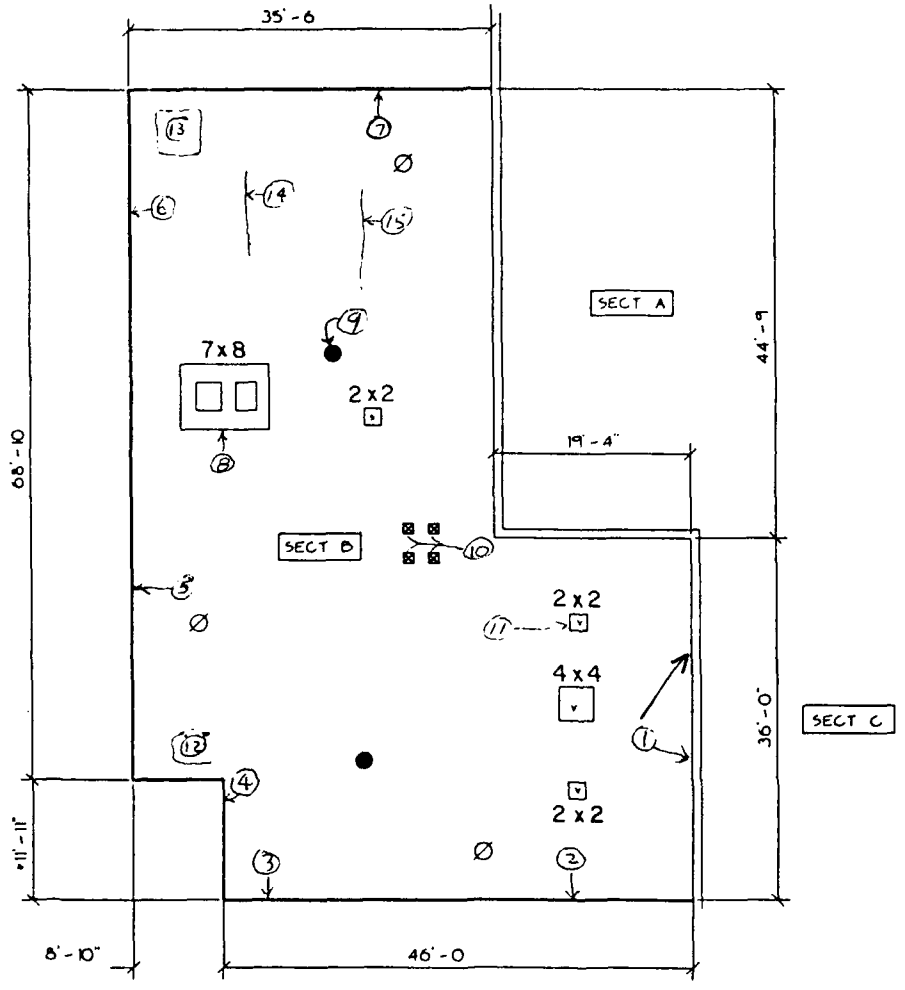
Distress Survey

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 its severity level, the specific defect present, and measure its quantity using the criteria defined in Chapters 3 and 4. Enter this information in the columns on the right side of the Roof Inspection Worksheet. Each distress encountered is assigned an identification number, starting with 1 (ID # in column 1) and numbering consecutively. Record the location of each distress on the roof plan using the identification number as shown in Figure 5. If, during the inspection, the Roof Inspection Worksheet becomes filled, continue recording on a second worksheet. (Appendix B contains an abbreviated list of identifiers for all the distresses/defects, which is designed to assist inspectors in rapidly identifying defects. A copy of the list can be attached to the bottom of a long [8 in. , 14 in.] clipboard, so it is exposed below the Roof Inspection Worksheet, as a ready reference during inspections.)

ROOF INSPECTION WORKSHEET	AGENCY/INST.: FORT XXX	
BUILDING 97	PER. FLASHING 271' LF	DATE 23 JULY 92
SECTION B	CURB FLASHING 70' LF	NAME B. MOORE

BF-BASE FL-MEM
BC-BASE FL-METAL
MC-METAL CAP
EM-EMBEDDED MET
FP-FLASHED PEN
PP-PITCH PAN
DR-DRAIN & SC
SP-SPLITS
RG-RIDGES
HL-HOLES
DS-DEF SEAMS
SC-SURF COAT
MD-MEM DET
SS-SYSTEM SEC
MS-MEM SUPPORT
PA-PATCHING
DV-DEB & VEG
EQ-EQ SUPPORT
PD-PONDING



ID #	DIS	SEV	DEF	QTY
1	BC	H	4	20
2	EM	H	1	1
3	EM	H	1	1
4	EM	M	2	1
5	EM	M	2	1
6	EM	H	2	1
7	EM	H	2	1
8	BF	M	2	2
9	DR	H	3	1
10	PP	L	1	4
11	MC	H	5'	1
12	PD	L	1	40
13	SS	H	1	50
14	DS	M	1	10
15	DS	H	2	15

SCALE: 1/16" = 1'-0"

NORTH

Figure 5. Completed Roof Inspection Worksheet.

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

1. Inspect the perimeter flashing. Establish a starting point at one corner of the roof section. Walk the perimeter, examining the base flashing, embedded edge metal flashing, and metal cap flashing. 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 curbed penetrations, flashed penetrations, pitch pans, drains, etc.

3. Inspect the roof membrane. 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 membrane.

Inspection Guidelines

Proper inspection requires surveying the entire roof section. However, if defects occur uniformly over a large area or if the roof is covered with ballast, use sampling procedures.

Representative Sampling Technique

When specific defects occur uniformly on a large area of the membrane or a long run of flashing, the following representative sampling technique can be used.

Select a portion of the roof (e.g., 1000 sq ft of membrane or 100 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 membrane 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 should be shown on the roof section plan.

Embedded Edge Metal Joints on Ballasted Roofs

As a method of sampling the embedded edge metal joints for ballasted systems, determine the number of joints by dividing the total length of embedded edge metal flashing by the length of the edge metal sections (often 10 ft). Move the gravel at every fourth joint to inspect for splits in the stripping material. Count the number of inspected joints having a specific defect and multiply by four to determine the total length of the defect. Replace ballast after completing inspection.

Defective Seams on Ballasted Roofs

For ballasted roofs, check field seams at five different locations on each roof section. Clear the ballast from a 5-ft length of the seam at each location and clean the exposed seam with a whisk broom. If all checked seams are without defects, assume the remaining field seams are satisfactory. If any defects are found, use the following sampling technique:

1. For roof sections with sheet widths of 10 ft or less, inspect 2 percent of the total length of field seams (2 ft every 100 ft of seam). For roof sections having sheet widths greater than 10 ft, inspect 4 percent of the total length of field seams (2 ft every 50 ft of seam). Measure length of each specific seam defect found.

2. Extrapolate to determine the total length of seam defects for the entire roof section from the total length of defect found. When 2 percent of the seams are inspected, multiply the actual

defect length by 50 to compute total length of defect. When 4 percent of the seams are inspected, multiply the actual defect length by 25 to compute the total length of defect.

3. Replace ballast after completing inspections.

General Guidelines

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

• When on the rooftop, be careful not to damage the roof. Do not step on unsupported flashing or membrane.

• If snow or a large area of ponding exist on the roof, postpone the inspection until the roof is clear.

• Wherever possible, measure lengths and areas to determine distress quantities. Estimating, instead of measuring, compromises the rating accuracy. Pacing to find lengths, or some other numerical estimating method, is preferable to "eyeball" estimates.

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

• Note existing problems that are not included in the lists of flashing and membrane distresses in Section C (Evaluation of Rooftop Conditions) or in Section D (Remarks) on the reverse side of the Roof Inspection Worksheet (Figure 6). A blank copy of this sheet is provided in Appendix B.

• 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 Section A (Evaluation of Interior Conditions) on the reverse side of the Roof Inspection Worksheet. Occupants can often provide valuable information.

• Walk the outside of the building and look for water stains, efflorescence, missing mortar, spalled brick, and gutter and drainage problems. Note any findings in Section B (Evaluation of Exterior Conditions) on the reverse side of the Roof Inspection Worksheet.

MCI and FCI Calculations

The MCI and FCI of a roof section are determined from the information recorded on the Roof Inspection Worksheet. The calculations are completed on the Roof Section Rating Form (Figure 7) using the following procedure. A blank copy of the Roof Section Rating Form is provided in Appendix B.

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 membrane distresses on the right. Total the quantities for each severity of each distress, calculate each density using the equations in Chapters 3 and 4, and determine deduct values (DV) from the Deduct Value Curves in Appendix A.

ROOF INSPECTION WORKSHEET - COMMENTS

INSTRUCTIONS: Circle response, i.e., Y = yes, N = no or U = unknown or not observed. If Y (yes), circle the type of problem.

A. EVALUATION OF INTERIOR CONDITIONS

1. Does the roof leak? Describe: Yes, Room 124, exterior wall — (Y) N U

2. Are there water stains on: — (Y) N U
   a. walls c. deck e. structural elements
   (b) ceilings d. floor f. other:_____

3. Do structural elements show any of the following: — Y (N) U
   a. cracks d. alteration g. physical damage
   b. splits e. rotting h. insect damage
   c. spalling f. settlement i. other:_____

4. Does the underside of the deck show any of the following: — Y N (U)
   a. rusting c. spalling e. sagging
   b. rotting d. cracks f. other_____

B. EVALUATION OF EXTERIOR CONDITIONS

1. Do the exterior walls show any of the follwoing: — (Y) N
   a. cracks c. spalling (e) water stains
   b. rusting d. movement f. other:_____

2. Does the fascia or soffit show any of the following: — Y (N)
   a. cracks c. spalling e. water stains
   b. rusting d. peeling f. other:_____

3. Do the gutters or downspouts show any of the following: — (Y) N
   (b) damaged d. disconnected f. other:_____

C. EVALUATION OF ROOFTOP CONDITIONS

1. Is there any unauthorized, unnecessary, or improperly installed equipment on the roof? — Y (N)
   a. equipment c. antennas e. cables
   b. signs d. platforms f. other:_____

2. Do adjacent parapet walls show any of the following: — (Y) N
   a. cracks c. cap cracked e. sealant flaws
   b. spalling (d) cap missing f. other:_____

D. REMARKS:_____

Figure 6. Reverse Side of Roof Inspection Worksheet.

ROOF SECTION RATING FORM

BUILDING 97	SECTION B	DATE 27 JUL 92	CALC. BY RWB
PER. FLASHING 271 FT CURB FLASHING 70 FT	FLASHING TOTAL 341 FT	AREA 3462 SQFT	CHKD. BY C.S

FLASHING

BF - BASE FL - MEM
BC - BASE FL - METAL
MC - METAL CAP
EM - EMBEDDED MET
FP - FLASHED PEN
PP - PITCH PAN
DR-DRAIN & SC

TYP	SV	QUANTITIES	TOT	DEN	DV
BC	H	20	20	5.9	22
EM	H	1+1+1+1	4	1.2	11
EM	M	1+1	2	.59	6
BF	M	2	2	.59	4
MC	H	1	1	.29	7
DR	H	1	1	.29	28
PP	L	4	4	1.2	4

CORRECTED DEDUCT VALUE (CDV) 33

FCI = 100 - CDV = 67
FLASHING RATING = GOOD

MEMBRANE

SP - SPLITS
RG - RIDGES
HL - HOLES
DS - DEF SEAMS
SC - SURF COAT
MD - MEM DET
SS - SYSTEM SEC
MS - MEM SUPPORT
PA - PATCHING
DV - DEB & VEG
EQ - EQ SUPPORT
PD - PONDING

TYP	SV	QUANTITIES	TOT	DEN	DV
PD	L	40	40	1.2	4
SS	H	50	50	1.4	23
DS	M	10	10	.29	5
DS	H	15	15	.43	32

CORRECTED DEDUCT VALUE (CDV) 38

MCI = 100 - CDV = 62
MEMBRANE RATING = GOOD

Figure 7. Roof Section Rating Form.

Determine Corrected Deduct Values

Tabulate flashing deduct values in descending order as shown in Table 1. Determine the sums of flashing deduct values (ΣDV) and the number of distresses with deduct values greater than 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 in Table 1.

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

Compute Membrane and Flashing Condition Indexes

Calculate flashing and membrane condition indexes using the following equations:

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

$$MCI = 100 - \text{Max. } CDV_{membrane}$$

Determine Membrane and Flashing Condition Ratings

Determine the corresponding descriptive condition ratings from Figure 1 for both indexes.

Table 1

Deduct Values in Descending Order

Flashing

(Distress data from the completed Roof Section Rating Form, Figure 7)

DV	ΣDV	q	$CDV_{flashing}$
28	28	1	28
22	50	2	32
11	61	3	(33)
7	68	4	33
6	74	5	32
4	78	6	32
4	82	7	29

Maximum $CDV_{flashing}$ = 33

Membrane

(Distress data from the completed Roof Section Rating Form, Figure 7)

DV	ΣDV	q	$CDV_{membrane}$
32	32	1	32
23	55	2	(38)
5	60	3	37
4	64	4	34

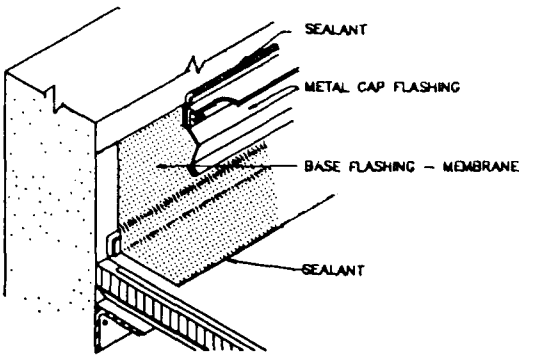
Maximum $CDV_{membrane}$ = 38

3 FLASHING DISTRESSES

Index

BASE FLASHING, MEMBRANE MATERIAL (BF)

Description: Base flashing is composed of membrane material or other flexible material. The base flashing extends from the roof surface upward above the plane of the membrane to provide a watertight termination of the membrane.



Severity Levels:

Low: Any of the following defects:

1. Light crazing or eroding of the base flashing.
2. Top of base flashing is less than 6 in. above the membrane.
3. Nailing strip or flashing batten with exposed fasteners is less than 6 in. above the roof surface.
4. Seam or side lap is open less than 1/2 in.
5. Flashing has repairs made with compatible materials.

Medium: Any of the following defects:

1. Crazing or eroding of the base flashing that has worn through to a reinforcement or scrim sheet or down to another layer of different color, or has resulted in obvious loss of sheet thickness.
2. Slippage, wrinkling, blistering, pulling, unbonding, or bridging of base flashing material that does not allow water to penetrate.
3. The presence of solvents, oil, or other chemicals with deterioration of the base flashing but does not allow water to penetrate.
4. Flashing has repairs made with dissimilar materials.
5. Seam or side lap is open more than 1/2 in. but does not allow water to penetrate the flashing.
6. Loose or missing termination bar where no counterflashing is used.
7. Loose or missing nailing strip.

High: Any of the following defects:

1. Crazing or eroding of the base flashing that has worn through the flashing allowing water to penetrate.
2. Holes, splits, or tears in base flashing, allowing water to penetrate.
3. Exposed gaps at top of the base flashing.
4. Seam or side lap is open through its entire width, allowing water to penetrate the flashing.
5. Holes through the base flashing caused by solvents, oil, or other chemicals.

Measurement: Measure length (ft) of base flashing having the above conditions. Holes, open side laps, and seams count as 1 ft each.

Density:

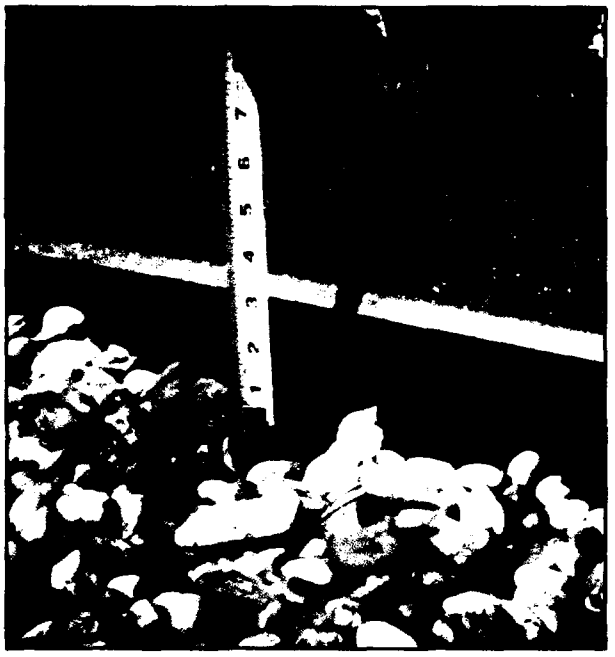
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = length of base flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

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

Causes:

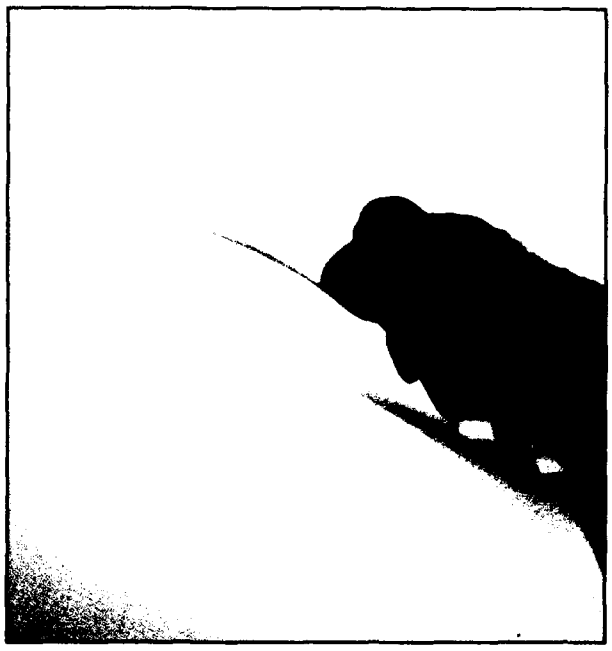
1. Flashing splits or tears can result from construction defects, mechanical damage, material shrinkage, unattached membrane pulling the flashing, or differential movement between the wall and the deck.
2. Slippage, wrinkling, or pulling of base flashing may result from weak or no attachment between the flashing and the substrate. This can result from any of the following conditions:
   - adhesive or flashing material was improperly applied or substrate was not properly prepared,
   - adhesive used was improper type or poor quality, or
   - fasteners were improper or too few to hold flashing to the substrate.



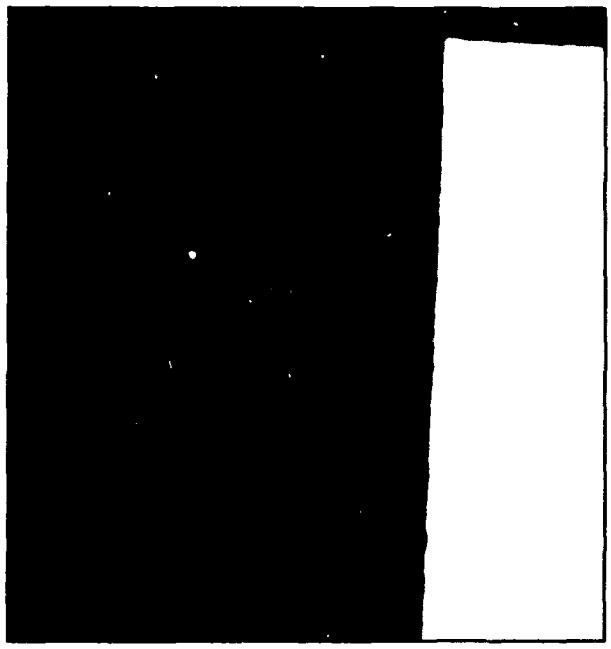
BFL2
<Low Severity>
Top of base flashing is less than 6 in. above the membrane

BFL3
<Low Severity>
Nailing strip with exposed fasteners is less than 6 in. above the roof surface

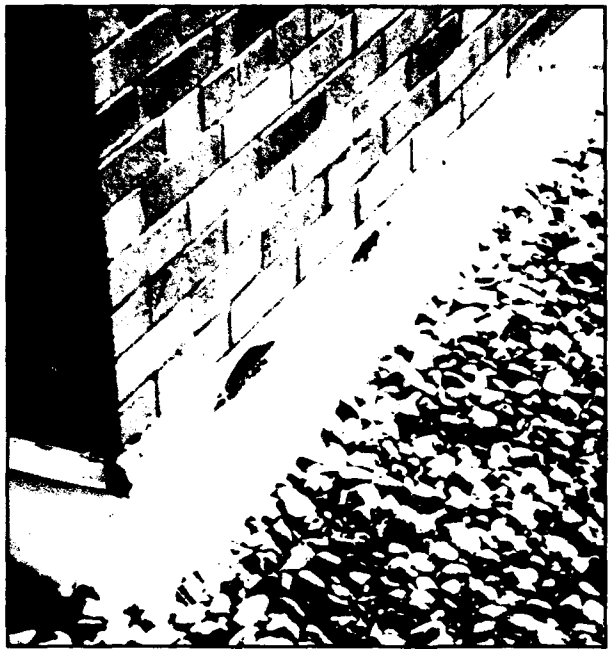
BASE FLASHING, MEMBRANE MATERIAL (BF)



BFL4
<Low Severity>
Seam is open less than 1/2 in.



BFM1
<Low Severity>
Crazing or eroding of base flashing through to another layer



BFM2
<Medium Severity>
Wrinkling of base flashing

BFM2
<Medium Severity>
Blistering of base flashing

BFM5
<Medium Severity>
Side lap is open more than 1/2 in. but is not allowing water to penetrate

BFM6
<Medium Severity>
Loose termination bar where no counterflashing is used

BFH1
<High Severity>
Eroding of base flashing that allows water to penetrate

BFH2
<High Severity>
Splits in the base flashing

BASE FLASHING, MEMBRANE MATERIAL (BF)

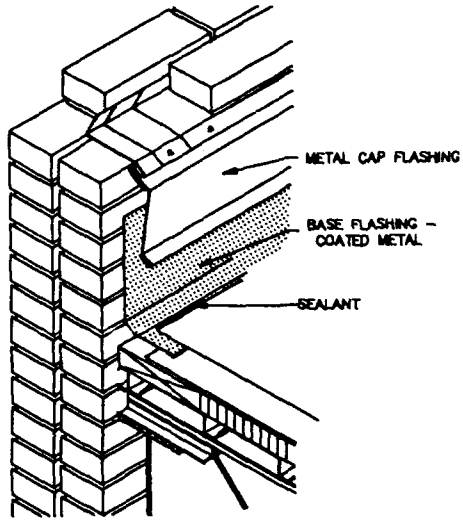
BFH2
<High Severity>
Tears in the base flashing

BFH3
<High Severity>
Exposed gap at the top of base flashing

BFH3
<High Severity>
Exposed gap at top of base flashing on ballasted roof

BASE FLASHING, COATED METAL (BC)

Description: Base flashing material is composed of membrane-coated metal. The metal extends from the roof surface upwards above the plane of the membrane providing a watertight termination of the membrane.



Severity Levels:

Low: Any of the following defects:

1. Loss of protective coating or light corrosion.
2. Distortion of joint covers.
3. Top of flashing is less than 6 in. above the roof surface.
4. Exposed fasteners.

Medium: Any of the following defects:

1. Joint cover is unbonded to metal base flashing, but does not allow water to penetrate.
2. Coated metal base flashing fasteners are loose.
3. Coated metal base flashing has pulled away from the wall or curb or has lifted up but top termination is watertight.
4. Crazing or eroding of the joint cover material that has not worn through and does not allow water to penetrate.
5. Coated metal base flashing has repairs made with dissimilar materials.

High: Any of the following defects:

1. Holes in metal base flashing.
2. Hole in joint cover or unbonding of joint cover from metal base flashing, allowing water to penetrate.
3. Exposed gaps at top termination of the base flashing.
4. Coated metal base flashing has pulled away from the wall or curb or has lifted up, allowing water to penetrate (rate full section of metal, normally a 10-ft length).

Measurement: Measure length (ft) of base flashing having the above conditions. Holes, open side laps, and seams count as 1 ft each. Each joint cover having a hole is counted as 1 ft. As a method of sampling the joint covers for ballasted systems, determine the total number of existing joints by dividing the total length of coated metal base flashing by the length of the metal sections (usually 10 ft). Every fourth joint should be inspected for defects in the cover strip. Count the number of inspected joints having a specific defect and multiply by 4 to determine the total length of the defect.

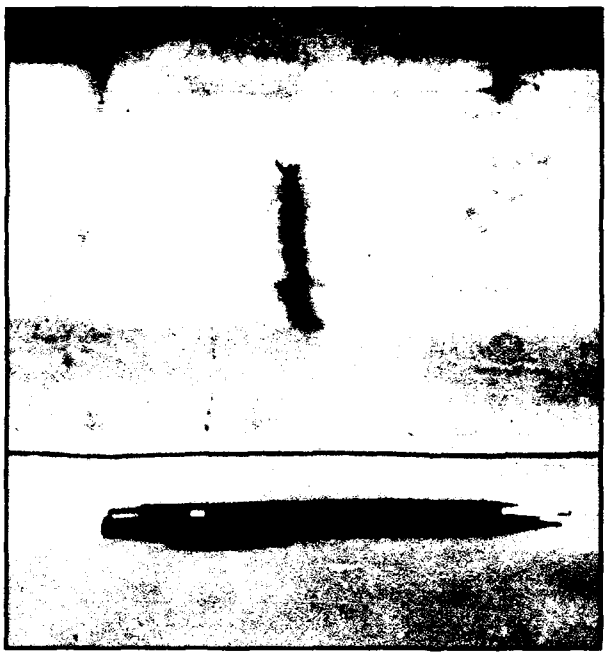
Density:

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

where A = length of base flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and for penthouses, courtyards, and curbed projections).

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

BCL1
<Low Severity>
Loss of protective coating



BCH2
<High Severity>
Split in joint cover allowing water to penetrate

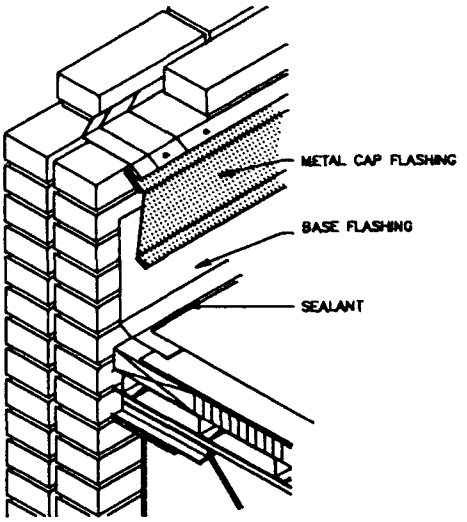
BASE FLASHING, COATED METAL (BC)

BCH4
<High Severity>
Base flashing has pulled away from curb,
allowing water to penetrate

BASE FLASHING, COATED METAL (BC)

METAL CAP FLASHING (MC)

Description: Metal cap flashing includes any sheet metal that serves to counterflash or cover a detail such as a parapet, firewall, roof area divider, equipment curb, raised roof edge, or an expansion joint, protecting the top termination of the base flashing and shedding water away from it. The metal cap flashing should be free to expand and contract.



Note: Not all single plys are installed with counterflashing to protect the top of the base flashing.

Severity Levels:

Low: Any of the following defects:

1. Loss of protective coating or corrosion without holes.
2. Top of counterflashing or metal coping is deformed and allows water to pond on the top.
3. Metal cap flashing is deformed but still performing its function.
4. Metal cap flashing has been sealed to base flashing.

Medium: Any of the following defects:

1. Corrosion has caused holes in the metal on a sloping or vertical surface.
2. Metal cap flashing has loose fasteners, failure of soldered or sealed joints, or loss of attachment.
3. Metal cap flashing has rough edges that are in contact with base flashing.

High: Any of the following defects:

1. Metal cap flashing is missing or displaced from its original position.
2. Corrosion has caused holes in the metal on a horizontal surface.
3. Metal cap flashing has open joints or missing joint covers where covers were originally installed.
4. Sealant at reglet or top of counterflashing is missing or no longer functional, allowing water to channel behind it.
5. Counterflashing is loose at the top allowing water to channel behind it.
6. Metal cap flashing does not extend over top of base flashing.

Measurement: Measure length (ft) of metal cap flashing having the above conditions. Individual defects (i.e., joints, holes) count as 1 ft minimum.

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 and flashings for penthouses, courtyards, and curbed projections).

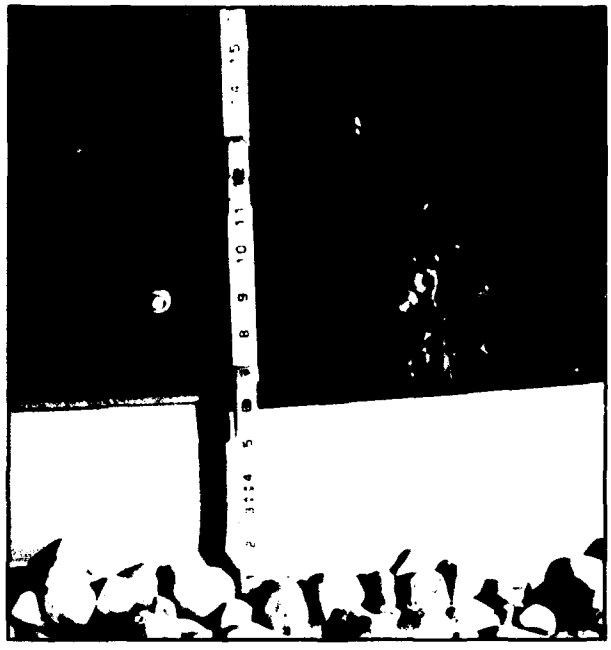
Note: A problem density is calculated for each existing severity level.

MCL1
<Low Severity>
Corrosion without holes

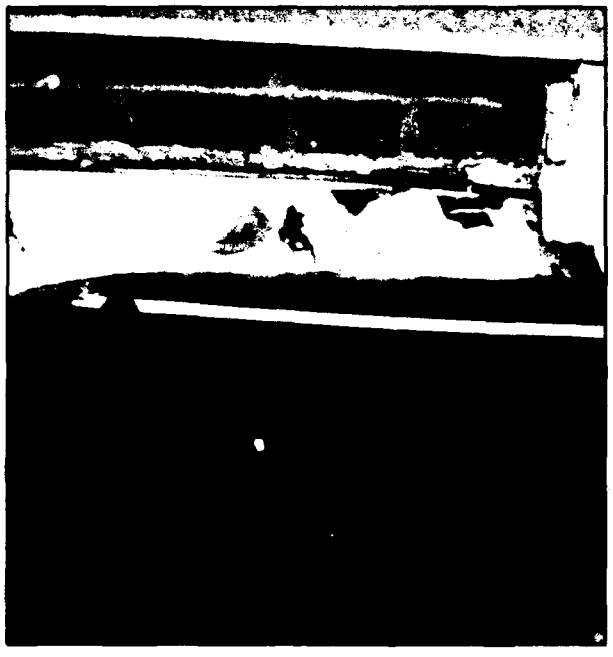
MCL1
<Low Severity>
Loss of protective coating

METAL CAP FLASHING (MC)

MCL3
<Low Severity>
Metal cap flashing is deformed



MCM2
<Medium Severity>
Metal cap flashing has loose fasteners



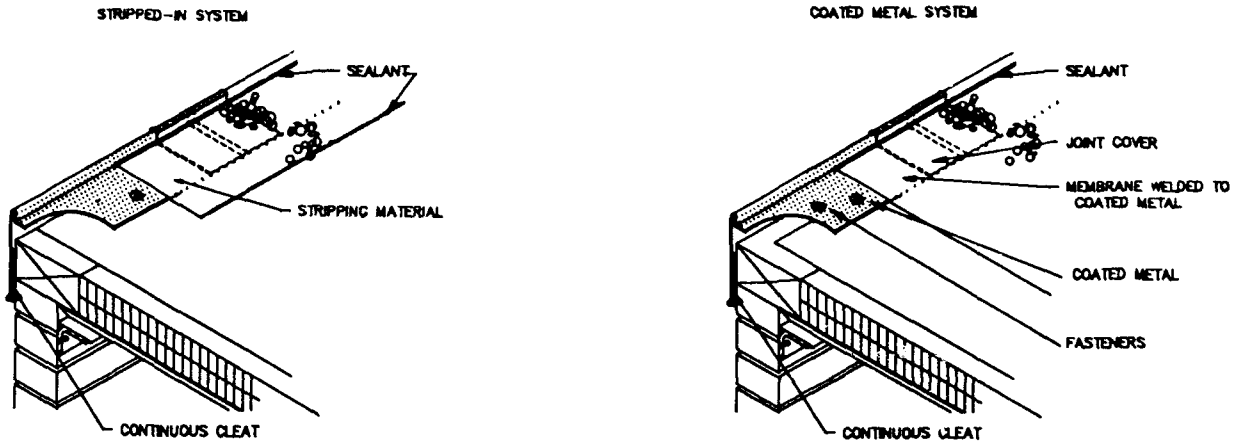
MCM3
<Medium Severity>
Metal cap flashing has rough edges that are in contact with the base flashing

MCH2
<High Severity>
Corrosion holes have occurred through the metal on a horizontal surface

MCH3
<High Severity>
Metal cap flashing has missing joint cover

METAL CAP FLASHING (MC)

EMBEDDED EDGE METAL (EM)



Description: Embedded edge metal is a formed strip of metal at the edge of the roof that continues down the vertical part of the wall to form a fascia or drip edge. This stripped-in flashing provides a finished termination for the roofing membrane. On all but coated-metal flashing systems, the metal is placed on top of the membrane and fastened to the deck through it. To make that area watertight, the metal is covered with membrane or flashing material (i.e., it is stripped in). Coated metal systems have their edge metal placed before the membrane. The membrane is adhered to the top of the coated metal, thereby eliminating the need to have it stripped in. A formed vertical projection (gravel stop) may be incorporated to prevent ballast from rolling or washing off the roof. Exterior and interior gutters, which are embedded in the membrane, are considered embedded edge metal. (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: Any of the following defects:

1. Loss of protective coating or light corrosion.
2. Termination battens have exposed fasteners.
3. Stripping material is open less than 1/2 in.
4. Distortion of joint covers.
5. For coated metal edge flashings that are not stripped in, membrane is open less than 1/2 in.

Medium: Any of the following defects:

1. Joint cover is unbonded to embedded edge metal, but does not allow water to penetrate.
2. Nails under stripping material are backing out.
3. Stripping material is crazing, checked, or cracked.
4. Stripping material is open more than 1/2 in., but edge metal fasteners are not exposed.
5. Loose or lifted metal with deterioration of the stripping material.

6. Embrittled joint stripping material.
7. The entire length of interior gutter is rated medium as a minimum due to the potential for leak damage.
8. For coated metal edge flashings that are not stripped in, membrane is open more than 1/2 in. but does not allow water to penetrate.

High: Any of the following defects:

1. The stripping material is missing or open and edge metal fasteners are exposed, or stripping material has holes, cuts or tears, allowing water to penetrate.
2. Hole in joint cover or unbonding of joint cover from embedded edge metal, allowing water to penetrate.
3. Holes through the metal.
4. Holes associated with loose or lifted embedded edge metal.
5. Holes in the interior gutter.
6. For coated metal edge flashings that are not stripped in, membrane is open allowing water to penetrate.

Measurement: Each split above a joint is counted as 1 ft. As a method of sampling the embedded edge metal joints for ballasted systems, determine the number of joints by dividing the total length of embedded edge metal flashing by the length of the edge metal sections (often 10 ft). Gravel should be moved at every fourth joint and the stripping material inspected for splits. Count the number of inspected joints having a specific defect and multiply by four to determine the total length of the defect.

Density:

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

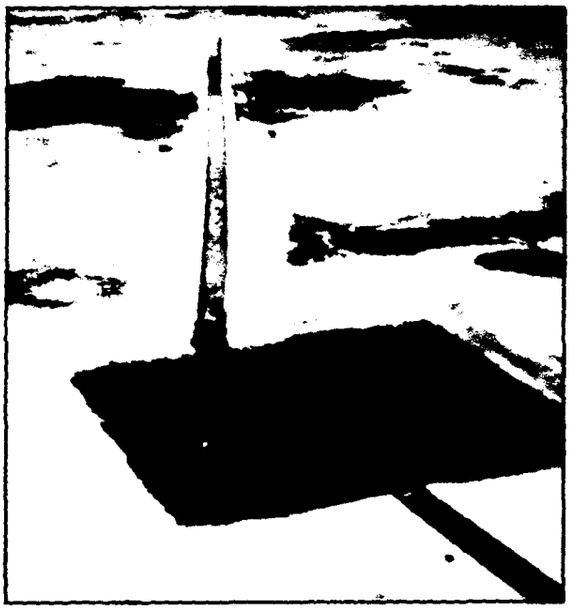
where A = length of embedded edge metal flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

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

Causes:

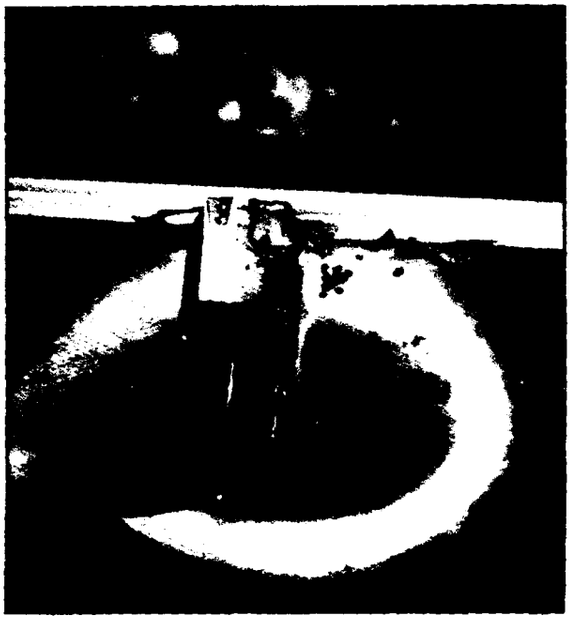
1. Splits in the stripping material and loose stripping material are caused by:
   - insufficient or improper nailing of the metal, allowing it to move,
   - insufficient bonding of the stripping material to the embedded metal, or
   - embrittlement or hardening of stripping material.
2. Exposed metal flanges can result from stripping material deterioration or the flange may have never been stripped-in.
3. Loose or lifted metal edge is caused by insufficient fastening, rotting or lack of a wood perimeter nailer, membrane shrinkage, or high winds.

EML4
<Low Severity>
Distortion of joint cover



EMM7
<Medium Severity>
Interior gutter

EMH1
<High Severity>
Stripping material is open

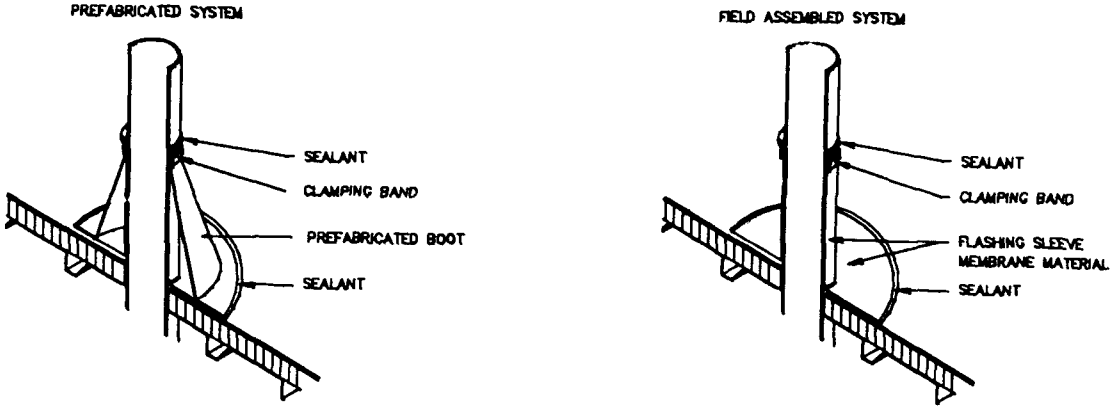


EMH1
<High Severity>
Stripping material is torn

EMH2
<High Severity>
Hole in joint cover

EMBEDDED EDGE METAL (EM)

FLASHED PENETRATIONS (FP)



Description: This category includes pipes, plumbing vent stacks, flues, ducts, conduits, guy wires, drain sumps, and other penetrations through the roof membrane (excluding pitch pans but including metal curbing for hatches and ventilators, where the metal flange is stripped into the membrane or, in the case of some coated metal flashing systems, the membrane is adhered to the top of the coated metal flange, thereby eliminating the need to have it stripped in).

Severity Levels:

Low: Any of the following defects:

1. Flashing sleeve is deformed.
2. Stripping material, boot, or membrane (for coated metal flashing sleeves) is open less than 1/2 in.
3. Top of flashing is less than 6 in. above the membrane.

Medium: Any of the following defects:

1. Stripping material is crazing, checked, or cracked.
2. Stripping material, boot, or membrane (for coated metal flashing sleeves) is open more than 1/2 in. but does not allow water to penetrate the flashing.
3. Top of flashing sleeve or boot is not sealed or is not rolled down into the existing plumbing vent stack.
4. Clamping band is loose or missing (where required).
5. Umbrella is open or no umbrella is present (where required).
6. Corrosion of metal or delamination of coating.

High: Any of the following defects:

1. Stripping material has holes, cuts, or tears.
2. Stripping material, boot, or membrane (for coated metal flashing sleeves) is open, allowing water to penetrate.

3. Holes, cuts, or tears in flashing sleeve or metal curb.
4. No flashing sleeve present.
5. Incompatible flashing material has been used.

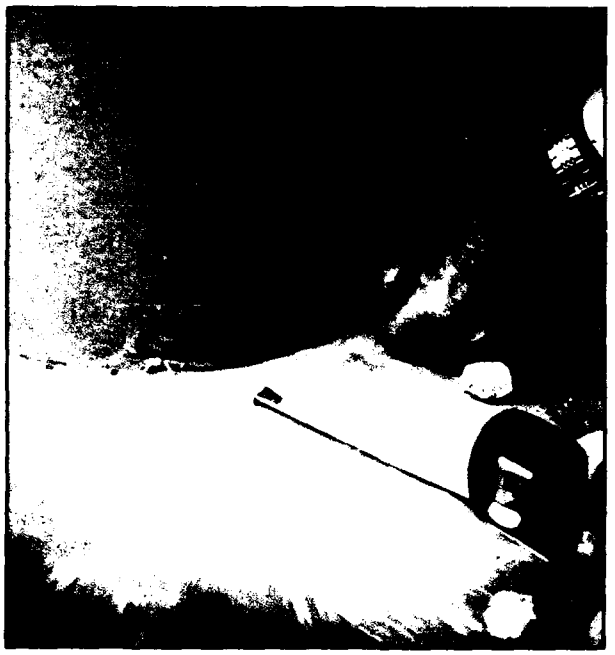
Measurement: Count each small distressed flashed penetration as 1 ft at the highest severity level present. For metal curbs and ducts with more than 1 ft of perimeter, measure the length (in ft) of the distressed perimeter.

Density:

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

where A = length of distressed flashed penetrations (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

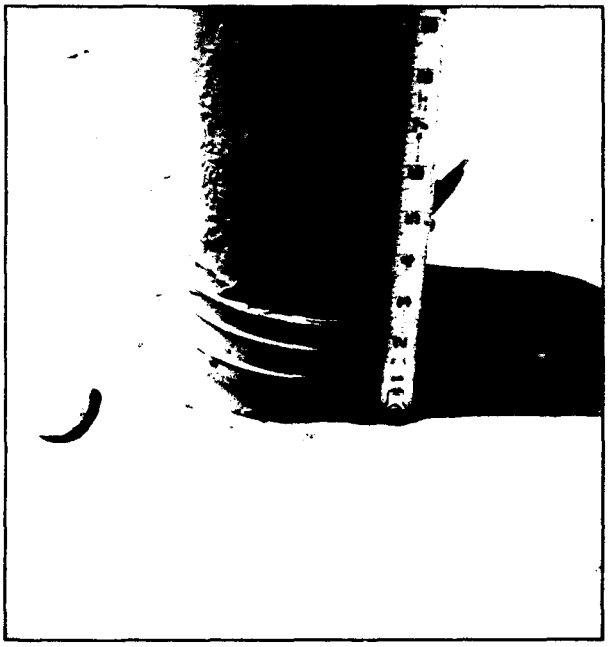
Note: A problem density is calculated for each existing severity level.



FPL2
<Low Severity>
Stripping material is open less than 1/2 in.

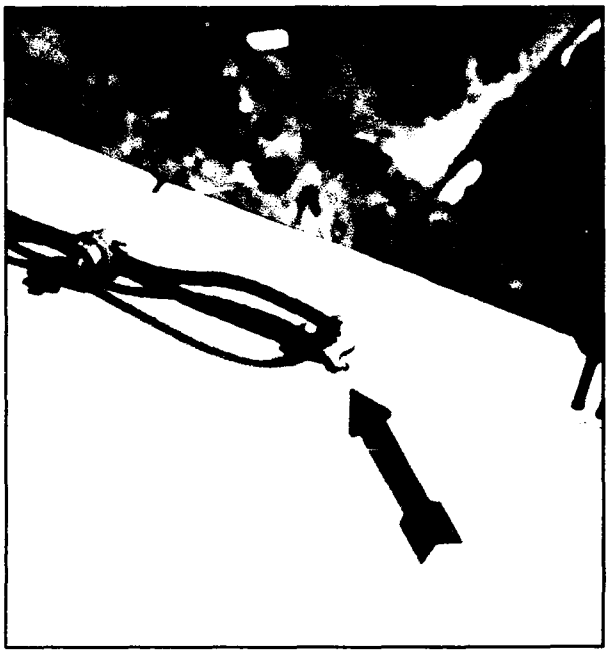
FPL3
<Low Severity>
Top of flashing is less than 6 in. above the ballasted roof surface

FLASHED PENETRATIONS (FP)



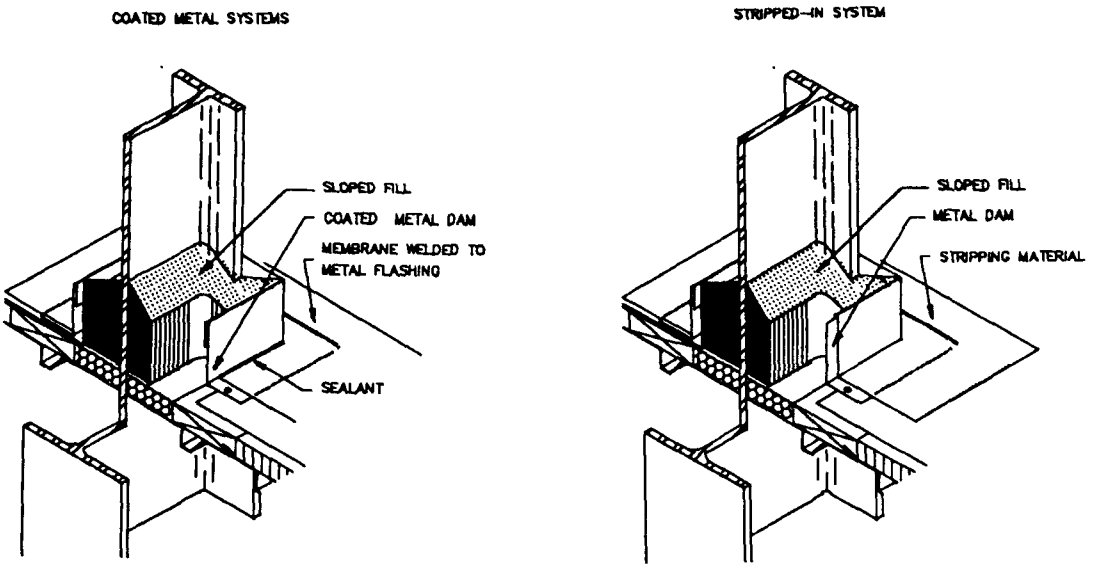
FPL3
<Low Severity>
Top of flashing is less than 6 in. above the membrane

FPH2
<High Severity>
Stripping material is open



FPH4
<High Severity>
No flashing sleeve present

PITCH PANS (PP)



Description: A pitch pan is a flanged metal sleeve placed around a roof-penetration element and filled with a sealer. For pitch pans on ethylene-propylene-diene monomer (EPDM) and Hypalon roofing systems, stripping material should cover the sides of the metal pan and terminate within the pan below the sealer.

Severity Levels:

Low:

1. All pitch pans are low severity at a minimum due to the maintenance requirements.

Medium: Any of the following defects:

1. Stripping material is crazing, checked, or cracked.
2. Stripping material or membrane (on coated metal pitch pans) is open more than 1/2 in. but does not allow water to penetrate the flashing.
3. Loss of protective coating or corrosion of metal.
4. For EPDM and Hypalon, stripping material is not covering the top of the metal pan or does not terminate below the sealer.

High: Any of the following defects:

1. Stripping material has holes, cuts, or tears, allowing water to penetrate through.
2. Edge of stripping material or membrane (on coated metal pitch pans) is open, allowing water to penetrate.
3. Sealer is below the metal rim, allowing ponding in the pan.
4. Sealer has cracked or separated from the pan or penetration.
5. Corrosion through the metal pan.

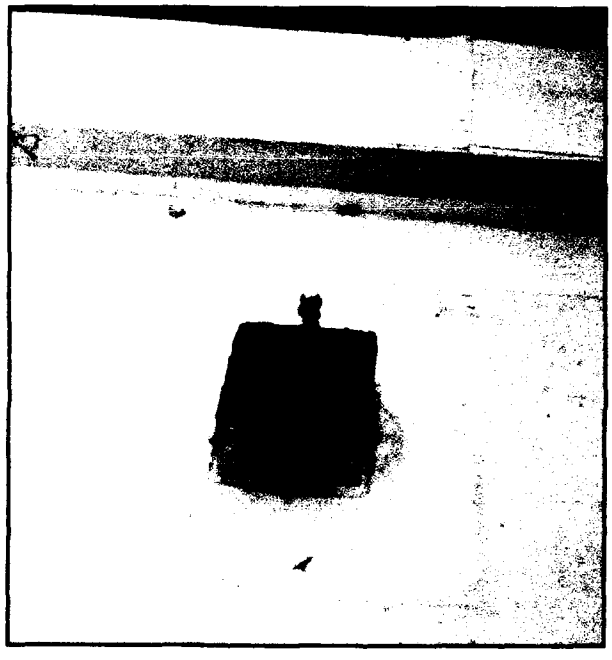
Measurement: Each distressed pitch pan should be counted once at the highest severity level present.

Density:

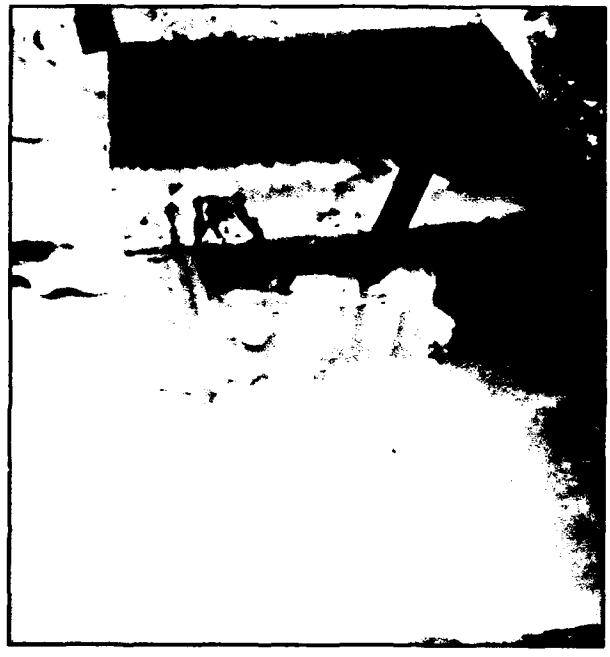
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = number of distressed pitch pans (ea)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

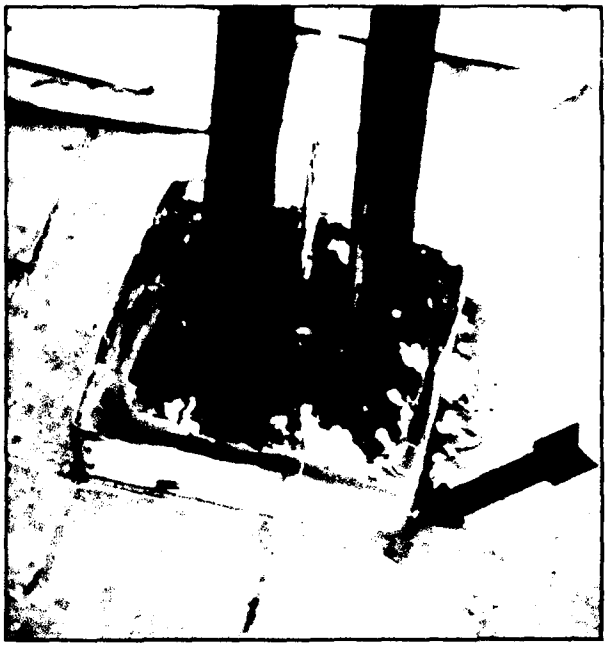
Note: A problem density is calculated for each existing severity level.



PPL1
<Low Severity>
Pitch pan installed and maintained correctly



PPM3
<Medium Severity>
Loss of protective coating



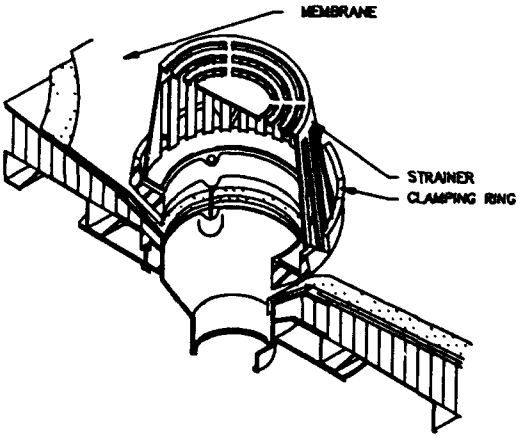
PPM4
<Medium Severity>
Stripping material is not covering metal pan on an EPDM system

PPH3
<High Severity>
Sealer is below metal rim

PITCH PANS (PP)

INTERIOR DRAINS AND ROOF LEVEL SCUPPERS (DR)

Description: A drain is a penetration of the roof membrane that allows water to flow into a piped drainage system. The drain fixture at the roof has a flange and/or clamping arrangement to which the roofing membrane is attached. Stripping material may also be present at the drain. A scupper is a channel through a parapet or raised roof edge that is designed to drain the roof. Roof-level scuppers are for primary drainage. Elevated (overflow) scuppers are for emergency drainage.



Note: Most single-ply roofing systems do not require stripping material around the drain.

Severity Levels:

Low: Any of the following defects:

1. Field seam within 1 ft of a drain or roof-level scupper.
2. Stripping material or membrane is open less than 1/2 in.

Medium: Any of the following defects:

1. Stripping material is crazing, checked, or cracked.
2. Stripping material or membrane is open 1/2 in. or more, but does not allow water to penetrate.
3. Strainer is broken or missing.
4. Scupper shows loss of protective coating or start of metal corrosion.
5. Drain has a field seam in the clamping ring.

High: Any of the following defects:

1. Stripping material has holes, cuts, or tears, allowing water to penetrate.
2. Stripping material or membrane is open, allowing water to penetrate.
3. Clamping ring is loose or missing from drain or bolts are missing.
4. Drain is clogged.
5. Scupper is broken or contains holes.
6. Holes, cuts, tears, or abrasions through the membrane within 2 ft of the drain or scupper.

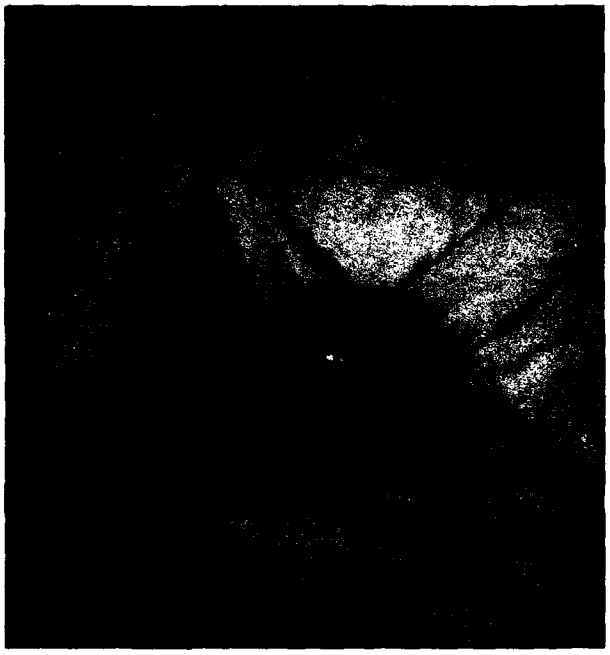
Measurement: Each distressed drain and scupper should be counted once at the highest severity level present.

Density:

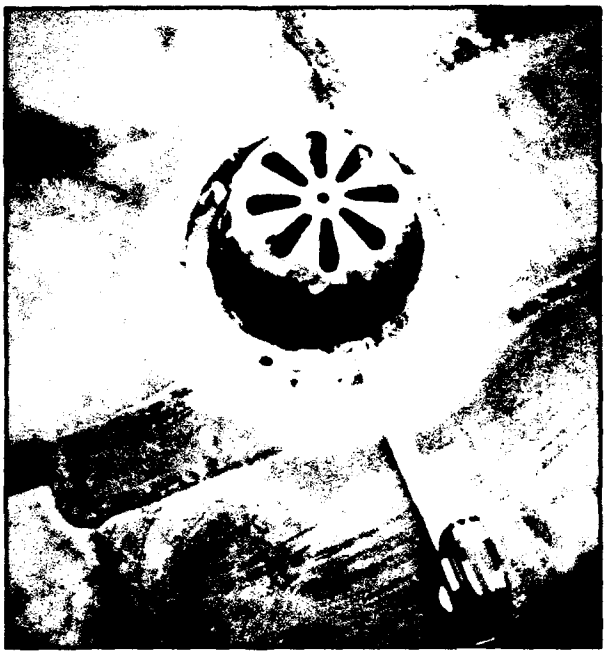
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = number of distressed interior drains and roof level scuppers
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

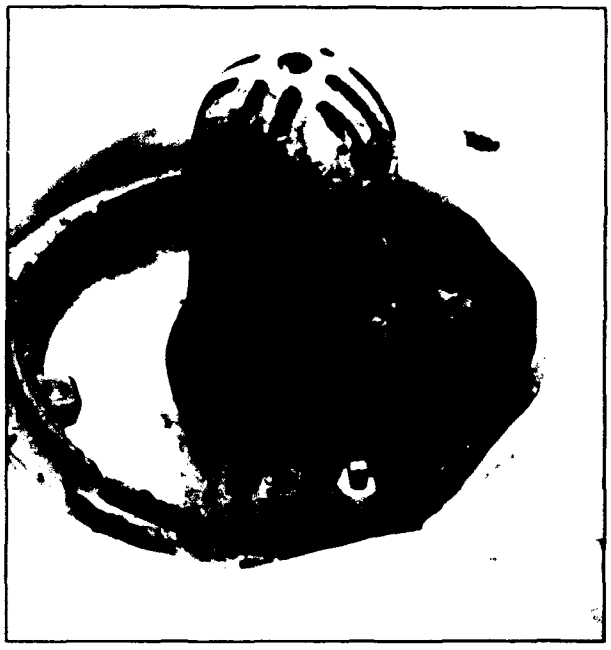
Note: A problem density is calculated for each existing severity level.



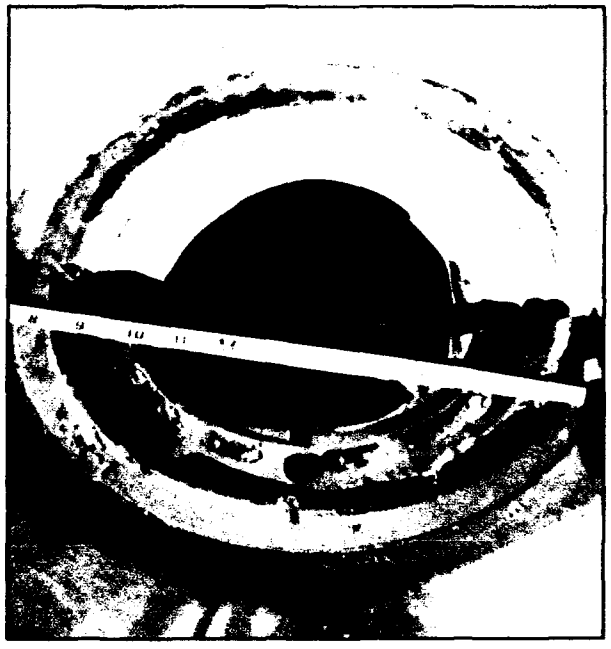
DRL1
<Low Severity>
Field seam is within 1 ft of a drain



DRM5
<Medium Severity>
Drain has a field seam in the clamping ring



DRH2
<High Severity>
Membrane is not clamped, allowing water to penetrate



DRH3
<High Severity>
Clamping ring is broken

DRH3
<High Severity>
Bolts are missing from clamping ring

DRH4
<High Severity>
Drain is clogged

DRH6
<High Severity>
Membrane tear within 2 ft of drain

4 MEMBRANE DISTRESSES

Index

SPLITS (SP)

Description: Splits are cracks or tears that extend through the membrane. They vary in length from a few inches to the length of the roof and in width from hair-line to more than 1 in.

Note: Cuts are rated as Holes, Cuts, and Abrasions (HL) distresses.

Severity Levels:

High:

1. All splits in the membrane are considered high severity due to their leak potential.

Measurement: Measure length of split.

Density:

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

where A = total length of membrane splits (ft)
B = total area of roof section being rated (sq ft).

Causes:

1. Membrane shrinkage or embrittlement.
2. Movement of the substrate.
3. Warping of insulation boards.
4. Thermal contraction of the membrane.

SPH1
<High Severity>
Membrane split

SPH1
<High Severity>
Membrane split on ballasted roof

RIDGES (RG)

Description: Ridges are long, narrow (usually less than 3 in.), raised portions of the roof membrane. Usually ridges occur directly above the insulation board joints.

Note: Wrinkles in the membrane are not rated as ridges. Wrinkles that block drainage and cause ponding are rated as Ponding (PD). Wrinkles occurring on fully-adhered systems are rated as System Securement Deficiencies (SS).

Severity Levels:

Low:

1. All ridges are rated low severity as a minimum.

High:

1. Open breaks have developed in the ridge allowing water to penetrate.

Measurement: Measure length of ridges running in all directions. When many ridges are present, the representative sampling technique may be used.

Density:

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

where A = total length of membrane ridges (ft)
B = total area of roof section being rated (sq ft).

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

Causes: Ridging can result from internally generated moisture collecting at insulation joints and affecting the membrane or from movement of the substrate.

RGL1
<Low Severity>
Watertight ridges having no open breaks

RGH1
<High Severity>
Open breaks have developed in the ridge

HOLES, CUTS, AND ABRASIONS (HL)

Description: Holes and cuts are membrane distresses caused by physical abuse from tools, traffic, debris, gravel, wind, etc., or manufacturing defects such as pinholes. Holes and cuts can be of various shapes and sizes. Abrasion is physical damage that has roughened or worn the membrane surface.

Severity Levels:

Low:

1. Surface scratches or abrasions with no significant loss of membrane thickness.

Medium:

1. Cuts, gouges, or abrasions with loss of membrane thickness but not fully penetrating the membrane.

High: Any of the following defects:

1. Holes, cuts, gouges, or abrasions that penetrate the membrane.
2. Holes through the membrane caused by underlying mechanical fasteners.

Measurement:

1. Count the total number of scratches, gouges, holes, and cuts in the membrane. If the distance between distresses is less than 1 ft, count the distresses as one. If the distress is longer than 1 ft, measure the length. Measure area of abrasion in square feet.
2. When large quantities of this problem are present, the representative sampling technique may be used.

Density:

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

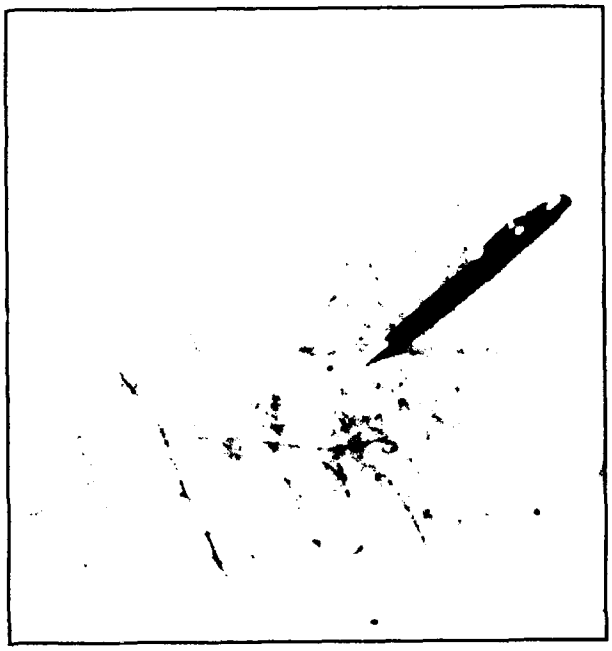
where A = total number and/or length of membrane scratches, gouges, holes and cuts (ft) or total area of abrasion (sq ft)
B = total area of roof section being rated (sq ft).

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

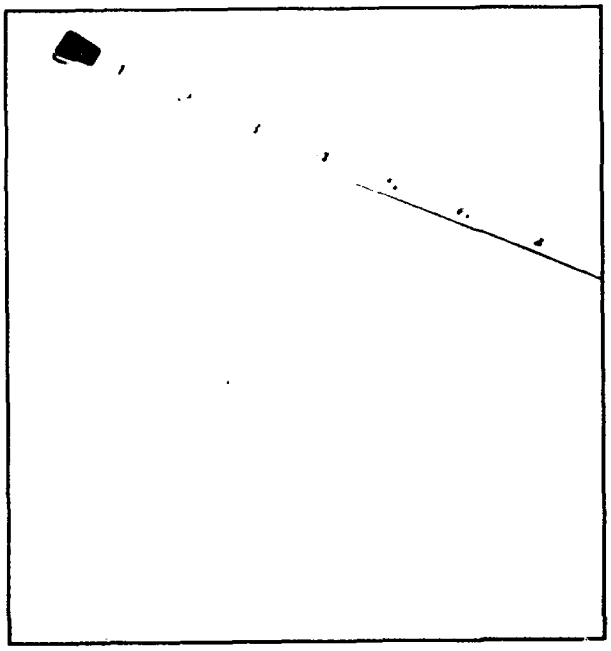
Causes:

1 Roof traffic.
2. Debris.
3. Broken or sharp ballast, especially at wrinkled areas.
4. Manufacturing defects such as pinholes.
5. Mechanical fasteners.
6. Wind-borne objects.

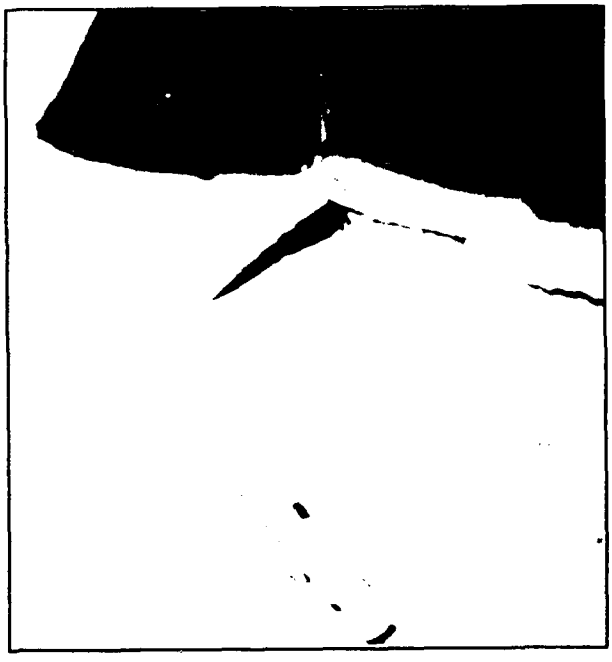
HOLES, CUTS, AND ABRASIONS (HL)



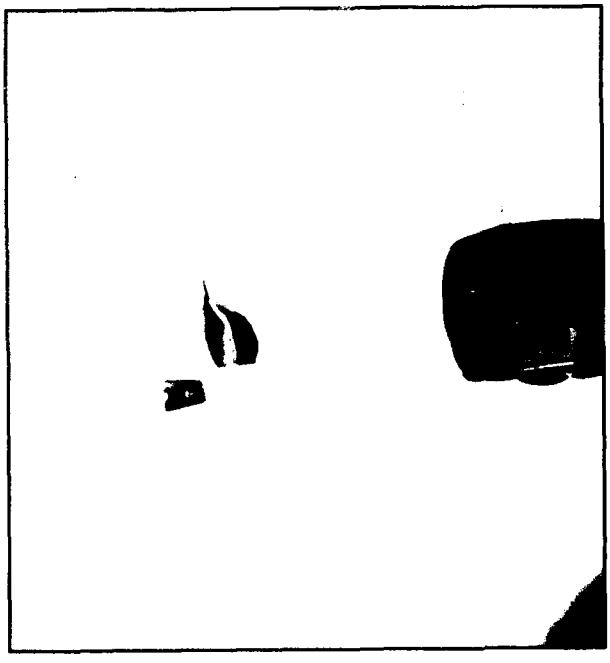
HLL1
<Low Severity>
Surface scratches and abrasions



HLM1
<Medium Severity>
Gouges not penetrating the membrane



HLH1
<High Severity>
Cut penetrating the membrane



HLH1
<High Severity>
Membrane hole

HLH2
<High Severity>
Nail protruding through membrane

HLH2
<High Severity>
Screw backing out through membrane

DEFECTIVE SEAMS (DS)

Description: Defective seams include incomplete, damaged, or weak seams that join two sheets of a membrane.

Note: For EPDM and polyvinyl chloride (PVC) membranes, all field seams should have lap sealant at the edges. All other membranes should have lap sealant at cut edges of seams that have exposed reinforcement material.

Severity Levels:

Low: Any of the following defects:

1. Missing lap sealant at field seam (EPDM and PVC membranes only).
2. Missing lap sealant at field seam which has exposed reinforcement material at seam edge (usually at end laps and field-cut edges of sheets).
3. Seam is open less than 1/2 in.
4. Wrinkling at seam that is watertight.
5. Seam intersections (e.g., T-joints) on EPDM that do not have a patch covering them.
6. Blisters within the seam.

Medium: Any of the following defects:

1. Seam is open 1/2 in. or more, but does not allow water to penetrate the membrane.
2. Pinch wrinkle at seam.

High: Any of the following defects:

1. Seam is open through its entire depth, allowing water to penetrate.
2. Fishmouths, wrinkles, or bunches at the seam that allow water to penetrate.

Measurement: For exposed membranes (no overlying ballast), inspect all seams visually.

For ballasted roofs, check field seams at five different locations on the roof section. Clear ballast from 5 ft of the seam at each location then clean the exposed seam with a whisk broom. If all checked seams are without defects, assume the remaining field seams are satisfactory. If any defects are found, use the following sampling technique:

1. For roof sections with sheet widths of 10 ft or less, inspect 2 percent of the total length of field seams (2 ft every 100 ft of seam). For roof sections having sheet widths greater than 10 ft, inspect 4 percent of the total length of field seams (2 ft every 50 ft of seam). Measure length of each specific seam defect found.

2. Extrapolate to determine the total length of seam defects for the entire roof section from the total length of defect found. When 2 percent of the seams are inspected, multiply the actual defect length by 50 to compute total length of defect. When 4 percent of the seams are inspected, multiply actual defect length by 25 to compute total length of defect.

Density:

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

where A = total length of defective seams (ft)
B = total area of roof section being rated (sq ft).

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

Causes:

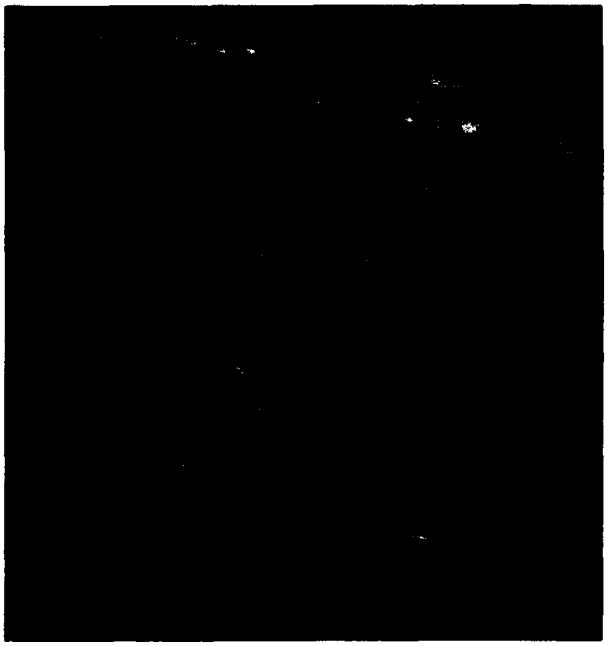
1. Seams improperly made.
2. Seams damaged in use.
3. Wrinkles in the membrane at the seam.

DSL1
<Low Severity>
Missing lap sealant

DSL2
<Low Severity>
Missing lap sealant with exposed reinforcement material

DEFECTIVE SEAMS (DS)

DSL3
<Low Severity>
Seam is open less than 1/2 in.



DSL4
<Low Severity>
Wrinkling at seam

DSL5
<Low Severity>
EPDM seam intersection does not have a patch

DSL6
<Low Severity>
Blisters within seam

DSM1
<Medium Severity>
Seam is open more than 1/2 in.

DSM2
<Medium Severity>
Pinch wrinkle at the seam

DSH1
<High Severity>
Seam is open through its entire depth

DEFECTIVE SEAMS (DS)

SURFACE COATING DETERIORATION (SC)

Description: Surface coating deterioration includes wear, blistering, or peeling of any surface coating applied for fire protection (such as adhesive coating and sand on an EPDM membrane) or solar reflectivity, but not waterproofing.

Severity Levels:

Low:

1. Color of underlying membrane can be seen through the coating or membrane has lost coating protection (for membrane with coating protection that does not have sand or mineral matter embedded).

Medium:

1. Membrane area has lost the sand or mineral matter portion of the coating protection (for membrane with coating protection that has sand or mineral matter embedded).

Measurement:

1. Measure the square feet of each affected area and rate at the highest severity level present.
2. When large quantities of this problem are present, the representative sampling technique may be used.

Density:

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

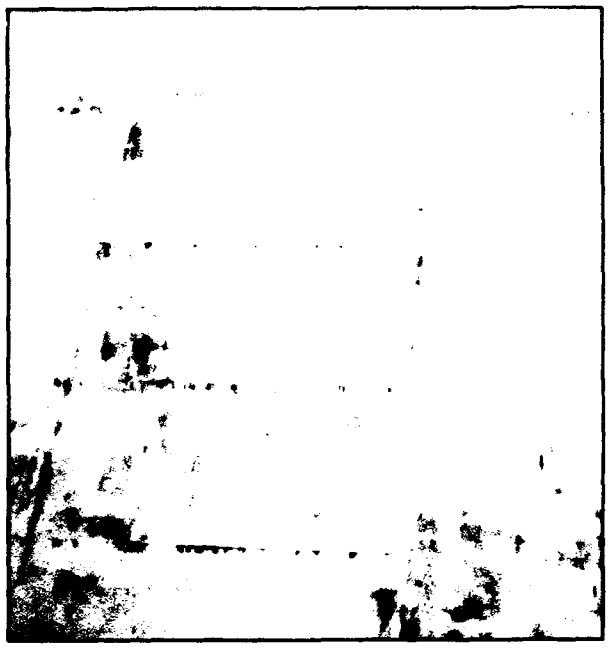
where A = total area of surface coating deterioration (sq ft).
B = total area of roof section being rated (sq ft).

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

Causes:

1. Weathering.
2. Roof traffic.
3. Poor adherence of coating to membrane due to material or application problems.

SCL1
<Low Severity>
Loss of protective coating



SCM1
<Medium Severity>
Loss of protective sand coating

SURFACE COATING DETERIORATION (SC)

MEMBRANE DETERIORATION (MD)

Description: This category includes erosion or crazing of the membrane. Erosion is the wearing away of the membrane surface creating a rough texture. Crazing is hairline cracking of the membrane.

Severity Levels:

Low:

1. Light crazing of the membrane surface.

Medium:

1. Crazing or eroding of the membrane surface that has worn through to a reinforcement or scrim sheet or down to another layer of different color, or has resulted in obvious loss of sheet thickness.

High:

1. Crazing or eroding of the membrane surface that has worn through the membrane allowing water to penetrate.

Measurement:

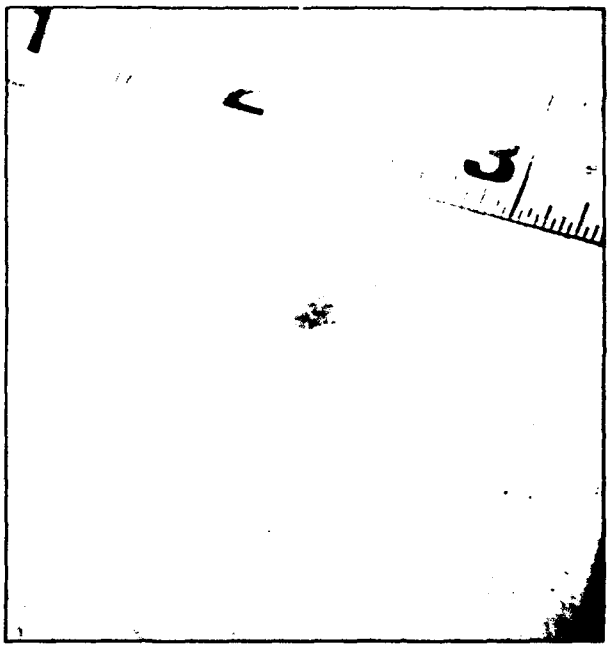
1. Measure the square feet of each affected area and rate at the highest severity level present.
2. When large quantities of this problem are present, the representative sampling technique may be used.

Density:

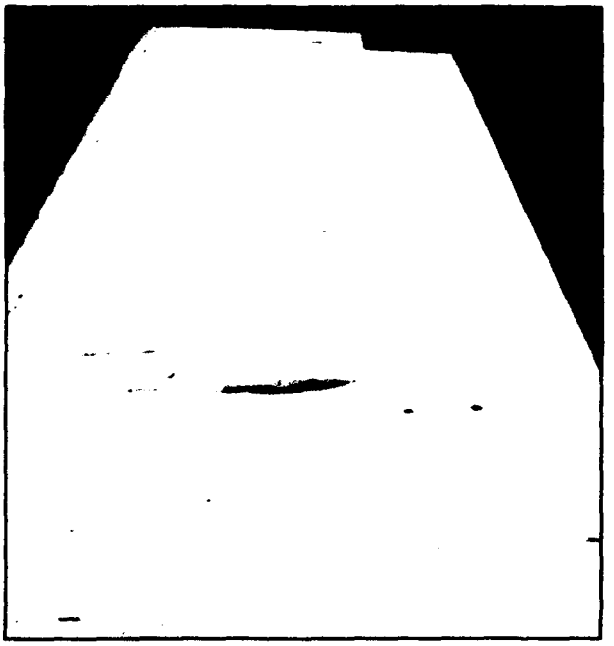
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

where A = total area of the membrane deterioration (sq ft)
B = total area of roof section being rated (sq ft).

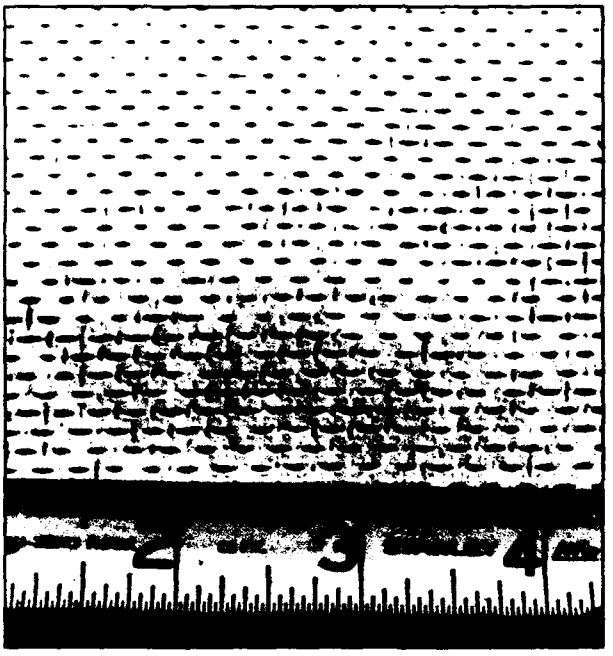
Note: A problem density is calculated for each existing severity level.



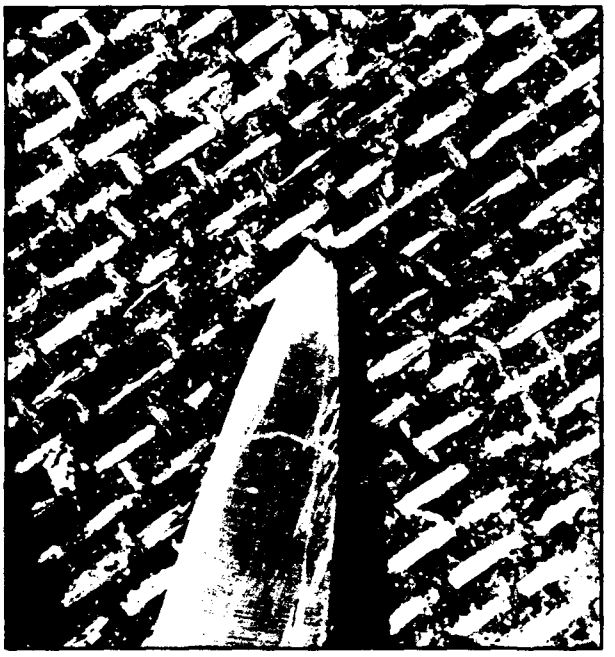
MDL1
<Low Severity>
Light crazing of membrane surface



MDL1
<Low Severity>
Light crazing of membrane shown by color change



MDM1
<Medium Severity>
Eroding of membrane with exposed scrim



MDH1
<High Severity>
Scrim completely exposed

MEMBRANE DETERIORATION (MD)

SYSTEM SECUREMENT DEFICIENCIES (SS)

Description: For fully adhered membranes, system securement deficiencies include membrane areas (including blisters) that are unattached to the substrate. For mechanically attached membranes, this category includes failed mechanical fasteners. For partially adhered membranes, the category includes membrane that is not adhered at points of attachment. For ballasted membranes, the membrane has areas where ballast is missing or displaced.

Note: Holes in the membrane caused by mechanical fasteners are rated as Holes (HL).
Note: If ballast is redistributed by the inspector to cover bare areas, these areas should not be counted as defects.
Note: For defect definitions, "building perimeter" is the area within 10 ft of a roof edge. These areas experience high wind uplift pressures.

Severity Levels:

Low: Any of the following defects:

1. For fully adhered systems, an area of unattached membrane or substrate of 2 sq ft or less.
2. For ballasted systems, a bare area of 4 sq ft or less.

Medium: Any of the following defects:

1. For fully adhered systems, an area of unattached membrane or substrate of greater than 2 sq ft but less than 100 sq ft (less than 25 sq ft at building perimeter).
2. For mechanically attached systems, an isolated mechanical fastener that has lost its attachment capability or backed out causing bridging of the membrane.
3. For partially adhered systems, an isolated point of attachment that has lost adherence.
4. For ballasted systems, a bare area of greater than 4 but less than 100 sq ft (less than 25 sq ft at building perimeter).

High: Any of the following defects:

1. For fully adhered systems, an area of unattached membrane or substrate 100 sq ft or greater (25 sq ft at building perimeter).
2. For mechanically attached systems, adjacent mechanical fasteners that have lost their attachment capability or backed out causing bridging of the membrane.
3. For partially adhered systems, adjacent points of attachment that have lost adherence.
4. For ballasted systems, a bare area of 100 sq ft or greater (25 sq ft at building perimeter).

Measurement:

1. Measure square feet of membrane having the above conditions. For mechanically fastened and partially adhered systems, count the effective area of unattached membrane.
2. When large quantities of this problem are present, the representative sampling technique may be used.

Density:

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

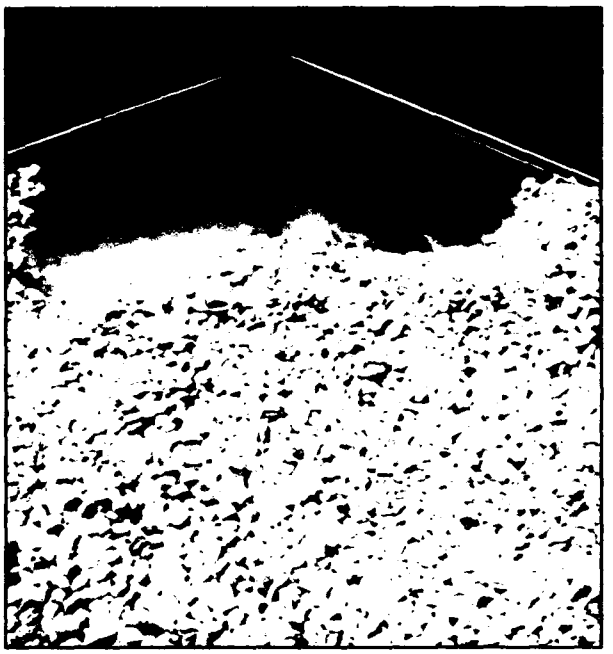
where A = total area of attachment defects (sq ft)
B = total area of roof section being rated (sq ft).

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

Causes:

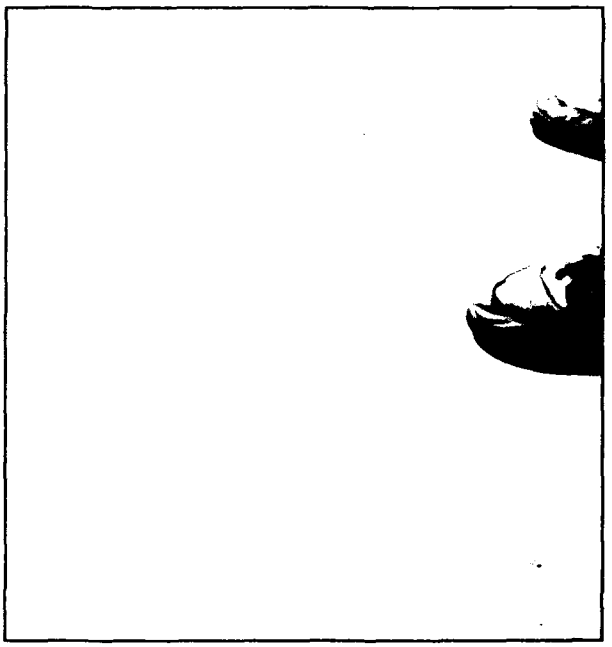
1. Overdriven, underdriven, or crooked placement of fasteners.
2. Membrane was adhered before the solvent had flashed off from the contact adhesive.
3. Wind damage.
4. Traffic damage.
5. Moisture within the system.

SSL1
<Low Severity>
Unattached membrane of less than 2 sq ft

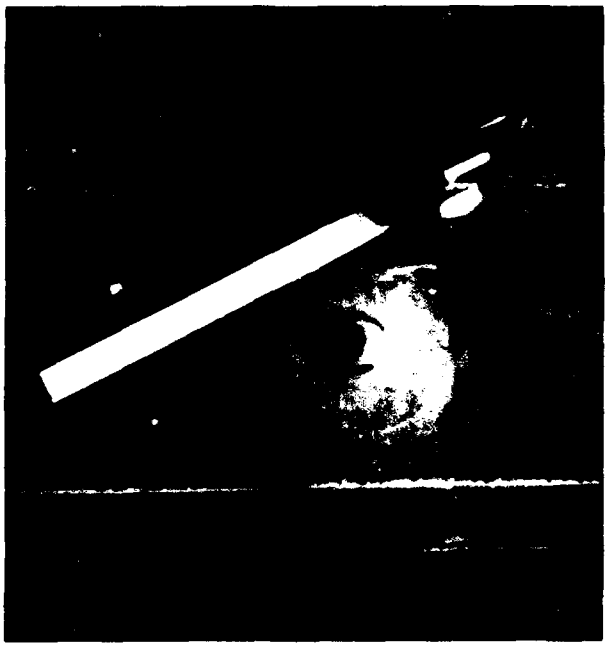


SSL2
<Low Severity>
Ballasted system, bare area of less than 4 sq ft

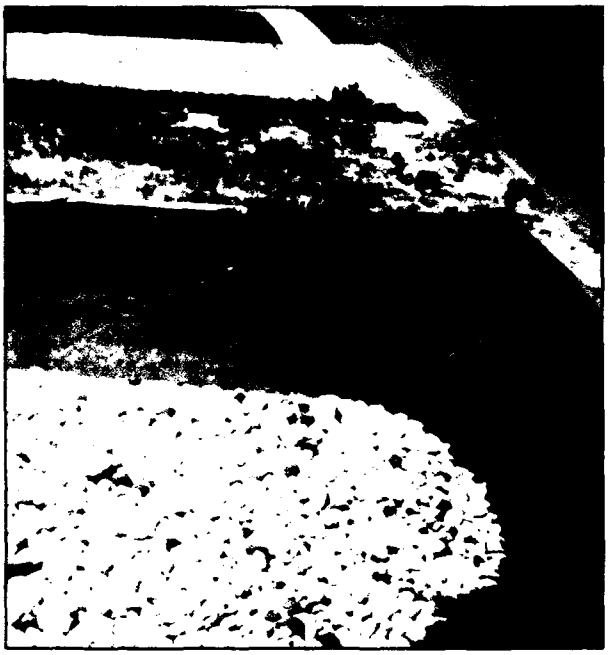
SYSTEM SECUREMENT DEFICIENCIES (SS)



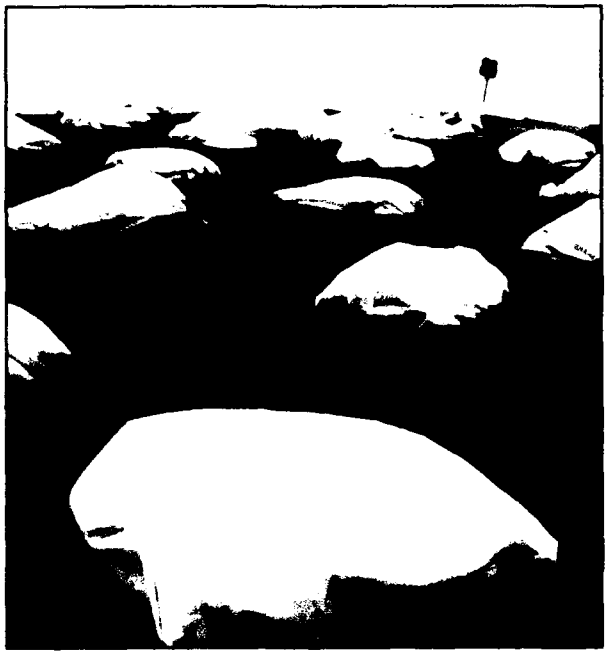
SSM1
<Medium Severity>
Unattached membrane of more than 2 sq ft but less than 100 sq ft



SSM2
<Medium Severity>
Unattached mechanical fastener

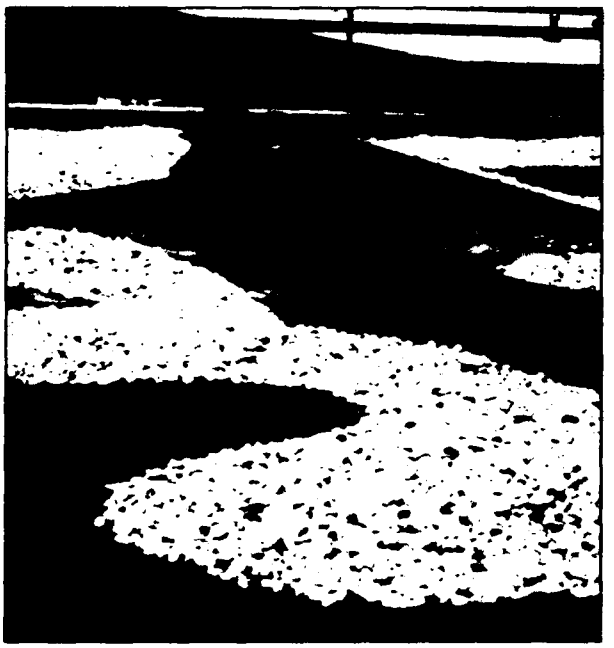


SSM4
<Medium Severity>
Ballasted system, bare area of less than 25 sq ft at building perimeter



SSH1
<High Severity>
Unattached membrane greater than 100 sq ft

SSH2
<High Severity>
Adjacent mechanical fasteners have lost their attachment capability



SSH4
<High Severity>
Ballasted system, bare area more than 100 sq ft

SYSTEM SECUREMENT DEFICIENCIES (SS)

MEMBRANE SUPPORT DEFICIENCIES (MS)

Description: The surface on which the membrane rests may not be smooth and continuous. For fully adhered membranes, partially adhered membranes, and mechanically attached membranes, this category includes warping, bowing, or shrinkage of insulation boards. For ballasted membranes, it includes displaced insulation boards. Localized absence of membrane support may be due to missing components below.

Note: Mechanical fastener defects and loose insulation boards are rated as System Securement Deficiencies (SS).

Severity Levels:

Low: Any of the following defects:

1. Membrane tension caused by warping or bowing of substrate.
2. Uneven joints or gaps more than 1/2 in. wide, but less than 2 in. between insulation boards.

Medium: Any of the following defects:

1. Uneven joints or gaps more than 2 in. wide between insulation boards or absence of substrate support for width of 2 in. or more.
2. For ballasted systems, insulation boards have been displaced.
3. Lumps indicating presence of foreign material between membrane and substrate.

Measurement:

1. Measure square feet of membrane area having the above conditions.
2. When many of these deficiences are present, the representative sampling technique may be used.

Density:

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

where A = total area of membrane support distress (sq ft)
B = total area of roof section being rated (sq ft).

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

Causes:

1. Poor attachment of substrate.
2. Dimensional instability of insulation, decking, or other support materials.
3. Wind displacement of insulation boards.
4. Construction debris.

MSL1
<Low Severity>
Membrane tension caused by warping or bowing of the substrate

MSM1
<Medium Severity>
Uneven support more than 2 in. wide

MSM2
<Medium Severity>
Insulation boards have been displaced

MSM3
<Medium Severity>
Lumps indicating foreign material

MEMBRANE SUPPORT DEFICIENCIES (MS)

PATCHING (PA)

Description: Patching is a localized temporary or permanent repair of the membrane using dissimilar materials. Repairs made with similar materials are not counted as patches; distresses associated with these repairs should be recorded in the appropriate category (often defective seams) and not as patching distresses.

Severity Levels:

Low:

1. All patches that are not made with similar materials as that of the original construction are rated as low severity as a minimum.

Medium:

1. All patches made with temporary materials (i.e., duct tape, caulkings, and sealants) are rated medium severity as a minimum.

High:

1. Other distresses of high severity are present within the patched area (count as patching distress only).

Measurement:

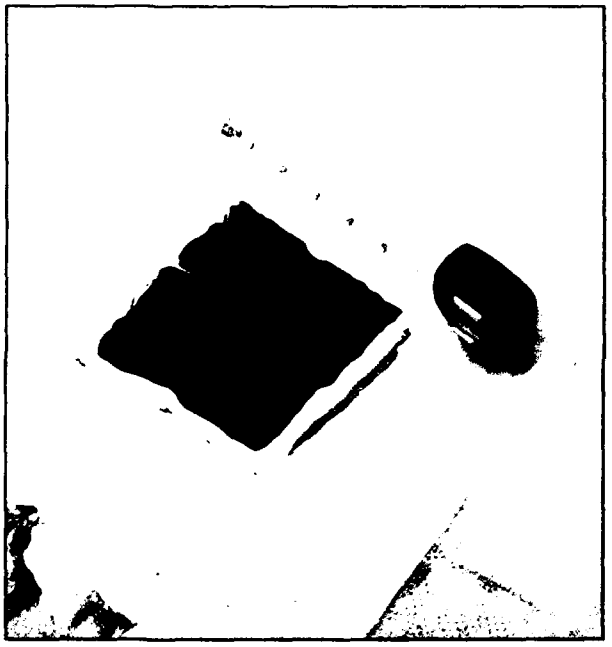
1. Measure square feet of each patch having the above conditions.
2. When large quantities of this problem are present, the representative sampling technique may be used.

Density:

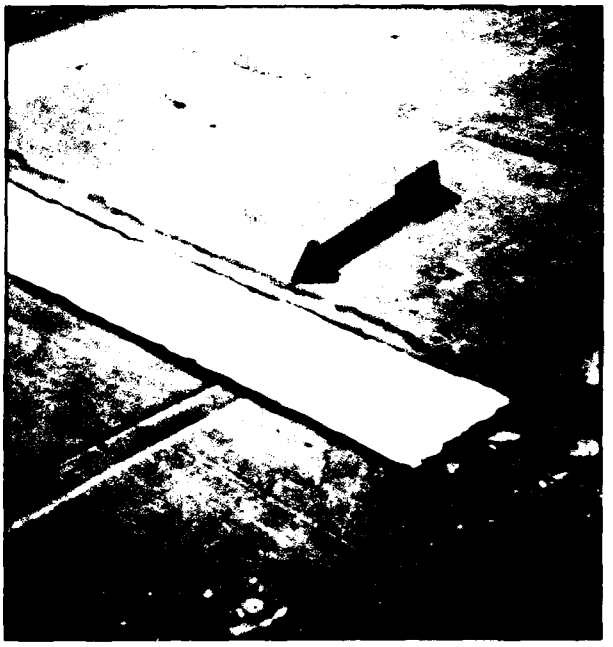
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

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

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



PAL1
<Low Severity>
Patch made with dissimilar material



PAH1
<High Severity>
Other distresses (i.e., fishmouths) along edge of patch

DEBRIS AND VEGETATION (DV)

Description: Debris and vegetation includes the presence of foreign objects, vegetation, fungal growth, solvents, oils, or other chemicals that could damage, puncture, or degrade the membrane.

Note: Accumulation of oils and grease can present a significant fire hazard and should be reported immediately.

Note: Do not rip out vegetation that is growing into the waterproofing system, as that may allow water to penetrate.

Severity Levels:

Medium: Any of the following defects:

1. Vegetation that has not penetrated the membrane.
2. Degradation of the membrane caused by solvents, oil, or other chemicals.
3. Foreign materials that are not removed from the roof during the inspection.

High: Any of the following defects:

1. Vegetation that has penetrated the membrane.
2. Degradation of the membrane caused by solvents, oil, or other chemicals allowing water to penetrate.

Measurement: Measure square feet of debris and vegetation having the above conditions.

Density:

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

where A = total area of debris and vegetation (sq ft)
B = total area of roof section being rated (sq ft).

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

Causes: Lack of preventative maintenance.

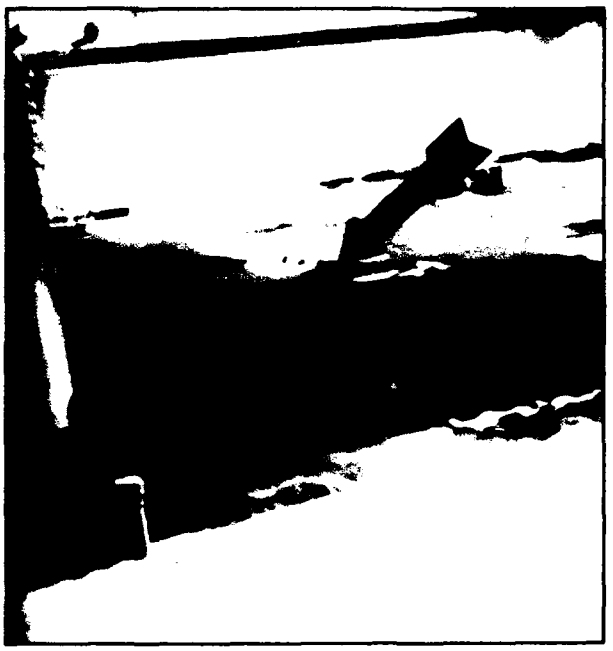
DVM1
<Medium Severity>
Vegetation that has not penetrated the membrane

DVM2
<Medium Severity>
Degradation of membrane caused by solvents or oil

DVM3
<Medium Severity>
Foreign materials that were not removed during inspection

DVH1
<High Severity>
Vegetation that has penetrated the membrane

DEBRIS AND VEGETATION (DV)



DVH2
<High Severity>
Degradation of membrane by oils has caused a hole, allowing water to penetrate

IMPROPER EQUIPMENT SUPPORTS (EQ)

Description: Improper equipment supports or pipes, conduits, and mechanical equipment supports (wood sleepers, channels, etc.) that are placed directly on the membrane with no protective pad or are not placed high enough to allow for maintenance of the membrane below the equipment. Repairing this distress may require replacing the surrounding insulation and membrane.

Note: Terminations for guy wires are rated as Flashed Penetration (FP) distresses.

Severity Levels:

Low:

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

Medium: Any of the following defects:

1. Movement of the support has displaced the membrane but has not cut or punctured it.
2. Equipment is bolted through the membrane but the membrane is sealed and watertight.

High: Any of the following defects:

1. Movement of support has cut or punctured the roof membrane.
2. The equipment is bolted through the membrane and the membrane is not sealed, allowing water to penetrate.

Measurement: Measure square feet of each improper equipment support. The minimum dimensions for length and width of a support shall be 1 ft.

Density:

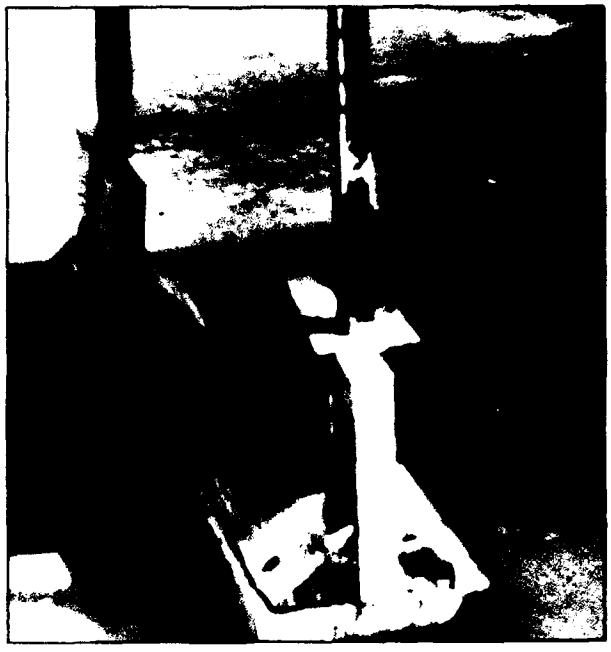
$$\frac{A}{B} \times 100 = \text{Problem Density}$$

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.

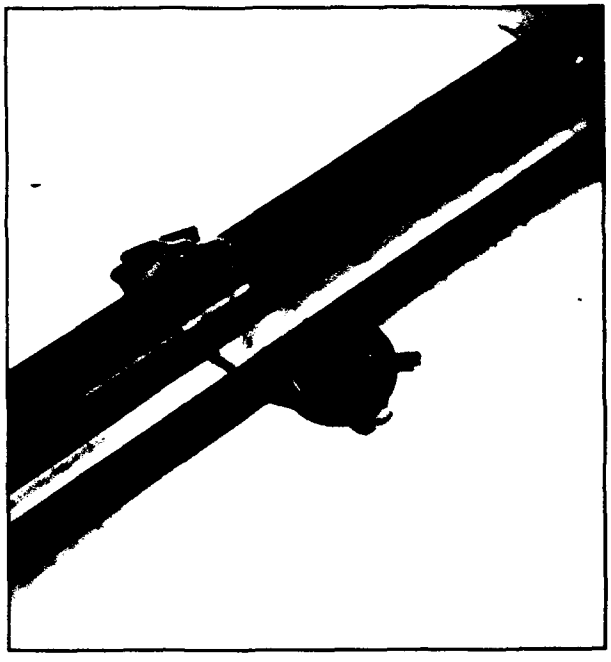
Causes:

1. Inadequate design.
2. Poor construction.



EQL1
<Low Severity>
Equipment stand supported by wood blocking

EQL1
<Low Severity>
Pipe supported by wood blocks



EQL1
<Low Severity>
Improper equipment supports

EQH1
<High Severity>
Movement of support has cut the membrane

IMPROPER EQUIPMENT SUPPORTS (EQ)

PONDING (PD)

Description: Ponding includes standing water or evidence of standing water by the presence of staining or accumulation of debris. Water that remains longer than 48 hr is considered ponded water.

Severity Levels:

Low:

1. General ponding is rated low severity.

Medium: Any of the following defects:

1. Ponding caused by wrinkles or folds in the membrane that block drainage.
2. Ponding caused by warping or bowing of the substrate beneath the membrane.

Measurement: Measure square feet of affected area.

Density:

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

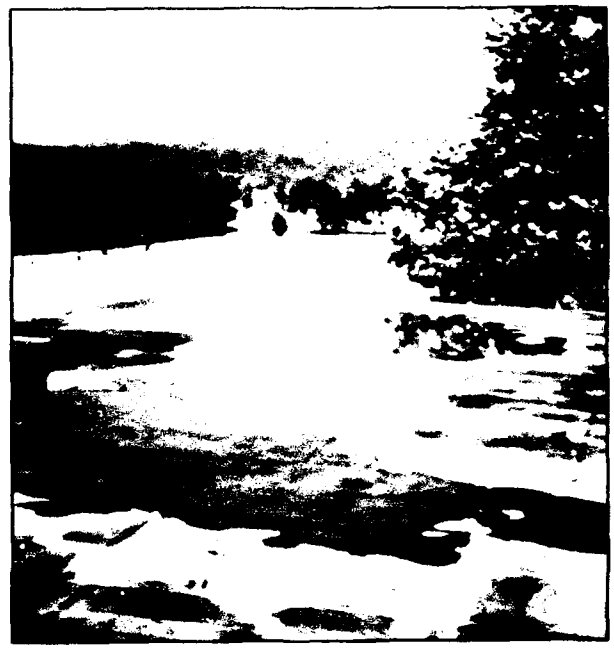
where A = total area of ponding (sq ft)
B = total area of roof section being rated (sq ft).

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

Causes:

1. Improper design or construction.
2. Irregularities of membrane surface.
3. Clogged roof drains or scuppers.
4. Deck deflection.

PDL1
<Low Severity>
General ponding



PDL1
<Low Severity>
General ponding in field of roof

PDM1
<Medium Severity>
Ponding caused by wrinkles or folds in the membrane

METRIC CONVERSION TABLE

1 ft = 0.305 m
1 sq ft = 0.0929 m^2
1 in. = 25.4 mm

REFERENCES

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

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Bailey, D. M., B. Young, S. Hansen, and J. Elston, *Micro ROOFER User's Guide*, USACERL ADP Report M-90/12 (USACERL, 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 (USACERL, September 1987a).

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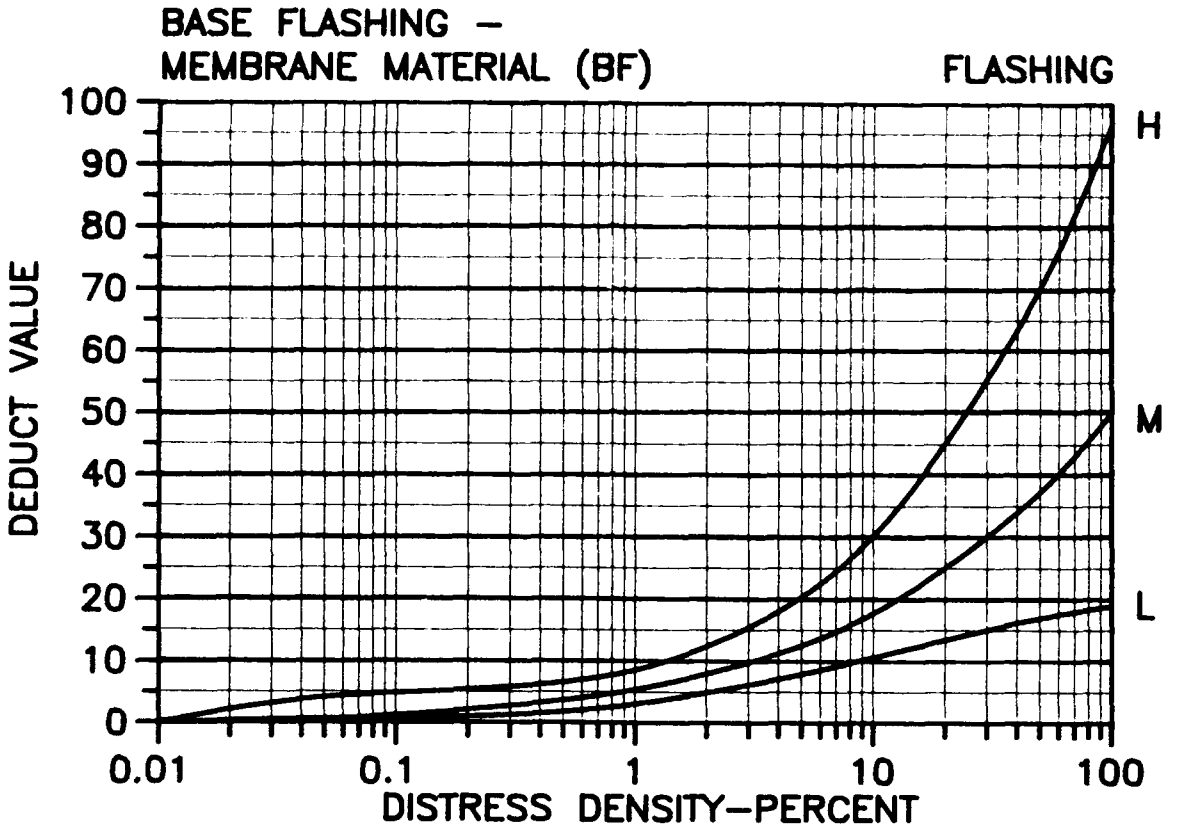
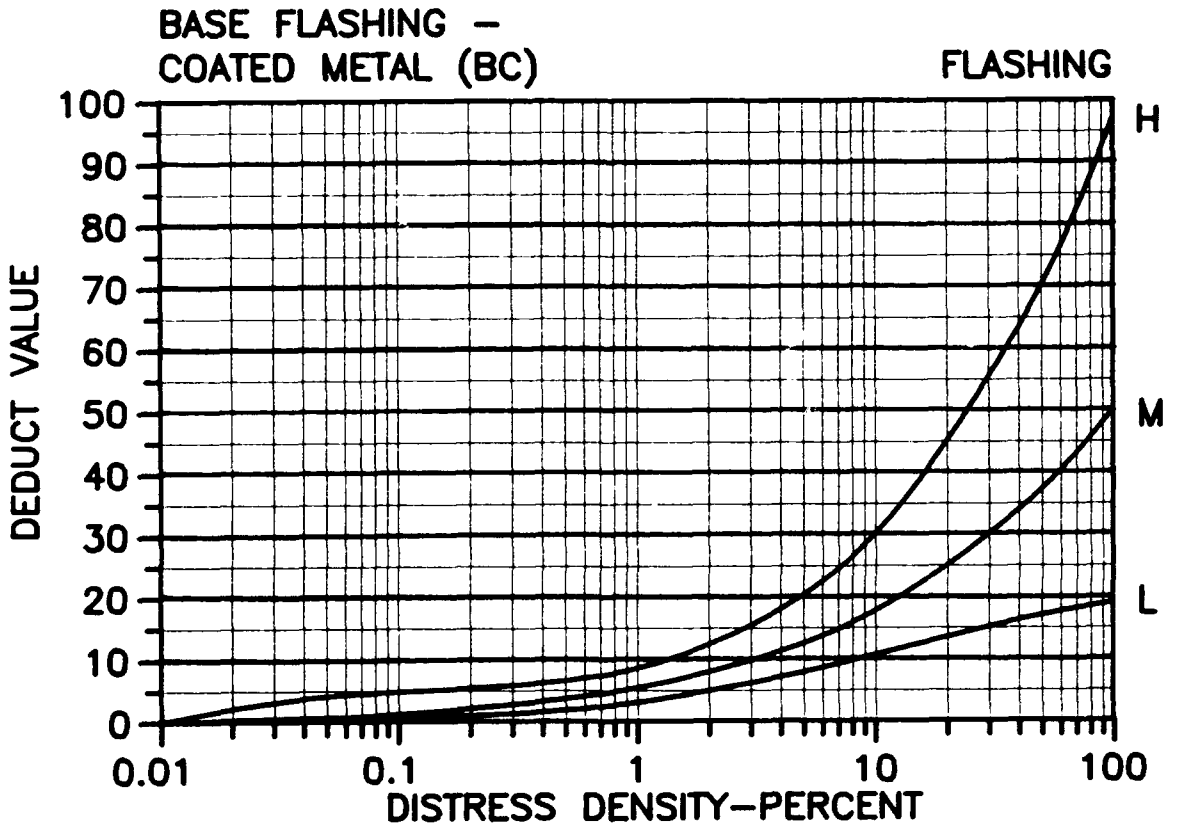
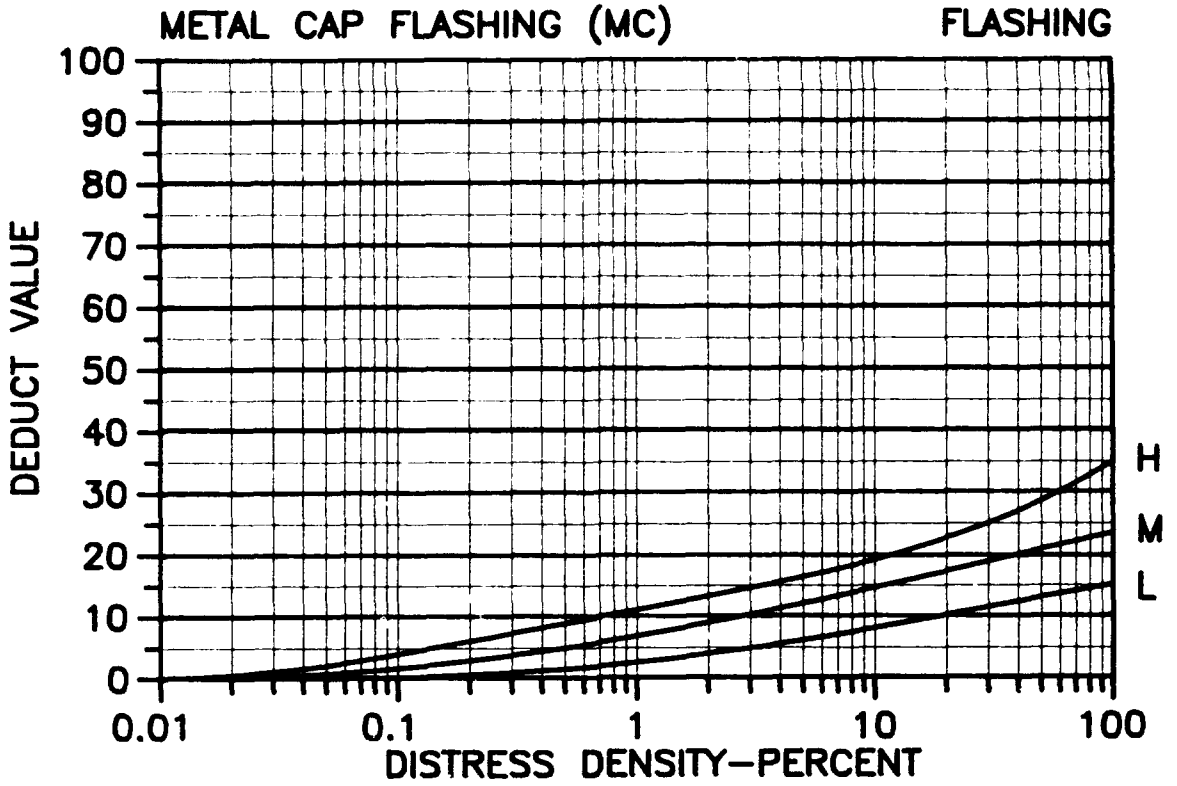
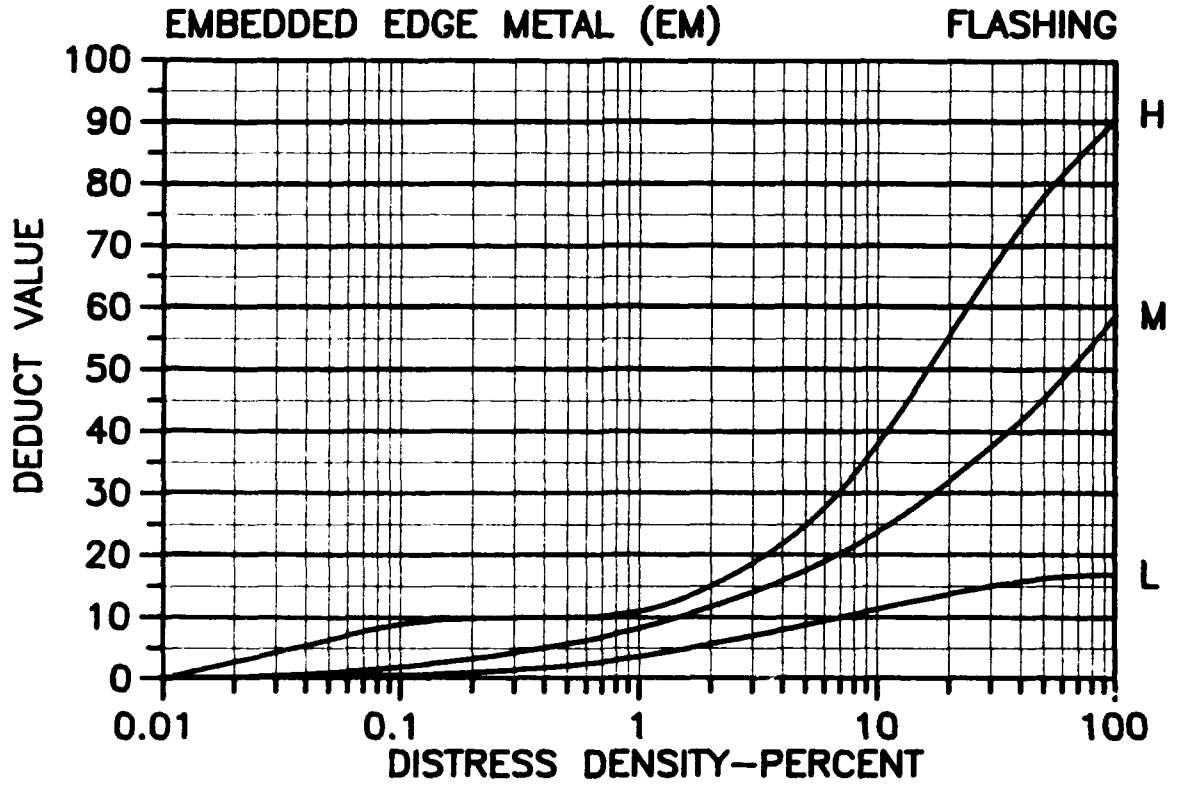
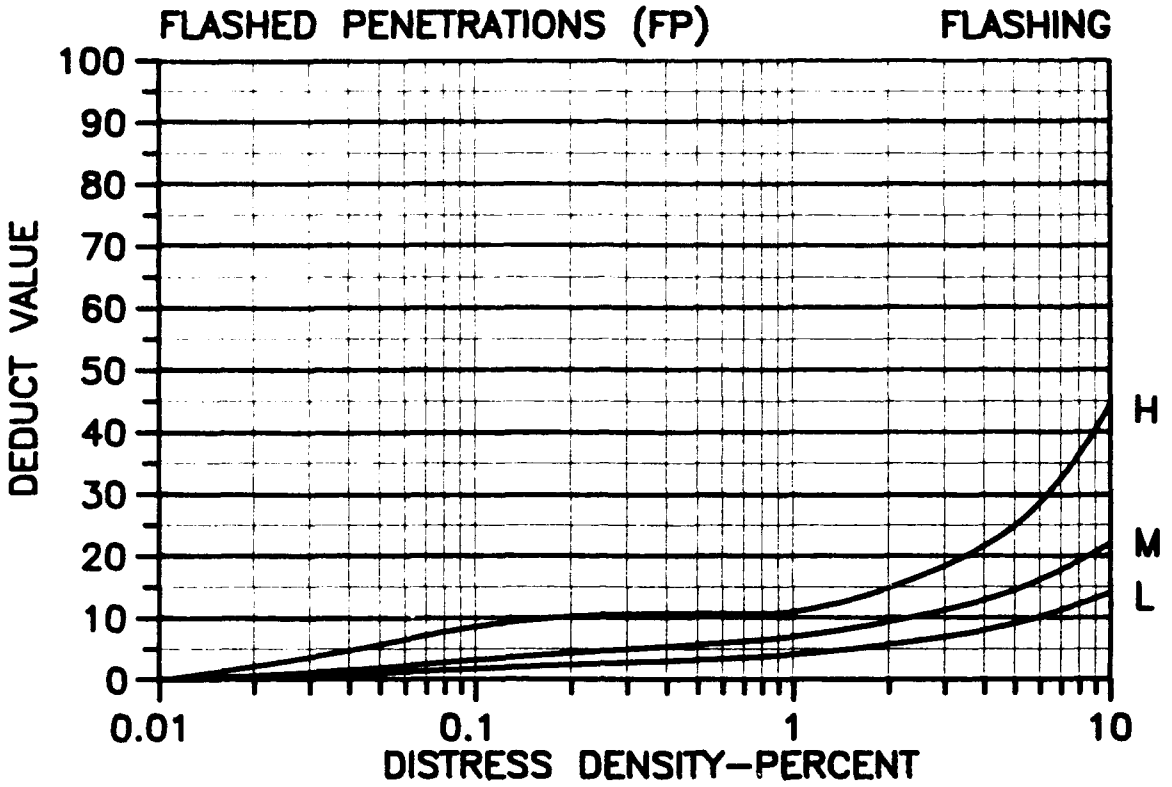
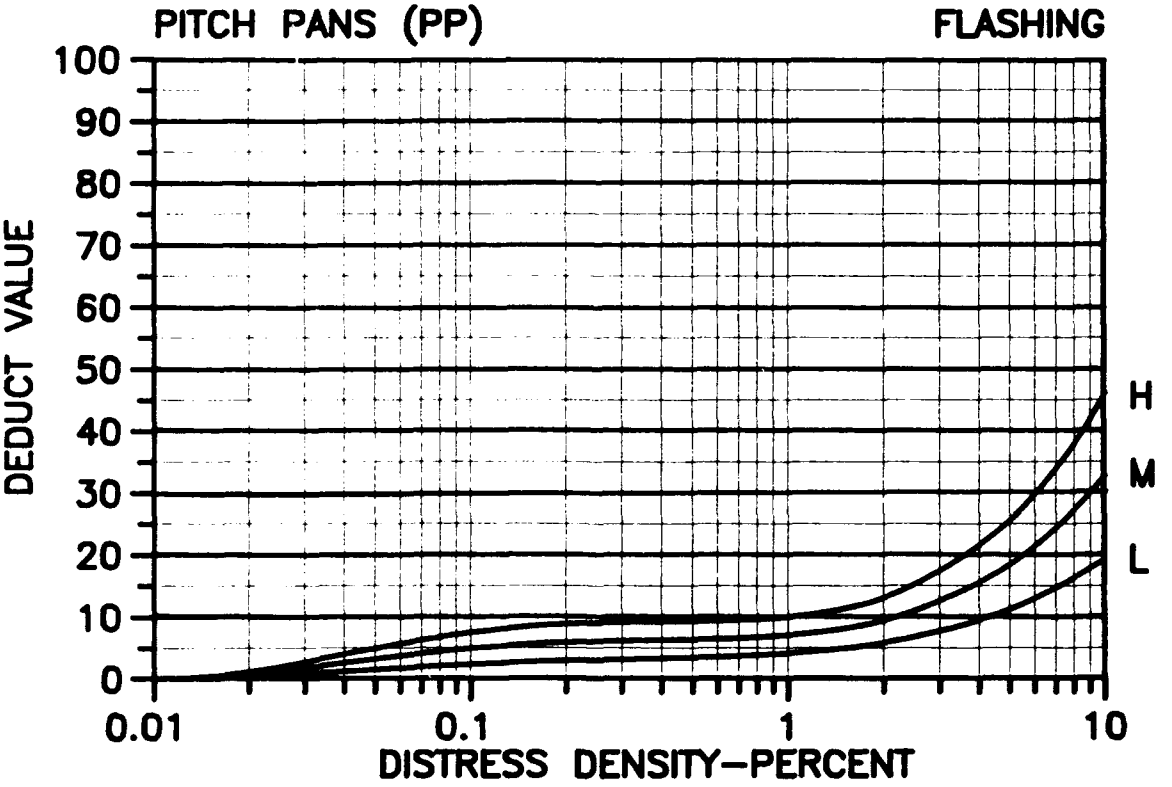

BASE FLASHING –
MEMBRANE MATERIAL (BF)
FLASHING
H
M
L
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT

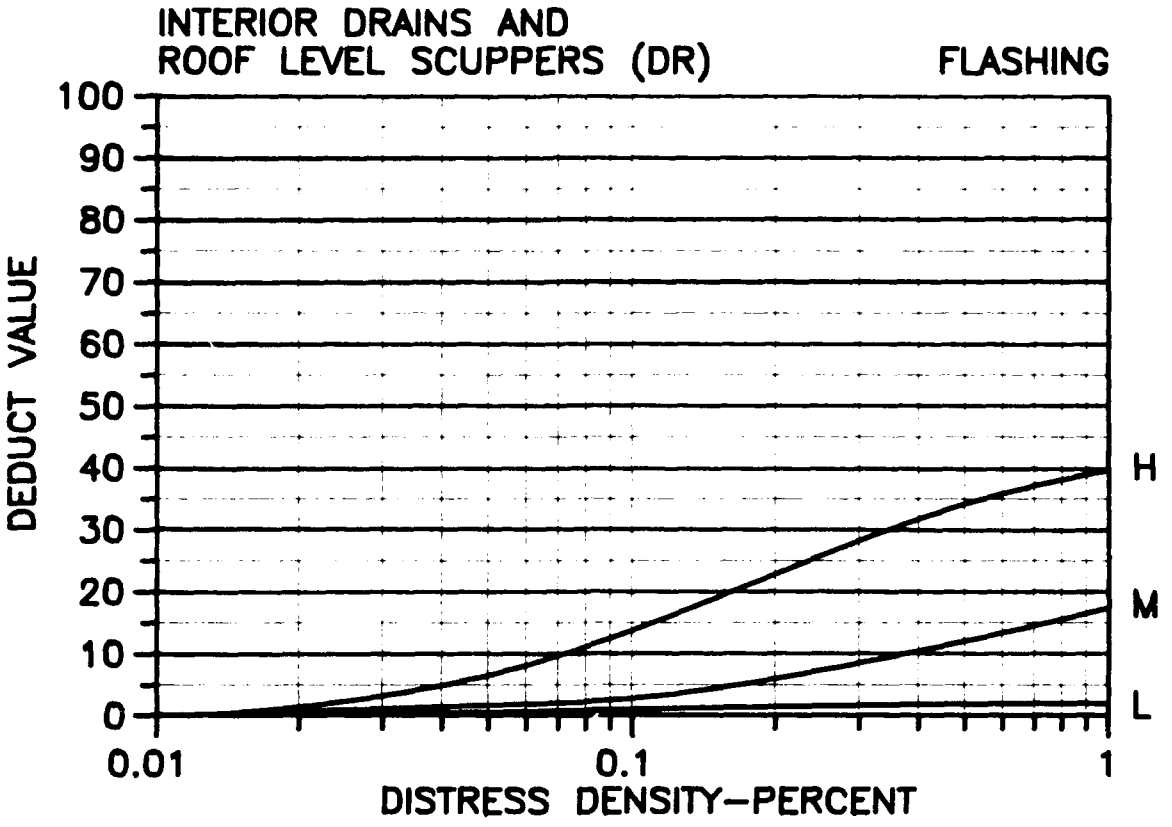

BASE FLASHING –
COATED METAL (BC)
FLASHING
H
M
L
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT

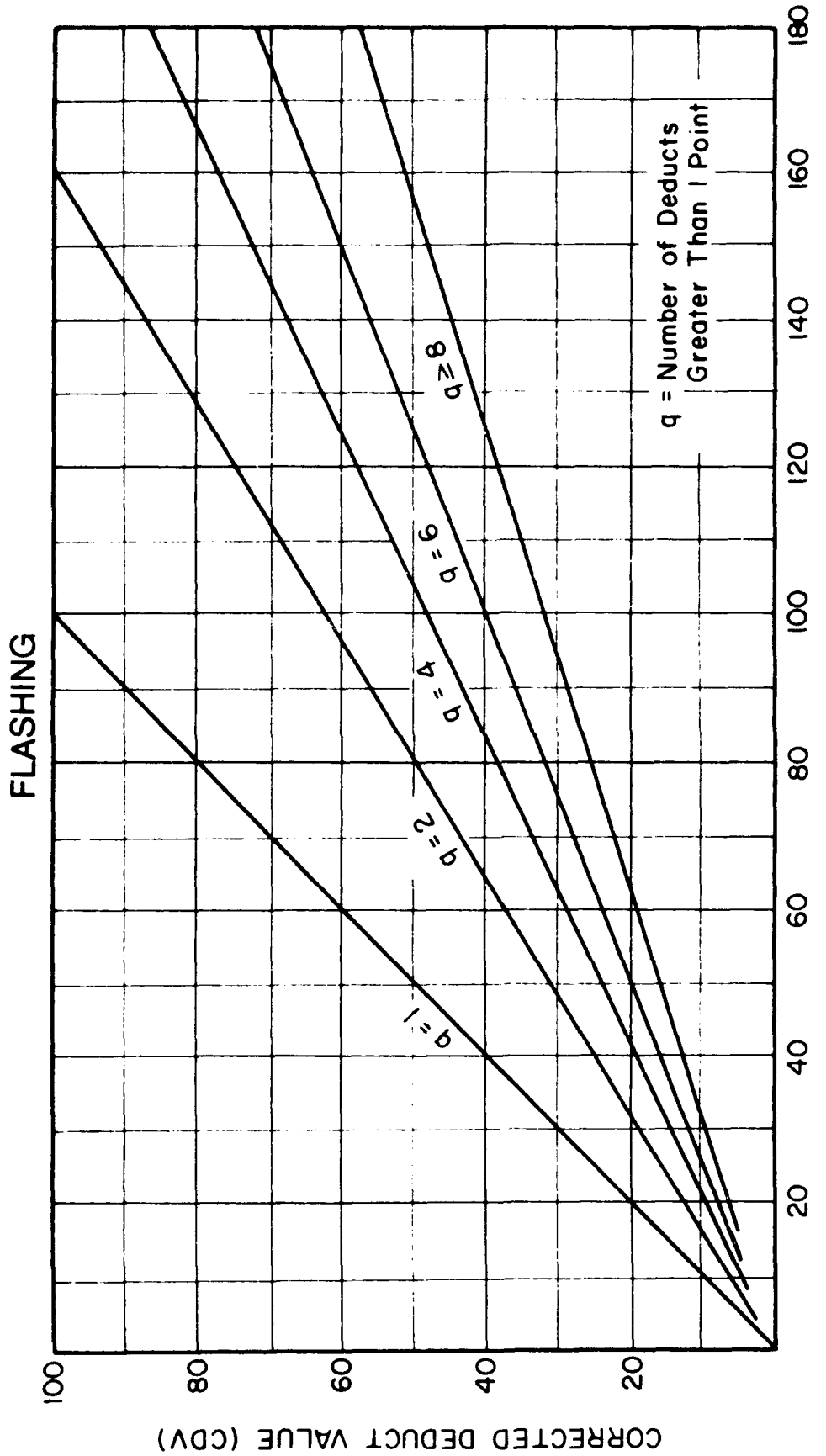

METAL CAP FLASHING (MC)
FLASHING
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT


EMBEDDED EDGE METAL (EM)
FLASHING
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

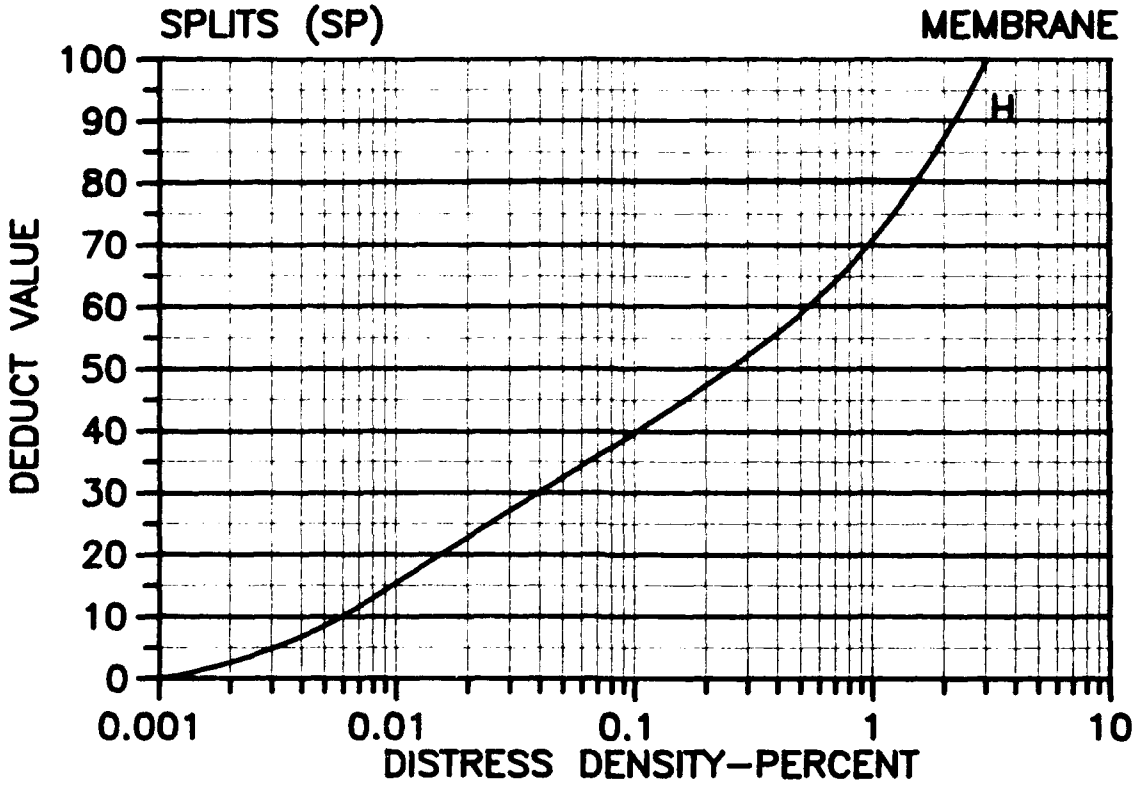

FLASHED PENETRATIONS (FP)
FLASHING
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
DISTRESS DENSITY–PERCENT

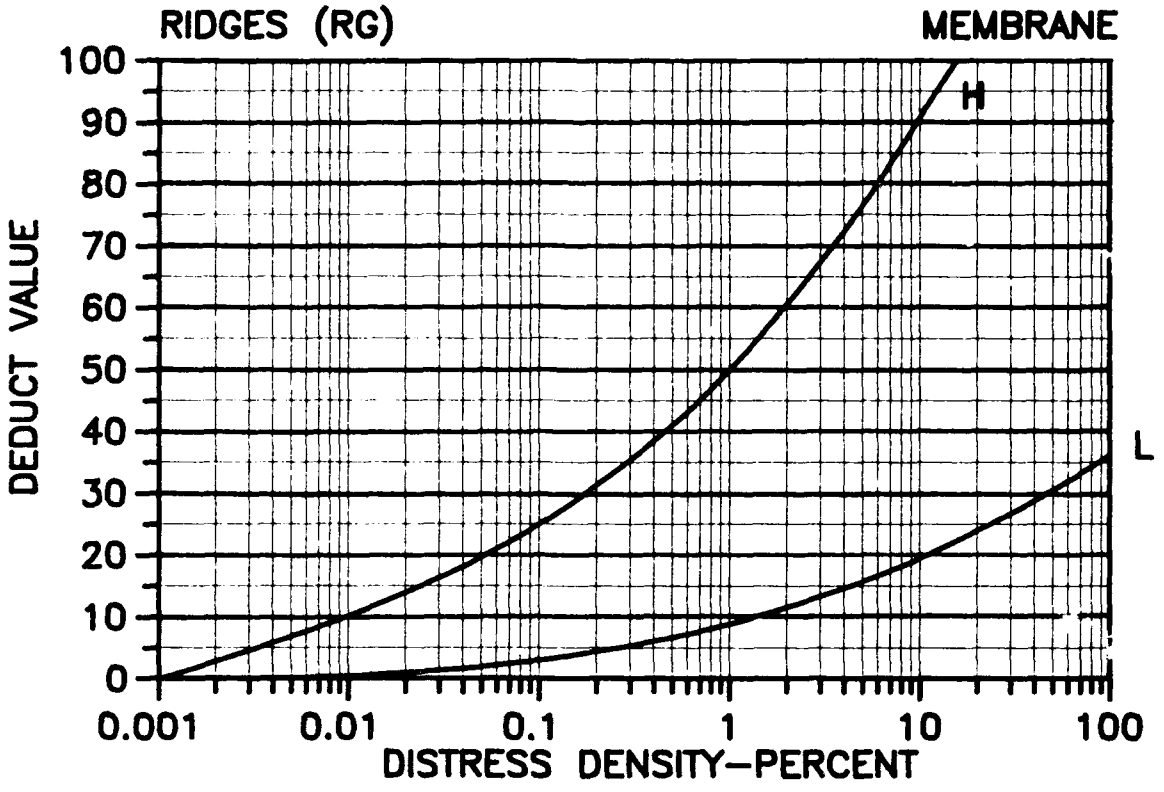

PITCH PANS (PP)
FLASHING
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
DISTRESS DENSITY–PERCENT

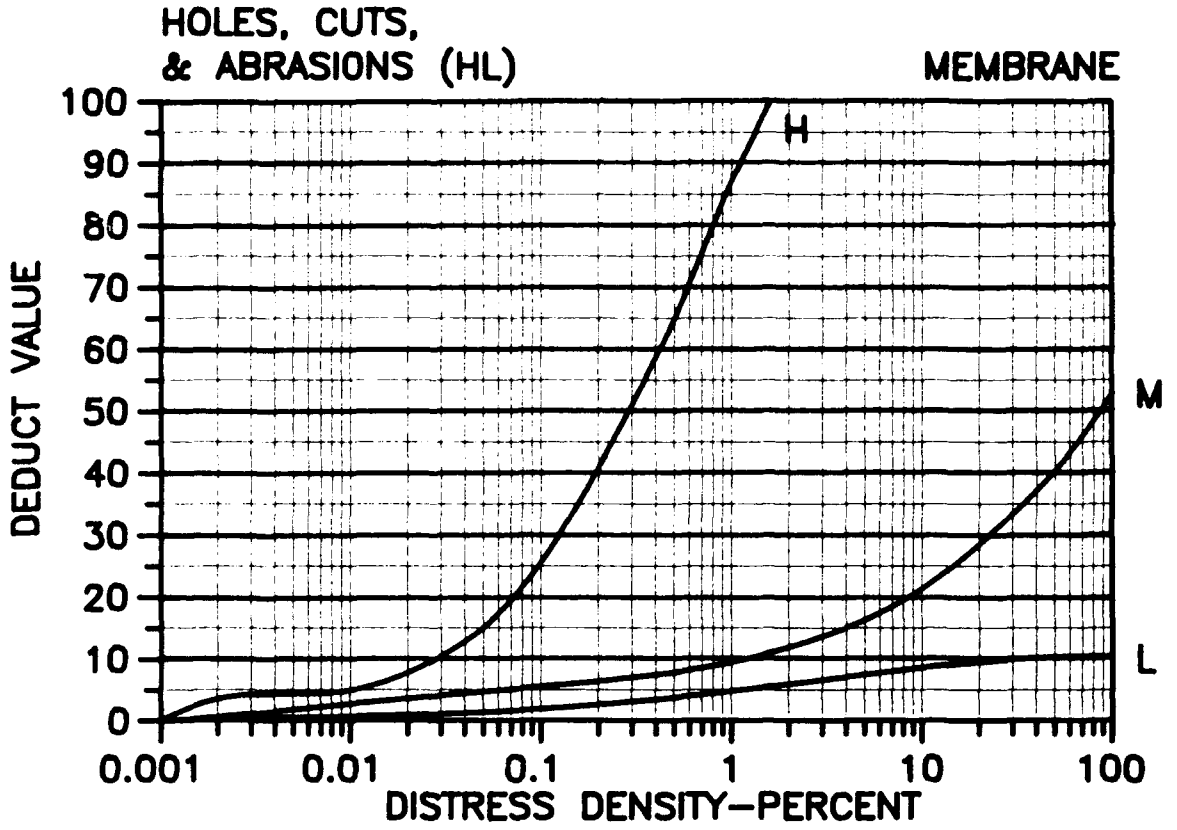

INTERIOR DRAINS AND
ROOF LEVEL SCUPPERS (DR)
FLASHING
100
90
80
70
60
50
40
30
20
10
0
DEDUCT VALUE
H
M
L
0.01
0.1
1
DISTRESS DENSITY–PERCENT

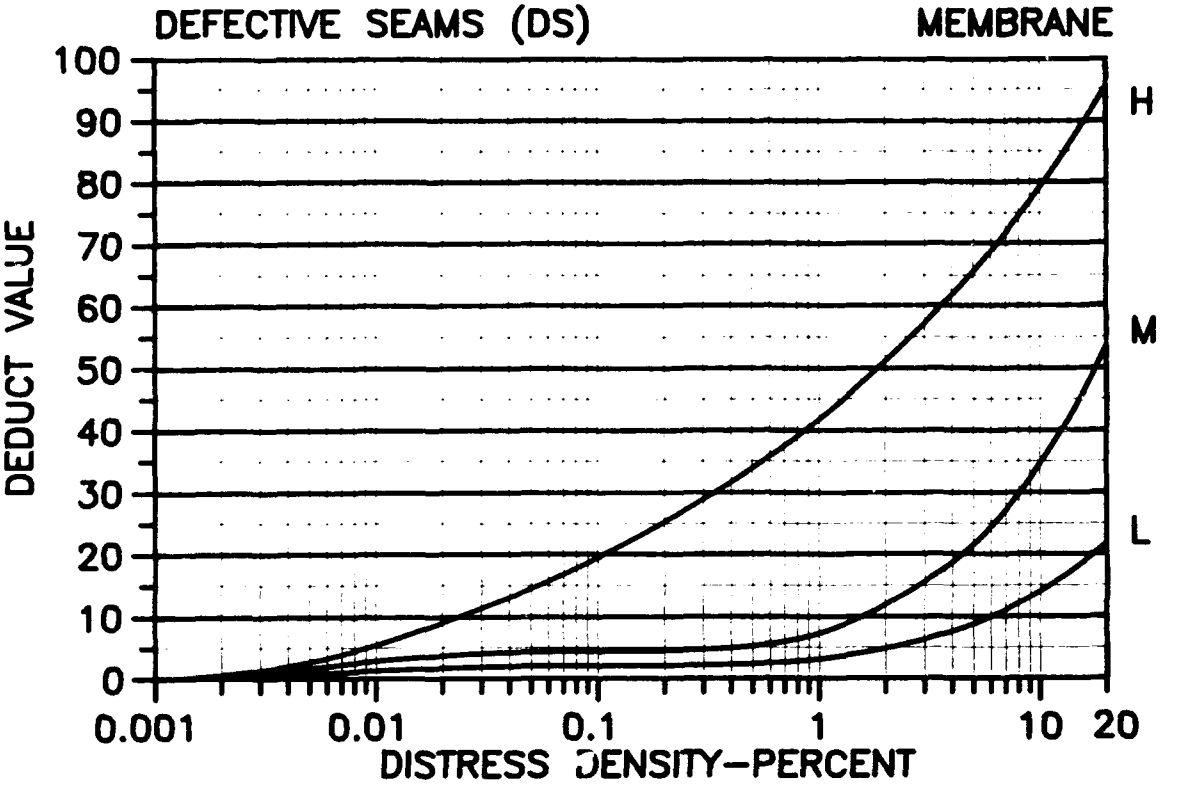


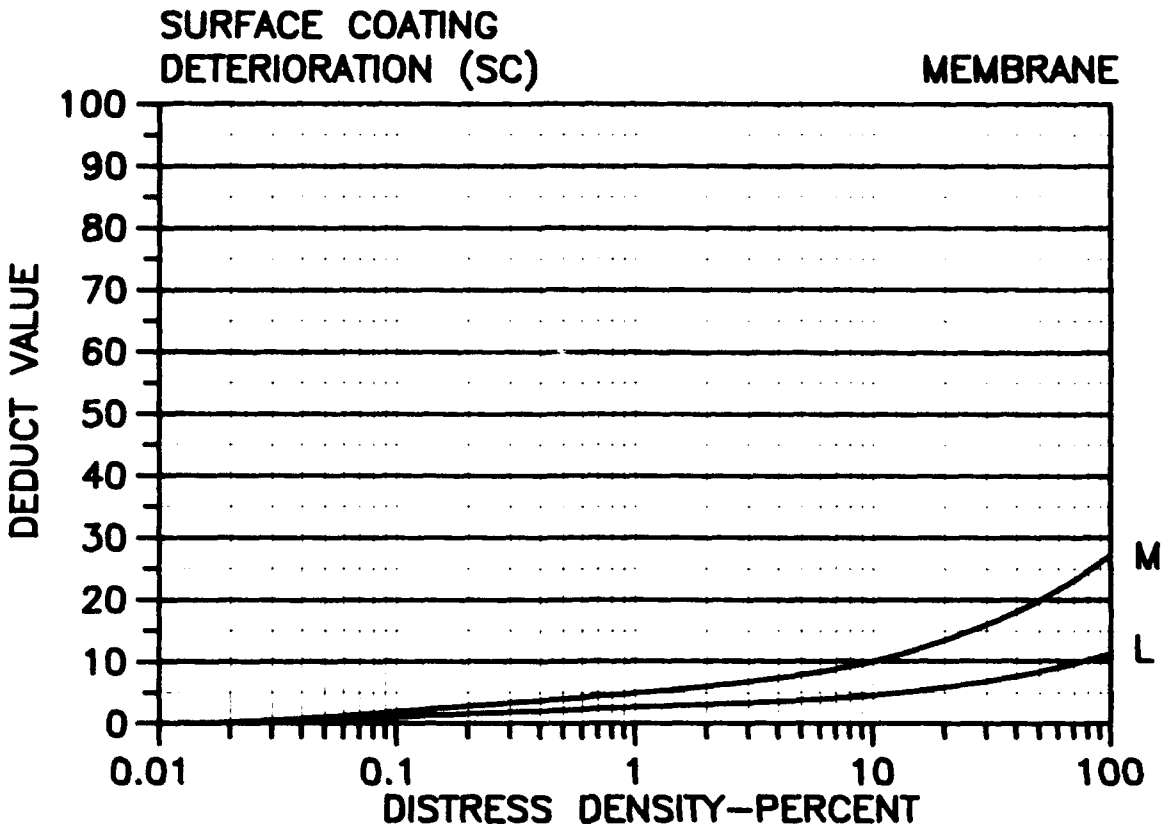
Corrected deduct values for flashing.

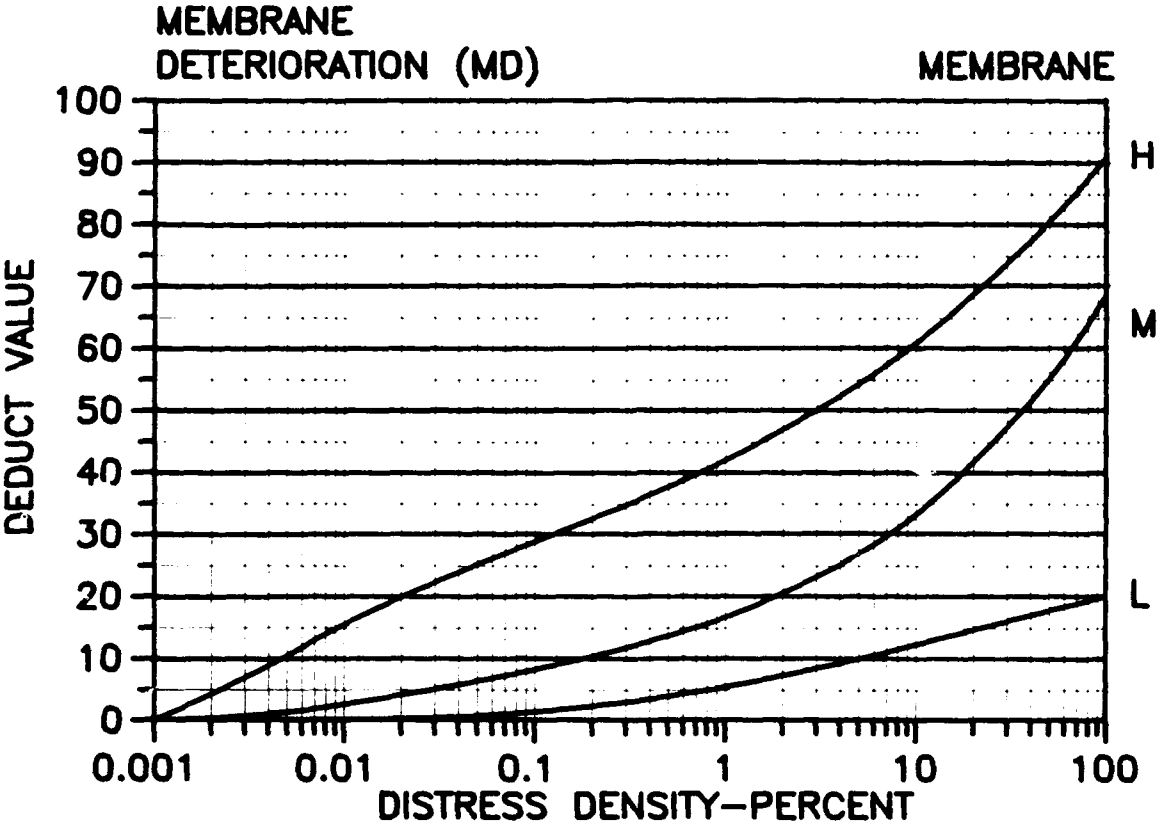

SPLITS (SP)
MEMBRANE
H
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
DISTRESS DENSITY–PERCENT


RIDGES (RG)
MEMBRANE
H
L
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT


HOLES, CUTS,
& ABRASIONS (HL)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.001
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT


DEFECTIVE SEAMS (DS)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.001
0.01
0.1
1
10
20
DISTRESS DENSITY–PERCENT


SURFACE COATING
DETERIORATION (SC)
MEMBRANE
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


MEMBRANE
DETERIORATION (MD)
MEMBRANE
DEDUCT VALUE
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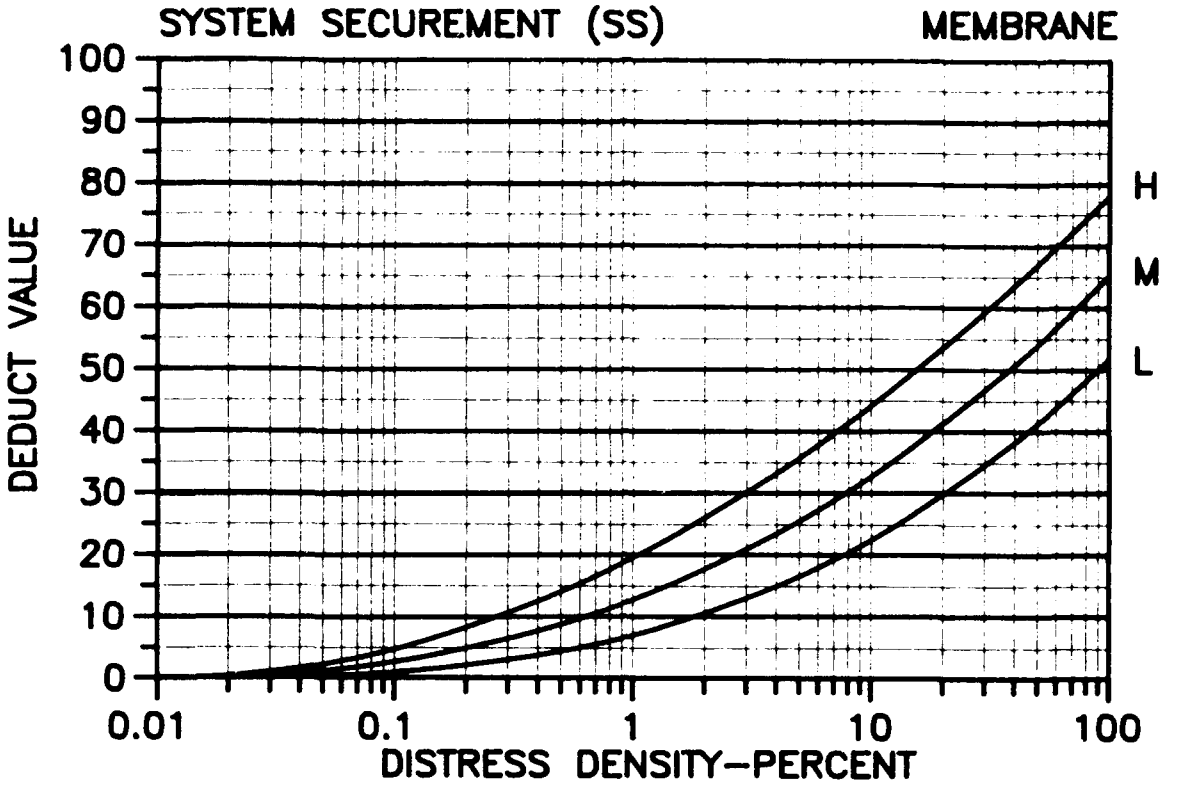
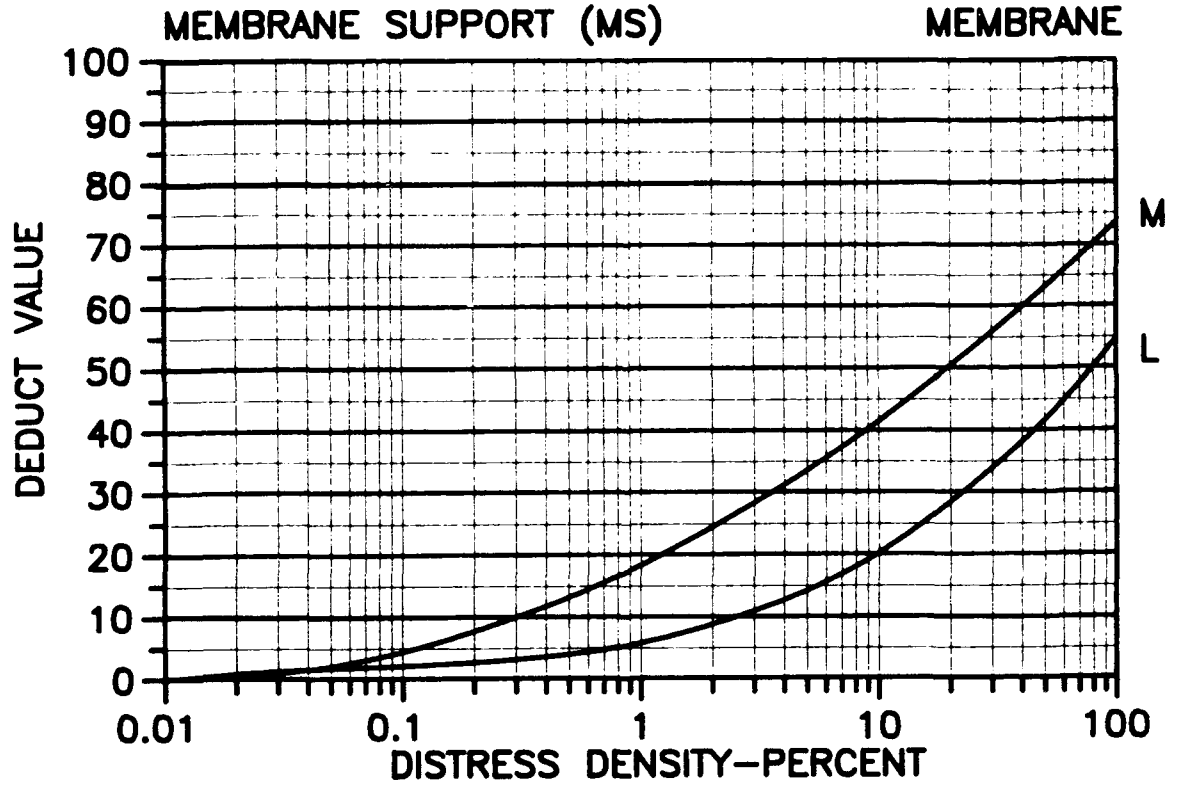
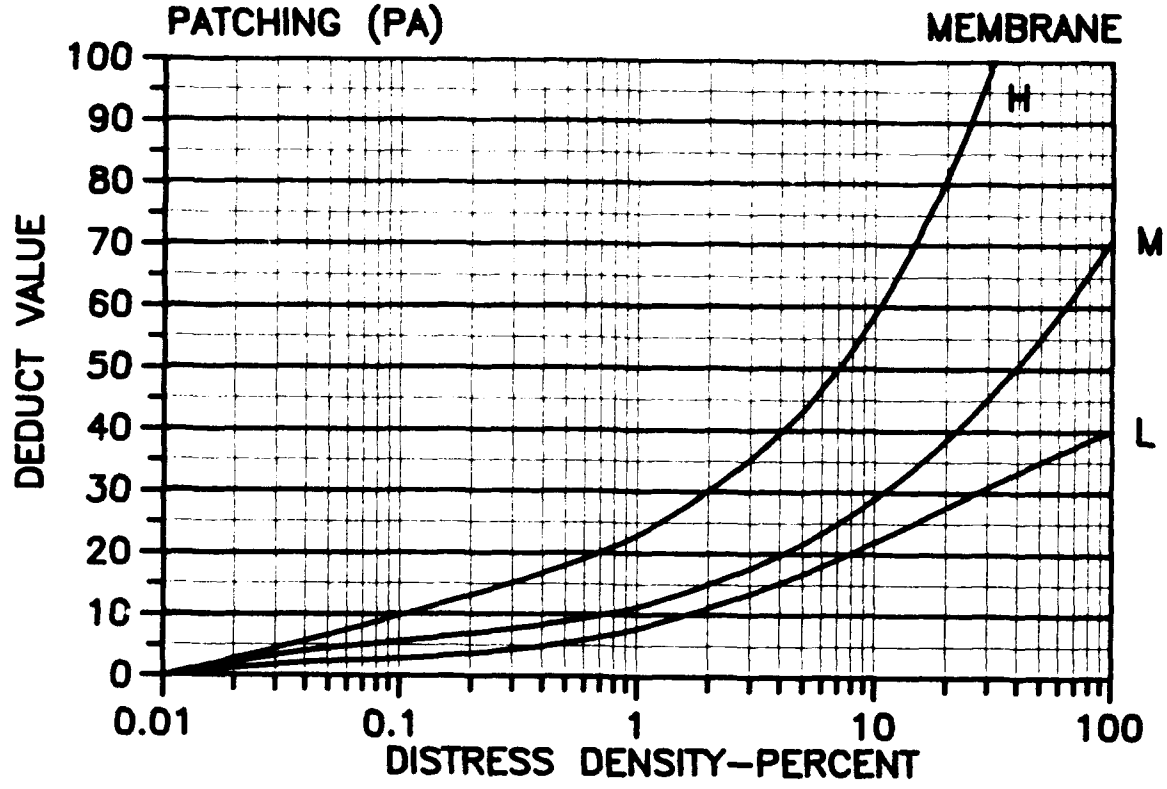
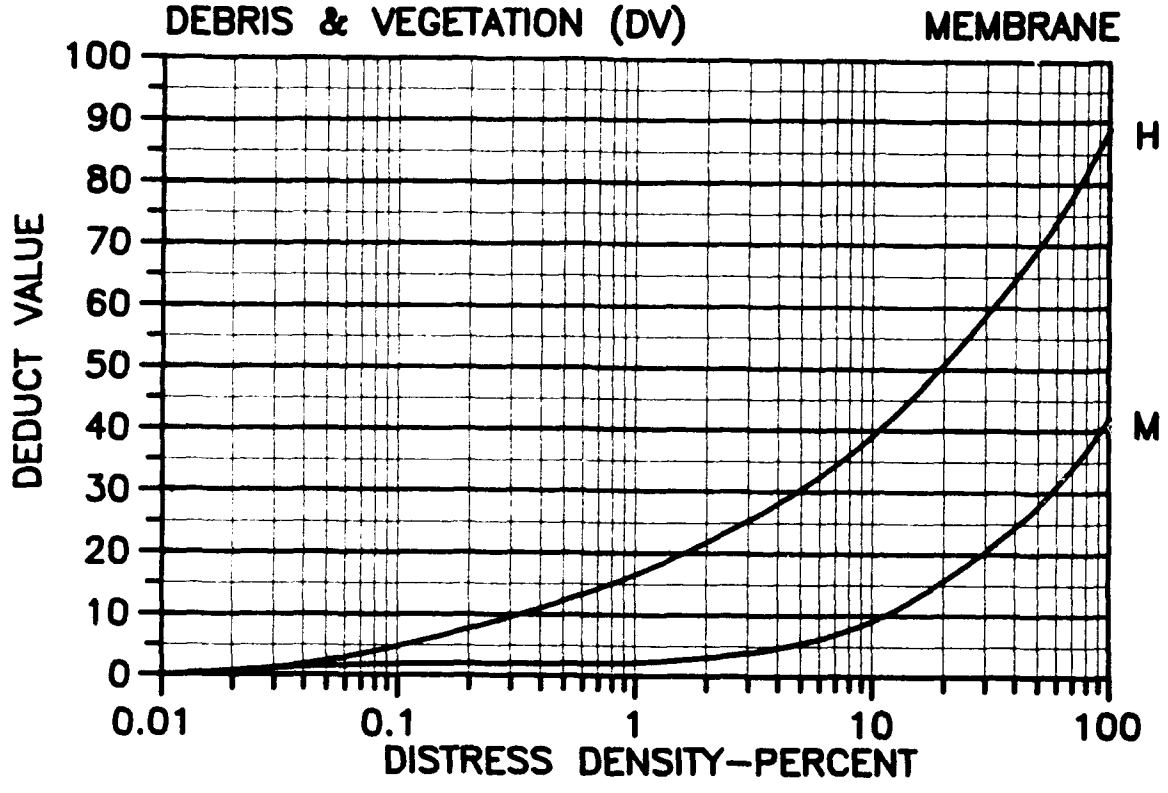
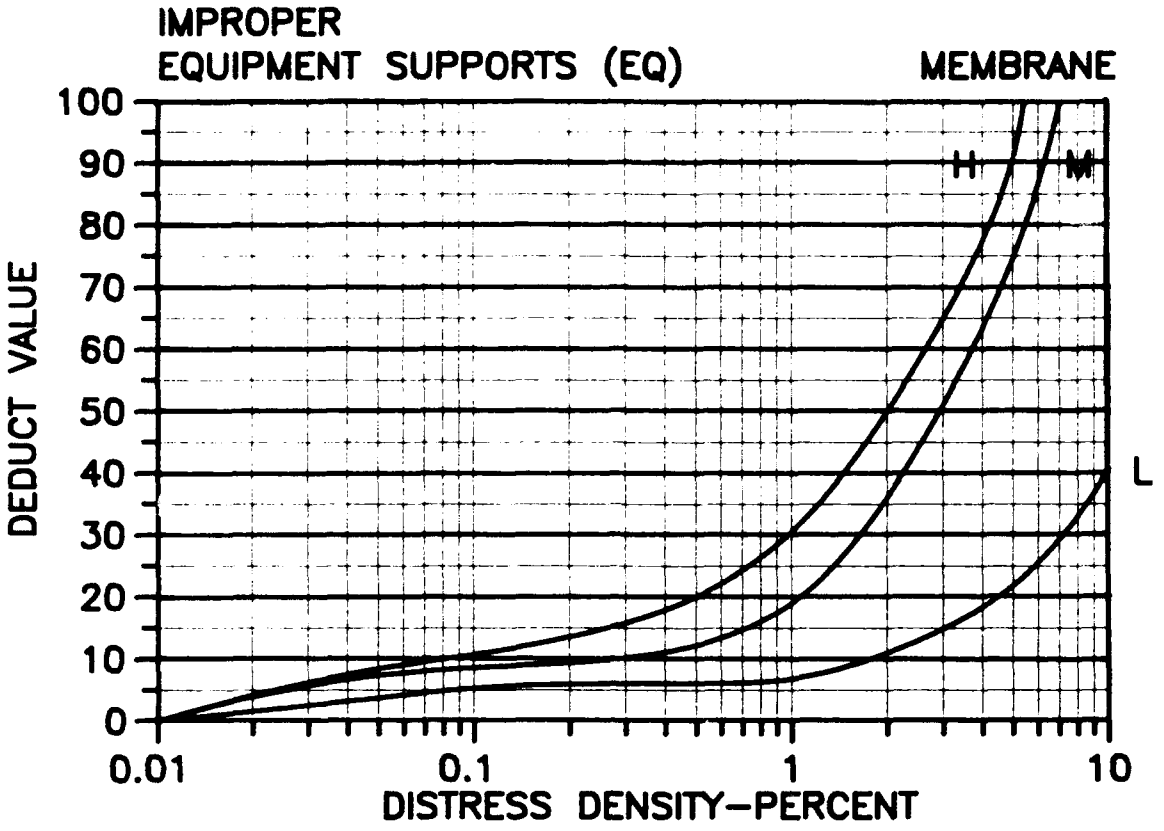
90
80
70
60
50
40
30
20
10
0
H
M
L
0.001
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT

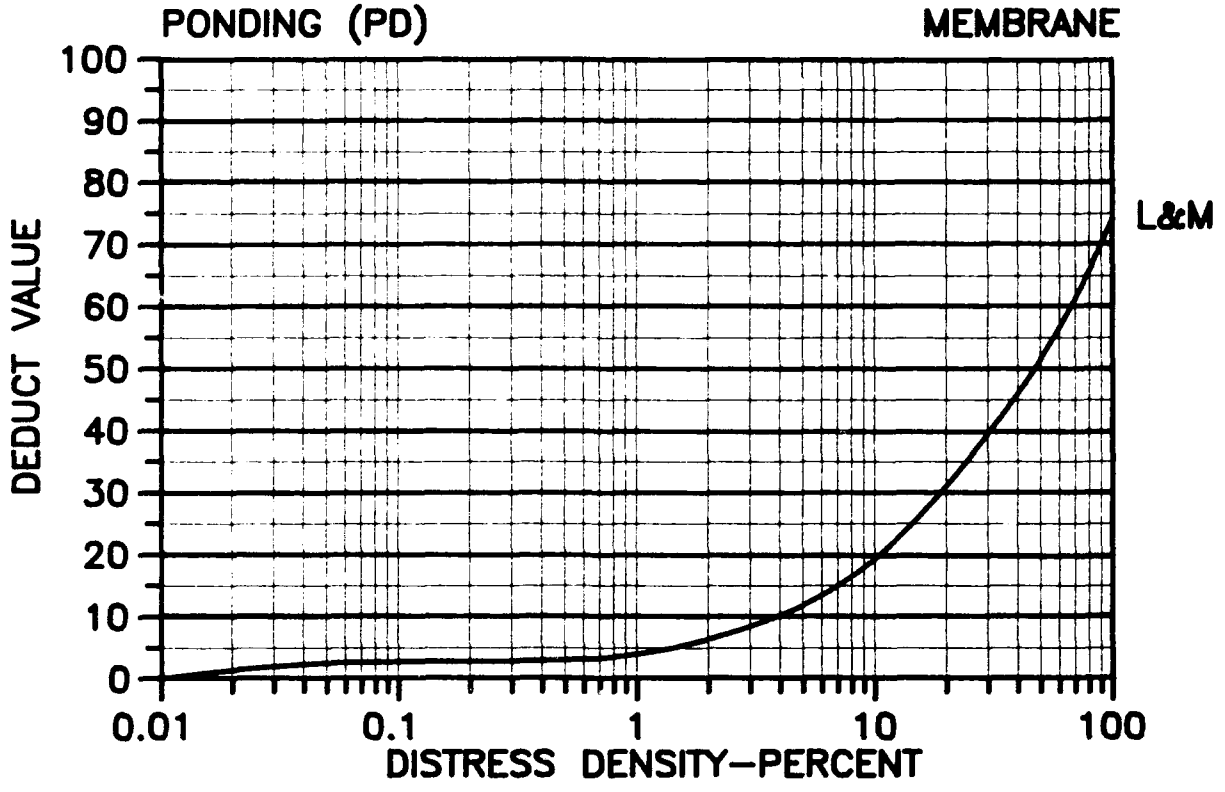

SYSTEM SECUREMENT (SS)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT

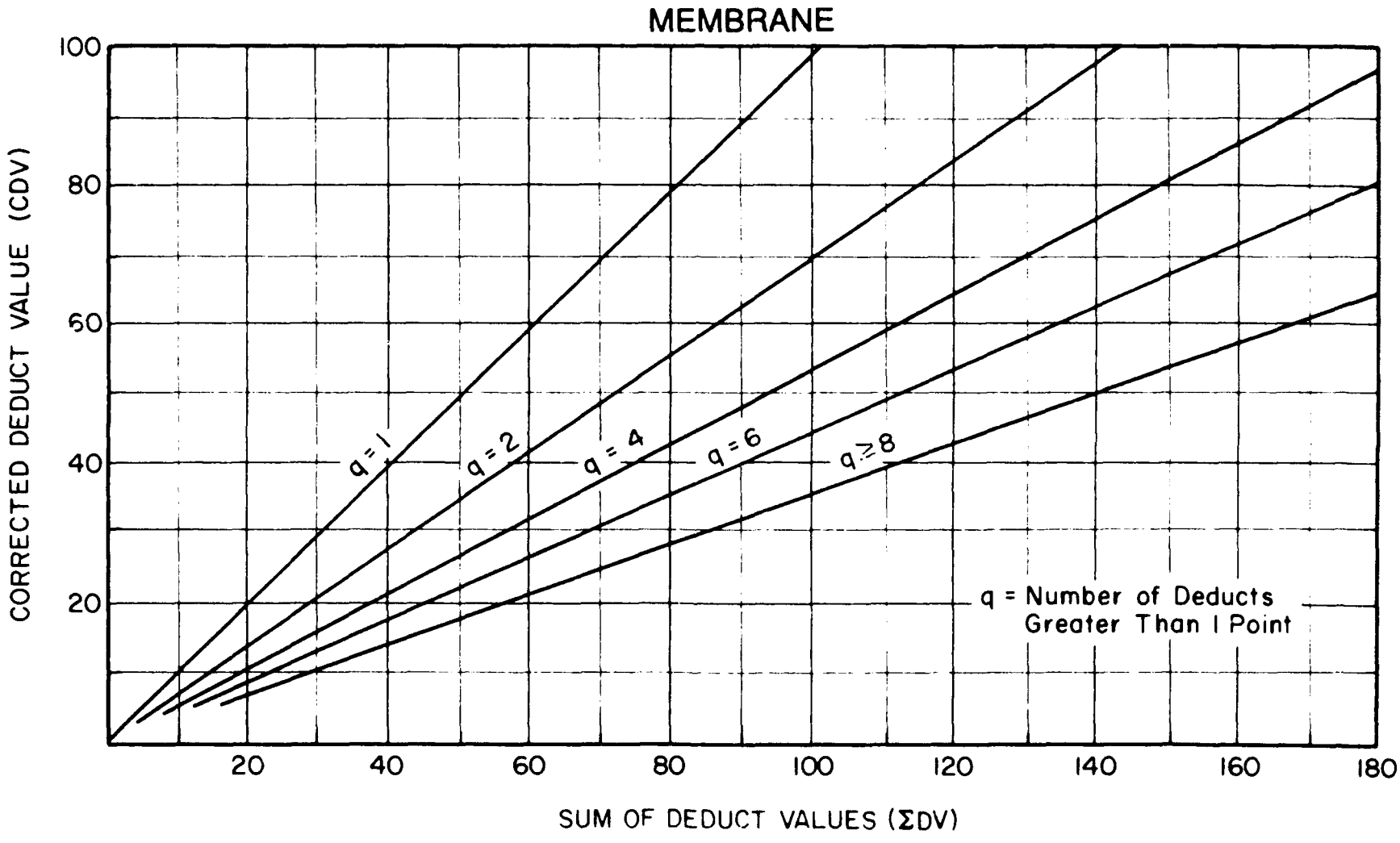

MEMBRANE SUPPORT (MS)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
M
L
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT


PATCHING (PA)
MEMBRANE
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


DEBRIS & VEGETATION (DV)
MEMBRANE
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


IMPROPER
EQUIPMENT SUPPORTS (EQ)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.01
0.1
1
10
DISTRESS DENSITY–PERCENT


PONDING (PD)
MEMBRANE
DEDUCT VALUE
100
90
80
70
60
50
40
30
20
10
0
L&M
0.01
0.1
1
10
100
DISTRESS DENSITY–PERCENT



Corrected deduct values for membrane.

APPENDIX B: Inspection and Rating Forms

On the following pages are a Roof Inspection Worksheet (front and back) and a Roof Section Rating Form that may be photocopied for use. Also included is an abbreviated list of single-ply distresses, severity levels, and defects for attachment to inspection clipboard.

ROOF INSPECTION WORKSHEET	AGENCY/INST.:				
BUILDING ________	PER. FLASHING ________	LF	DATE ________		
SECTION ________	CURB FLASHING ________	LF	NAME ________		

BF-BASE FL-MEM	PP-PITCH PAN	DS-DEF SEAMS	PA-PATCHING
BC-BASE FL-METAL	DR-DRAIN & SC	SC-SURF COAT	DV-DEB & VEG
MC-METAL CAP	SP-SPLITS	MD-MEM DET	EQ-EQ SUPPORT
EM-EMBEDDED MET	RG-RIDGES	SS-SYSTEM SEC	PD-PONDING
FP-FLASHED PEN	HL-HOLES	MS-MEM SUPPORT	

ID #	DIS	SEV	DEF	QTY

SCALE: ________

NORTH

ROOF INSPECTION WORKSHEET - COMMENTS

INSTRUCTIONS: Circle response, i.e., Y = yes, N = no or U = unknown or not observed. If Y (yes), circle the type of problem.

A. EVALUATION OF INTERIOR CONDITIONS

1. Does the roof leak? Describe:_____ Y N U
   _____
   _____

2. Are there water stains on: Y N U
   a. walls c. deck e. structural elements
   b. ceilings d. floor f. other:_____

3. Do structural elements show any of the following: Y N U
   a. cracks d. alteration g. physical damage
   b. splits e. rotting h. insect damage
   c. spalling f. settlement i. other:_____

4. Does the underside of the deck show any of the following: Y N U
   a. rusting c. spalling e. sagging
   b. rotting d. cracks f. other_____

B. EVALUATION OF EXTERIOR CONDITIONS

1. Do the exterior walls show any of the follwoing: Y N
   a. cracks c. spalling e. water stains
   b. rusting d. movement f. other:_____

2. Does the fascia or soffit show any of the following: Y N
   a. cracks c. spalling e. water stains
   b. rusting d. peeling f. other:_____

3. Do the gutters or downspouts show any of the following: Y N
   a. loose c. missing e. clogged
   b. damaged d. disconnected f. other:_____

C. EVALUATION OF ROOFTOP CONDITIONS

1. Is there any unauthorized, unnecessary, or improperly installed equipment on the roof? Y N
   a. equipment c. antennas e. cables
   b. signs d. platforms f. other:_____

2. Do adjacent parapet walls show any of the following: Y N
   a. cracks c. cap cracked e. sealant flaws
   b. spalling d. cap missing f. other:_____

D. REMARKS:_____
_____
_____
_____
_____

ROOF SECTION RATING FORM

BUILDING ______	SECTION ______	DATE ______	CALC. BY ______
PER. FLASHING ______ FT CURB FLASHING ______ FT	FLASHING TOTAL ______ FT	AREA ______ SQFT	CHKD. BY ______

FLASHING

BF - BASE FL - MEM
BC - BASE FL - METAL
MC - METAL CAP
EM - EMBEDDED MET
FP - FLASHED PEN
PP - PITCH PAN
DR-DRAIN & SC

TYP	SV	QUANTITIES	TOT	DEN	DV
CORRECTED DEDUCT VALUE (CDV)					

FCI = 100 - CDV = ______

FLASHING RATING = ______

MEMBRANE

SP - SPLITS
RG - RIDGES
HL - HOLES
DS - DEF SEAMS
SC - SURF COAT
MD - MEM DET
SS - SYSTEM SEC
MS - MEM SUPPORT
PA - PATCHING
DV - DEB & VEG
EQ - EQ SUPPORT
PD - PONDING

TYP	SV	QUANTITIES	TOT	DEN	DV
CORRECTED DEDUCT VALUE (CDV)					

MCI = 100 - CDV = ______

MEMBRANE RATING = ______

ROOFER (SPM)

LIST OF DISTRESSES, SEVERITY LEVELS, AND DEFECTS FOR SINGLE-PLY MEMBRANE (SPM) ROOFS

FLASHING DISTRESSES (SPM)

BF-LOW (LF)
1. Light crazing
2. Low, <8" High
3. Low nail strip, <8"
4. Seam/lap, open <1/2"
5. Repair, compat mat

BF-MED
1. Crazing to reinf
2. Unbond, not open
3. *Solv/oil, no det*
4. Repair, dissim mat
5. Seam open >1/2"
6. Loose term bar
7. Loose nail strip

BF-HIGH
1. Crazing thru flash
2. HL/SP, pene
3. Expose gap at top
4. *Seam open, pene*
5. Solv/oil, det/holes

BC-LOW (LF)
1. Loss of coating
2. Distorted joint cvr
3. Low, <8"
4. Exposed fastener

BC-MED
1. CVR unbond, *no pene*
2. Fasteners loose
3. Flash loose, no pene
4. Embrit jt cvr mat
5. Repair, dissim mat

BC-HIGH
1. Holes
2. Hole in jt cvr, pene
3. Exposed gap at top
4. FL pulled, pene

MC-LOW (LF)
1. Loss of coat, jt corr
2. Top of CF is deform
3. *Metal cap is deform*
4. MC sealed to BF

MC-MED
1. HL on vert surface
2. Fast loose, failed jt
3. Rough edges at BF

MC-HIGH
1. *Metal cap FL missing*
2. HL on horiz surface
3. MC missing jt cvr
4. Seal at top miss
5. CF loose, pene
6. Does not cover BF

EM-LOW (LF)
1. Loss of prot coat
2. Term batt exp fast
3. Strip mat open, <1/2"
4. Joint cvr distorted
5. CM not stripped in

EM-MED
1. Joint cvr unbond
2. Nails backing out
3. Strip crazed
4. Strip open, >1/2"
5. Loose mat, det mat
6. Embrit jt strip mat
7. Interior gutter
8. Coat EM open, >1/2"

EM-HIGH
1. *Strip open*
2. HL on jt cvr, open
3. HL in metal
4. HL by loose EM
5. HL in interior gutter
6. Coat EM, open, pene

FP-LOW (LF)
1. Sleeve deformed
2. Strip open, <1/2"
3. Low, <8"

FP-MED
1. Strip mat crazed
2. Strip open, no pene
3. Sleeve top not seal
4. Clamp loose/miss
5. Umbrella o en/miss
6. Metal corroding

FP-HIGH
1. *HL in strip mat*
2. Base FP open, pene
3. HL in FP or curb
4. No sleeve
5. Incompat mat used

PP-LOW (EA)
1. All

PP-MED
1. Strip mat crazed
2. Strip open, no pene
3. Loss of protect coat
4. Strip not cover pan

PP-HIGH
1. *HL in strip mat*
2. Strip open, pene
3. Sealer low
4. Sealer cracked
5. Corrosion thru pan

DR-LOW (EA)
1. Seam <12" from DR
2. Strip open, <1/2"

DR-MED
1. Strip mat crazed
2. Strip open, no pene
3. Strainer broken/miss
4. Scupper-loss of coat
5. Field seam in ring

DR-HIGH
1. Holes in strip mat
2. Strip, open, pene
3. Ring loose/miss
4. Drain clogged
5. Scupper broken/HL
6. Holes, <24" from DR

MEMBRANE DISTRESSES (SPM)

SP HIGH (LF)
1. *All*

RG-LOW (LF)
1. All, no breaks

RG-HIGH
1. Open breaks

HL-LOW (SF)
1. Surf scratched

HL-MED
1. Not penetrating

HL-HIGH
1. Penetrating
2. By mech fastener

DS-LOW (LF)
1. No lap seal (E-P)
2. No lap seal (reinf)
3. Seam open, <1/2"
4. Wrinkle seam, sealed
5. No reinf at "T"
6. Blister in seam

DS-MED
1. Seam open, >1/2"
2. Wrinkle in seam (E)

DS-HIGH
1. Seam open, pene
2. Fishm/wrinkle, open

SC-LOW (SF)
1. *Loss of coating*

SC-MED
1. Loss of sand coat

MD-LOW (SF)
1. Light crazing

MD-MED
1. *Crazing to reinf*

MD-HIGH
1. Eroded thru mem, pene

SS-LOW (SF)
1. FA, ≤ 2 SF
2. BS, ≤ 4 SF

SS-MED
1. FA, >2 or <100 SF
2. MA, isolated fast
3. PA, isolated fast
4. BS, >4 or <100 SF

SS-HIGH
1. FA, ≥100 SF/25 per
2. MA, adj fast loose
3. PA, adj fast loose
4. BS, ≥100 SF/25 per

MS-LOW (SF)
1. Tension by warping
2. Jt width, 1/2" - 2"

MS-MED
1. Jt width > 2"
2. BS, insul displaced
3. Lumps by mat

PA-LOW (SF)
1. All w/compat mat

PA-MED
1. All w/incompat mat

PA-HIGH
1. With HIGH Distress

DV-MED (SF)
1. Veg, no pene
2. Solv/oil, no pene
3. Foreign mat

DV-HIGH
1. Veg pene mem
2. Solv/oil, thru mem

EQ-LOW (SF)
1. All, improper attach

EQ-MED
1. Move, no puncture
2. Bolt, watertight

EQ-HIGH
1. Move, puncture
2. Bolt, water penetrat

PD-LOW (SF)
1. All, after 48 hrs

PD-MED
1. By wrinkles
2. Warp of substrate

INSULATION DISTRESS: IN-HIGH (SF)
1. Wet Insulation

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