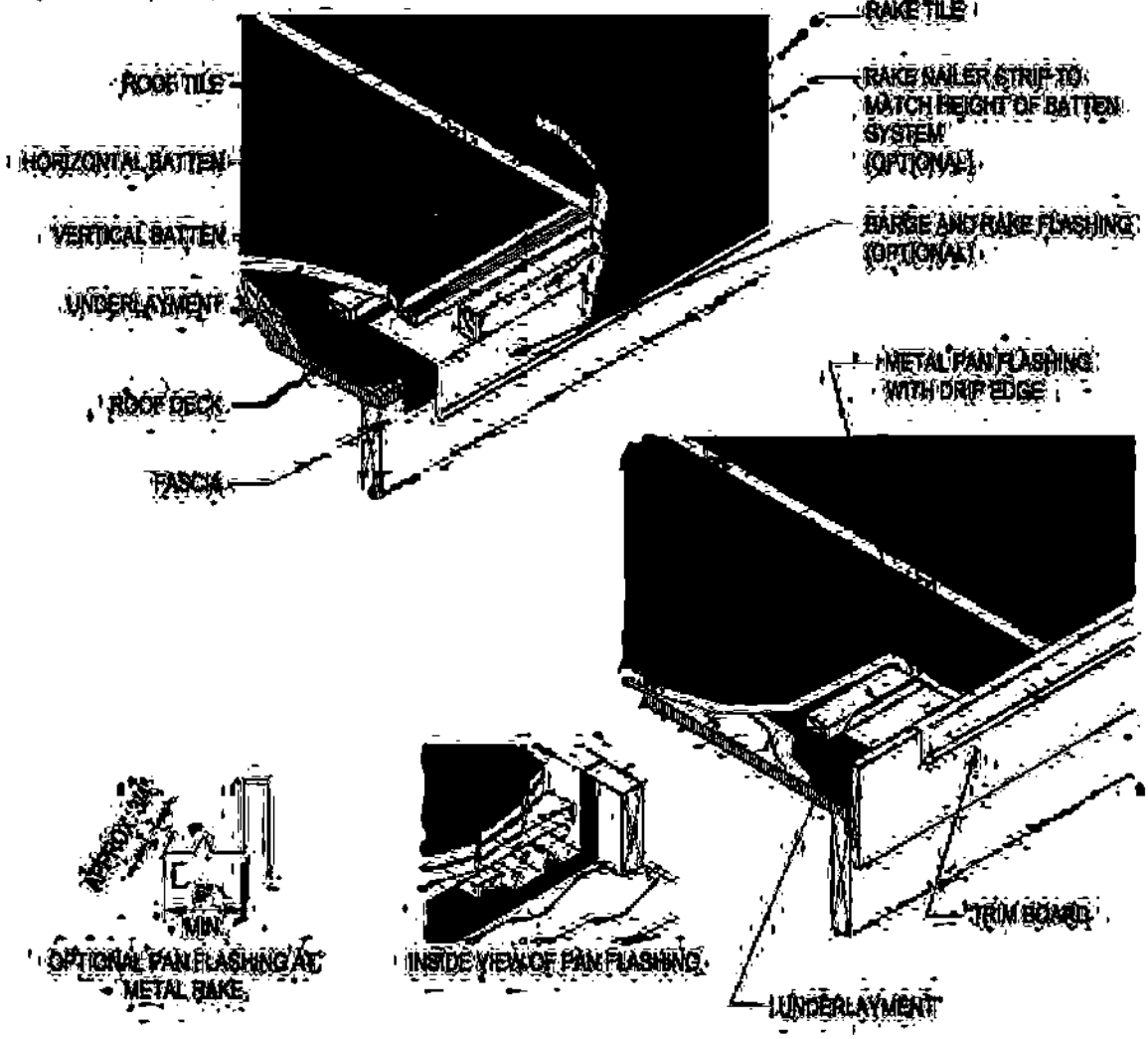
RAKE FLASHING - COUNTER BATTEN SYSTEM (Where Required)

MC-19



Notes:

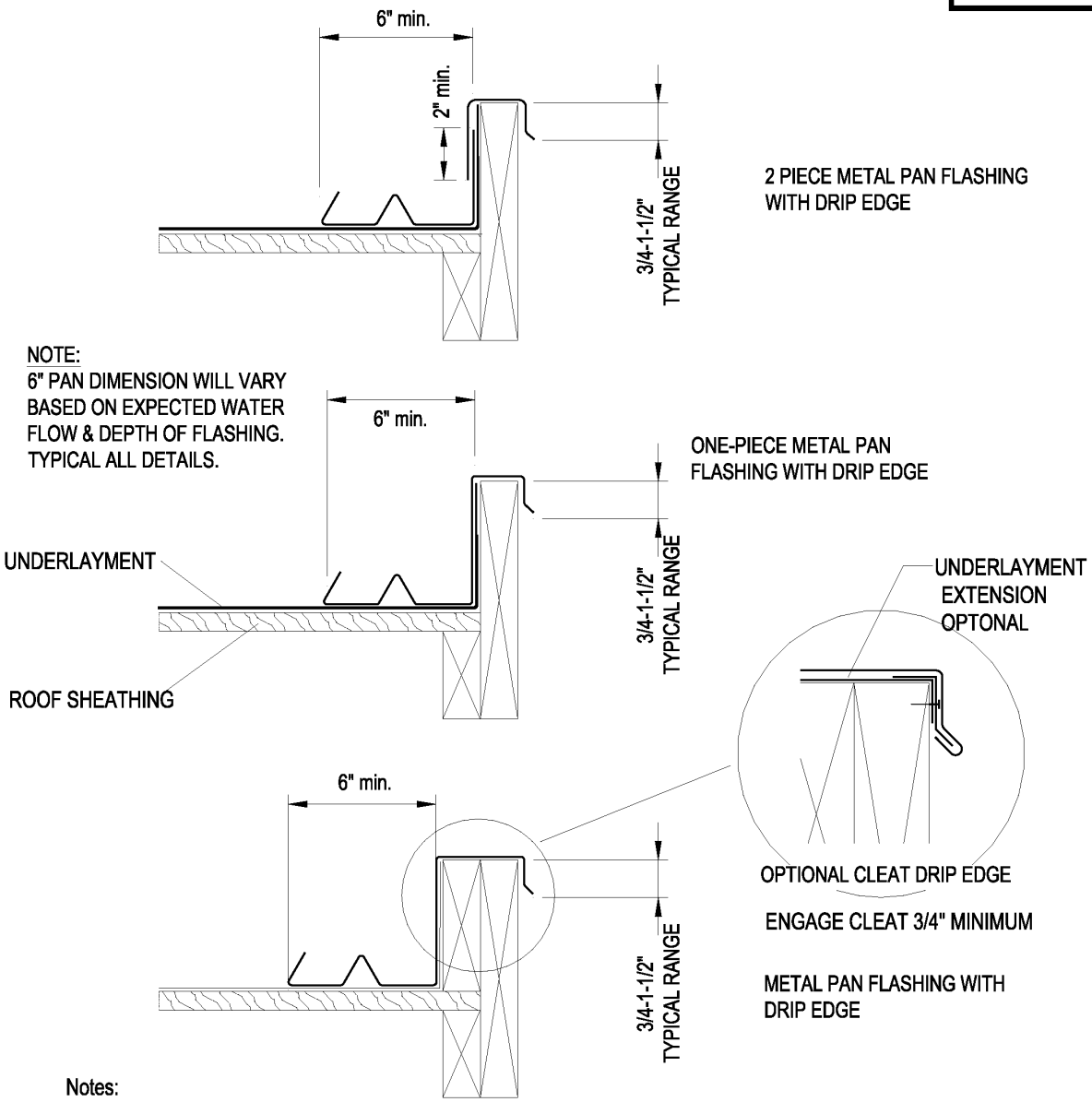
1. For recommended underlayment and fastening requirement, see Table 1A and 1B.
2. Sheet metal Flashing shall be a minimum of (No. 26 galvanized sheet gauge) not less than 0.019 inch corrosion-resistant metal (G90). See Table A for additional options.
3. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions and local area practice.
4. Rake flashing and wood nailer/trim board shall be raised above the roof deck to a height greater than the height of the installed roof tile.
5. Rake flashing must be fastened into a minimum 2" nominal gable fascia board, gable trim, or equivalent in dimension from multiple places.

Drawing shown depicts the application of all the profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAKE FLASHING - EXAMPLES

MC-19A

SEE DRAWING MC-12B FOR ADDITIONAL FLASHING INFORMATION



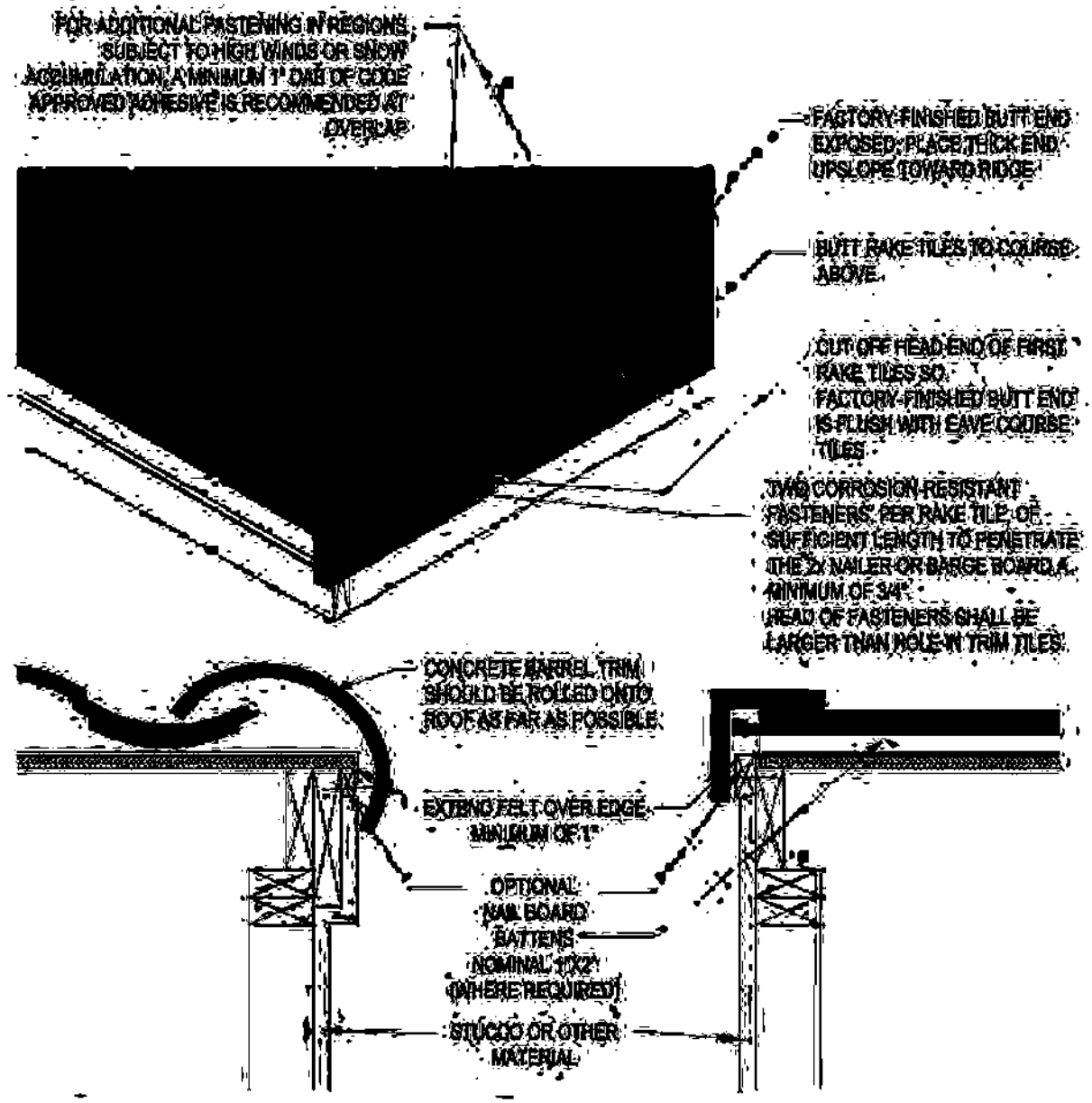
Notes:

1. Flashing details may vary according to local weather conditions, roof size, location, slope of roof and contributary run-off area.
2. Underlayment will extend a minimum of 4" up vertical wood blocking, wall, or to the top of fascia or gable trim.
3. Sheet metal flashing should be a minimum of (No. 26 galvanized sheet gauge) not less than 0.019 inch corrosion-resistant metal (G90). See Table A for additional options.
4. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions, and area practices.
5. Rake flashing and wood nailer/trim board will be raised above the roof deck to a height greater than the height of the installed roof tile.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAKE TILE INSTALLATION

MC-19B



Notes:

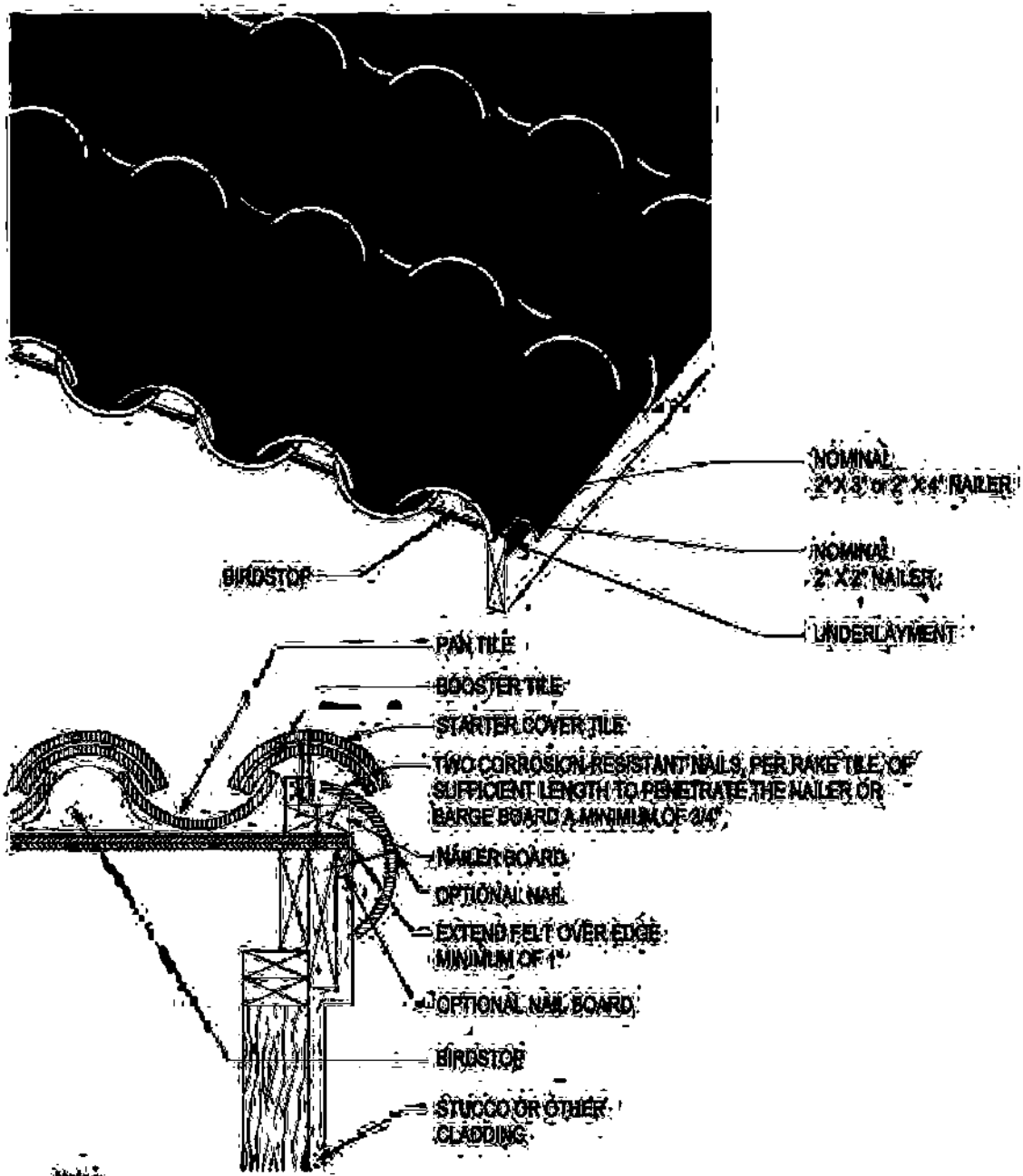
1. Dimensions shown are minimums and are intended to be appropriate to allow for reasonable variations due to field conditions, and area practices.
2. Rake tiles must be fastened into a minimum nominal 2" gable rafter or equivalent in dimension.
3. The fasteners must penetrate a minimum of 3/4" into dimensional wood lumber.
4. See Table 1A for additional fastening instructions.

Drawing shown depicts the application of all the profiles. Unless otherwise noted, it will apply to other concrete or clay tiles.

GABLE \ EAVE INSTALLATION - BARREL TILE

MC-20

(CLAY TILE INSTALLATIONS)



Notes:

1. Dimensions shown are minimums and are intended to be appropriate to allow for reasonable tolerances due to field conditions, and area practice.
2. See Table 1k for additional fastening requirements.

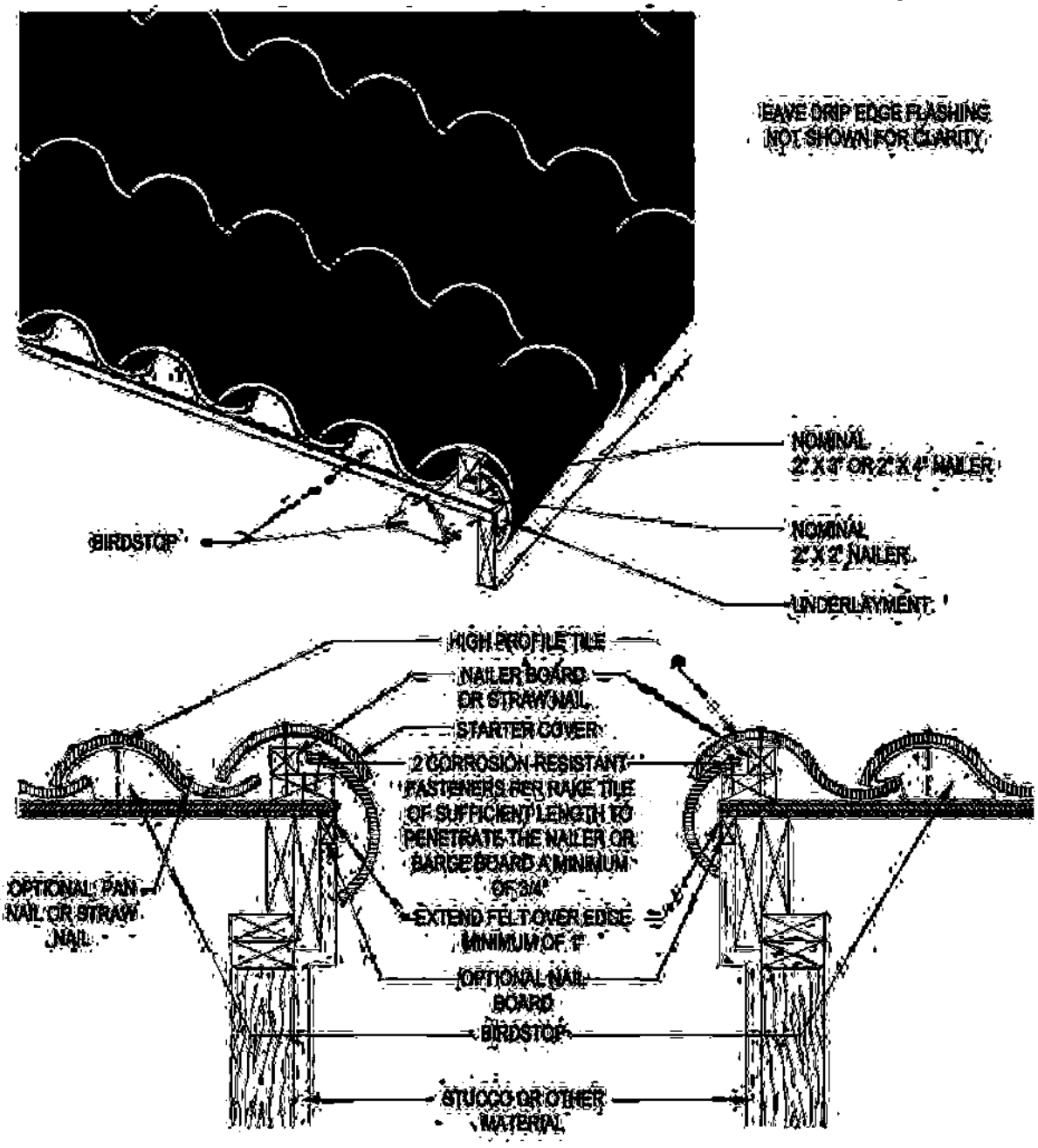
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tile.

Appendix A

GABLE \ EAVE INSTALLATION

(CLAY TILE INSTALLATIONS)

MC-20A



Notes:

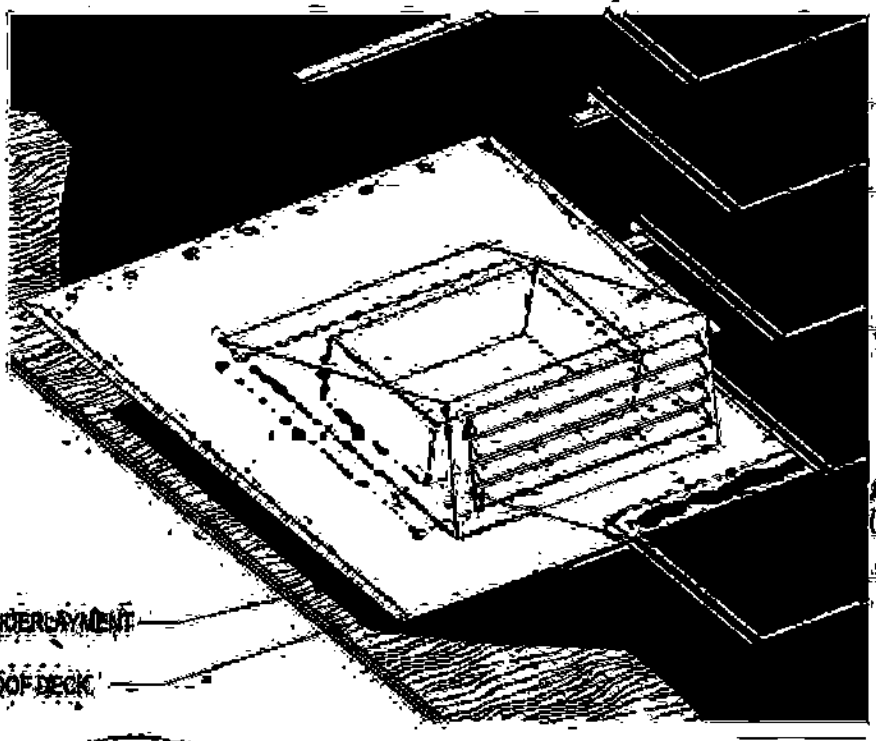
1. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

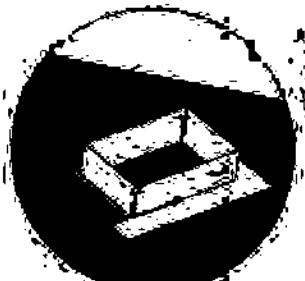
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

ROOF VENTS (OFF RIDGE)

MC-21

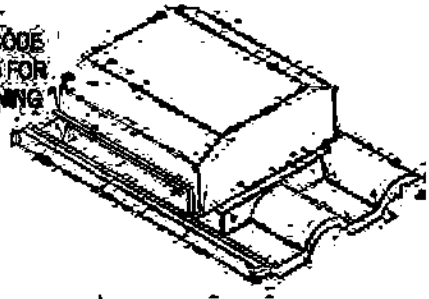
VENTS TO BE INSTALLED PER VENT MANUFACTURER INSTRUCTIONS





UNDERLAYMENT DETAIL AT DECK FLASHING

NOTE:
CHECK LOCAL CODE REQUIREMENTS FOR VERMIN SCREENING



VENTED TILES AVAILABLE TO MATCH INDIVIDUAL TILE MANUFACTURER PROFILES

HEIGHT OF FLASHING TO BE MINIMUM 1/2"

Notes:

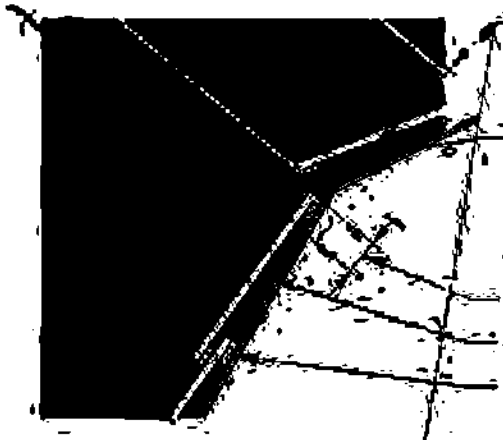
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 (ASTM D4869 Type IV) or approved equal is required as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. A secondary flashing, as depicted in the left inset drawing, is required around the penetration to prevent moisture intrusion should water reach the underlayment, under the roof tile. This secondary or deck flashing is required with all tiles.
3. For climates with wind driven rain or blowing snow, consult local building official for approved application.
4. Where flashing is of metal, should be minimum of (No. 26 galvanized sheet gauge) not less than 0.019 inch corrosion-resistant metal (G90). See Table A for additional options.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

Appendix A

SLOPE CHANGE APPLICATIONS

MC-22



UNDERLAYMENT, SEALANT OR SEAL STRIP OVER TOP OF FLASHING

MALEABLE METAL FLASHING OR RIGID METAL WITH WEATHERBLOCKING FOR PROFILE TILES. FOR FLAT TILES, PREFORMED METAL WITH HEMMED EDGE(S) MAY BE USED OVER BREAK FLASHING TO PROVIDE A SNUG FIT

FLASHING MUST LAP TILES' MINIMUM

UNDERLAYMENT

BATTEN (WHERE REQUIRED)

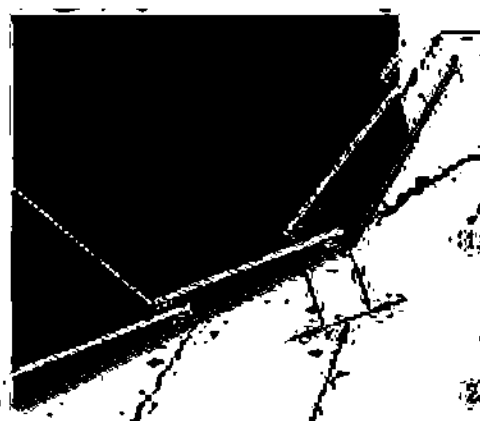
OPTION 1
WITH METAL
TRANSITION FLASHING

MALEABLE METAL FLASHING OR RIGID METAL WITH WEATHERBLOCKING FOR PROFILE TILES. FOR FLAT TILES, PREFORMED METAL WITH HEMMED EDGE(S) MAY BE USED OVER BREAK FLASHING TO PROVIDE A SNUG FIT

BATTEN (WHERE REQUIRED)

UNDERLAYMENT

3" MIN.



OPTION 2
WITHOUT METAL
INCREASE HEADLAP OR PROVIDE WEATHERBLOCKING TO STOP BACK FLOW OF WATER AT TRANSITION SEAL AS REQUIRED.

BATTEN (WHERE REQUIRED)

UNDERLAYMENT

3" MIN.

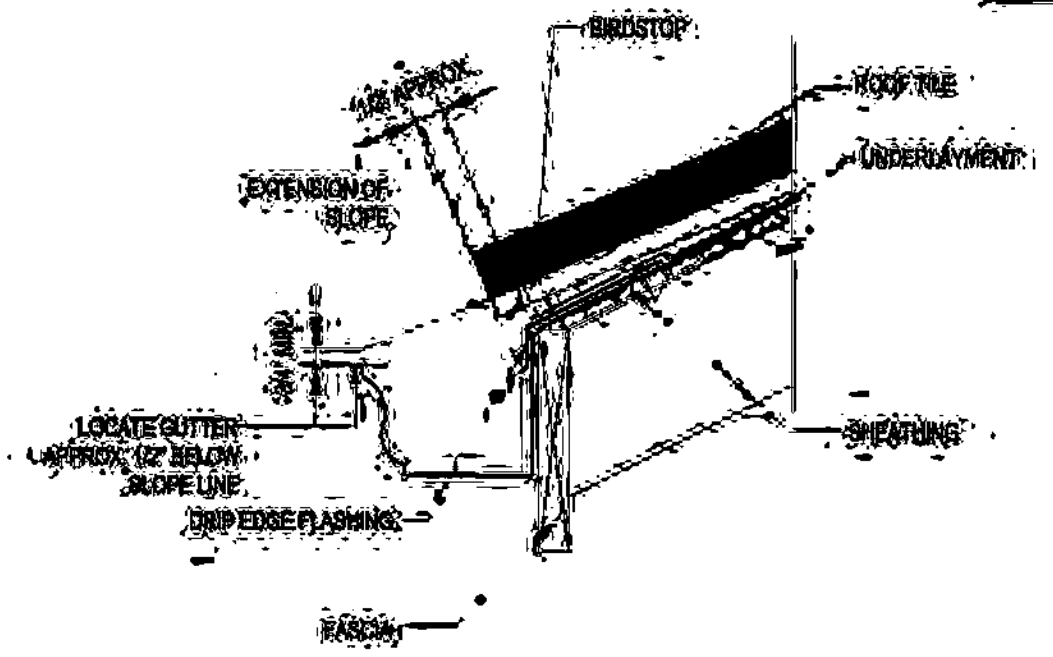
Notes:

1. One layer of No.30 asphalt saturated felt complying with ASTM D-226 (ASTM D4869 Type IV) or approved equal is required as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions and field practices.

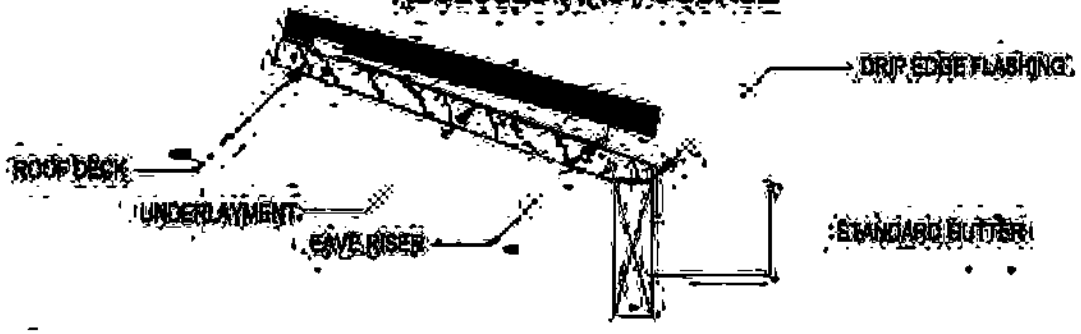
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

GUTTERS

MC-23



RECESSED FIRST COURSE



Notes:
This drawing is included to show one style of gutter installation since gutter conditions will vary by climatic conditions. Please contact your local gutter manufacturer for specific installation requirements.

Notes:
1. For recommended underlayment and flashing requirement, see Table 1A and 1B.
2. At eave drip edge flashing is required with stucco finish, EIFS (Exterior Insulated Finish System) and built-back conditions.
3. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 less than or equal to 7:12. Direct deck nailing attachment of tile may be permissable.
4. Eave closure should be of height equal to combined thickness of batten system and thickness of one course of tile.
5. Dimensions shown are minimums and are intended to be appropriate to allow for reasonable tolerance due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

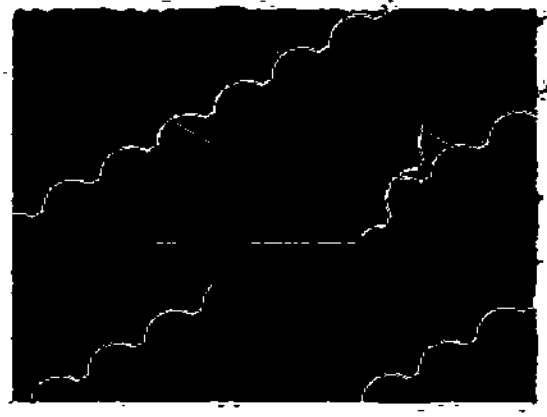
Appendix A

TILE REPAIRS\REPLACEMENT

MC-24

When replacing an individual tile, one method is to remove the broken tile by breaking into smaller pieces with a hammer or other appropriate tool. This will minimize the disturbance of surrounding tiles. Once the tile has been removed, any remaining fasteners should be removed and the resulting hole in the underlayment cleaned and patched.

FOR APPLICATIONS WITHOUT BATTENS

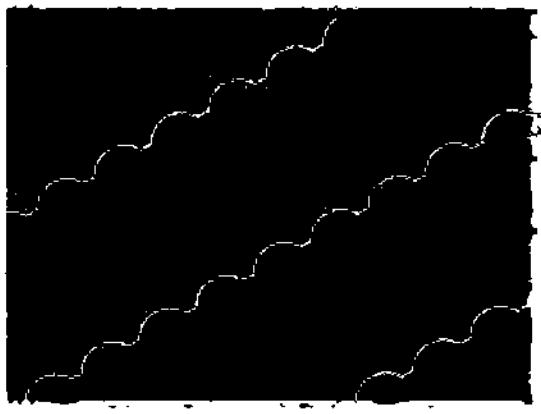


YES (PROPER LOCATION)

NO (IMPROPER LOCATION)

TILE ADHESIVE (CODE APPROVED, SEE PAGE 5)

FOR APPLICATIONS WITH BATTENS



Wedge surrounding tiles up and slide new tile into place.
FOR SLOPES OVER 7:12 (Battens required)
Remove broken tile and fastener. Wedge surrounding tiles, apply code approved roof tile adhesive and slide new tile in place.

TILE ADHESIVE (CODE APPROVED, SEE PAGE 5)

Note:
The replacement tile may be slipped into place and fastened with an approved roof tile adhesive. It is important that the adhesive is placed in a position that will assure contact with adjacent tiles without affecting the flow of water. If adhesive is applied to the interlocking water channel, it must be placed above the headlap to avoid water damming.
Remove any shim that had been used during the repair process and ensure that all tiles surrounding the replaced piece properly fit and are seated.

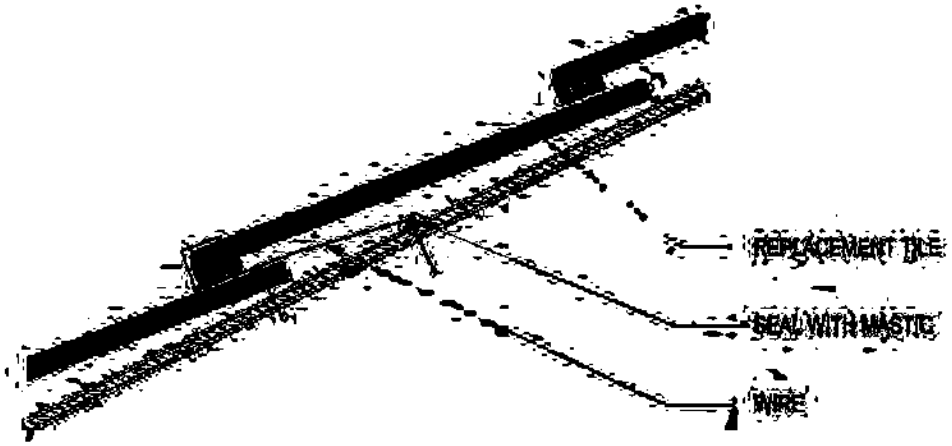
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to the concrete or clay tiles.

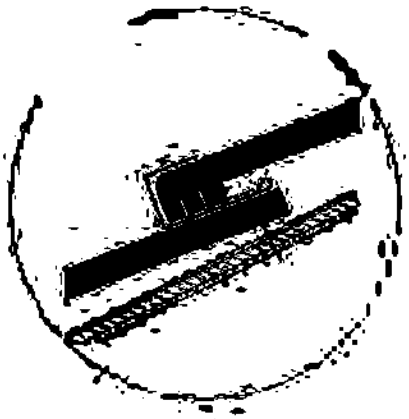
TILE REPAIR / REPLACEMENT - CONTINUED:

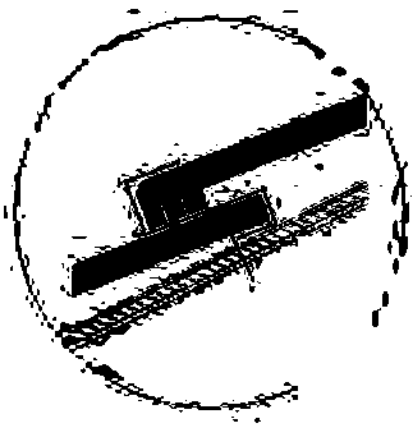
MC-24A

OPTIONAL METHODS OF REPLACEMENT TILE ATTACHMENT

(USE HOOKS INSTALLED PER ICC / ROOF MANUFACTURER INSTRUCTIONS)







Notes:

1. Clear area of debris where broken tile is to be replaced. Remove fasteners from the previous tile. Fasteners may be removed by using a slide ripper or, in the case of some screws, use a hacksaw blade.
2. Lift nose of tile in course above. Then slide replacement tile, underneath the overlapping tile and over the hook, then slide tile into the hook and down until bracket 'L' hooks underneath lip of course below.
3. Adjust replacement tile to align or interlock (depending on the tile type) with tiles to either side.
4. Another method is to fasten a 12 gauge copper wire into the deck, replacing the tile and then bending the exposed wire. A sheet metal (e.g. copper) strip can also be used over the tile nose.
5. Make adjustment for field conditions.

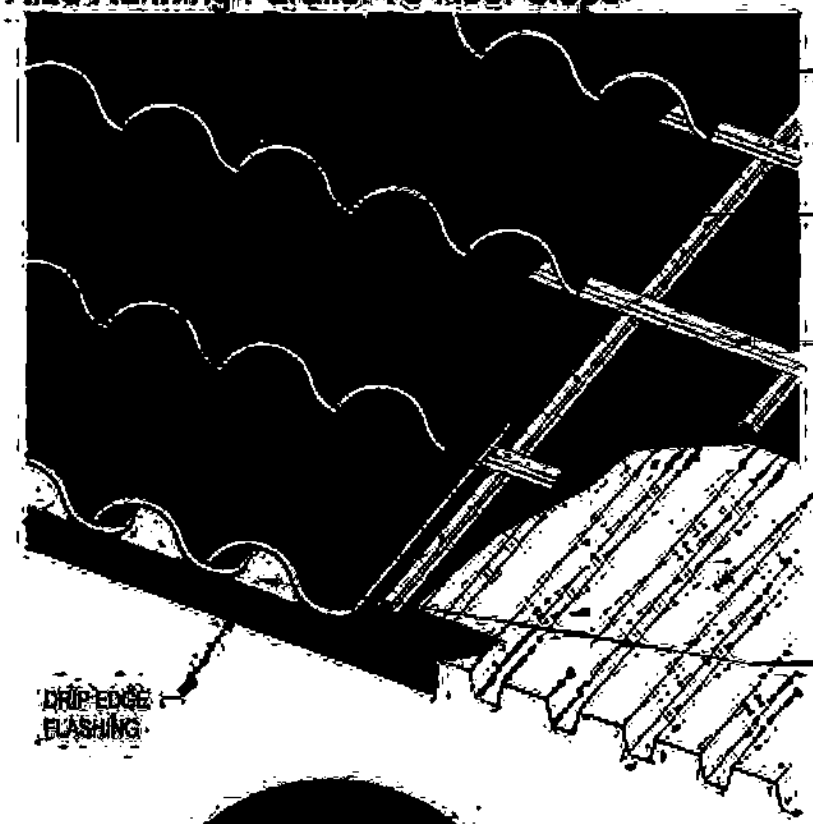
Drawing shown depicts the application of all the profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

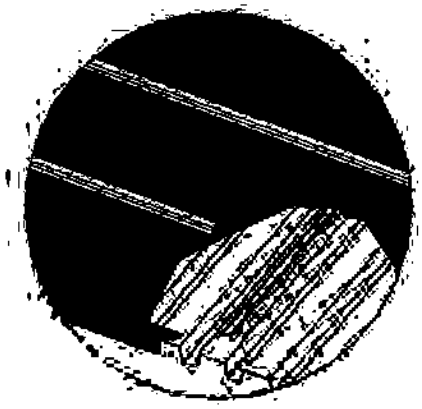
Appendix A

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

MC-25

Installation on Metal Deck - Considerations: Ribs Running Parallel To Roof Slope





The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

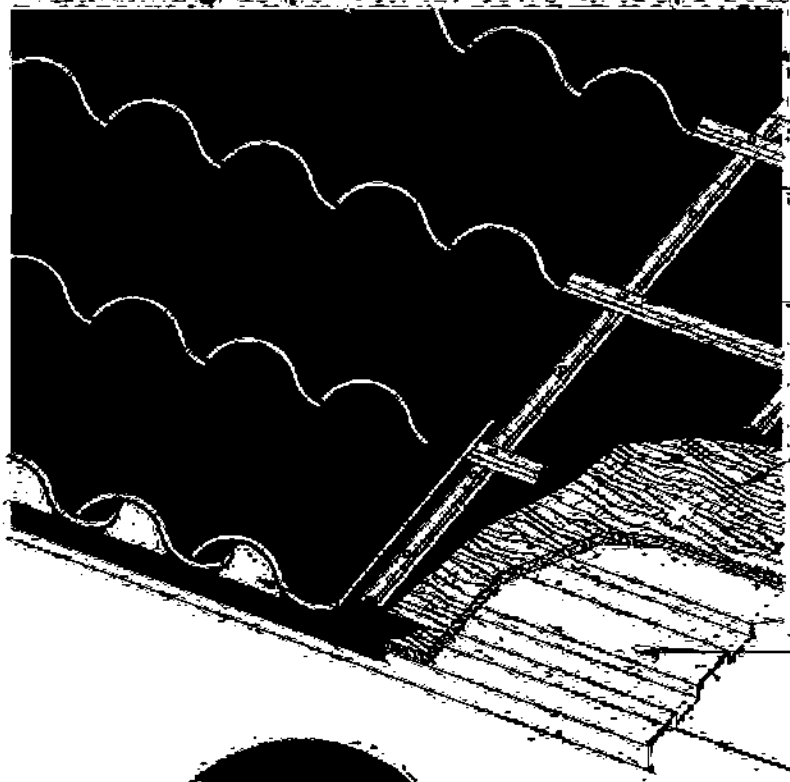
1. Vertical battens to be metal or as approved or designed as per metal deck manufacturer.
2. For recommended underlayment and fastening requirement, see Table 1A and 1B.
3. A drip edge flashing is required with stucco beads, EIFS (Exterior Insulated Finish System) and slight fascia perimeter edges.
4. Eave closure should be of height equal to combined thickness of batten system and thickness of one course of tile.
5. Dimensions shown are maximums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all the profiles. Unless otherwise noted, it would apply to either concrete or clay tile.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

MC-25A

Installation on Metal Deck - Optional Considerations
Ribs Running Perpendicular To Roof Slope With Rigid Sheathing



FOR FIRE-RATED SYSTEMS, ADDITIONAL COMPONENTS MAY BE REQUIRED.

The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

1. Vertical battens to be metal or as approved or designed as per metal deck manufacturer.
2. For recommended underlayment and fastening requirement, see Table 1A and 1B.
3. A sheet metal gap edge flashing is required with stucco fascia, EIFS (Exterior Insulated Finish System) and flush fascia perimeter edges.
4. The fasteners must penetrate a minimum of 3/4" into dimensional wood decking or pass through wood panel sheathing which ever is less.
5. Eave closure should be of height equal to combined thickness of batten system and thickness of one course of tile.
6. On Type I (Non-Combustible) building all components must be fire-resistant as approved by local building officials.
7. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

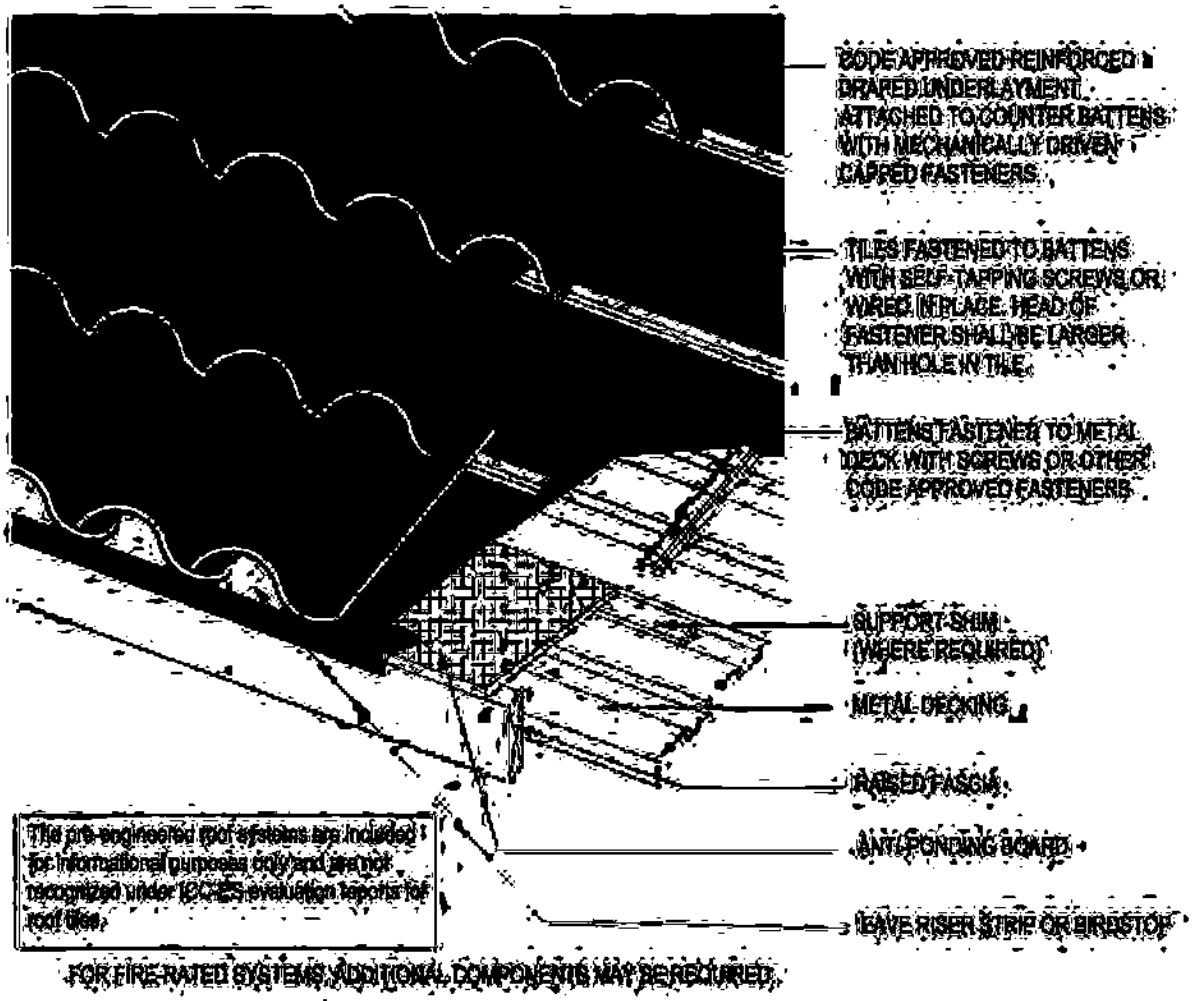
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

Appendix A

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

MC-25B

Installation on Metal Deck - Optional Considerations - Ribs Running Perpendicular To Roof Slope



Notes:

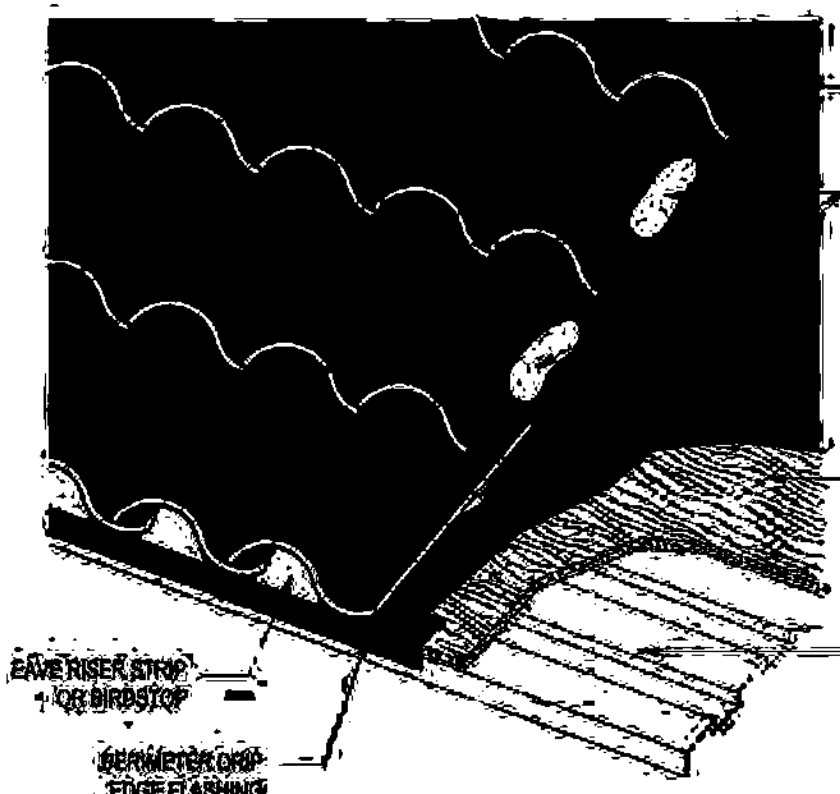
1. Vertical battens to be metal or as approved or designed as per metal deck manufacturer.
2. For recommended underlayment and fastening requirements, see Table 1A and 1B.
3. A sheet metal gap edge flashing is required with: stucco fascia, EIFS (Exterior Insulated Finish System) and both fascia perimeter edges.
4. Eave closure should be of height equal to combined thickness of batten system and thickness of one course of tile.
5. On Type I (Non-Combustible) building all components must be fire-resistant as approved by local building officials.
6. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shows details for the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tile.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

MC-25C

Installation on Metal Deck - Optional Considerations - Adhesive Based Systems - Solid Sheathing



Note: Adhesion of underlayment to substrate shall be in accordance with assemblies recognized in a current ICC-ES evaluation report for roof tile adhesives evaluated to the requirements of AC-162.

The pre-engineered roof systems are included for informational purposed only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:
1. On Type I (Non-Combustible) building all components must be fire resistant as approved by local building officials.
2. Dimensions shown are recommended minimums and are intended to be appropriate to allow for reasonable tolerances due to field conditions.

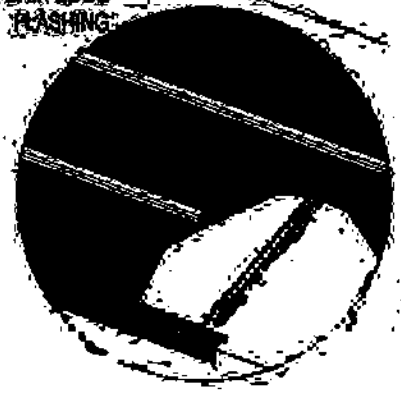
Drawing is representative of all tile profiles. Does not imply that it could apply to other versions of this tile.

Appendix A

SPECIALTY CONDITIONS - PRE-ENGINEERED DECK

MC-26

Installation on Concrete Deck Considerations
Adhesive Based Systems - On Counter Batten



OPTION:
CODE APPROVED REINFORCED DRAPED UNDERLAYMENT

The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:
1. Vertical battens to be metal or as approved or designed as per metal deck manufacturer.
2. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED DECK

MC-26A

Installation on Concrete Deck Considerations
Adhesive based systems - Direct to Deck

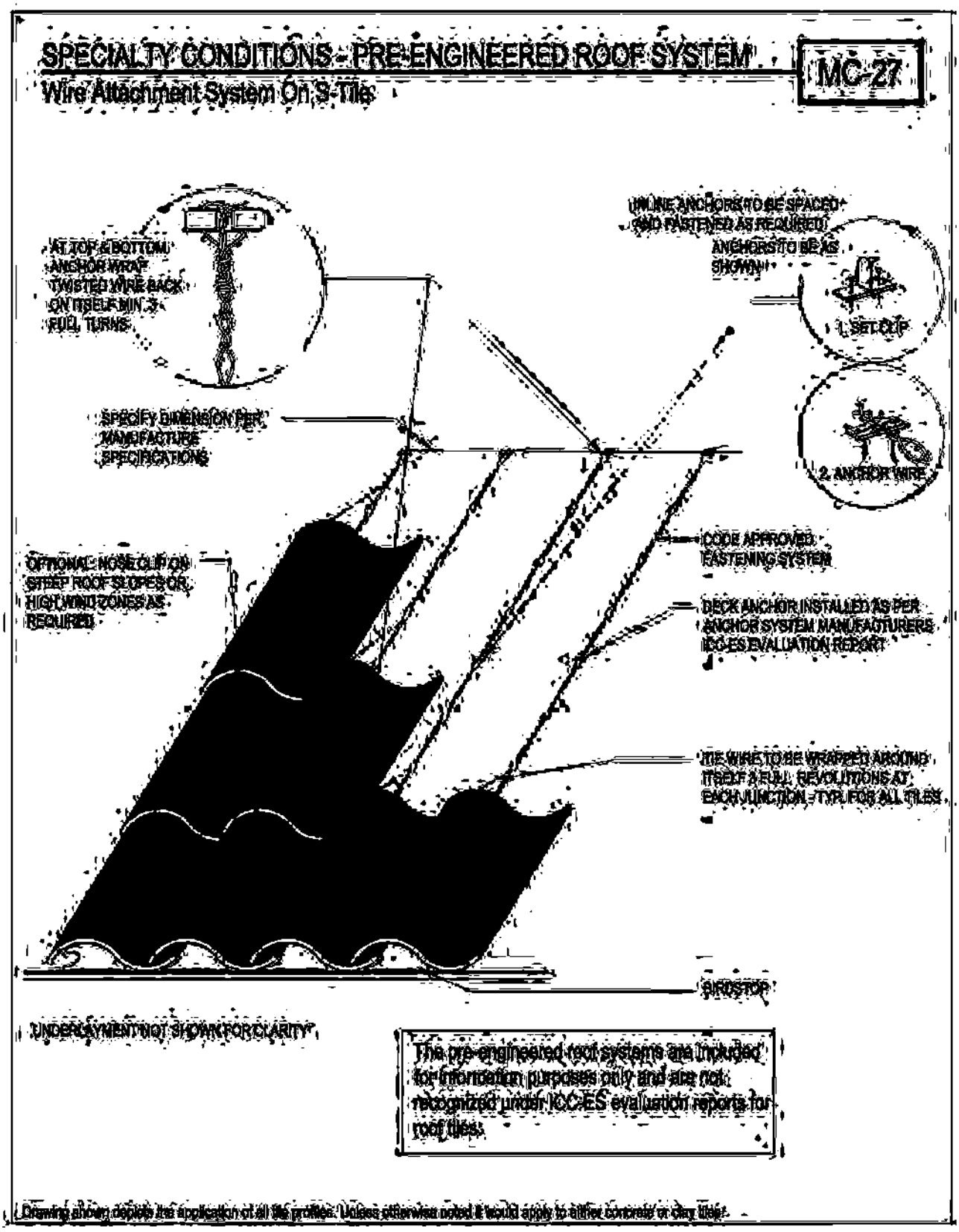
Note: Adhesion of underlayment to substrate shall be in accordance with assemblies recognized in a current ICC-ES evaluation report for roof tile adhesives evaluated to the requirements of AC-162.

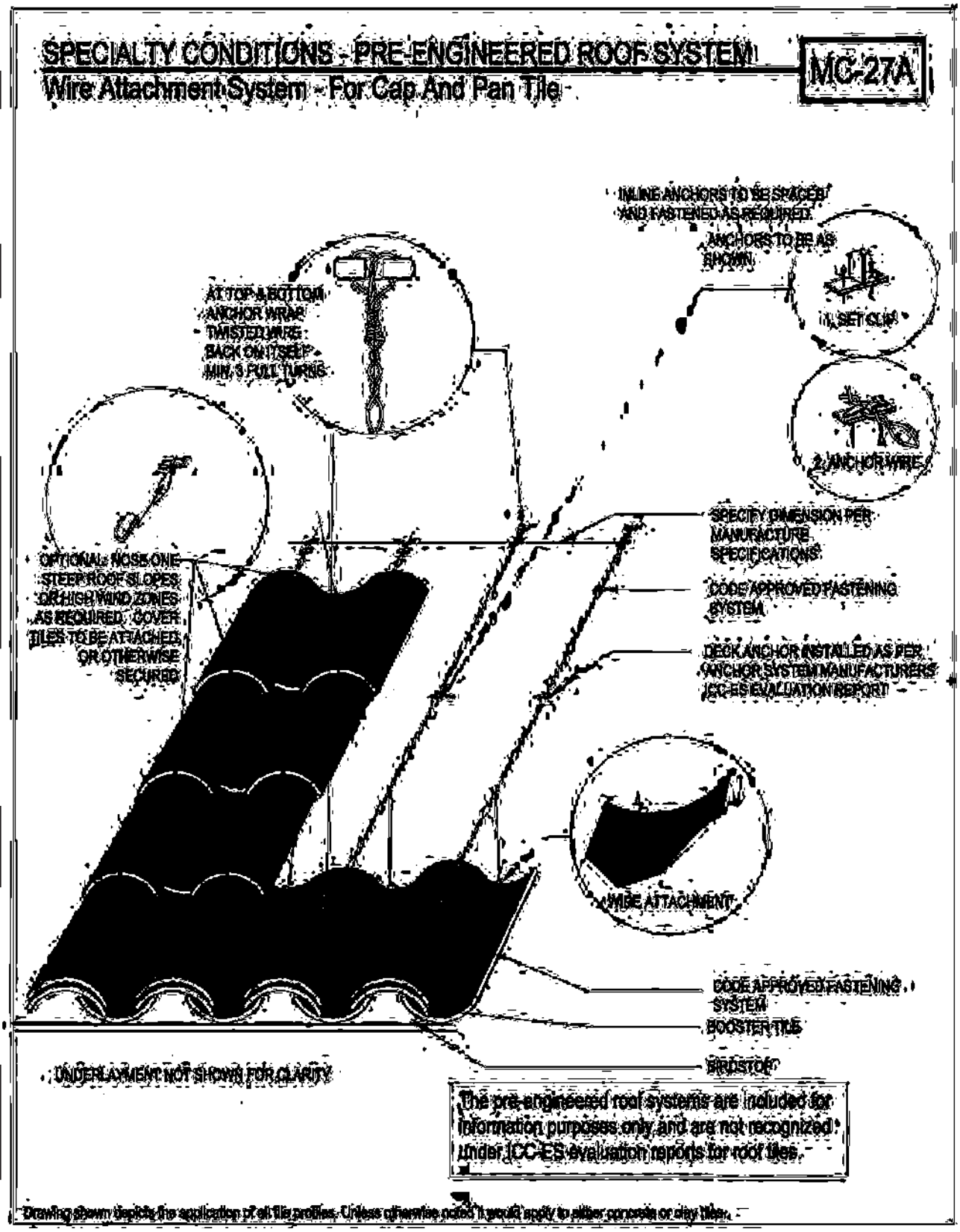
The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:
Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

Appendix A

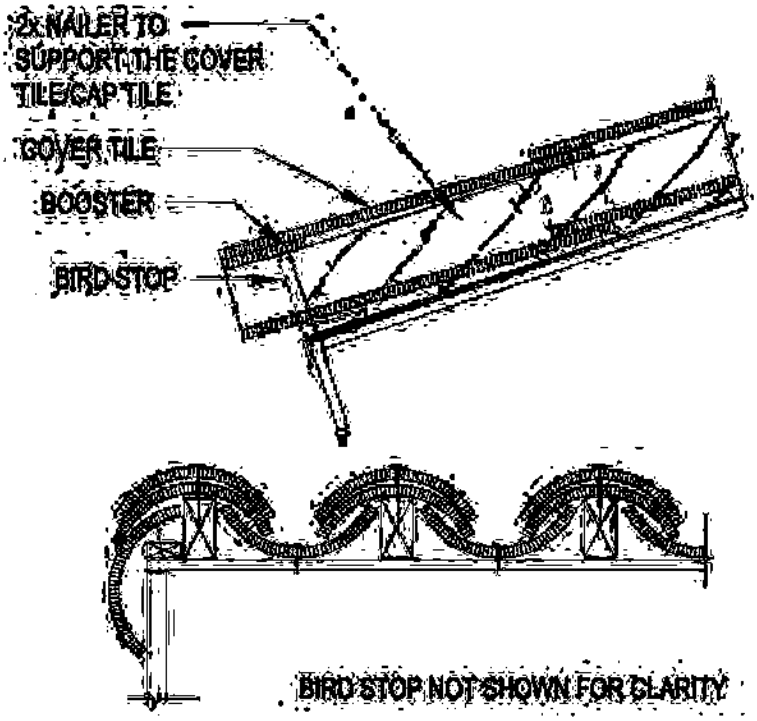

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF SYSTEM
MC-27
Wire Attachment System On S-Tile
AT TOP & BOTTOM ANCHOR WRAP TWISTED WIRE BACK ON ITSELF MIN. 3 FULL TURNS
IN-LINE ANCHORS TO BE SPACED AND FASTENED AS REQUIRED
ANCHORS TO BE AS SHOWN
1 SET CLIP
2 ANCHOR WIRE
SPECIFY DIMENSION PER MANUFACTURE SPECIFICATIONS
OPTIONAL NOSE CLIP ON STEEP ROOF SLOPES OR HIGH WIND ZONES AS REQUIRED
CODE APPROVED FASTENING SYSTEM
DECK ANCHOR INSTALLED AS PER ANCHOR SYSTEM MANUFATURERS ICC-ES EVALUATION REPORT
TIE WIRE TO BE WRAPPED AROUND ITSELF 2 FULL REVOLUTIONS AT EACH JUNCTION - TYP. FOR ALL TILES
BIRDSTOP
UNDERLAYMENT NOT SHOWN FOR CLARITY
The pre-engineered roof systems are included for information purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tile.

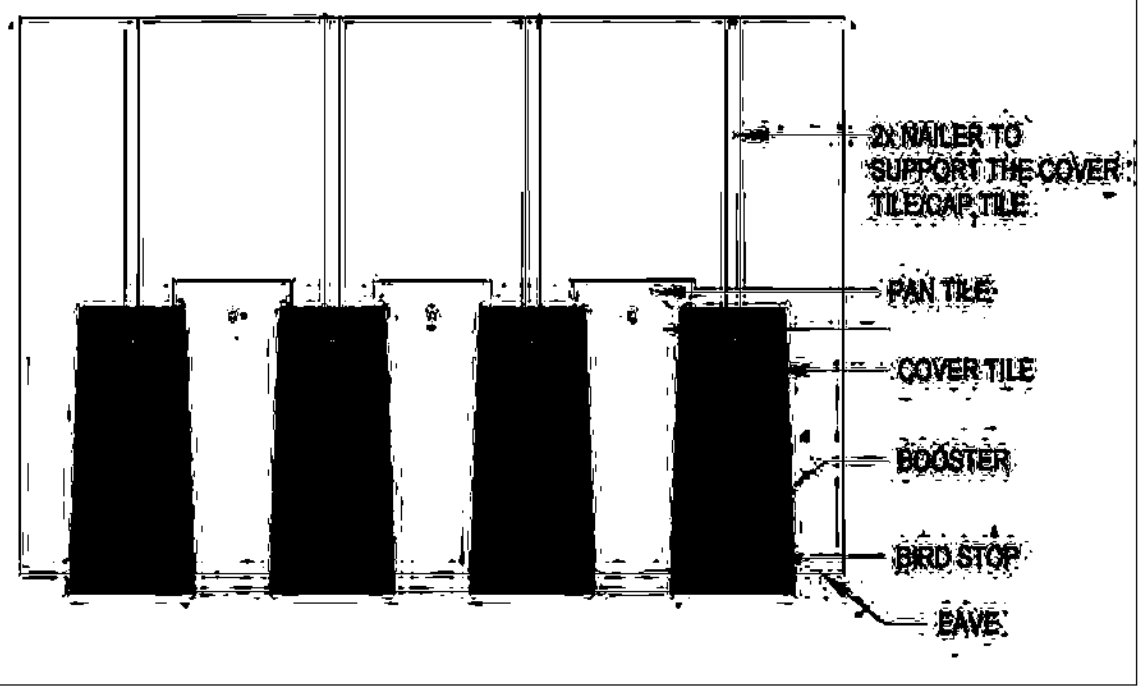

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF SYSTEM
Wire Attachment System - For Cap And Pan Tile
MC-27A
INLINE ANCHORS TO BE SPACED AND FASTENED AS REQUIRED
ANCHORS TO BE AS SHOWN
AT TOP & BOTTOM ANCHOR WRAP TWISTED WIRE BACK ON ITSELF MIN. 3 FULL TURNS
1 SET CLIP
2 ANCHOR WIRE
OPTIONAL - NOSE ONE STEEP ROOF SLOPES OR HIGH WIND ZONES AS REQUIRED. COVER TILES TO BE ATTACHED OR OTHERWISE SECURED
SPECIFY DIMENSION PER MANUFACTURE SPECIFICATIONS
CODE APPROVED FASTENING SYSTEM
DECK ANCHOR INSTALLED AS PER ANCHOR SYSTEM MANUFACTURERS ICC-ES EVALUATION REPORT
WIRE ATTACHMENT
CODE APPROVED FASTENING SYSTEM
BOOSTER TILE
BIRDSTOP
UNDERLAYMENT NOT SHOWN FOR CLARITY
The pre-engineered roof systems are included for information purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.
Drawing shown depicts the application of tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS

MC-27B

Nailer Installations - (Optional) for Cap and Pan





DRAPED UNDERLAYMENT APPLICATIONS

Underlayment applications under battens (e.g., sarking systems or open batten systems) that is recognized in an ICC-ES Evaluation Report for this use and approved by local building officials.

Two types of underlayment may be used in draped applications:

Rolled underlayment (non-rigid)
Rigid underlayment (rigid board)

INSTALLATION OF UNDERLAYMENT UNDER SPACED SHEATHING (Draped Underlayment)

ROLLED UNDERLAYMENT

A tapered antiponding board not less than 8" x 1/2" shall be nailed to the top of the fascia board to prevent the underlayment from sagging below the line of the fascia board.

The underlayment shall drape not less than 3/4" and no more than 1 1/2" between the trusses or rafters.

The underlayment shall be laid over the ridge to provide 6" laps in each direction at ridges (providing a minimum 12" overlap).

The underlayment shall be laid over the hip to provide minimum 6" side laps in each direction at hips and shall be fastened at two adjacent trusses or rafters.

When ending a roll in the field or the truss or rafter, begin a new roll one full truss or rafter back creating 24" side lap and mechanically fix both end and starter rolls on a member.

At roof-to-wall and roof-to-curb intersections/abutments the underlayment shall be turned up not less than 6" and shall be fastened to the abutting wall.

A lining ply or sheet of underlayment shall be installed in the valley and extend not less than 24" on each side of the valley center line. Underlayment shall be laid from each adjacent roof side parallel with the fascia board, or downslope roof perimeter, and shall be brought to the valley centerline.

Vents and protrusions such as plumbing stacks shall be flashed or sealed at the underlayment layer with membrane compatible sealant to prevent water from passing into the attic space.

RIGID UNDERLAYMENT

Rigid underlayment shall be installed with the longest side horizontal, allowing a minimum 6" side lap on the trusses or rafters and a minimum 4" head lap.

At the eave the underlayment shall overhang not less than 3/4" and shall be protected by an approved self adhering membrane a minimum of 6" on both sides.

Where a fascia board is used, the underlayment shall be fastened to the top of the fascia board and the junction of the trusses or rafters at the fascia.

The underlayment shall lap ridges and hips a minimum 6" in each direction, providing a total 12" overlap. At hip locations fastened to an adjacent truss or rafter.

A lining ply or base sheet shall be installed in the valley and extend not less than 24" on each side of the valley center line. The head lap shall be a minimum of 4".

Vents and protrusions, such as plumbing stacks, shall be flashed or sealed at the underlayment layer with membrane compatible sealant to prevent water from passing into the attic space.

TILE BATTENS FOR SPACED SHEATHING

Tile battens for spaced sheathing shall be a minimum 1" x 4" nominal spruce/pine/fir (SPF) standard No. 2 or better grade, or structurally equal. Fasteners and other fastening devices shall be corrosion resistant with shanks a minimum No. 11 gauge diameter and of sufficient length to penetrate 3/4" into the truss or rafter.

ADHESIVE SECUREMENT SYSTEMS (WHEN USED AS AN ALTERNATIVE TO MECHANICAL FASTENING)

As an alternative to mechanical fastening of roof tiles, the use of foam adhesive securement systems that are approved by the authority having jurisdiction may be used.

The restrictions, if any, are found in the code approval or evaluation report and will address any special considerations for underlayment attachment climate restrictions and the required amount and placement of the foam adhesive materials to provide the code required uplift resistance when installed on direct deck and batten applications for concrete and clay tile.

When deciding to use foam adhesives for the securement of tile, consideration must be made on the compatibility of the adhesive to the underlayment surface. Although most code approved foam adhesives bond well to a variety of products like smooth or granulated underlayments, metal, concrete, clay, wood, etc., typically, they do not adhere to polyethylene or silicon surfaced products.

Design Considerations For High Wind Applications

Please Refer to Tile Manufacturer's ICC-ES Evaluation Report for Additional Details.

The installation requirements provided in Table 1A and 1B provide the normal installation guidelines for concrete and clay tile to comply with the International Building Code (Section 1507.3.7). The installation of tile in the specific regions of the country that are identified by ASCE 7-05 as subjected to wind speeds in excess of 100 miles per hour, may be required to have additional fastening options not found in Tables 1A and 1B.

The Tile Roofing Institute has derived various uplift resistance values for nails, screws and adhesive fastening systems. Each of these methods of installation may have limiting factors depending upon wind speed, roof slope and roof height. Please consult with your tile supplier or design professional for additional information about these optional systems for those unique installations.

IRC: On buildings having a maximum mean roof height of 40 feet (12.2m), tile application must comply with IRC section R905.3.7. For higher basic wind speeds or mean roof heights, installation must be in compliance with IBC Sections 1507.3.7 & 1609.5.3.

The following design aids are provided to the roof designer for consideration in determining the required aerodynamic uplift moment for roof tiles for wind applications beyond the prescriptive requirements in the IBC or IRC. These tables were developed based on the requirements of IBC Section 1609.5.3 and ASCE 7-05. Buildings and other structures that represent a substantial hazard to human life in the event of failure are to be designed using an Importance Factor of 1.15 (See ASCE 7-05, Table 1-1 for more information).

Design of Attachment System:

Building is a low rise structure located in an Exposure B region where the basic wind speed is 140 mph (3-second gust). The building is a Category II structure. The mean roof height of the building is 30 feet. The roof is a gable roof with a roof slope of 3:12. The terrain around the building does not abruptly change so as to create any wind speedup effects due to channeling, or shielding. The building is not located on a hill, ridge, or escarpment that would cause the wind to speedup. The roof tiles will be flat/low profile concrete roof tile with a total tile length of 16-½" and an exposed width of 11". The roof tiles weigh 9 pounds each. The roof covering is installed on solid sheathing.

Example 1: Calculate the Required Aerodynamic Uplift Moment and the Allowable Aerodynamic Uplift Resistance from Table 7:

Velocity Pressure:

$q_h = 0.00256\ K_z\ K_{zt}\ K_d\ V^2\ I$ (ASCE 7 - 6.5.10)

q_h = velocity pressure elevation at height z (psf)

K_z = velocity pressure exposure coefficient at height z (ASCE 7 - Table 6-3)

$K_z = 0.70$

K_{zt} = topographic factor (ASCE 7 - Figure 6-4)

$K_{zt} = 1.00$

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K_d = wind directionality factor (ASCE 7 - Table 6-4)

$K_d = 0.85$

V = basic wind speed (mph) (ASCE 7 - Figure 6-1)

V = 140 mph

I = importance factor (ASCE 7 - Table 6-1)

I = 1.00

$q_h = 0.00256\ K_z\ K_{zt}\ K_d\ V^2\ I = 0.00256\ (0.70)\ (1.00)\ (0.85)\ (140\ mph)^2\ (1.00)$

$q_h = 29.85$ psf

Required Aerodynamic Uplift Moment:

$M_a = q_h\ C_L\ b\ L\ L_a\ (1- GC_p)$ (IBC - Eq. 16-33)

M_a = aerodynamic uplift moment (ft-lbf)

q_h = velocity pressure elevation at mean roof height h (psf)

$q_h = 29.85$ psf

C_L = lift coefficient = 0.2 (IBC - Section 1609.5.3)

b = exposed width of roof tile (ft)

b = 11" ~ 0.917'

L = length of roof tile (ft)

L = 16-½" ~ 1.375'

L_a = moment arm for the roof tile = 0.76 L (IBC - Section 1609.7.3)

$L_a = 0.76\ (16\text{-}½") = 12.54" \sim 1.045'$

GC_p = product of external pressure coefficient and gust factor

$GC_p = -2.6$

Note: The external pressure coefficient for Zone 3 was selected to calculate the required aerodynamic uplift moment. The use of this external pressure coefficient is conservative for zones 1 and 2.

$M_a = q_h\ C_L\ b\ L\ L_a\ (1- GC_p) = (29.85\ psf)\ (0.2)\ (0.917')\ (1.375')\ (1.045')\ (1 - [-2.6])$

$M_a = 28.3$ ft lbf

Required Aerodynamic Uplift Resistance:

For a direct deck installation select a fastening system from Table 7, Allowable Aerodynamic Uplift Moments - Mechanical Fastening Systems that is equal to or greater than 28.3 ft-lbf in order to comply with the code, such as 2-10d ring shank nails or 1-#8 screw.

2-10d ring shank nails = 39.1 ft-lbf (TRI Manual - Table 7)

1-#8 screw = 39.1 ft-lbf (TRI Manual - Table 7)

Example 2: Determine the Required Aerodynamic Uplift Moment using Table 5 or Table 6 and Allowable Aerodynamic Uplift Resistance from Table 7:

The flat/low concrete roof tile is within the combined maximum tile length and maximum exposed width listed in Table 6E, Maximum Combination of Tile Length and Tile's Exposed Width. This roof tile may be designed using the appropriate Table 5 or Table 6.

Based on the exposure and the roof pitch the appropriate table is Table 5A, Exposure B - Required Aerodynamic Uplift Moment. Table 5A indicates that the required aerodynamic uplift moment for this roof covering, M_a, is 30.3 ft-lbf.

Required aerodynamic uplift moment, M_a, = 30.3 ft lbf (TRI Manual - Table 5A)

Note: The difference between the M_a's in Example 1 and Example 2 is in the tile factor. Table 5 and Table 6 are based on a tile factor of 1.407 ft³ while the actual tile factor for this roof tile is 1.318 ft³. (Tile Factor = b L L_a = (0.917') (1.375') (1.045') = 1.318 ft³).

Required Aerodynamic Uplift Resistance:

For a direct deck installation select a fastening system from Table 7, Allowable Aerodynamic Uplift Moments - Mechanical Fastening Systems that is equal to or greater than 30.3 ft-lbf in order to comply with the code, such as 2-10d ring shank nails or 1-#8 screw.

2-10d ring shank nails = 39.1 ft-lbf (TRI Manual - Table 7)

1-#8 screw = 39.1 ft-lbf (TRI Manual - Table 7)

Example 3: Design the Roof Tile Installation for a Lightweight Roof Tile:

The roof tile installation is identical to the previous examples except that the roof tiles lightweight roof tiles weighing 5 pounds each.

The flat/low lightweight concrete roof tile is within the combined maximum tile length and maximum exposed width listed in Table 6E, Maximum Combination of Tile Length and Tile's Exposed Width. This roof tile may be designed using the appropriate Table 5 or Table 6.

Required Aerodynamic Uplift Moment:
Based on the exposure and the roof pitch the appropriate table is Table 5A, Exposure B - Required Aerodynamic Uplift Moment. Table 5A indicates that the required aerodynamic uplift moment for this roof covering, M_a, is 30.3 ft-lbf.

M_a, = 30.3 ft lbf (TRI Manual - Table 5A)

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Mechanical Attachment Resistance:

For a direct deck installation select a fastening system from Table 7, Allowable Aerodynamic Uplift Moments - Mechanical Fastening Systems select an attachment resistance that is equal to or greater than 30.3 ft-lbf. Use 1-#8 screw which has a resistance of 39.1 ft-lbf.

1-#8 screw = 39.1 ft-lbf (TRI Manual - Table 7)

Attachment Resistance:

Determine the attachment resistance with the generic restoring gravity moment used in Table 7. Footnote 10 for Table 7 states that the table is based on a generic restoring gravity moment of 6.5 ft-lbf for a direct deck installation and 5.5 ft-lbf for a batten installation. Based on a direct deck installation the attachment resistance for 1-#8 screw is 32.6 ft-lbf.

M_f = 39.1 ft-lbf - 6.5 ft-lbf = 32.6 ft-lbf

Restoring Gravity Moment:

From Table 6F the restoring gravity moment for a roof tile weighing 5 lbm is 3.17 ft-lbf

M_g = 3.17 ft-lbf (TRI Manual - Table 6F)

Allowable Aerodynamic Uplift Resistance:

The allowable aerodynamic uplift resistance for the flat/low lightweight concrete roof tile is the sum of the attachment resistance plus the restoring gravity moment for the flat/low lightweight concrete roof tile.

Allowable Aerodynamic Uplift Resistance, $M_{all} = M_f + M_g$ = 32.6 ft-lbf + 3.17 ft-lbf = 35.77 ft-lbf

M_{all} = 35.8 ft-lbf > M_a, = 30.3 ft lbf

The use of 1-#8 screw to install each lightweight roof tile complies with the code for uplift resistance.

Appendix B

TABLE 5A
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Gable Roof 2 ½:12 < θ < 6:12 (12° < θ < 27°) Hip Roof 5 ½:12 < θ < 6:12 (25° < θ < 27°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	11.2	12.5	15.4	17.0	18.7	22.2	24.1	26.1	30.3	32.5	34.7	44.6
40	12.1	13.6	16.8	18.5	20.3	24.1	26.2	28.3	32.9	35.3	37.7	48.5
50	12.9	14.5	17.9	19.7	21.6	25.7	27.9	30.2	35.0	37.6	40.2	51.6
60	13.6	15.2	18.8	20.8	22.8	27.1	29.4	31.8	36.9	39.6	42.4	54.4
	Importance Factor = 1.15											
0-30	12.8	14.4	17.8	19.6	21.5	25.6	27.7	30.0	34.8	37.3	40.0	51.3
40	13.9	15.6	19.3	21.3	23.3	27.8	30.1	32.6	37.8	40.5	43.4	55.7
50	14.8	16.6	20.6	22.7	24.9	29.6	32.1	34.7	40.3	43.2	46.2	59.4
60	15.6	17.5	21.6	23.9	26.2	31.2	33.8	36.6	42.4	45.5	48.7	62.6

TABLE 5B
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Hip Roof 2 ½:12 < θ < 5 ½:12 (12° < θ < 25°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	8.4	9.4	11.6	12.8	14.0	16.7	18.1	19.6	22.7	24.4	26.1	33.5
40	9.1	10.2	12.6	13.9	15.2	18.1	19.6	21.3	24.6	26.4	28.3	36.3
50	9.7	10.9	13.4	14.8	16.2	19.3	20.9	22.6	26.3	28.2	30.2	38.7
60	10.2	11.4	14.1	15.6	17.1	20.3	22.1	23.9	27.7	29.7	31.8	40.8
	Importance Factor = 1.15											
0-30	9.6	10.8	13.3	14.7	16.1	19.2	20.8	22.5	26.1	28.0	30.0	38.5
40	10.4	11.7	14.5	15.9	17.5	20.8	22.6	24.4	28.3	30.4	32.5	41.8
50	11.1	12.5	15.4	17.0	18.6	22.2	24.1	26.0	30.2	32.4	34.7	44.5
60	11.7	13.2	16.2	17.9	19.6	23.4	25.4	27.4	31.8	34.1	36.5	46.9

TABLE 5C
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Gable Roof 6:12 < θ < 12:12 (27° < θ < 45°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	6.8	7.6	9.4	10.4	11.4	13.6	14.7	15.9	18.5	19.8	21.2	27.3
40	7.4	8.3	10.2	11.3	12.4	14.8	16.0	17.3	20.1	21.5	23.1	29.6
50	7.9	8.8	10.9	12.0	13.2	15.7	17.1	18.5	21.4	23.0	24.6	31.6
60	8.3	9.3	11.5	12.7	13.9	16.6	18.0	19.4	22.5	24.2	25.9	33.2
	Importance Factor = 1.15											
0-30	7.8	8.8	10.9	12.0	13.1	15.6	17.0	18.3	21.3	22.8	24.4	31.4
40	8.5	9.5	11.8	13.0	14.3	17.0	18.4	19.9	23.1	24.8	26.5	34.1
50	9.1	10.2	12.6	13.8	15.2	18.1	19.6	21.2	24.6	26.4	28.3	36.3
60	9.6	10.7	13.2	14.6	16.0	19.1	20.7	22.4	25.9	27.8	29.8	38.2

TABLE 5D
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Monoslope Roof 2 ½:12< θ < 6 ¾:12 (12° < θ < 30°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	12.1	13.6	16.7	18.4	20.2	24.1	26.1	28.3	32.8	35.2	37.6	48.3
40	13.1	14.7	18.2	20.0	22.0	26.2	28.4	30.7	35.6	38.2	40.9	52.5
50	14.0	15.7	19.4	21.3	23.4	27.9	30.2	32.7	37.9	40.7	43.6	55.9
60	14.7	16.5	20.4	22.5	24.7	29.4	31.9	34.5	40.0	42.9	45.9	58.9
	Importance Factor = 1.15											
0-30	13.9	15.6	19.2	21.2	23.3	27.7	30.1	32.5	37.7	40.5	43.3	55.6
40	15.1	16.9	20.9	23.0	25.3	30.1	32.6	35.3	40.9	43.9	47.0	60.4
50	16.1	18.0	22.3	24.5	26.9	32.1	34.8	37.6	43.6	46.8	50.1	64.3
60	16.9	19.0	23.5	25.9	28.4	33.8	36.6	39.6	46.0	49.3	52.8	67.8

TABLE 6A
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Gable Roof 2 ½:12 < θ < 6:12 (12° < θ < 27°) Hip Roof 5 ½:12 < θ < 6:12 (25° < θ < 27°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	13.5	15.2	18.7	20.6	22.6	26.9	29.2	31.6	36.7	39.3	42.1	54.1
20	14.4	16.1	19.9	21.9	24.1	28.6	31.1	33.6	39.0	41.8	44.7	57.5
25	15.1	16.9	20.8	23.0	25.2	30.0	32.6	35.2	40.8	43.8	46.9	60.2
30	15.6	17.5	21.7	23.9	26.2	31.2	33.8	36.6	42.4	45.5	48.7	62.6
40	16.6	18.6	23.0	25.4	27.8	33.1	35.9	38.9	45.1	48.4	51.8	66.5
50	17.4	19.5	24.1	26.6	29.2	34.7	37.7	40.7	47.3	50.7	54.2	69.7
60	18.1	20.3	25.1	27.6	30.3	36.1	39.1	42.3	49.1	52.7	56.4	72.4
	Importance Factor = 1.15											
0-15	15.5	17.4	21.5	23.7	26.0	31.0	33.6	36.4	42.2	45.2	48.4	62.2
20	16.5	18.5	22.9	25.2	27.7	32.9	35.7	38.6	44.8	48.1	51.4	66.1
25	17.3	19.4	24.0	26.4	29.0	34.5	37.4	40.5	47.0	50.4	53.9	69.2
30	18.0	20.2	24.9	27.5	30.1	35.9	38.9	42.1	48.8	52.4	56.0	72.0
40	19.1	21.4	26.5	29.2	32.0	38.1	41.3	44.7	51.8	55.6	59.5	76.5
50	20.0	22.5	27.7	30.6	33.5	39.9	43.3	46.9	54.3	58.3	62.4	80.1
60	20.8	23.3	28.8	31.8	34.9	41.5	45.0	48.7	56.5	60.6	64.8	83.3

TABLE 6B
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Hip Roof 2 ½:12 < θ < 6:12 (12° < θ < 27°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	10.1	11.4	14.0	15.5	17.0	20.2	21.9	23.7	27.5	29.5	31.6	40.6
20	10.8	12.1	14.9	16.4	18.0	21.5	23.3	25.2	29.2	31.3	33.5	43.1
25	11.3	12.7	15.6	17.2	18.9	22.5	24.4	26.4	30.6	32.9	35.2	45.2
30	11.7	13.2	16.2	17.9	19.6	23.4	25.4	27.4	31.8	34.1	36.5	46.9
40	12.5	14.0	17.3	19.0	20.9	24.8	27.0	29.2	33.8	36.3	38.8	49.9
50	13.1	14.6	18.1	19.9	21.9	26.0	28.3	30.6	35.4	38.0	40.7	52.3
60	13.6	15.2	18.8	20.7	22.7	27.1	29.4	31.8	36.8	39.5	42.3	54.3
	Importance Factor = 1.15											
0-15	11.7	13.1	16.1	17.8	19.5	23.2	25.2	27.3	31.6	33.9	36.3	46.6
20	12.4	13.9	17.1	18.9	20.7	24.7	26.8	29.0	33.6	36.1	38.6	49.6
25	13.0	14.6	18.0	19.8	21.7	25.9	28.1	30.4	35.2	37.8	40.4	51.9
30	13.5	15.1	18.7	20.6	22.6	26.9	29.2	31.6	36.6	39.3	42.0	54.0
40	14.3	16.1	19.8	21.9	24.0	28.6	31.0	33.5	38.9	41.7	44.6	57.3
50	15.0	16.8	20.8	22.9	25.2	29.9	32.5	35.1	40.8	43.7	46.8	60.1
60	15.6	17.5	21.6	23.8	26.1	31.1	33.8	36.5	42.4	45.4	48.6	62.4

TABLE 6C
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Gable Roof 6:12 < θ < 12:12 (27° < θ < 45°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	8.3	9.3	11.4	12.6	13.8	16.5	17.9	19.3	22.4	24.0	25.7	33.0
20	8.8	9.8	12.1	13.4	14.7	17.5	19.0	20.5	23.8	25.5	27.3	35.1
25	9.2	10.3	12.7	14.0	15.4	18.3	19.9	21.5	25.0	26.8	28.6	36.8
30	9.6	10.7	13.2	14.6	16.0	19.1	20.7	22.4	25.9	27.8	29.8	38.2
40	10.2	11.4	14.1	15.5	17.0	20.2	22.0	23.8	27.6	29.6	31.6	40.6
50	10.6	11.9	14.7	16.2	17.8	21.2	23.0	24.9	28.9	31.0	33.2	42.6
60	11.1	12.4	15.3	16.9	18.5	22.0	23.9	25.9	30.0	32.2	34.4	44.2
	Importance Factor = 1.15											
0-15	9.5	10.7	13.2	14.5	15.9	18.9	20.5	22.2	25.8	27.6	29.6	38.0
20	10.1	11.3	14.0	15.4	16.9	20.1	21.8	23.6	27.4	29.4	31.4	40.4
25	10.6	11.9	14.6	16.1	17.7	21.1	22.9	24.7	28.7	30.8	32.9	42.3
30	11.0	12.3	15.2	16.8	18.4	21.9	23.8	25.7	29.8	32.0	34.2	44.0
40	11.7	13.1	16.2	17.8	19.6	23.3	25.3	27.3	31.7	34.0	36.4	46.7
50	12.2	13.7	16.9	18.7	20.5	24.4	26.5	28.6	33.2	35.6	38.1	49.0
60	12.7	14.3	17.6	19.4	21.3	25.4	27.5	29.8	34.5	37.0	39.6	50.9

TABLE 6D
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Monoslope Roof 2 ½:12< θ < 6 ¾:12 (12° < θ < 30°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	14.6	16.4	20.3	22.3	24.5	29.2	31.7	34.3	39.7	42.6	45.6	58.6
20	15.6	17.4	21.5	23.7	26.1	31.0	33.7	36.4	42.2	45.3	48.5	62.2
25	16.3	18.3	22.6	24.9	27.3	32.5	35.3	38.1	44.2	47.5	50.8	65.2
30	16.9	19.0	23.5	25.9	28.4	33.8	36.6	39.6	46.0	49.3	52.8	67.8
40	18.0	20.2	24.9	27.5	30.2	35.9	38.9	42.1	48.8	52.4	56.1	72.0
50	18.9	21.2	26.1	28.8	31.6	37.6	40.8	44.1	51.2	54.9	58.8	75.5
60	19.6	22.0	27.1	29.9	32.8	39.1	42.4	45.9	53.2	57.1	61.1	78.4
	Importance Factor = 1.15											
0-15	16.8	18.9	23.3	25.7	28.2	33.6	36.4	39.4	45.7	49.0	52.5	67.4
20	17.9	20.1	24.8	27.3	30.0	35.7	38.7	41.9	48.5	52.1	55.7	71.6
25	18.8	21.0	26.0	28.6	31.4	37.4	40.6	43.9	50.9	54.6	58.4	75.0
30	19.5	21.8	27.0	29.7	32.6	38.8	42.1	45.6	52.9	56.7	60.7	78.0
40	20.7	23.2	28.7	31.6	34.7	41.3	44.8	48.4	56.2	60.3	64.5	82.8
50	21.7	24.3	30.0	33.1	36.3	43.3	46.9	50.8	58.9	63.2	67.6	86.8
60	22.6	25.3	31.2	34.4	37.8	44.9	48.8	52.7	61.2	65.6	70.2	90.2

Appendix B

TABLE 6E
Maximum Dimensions to Satisfy Tile Factor of 1.407 ft^3

Maximum Combination of Tile Length and Tile's Exposed Width										
Maximum Tile Length (inches)	20	18-½	18	17-½	16-½	16	15-½	15	14-½	14
Maximum Exposed Width (inches)	8	9-1/4	9-3/4	10-1/4	11-3/4	12-½	13-1/4	14	15	15

TABLE 6F
Restoring Gravity Moment

Maximum Combination of Tile Length and Tile's Exposed Width						
Tile Weight (lbs)	5	6	7	8	9	10
M_g (ft-lbft)	3.17	3.80	4.43	5.06	5.7	6.33

Notes for Tables 5A through 6F:

1. Roof tiles shall comply with the following dimensions:
   (1) The total length of the roof tile shall be between 1.0 foot and 1.75 feet.
   (2) The exposed width of the roof tile shall be between 0.67 feet and 1.25 feet.
   (3) The maximum thickness of the tail of the roof tile shall not exceed 1.3 inches.

Notes cont'd from page 83

2. The required aerodynamic uplift moments in these tables are based on a roof tile that has a Tile Factor of 1.407 ft^3. The required aerodynamic uplift moment for roof tiles with a Tile Factor other than 1.407 ft^3 may be determined by using the following procedure. These tables are conservative for roof tiles with a Tile Factor less than 1.407 ft^3.
   (1) Calculate the Tile Factor for the desired roof tile.
   Tile Factor = b (L) (La)
   b = exposed width of the roof tile (ft)
   L = total length of roof tile (ft)
   L_a = moment between point of rotation and the theoretical location of the resultant of the wind uplift force.
   For the standard roof tiles the moment arm = 0.76 L (See IBC - Section 1609.7.3)
   (2) Based on exposure, roof style, roof pitch, importance, basic wind speed, and mean roof height select the appropriate required aerodynamic uplift moment from the tables for the desired roof tile.
   (3) Multiply the selected required aerodynamic uplift moment by the ratio of the tile factor for the desired roof tile and 1.407 ft^3.
   (4) Select an attachment system that is equal to or greater than the calculated required aerodynamic uplift moment in step 3.
3. Table 6E provides a combination of exposed widths and total lengths that generate a Tile Factor of 1.407 ft^3. The table "Maximum Combination of Tile Length and Tile's Exposed Width" provides a listing of tiles that fit this Tile Factor.

TABLE 7
Allowable Aerodynamic Uplift Moments
Mechanical Fastening Systems

Direct Deck Installation		
Roof Tile Profiler	**15/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	39.1 36.1 28.6
Flat/Low Medium High	1-#8 screw	39.1 33.3 28.7
Flat/Low Medium High	2-#8 screws	50.1 55.5 51.3
Flat/Low Medium High	1-10d smooth or screw shank nail	13.5 12.9 11.3
Flat/Low Medium High	2-10d smooth or screw shank nails	20.2 19.1 13.1
Flat/Low Medium High	1-10d smooth or screw shank nail with clip	25.2 25.2 35.5
Flat/Low Medium High	2-10d smooth or screw shank nail with clip	38.1 38.1 44.3

TABLE 7 (Cont'd)
Allowable Aerodynamic Uplift Moments
Mechanical Fastening Systems

Batten Installation		
Roof Tile Profiler	**15/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	24.6 36.4 26.8
Flat/Low Medium High	1-#8 screw	25.6 30.1 25.5
Flat/Low Medium High	2-#8 screws	36.1 41.9 37.1
Flat/Low Medium High	1-10d smooth or screw shank nail	10.1 8.7 8.2
Flat/Low Medium High	2-10d smooth or screw shank nails	12.8 11.9 12.7
Flat/Low Medium High	1-10d smooth or screw shank nail with clip	27.5 27.5 29.4
Flat/Low Medium High	2-10d smooth or screw shank nail with clip	37.6 37.6 47.2
Direct Deck Installation		
Roof Tile Profiler	**19/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	46.4 45.5 41.2
Flat/Low Medium High	1-10d smooth or screw shank nail	16.0 15.2 13.0
Flat/Low Medium High	2-10d smooth or screw shank nails	25.0 23.4 15.4

Notes for Table 7:

1. For attachment systems not listed in the table for 19/32" sheathing use the allowable aerodynamic uplift resistance from the table for 15/32" sheathing.
2. Fasteners shall have a minimum edge distance of 1-½ inches from the head of the tile and located in the pan of the tile to obtain the values in Table 7. Consult the tile manufacturer for additional limitations or restrictions.

Notes cont'd on page 86

Notes for Table 7(Cont'd)**:**

3. Ring shank nails shall be 10d ring shank corrosion resistant steel nails with the following minimum dimensions: (3 inches long, 0.283 inch flat head diameter, 0.120 inch undeformed shank diameter or 0.131 inch screw diameter).
4. Smooth or screw shank nails shall be 10d corrosion resistant steel (with the following minimum dimension. 3 inch long, 0.283 inch flat head diameter, 0.120 inch undeformed shank diameter or 0.131 inch screw diameter).
5. Screws are #8 course threaded, 2.5 inches long corrosion-resistant steel wood screws conforming to ANSI/ASME B 18.6.1.
6. The fastener hole nearest the overlock shall be used when a single nail or screw is required. The fastener hole nearest the underlock and the fastener hole nearest the overlock shall be used when two nails or screws are required.
7. When using eave and field clips, attachment of the tiles is accomplished by a combination of nails and clips. Tiles are nailed to the sheathing or through the battens to the sheathing with one or two 10d corrosion resistant nails (Note 2 and 3 above) as required by Tables 5 and 6. Additionally, each tile is secured with a 0.060 inch thick and 0.5 inch wide clip which is secured to the plywood sheathing or eave fascia, as appropriate, with a single nail per clip. The nail shall be placed in the hole closest to the tile for clips having more than one nail hole. The following clip/nail combinations are permitted:
   (1) Aluminum alloy clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
   (2) Galvanized steel deck clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
   (3) Stainless steel clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
8. Field clips and eave clips are to be located along the tile where the clip's preformed height and the tile's height above the underlayment are identical.
9. Counter batten values not included.
10. For attachment systems not listed in table for 19/32 inch sheathing, use allowable aerodynamic uplift moment from table for 15/32 inch sheathing.
11. The allowable aerodynamic uplift moments include a generic restoring gravity moment of 6.5 ft-lbf for a direct deck installation and a generic restoring gravity moment of 5.5 ft-lbf for a batten installation."

Additional Notes [outside the scope of ICC-ES report (ERS-2015P) on this manual]

Allowable Aerodynamic Uplift Moments
Adhesive Fastening Systems

Refer to the adhesive manufacturer for the allowable aerodynamic uplift moment for the installation method used to comply with the applicable code requirements. Installation of roof tiles using the adhesive system should be done by technicians trained and having a current certification by the adhesive manufacturer to comply with the applicable code requirements.

Allowable Aerodynamic Uplift Moments
Mortar Fastening Systems

Refer to the pre-bagged mortar mix manufacturer for the allowable aerodynamic uplift moment for the installation method used to comply with the applicable code requirements. Mixing of mortar at the jobsite is not a recommended practice. Installation of roof tiles using the mortar system should be done by technicians trained and having a current certification by the mortar mix manufacturer to comply with the applicable code requirements.

Design Considerations for Installations in Earthquake Regions

[Outside the scope of ICC-ES report (ERS-2015P) on this manual.]

The Tile Roofing Institute in conjunction with the University of Southern California, Structural Engineering Department conducted a series of testing on the Seismic Performance of Concrete and Clay Tile. The testing concluded that Concrete and Clay tile, when installed according to ICC code requirements, withstood forces almost twice the code requirements for structures.

Tile is the only roofing material to have conducted such testing on roof assemblies and is pleased to report that concrete and clay tile will not require any additional fastening requirements, other than those required under the current ICC code.

GLOSSARY OF TERMS

Abutment: The intersection between the roof and the chimney, wall or other vertical face.

Adhesives: A bonding agent to join two surfaces for the purpose of permanent attachment as approved by the local building official.

Anti-Ponding: A device such as beveled cant strip or shop-formed sheet metal is recommended at all raised fascia conditions to support the underlayment.

Batten: A nonstructrual horizontal fastening strip to which the roof tiles are attached.

Batten Lugs: Protrusions (anchor lugs) on the underside of the tile designed to engage over the upper edge of tiling battens.

Bedding: Refers to the installation of roof tiles to a mortar or adhesive foam patty and is structural in nature for the basic securement.

Bird Stop: A product used at the eave of a profile tile roof to stop birds from entering below the tile.

Booster Tile: Normally 3"-4" long tile strip used to lift up the cover tile. Sometimes it is used in boosting up field tile to create an authentic looking roof.

Cant Angle: The angle formed between the upper surface of the installed roof tile and the roof deck.

Clay Rooftile: An interlocking or non-interlocking clay roof covering, used to cover the roof surface.

Concrete Rooftile: An interlocking, or non-interlocking concrete roof covering, used to cover the roof surface.

Counter Battens: Vertical furring strips running beneath and perpendicular to horizontal tile batten, to allow drainage and air flow beneath the roof tile. Also known as strapping.

Counter Flashing: A flashing material that provides the enclosure at the transition line between the roof to wall flashing at intersecting vertical surfaces.

Counter Batten System: A method of elevating horizontal battens above the roof deck to allow drainage and air flow beneath the horizontal battens and roof tile

Cricket: See Saddle.

Dead Loads: The weight of all materials of construction incorporated into the roof assembly including but not limited to, fixed service equipment, roof tiles, battens, underlayment, flashing, roof deck, etc.

Direct Deck: Those tiles fastened directly to the roof deck without the use of battens.

Eave: Outer edge of the roof downslope.

Eave Closure: A material available for S-tile or Pan and Cover tile. Eave closures are used to close the convex opening created by the shape of the tile at the eave. This accessory also provides the proper rise for the first course of tile. See Bird Stop.

Eave Riser: Method/material used for elevating the nose of the first course of tile to the plane of the field tile.

Fascia: A decorative board concealing the lower ends of the rafters or the outer edge of the gable.

Flashing: Impervious material used to cover, waterproof, and direct water away from roof penetrations and from intersections between the roof tile and other materials.

Fully Engaged: The horizontal batten material thickness shall be equal to or greater than the design depth of the anchor lug of the tile.

Gable End: The generally triangular area at the end of a sloped roof extending from the eaves to the ridge.

Head Lap: The measurement of the overlap between a course of roofing components and the course above.

Headwall Flashing: The flashing that is installed at the horizontal, intersecting wall or other vertical surface.

Hem: An edge of metal bent back on its self to give strength to the edge of the metal.

High Profile Tile: Those tiles having a rise to width ratio greater than 1:5. (Typically referred to as "S" or barrel, 2-piece, Pan & Cover tile). Measured in the installed condition.

Hip: The exterior sloping ridge formed by the intersection of two inclined roof surfaces.

Hip/Ridge Tile: Accessory trim tile used to cover a hip or a ridge.

Hip Starter: The closed hip piece which is used at the outside corner, intersecting of two eaves to start the hip tile.

Interlocking Tile: Those tiles with a system of rib(s) or groove(s) enabling the joining of adjacent tiles in the same horizontal or vertical row, with the overlapping lock covering the underlapping lock.

Length: The maximum overall dimension of the tiles as measured parallel to the water course.

Live Loads: A load produced by the use and occupancy of the building or other structure that does not include construction or environmental loads, such as wind load, snow load, rain load, earthquake load, flood load, or dead load.

Low Profile Tile: Low profile tiles are defined as those flat tiles having a top surface rise equal to or less than ½".

Medium Profile Tile: Tiles having a rise greater than ½" and a rise to width ratio of less than or equal to 1:5.

Metal Drip Edge: Perimeter metal flashing installed to protect raw edges of roof deck.

Mortar: A mixture of cementitious material, aggregate, and water used for bedding, jointing, and bonding of masonry or roof tile and accessories.

Nail Hole: A small opening passing partially or totally through the tiles to allow the penetration of a nail, screw or other approved fastener for the purpose of fastening the tile to a support.

Nailer Board/Stringer: A piece of wood or other material of proper height, attached to a roof at the ridge and/or hips to allow for proper support and means of attachment for the hip and ridge tile. Can also be used in pan and cover applications under the cover tile for proper support. (Commonly known as a vertical stringer)

Non-Interlocking Tile: Those tile that do not have vertical rib(s) or grooves creating an interlocking tile.

Nose Clips: A fastening device designed to hold the nose (or butt) end of the tile against uplift or sliding down the slope. Also known as wind clips or tile locks.

Nose Lugs: Protrusion(s) on the underside of the tile that are designed to restrict the flow of weather between two consecutive courses of tile.

Pan and Cover Tile: Semi-circular shape tile. Also known as two piece mission or barrel mission tile. There are tapered and straight two piece mission styles available.

Pan Flashing: Metal flashing running under the tile at the side walls.

Point-up: The application of mortar to fill voids to various ends, sides and angles of a tile roof, which are non structural in nature.

Profile: The contour of the top surface of the tiles when viewed from the nose end.

Rake Trim: A roof tiling accessory used to cover the intersection between the gable end and a roof.

Ridge Trim: The piece of ridge available to close off the gable end and peak of a roof. Some ridge tile have an interlocking feature and require either a "starter" or "finisher".

Ridge Tile: See hip/ridge tile.

Roof Live Load: A load on the roof produced (1) during the maintenance by workers, equipment, and materials and (2) during the life of the structure by moveable objects, such as planters or other similar small decorative appurtenances that are not occupancy related.

Saddle Flashing: The flashing at the upper intersection between a chimney or skylight and the roof. (Commonly referred to as a Cricket or Backpan)

Side Clips: A fastening device for tile with a side interlock designed to prevent rotation of the tile when subjected to uplifting forces. Also known as hurricane clip.

Side Lap: The measurement of the overlap between a roofing component and a component to one side of it.

Side Wall: The vertical intersection that runs parallel to the roof slope.

Spaced Sheathing: Sheathing boards or battens, which are mechanically attached to the rafters or framing members, with gaps or spaces between them and is used in lieu of a solid sheathing.

Standard Weight Rooftile: Roof tile of mass/unit area of 9 lbs/ft^2 or greater installed weight excluding all other roofing components.

Starter Tile: First course of cover tile for two piece misson. Normally 3"-4" shorter than the field tile.

Step Flashing: A piece of flashing material covering each course of tile at sidewalls.

Stringer: See nailer board.

Sweat Sheet/Bleeder Sheet: A layer of underlayment under the valley metal to prevent moisture/condensation from entering the roof deck.

Tile Course: The horizontal increment of exposure.

Tile Thickness: Any vertical measurement of the cross section of the tiles excluding the lapping area, head or nose lugs, and weather checks.

Tile Thickness (visual): The overall thickness of the tile profile when installed as measured from the top surface of the lower tile to the top surface of the upper tile.

Tile Batten: See Batten

Underlayment: A water shedding membrane installed over the roof sheathing, rafters, or trusses. The underlayment may be rigid or roll form.

Valley: The angle of a roof where two slopes intersect internally.

Closed Valley: Where tile(s) are cut to meet at the center of the valley metal.

Open Valley: Where tile(s) are cut to expose the trough area of the metal.

Vent Tile: A tile designed to allow air circulation from the roof space to the outside.

Water Course: The valley portions of profiled tiles along which water drains.

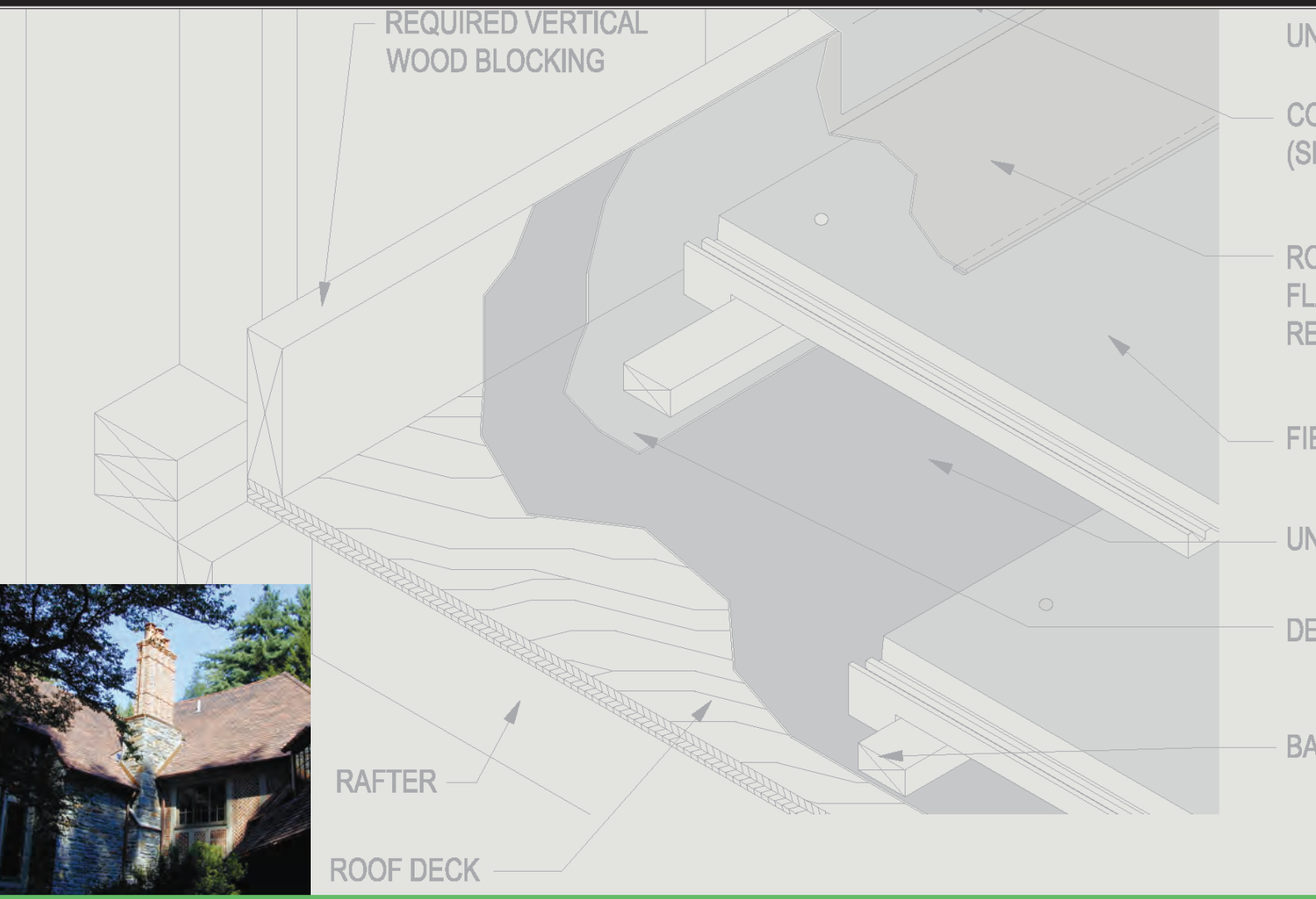
Weather Blocking: A barrier of moldable or preformed rigid material which blocks the entry of wind driven moisture at openings between the field tile and trim tile or the field tile and roof flashing.

Weather Checks: Protrusion(s) on the tile that are designed to restrict the flow of water between two consecutive courses of tile.

Width: The maximum overall dimension of the tiles as measured perpendicular to the length of the water channel.

Width, Exposed: The maximum overall dimension of the tile as measured perpendicular to the length of the water channel minus the side lap of the adjacent roof tile.

Wire Tie System: A roof tile fastening system approved by the local building code, that limits the penetration of the underlayment and allows tile to be fastened to non-nailable roof decks.



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