

VERMONT SLATE COMPANY, LLC

Post Office Box 114 • Poultney, Vermont 05764
Phone: (912) 964-9609 • Toll-Free: (866) 895-9940 • Facsimile: (802) 884-4600
www.VermontSlateCo.com • Sales@VermontSlateCo.com

GENERAL INSTALLATION GUIDELINES FOR NATURAL QUARRIED ROOFING SLATE

Version 1.0.5, Published by unanimous vote of the SRCA Board of Directors, 4/4/2012

PART 1 - GENERAL PROJECT PREPARATION AND EXECUTION

1.1. CONTRACTORS

- A. It is recommended that prospective contractors have foremen or supervisors who have a minimum of five years of professional experience in installing natural slate roofing.
- B. Contractors shall furnish all insurance, permits, labor, materials, equipment, apparatus, tools, transportation and services necessary for, and incidental to, the proper installation and completion of the slate roof. This work may include removing and properly disposing off-site of existing slate roofing or other shingles, if any; installing underlayment; installing new sheet metal roof flashings, and installing new or salvaged roofing slate to cover the entire existing slate roof area, leaving a very long term, damage resistant, weatherproof roof.
- C. Contractors shall use workmen who are trained and experienced in laying slate, installing metal flashing, and all other skills needed to satisfactorily complete the project as specified, or use workmen who are under the full-time supervision of a foreman or supervisor with such training and experience.
- D. Contractors shall be skilled in the use of slate hammers for punching and nailing slate shingles, slate rippers for removing slates already installed, slate cutters for trimming and cutting slate shingles, slaters stakes used with slate hammers that have a cutting shank, roof brackets and scaffolding for staging the roof, and hook ladders for accessing areas of the roof not staged.
- E. Contractors shall make certain that the surfaces to which the roof slates are to be applied are in a suitable condition for this application or that they have been repaired to a condition satisfactory for slating. All surfaces to be slated must be swept clean of any debris.
- F. Contractors shall keep the building weatherproof and make every reasonable attempt to complete the project on schedule. Work is to be scheduled when weather conditions allow the work to be performed according to manufacturer's recommendations and in compliance with warranty requirements.

1.2. CONTRACT DOCUMENTS

- A. Contractors will provide contract documents that include detailed specifications for all materials and installation styles, including, but not limited to slate types, thicknesses, colors, and origins; nail types and lengths; underlayment types and weights; headlaps; ridge style; valley style; flashing materials, including weights, types and sizes of metals.

B. Contract documents shall also include a detailed warranty (see Section 1.8). It is recommended that this SRCA General Roofing Installation Guidelines for Natural Quarried Slate document be attached to the contract as an addendum.

1.3. MATERIALS DELIVERY AND STORAGE

A. Contractor shall guarantee all material to be as specified.

B. Materials are to be delivered on manufacturer's unopened skids with intact labels indicating source whenever possible, and are to be stored on pallets to avoid water damage when necessary.

C. Rolled goods are to be stored on end. Manufacturer's recommendations for job-site storage and protection are to be followed.

D. Materials are not to be stored on existing fire escapes, in areas that may obstruct the ingress or egress of essential doorways or walkways, or on low-slope roofs or other roof slopes where the weight of the materials may damage the roof structure.

E. Temporary roof coverings, tarps, or other materials are to remain available onsite in the event that the work must be ceased suddenly due to weather conditions and the roof needs to be weathered in until such time as the work may be continued.

1.4 CODES AND REGULATIONS

A. Contractor shall review and comply with all federal, state, local and contractual regulations regarding specific installations, and abide by any applicable building, safety and health codes related to construction practices or use of equipment.

B. Contractor shall review and comply with the regulations of local governing Historical Societies and the National Registry of Historic Properties, when applicable.

1.5 PROTECTION OF ROOF SURFACES

A. Workers are to avoid walking on the slate surfaces during installation.

B. The roof is to be properly staged to allow safe work surfaces, such as planks, that prevent unnecessary foot traffic on the slates.

C. Where foot traffic is unavoidable; roof ladders, hook ladders, chicken ladders, foam pads or other such devices should be used to protect the slates.

1.6 INSURANCE

A. Contractor will carry Liability Insurance and Workers Compensation Insurance.

B. Contractor will provide, upon request, Certificates of Insurance to Owner, with Owner named as Certificate Holder, prior to the execution of any work.

1.7 CLEANING UP

A. Tools, equipment, surplus materials, slate scraps, and debris resulting from the slate roof installation shall be organized and cleaned up, or removed and disposed of on a daily basis.

B. A dumpster may be used for storage of removed materials.

C. Gutters and roof areas will be cleaned of debris at the end of each work day and upon completion of the work.

D. Dust and dirt may infiltrate into the attic space during installation or removal of roofing slate. Owner shall be advised to remove any valuable items from the roof or attic spaces and/or to cover such items with plastic, tarps, or other suitable covering prior to the commencement of any work. Contractor shall not be held responsible for dust and dirt in attic spaces other than to broom sweep accessible areas as needed.

1.8 WARRANTY

A. Contractor shall warranty the work, covering both material and labor for defects that may occur, for a minimum period of five years. Repairs or replacement of defective slates or flashing during the warranty period shall be at no cost to the Owner.

B. It is recommended that near the end of the warranty period and before the expiration of the warranty, Contractor will inspect the Work and replace all broken, cracked, displaced, or otherwise deteriorated roofing slates in all areas of the new slate roofing. Owner shall otherwise visually inspect the Work on an annual basis and report to the contractor any observed defects that are covered by the warranty.

C. The contractor will not be held responsible for unusual and damaging weather events such as large hail, strong winds, lightning, flooding, earthquakes, or excessive snow and ice buildup.

D. Contractor's warranty terms are to be clearly detailed in the contract documents.

1.9 EXTRA MATERIAL

A. Contractor shall provide for the Owner one square of field slates used in the Work as maintenance stock for future repairs.

B. The maintenance stock is to be placed in storage in a location at the work site to be determined by the Owner.

PART 2 - ROOFING SLATE

2.1 PROCUREMENT

A. Roofing slates are to be procured from **The Vermont Slate Company** so that additional matching supplies can be obtained if needed. A single quarry source is recommended.

B. Slates shall be supplied by manufacturers that are experienced in the production of roofing slate and that quarry or mine high-quality rock specifically selected for roofing grade applications. Such slates will be supplied with a manufacturer's warranty in writing. Substitution of slates with slates from other sources is not to be permitted without written approval from the Owner or architect.

C. Slates are to be identified and labeled according to the quarry source and location. For example, slates from Europe are not to be identified as "Vermont" or "Pennsylvania" slates without also clarifying the foreign source.

2.2 QUALITY CONTROL

A. Slates shall conform to ASTM C 406 and shall be Grade S1 (minimum 575 lbf breaking load¹, maximum 0.25% absorption², and maximum 0.002 inches depth of softening³)

[¹ASTM C120, Test Methods of Flexure Testing of Slate (Breaking Load, Modulus of Rupture, Modulus of Elasticity); ²ASTM C 121, Test Method for Water Absorption of Slate; ³ASTM C 217, Test Method for Weather Resistance of Slate]

B. All slate shall be hard, dense, sound rock of natural cleft with chamfered (beveled) edges. No broken or cracked slate shall be used, although broken slates may be cut into smaller, unbroken pieces.

C. The slates shall be machine punched, hand punched for nail holes when of standard thickness (3/16" to 1/4" or 4.8mm to 6.4mm) or optionally drilled and counter-sunk when 3/8" or thicker for a minimum of two nail holes each. The holes punched in the slates shall be the correct diameter to provide a snug fit for the shank of the roofing nails. Slates shall be punched or drilled back to front (except starter slates, which are punched front to back). Slates are to be punched on the thinner end if there is a variation in the thickness along the length of the slate.

D. Slates with rectangular corners on the exposed end shall be rejected if a corner is broken off greater than 1.5 inches in either direction, although such slates may be used for cutting into smaller pieces.

E. Curvature of slates shall not exceed 1/8 inch over a distance of 12 inches. Curved slates shall be trimmed and punched to permit them to be laid with the convex side facing up.

F. Defects in slates such as "knuckles," "knots," "knurls" and "cramps" which protrude above the surface of the slates shall be positioned such that they remain on the exposed top surface of the slate after installation. Knots, knurls and cramps are not permitted on the back or covered portions of the slates unless removed by grinding beforehand. A slate shall be rejected if a surface defect adversely affects the proper laying of the slate.

G. Slates are to be free of pyrite inclusions that can visibly leach rust stains onto the roof.

H. Slates shall not have carbon-bearing bands known as "ribbons" as these are considered defects that undermine the longevity of the slate.

I. Nail holes are to be positioned no more than 1.5" in from the side edges of any slates that are 10" wide or narrower. Nail holes must be positioned far enough from the bottom of the slates that the top of the underlying slates will not be penetrated by the slating nails.

2.3 INSTALLATION STYLES

A. Slate installation styles may include, but are not limited to:

1. A "standard" pattern where all of the slates are the same length and width, although these can include slates of differing colors and shapes;
2. A "random width" style where the slates are the same length, but differing widths;
3. A "textural" style where thicknesses, textures, colors, lengths, widths and types of slate may be blended for architectural effect;
4. A "graduated" style where thicker, longer slates are installed near the eaves and the slates gradually decrease in thickness and size as they near the top of the roof;
5. A "staggered butt" style where slates of varying lengths are installed in such a manner that the exposed butts are staggered.

B. When mixed, graduated, or textural slate styles are to be installed, or slates with mixed colors, sizes, types and/or thicknesses, the quantities of the various sizes and types of slates and the layout patterns of the slates are to be clearly specified in the contract documents.

PART 3 - GENERAL MATERIALS

3.1 ROOFING FELT

A. All surfaces to be slated are to be covered with a temporary rolled roofing underlayment in order to weather in the building, when needed.

B. Roofing underlayment shall, at a minimum, comply with ASTM D 226 asphalt-saturated rag felt, Type II, No. 30.

C. Felt shall be installed horizontally with sections overlapped toward eaves or drains by a minimum of two inches and at ends by a minimum of six inches. The felt shall overlap hips and ridges by approximately 12 inches. All felt shall be preserved unbroken, tight, and whole.

D. Felt shall be secured with minimum 1" electro-galvanized roofing nails along laps, ends, and in the field as necessary to properly hold the felt in place and to protect the building from water infiltration until covered with slate.

E. The maximum length of exposure for felts prior to slating shall be one month. When the felt must be left for long periods before the slates can be installed, the exposed nail heads are to be skimmed over with a thin layer of trowel grade roof mastic to prevent leakage around the nail heads.

F. When self-adhesive underlayment is used along eaves or elsewhere, it is to be covered with felt.

G. On slopes from 4:12 to 12:12, a double layer of 30 lb. felt, or a single layer of 40 lb. felt is recommended when the felt is not going to be slated over immediately. Slopes over 12:12 may use a single layer of felt as may any slope that is to be slated within a few days.

3.2 NAILS

A. Nails shall be solid copper, smooth-shank roofing nails, minimum 11 gauge, minimum 1.25" length. Copper nails 2.5" or longer shall be minimum 10 gauge. Alternatively, Type 304 smooth-shank stainless steel roofing nails can be used, not less than 1.25" long.

B. Hot-dipped galvanized smooth-shank roofing nails may be utilized when specified.

C. Nail length is to be approximately twice the thickness of the slates plus 1". Nails are to fully embed into the roof decking material without more than 1/4" nail length being exposed on the underside of the roof decking. When the underside of the roof decking is exposed such as at overhanging eaves, the nails shall be long enough to penetrate the roof decking but not so long that they may be visibly driven through.

D. Recommended nail lengths are as follows when 1" or thicker roof deck is utilized:

1. 3/16"-1/4" thick slates are to be fastened with 1.5" nails.
2. 3/8" thick slates are to be fastened with 1.75" nails.
3. 1/2" thick slates are to be fastened with 2" nails.
4. 3/4" thick slates are to be fastened with 2.5" nails.
5. 1" thick slates are to be fastened with 3" nails.

3.3 FLASHING

A. Flashing shall be minimum 16 ounce copper conforming to ASTM B 370, or minimum 28 gauge stainless steel. Minimum 20 ounce copper flashing is recommended.

B. Flashing shall be installed where there are roof plane intersections, where the roof abuts walls, parapets, dormers and chimneys, or where there are roof penetrations.

C. All flashings and fasteners are to be galvanically compatible metals.

D. The SMACNA "Architectural Sheet Metal Manual" and the publication "Copper and Common Sense" by Revere Copper Products are recommended as guidebooks for flashing installations.

3.4 MASTIC

- A. Roof mastic shall be non-asbestos fibered asphalt cement complying with ASTM D 4586.
- B. Roof mastic shall be designed for trowel application.

3.5 SLATE HOOKS

- A. Slate hooks shall be minimum three inches long, solid copper or stainless steel.
- B. Standard slate hooks are for use with slate of commercial standard thickness only. Custom slate hooks may be fabricated by the Contractor for use with slates up to 1/2" in thickness.

3.6 CANTS

- A. Wood cants for installing underneath the starter course of slate shingles shall be minimum 1/4 inch by 1 inch plaster lath or other solid, glue-free wood. Alternatively, minimum 16 ounce copper or 28 gauge stainless steel edging with a built-in cant may be used.
- B. When installing standard thickness slates (3/16" to 1/4" thick) the cant should be approximately 1/4" to 3/8". Thicker slates will require a greater cant.

3.7 ROOF DECKING

- A. The roof deck is recommended to be a minimum of 3/4" thick, solid, glue-free wood.
- B. Nailable concrete and gypsum concrete are also suitable roof decking materials.
- C. Minimum 3/4" glue-free slating lath or skip sheathing can be spaced on rafters as a nailing substrate.
- D. Minimum 3/4" glue-free boards, slating lath or skip sheathing can be installed over glued or laminated roof decks to provide a suitable nailing substrate.

PART 4 - SLATE EXECUTION

4.1 FASTENERS

- A. All standard slates shall be fastened with minimum two roofing nails fastened above the head of the underlying slate and as far from the center of the slate as is practical.
- B. Larger, heavier slates may need four nails per slate.
- C. Screws are not to be used when fastening slates.
- D. Slates overlapping sheet metal shall have the nails placed so as to minimize puncturing the metal.
- E. Exposed nail heads are not permissible except where unavoidable. Any exposed nail heads shall be sealed with gaskets or approved sealants. The application of slate dust to cover exposed sealants is recommended.
- F. Nails shall not be driven in so far as to produce an excessive strain on the slates, and shall instead be driven to a depth such that the nail heads lie within the counter-sunk nail hole and do not rub excessively against the overlying slates.
- G. Use of pneumatic or electric nail guns to install slate shingles shall not be permitted.

H. Slates are not to be bedded in roof mastic or other adhesives except where absolutely necessary such as at exposed edges in high-wind areas.

I. Ridges and hips shall be installed without exposed fasteners.

J. If a slating nail is installed in a crack or hole in the sheathing, it shall be renailed properly.

4.2 HEADLAP

A. All standard field slates shall be installed with a minimum 3" headlap when the roof slope is 8:12 up to 20:12.

B. On slopes 20:12 or greater, slates may be installed with a 2" headlap.

C. Less than an 8:12 slope down to 4:12, the slates shall be installed with a minimum 4" headlap.

D. Installing roofing slates on slopes less than 4:12 is not recommended.

E. Headlaps may be increased at ice-dam prone or poor drainage areas.

4.3 EAVES SLATES, EDGE SLATES AND STARTER COURSES

A. Eave slates shall be laid to provide a minimum 1.5" projection beyond the furthest extent of the fascia, cornice, crown molding, metal drip edge, trim, or other construction material at the eaves.

B. Rake edge (gable end) slates shall extend 1" beyond the furthest extent of the gable trim, fascia or drip edge.

C. Slates at the eaves shall be doubled by first installing a slate starter or under-eave course installed back side up (chamfered side down). The first course of slate shall be laid over the starter course so that the drip edges of both courses align flush. The first course of slates shall break side-butt joints with the starter course side-butt joints by not less than 3". The second course of slates must overlap the starter course by a minimum of 3" and not less than the general headlap of the field slates along the eaves [see Figure 1].

D. The starter course of slates is to be canted to allow the starter slates to be tilted to the same angle as the field slates. The cant strip may be a solid, glue-free wood strip. Alternatively, a minimum 16 ounce copper or 28 gauge stainless steel drip edge with a cant built-in may be utilized.

4.4 SLATE INSTALLATION

A. Slate shall be installed starting at the bottom or eaves and proceeding toward the ridge or top.

B. All slates will be installed following straight chalk lines marking the top edge of each course of slates, whenever possible.

C. When supplied on pallets, slates are not to be used from one pallet at a time, but are to be used from all pallets simultaneously in order to blend the various pallets uniformly on the roof.

D. Slate side-butt joints shall be positioned as near the mid-point of the underlying slates as possible, and not less than 3" from the underlying side-butts. Each slate course shall break butt-joints laterally by a minimum of 3", if possible, with the underlying or overlying courses.

E. When installed, slates shall be butted side-to-side touching, or with a maximum 1/8" gap between slates, on average.

F. Slate will be neatly fitted around any pipes, ventilators, and other roof penetrations.

G. Slates are to be cut from the back side in order to preserve the chamfered edge on the front exposed surface. Use of grinders, saws, or other mechanical means to cut and trim roofing slates shall not be permitted unless the slates maintain a chamfered appearance along the exposed sawn edges. At the apex of slated hips and ridges, and at the juncture of a closed valley, the chamfered edge may, as an option, be reversed to create a tighter fitting joint.

H. In ice-dam prone areas, slates may be installed with an increased headlap. Additional underlayment may also be used in ice-dam prone areas, such as Type II felt installed on top of the existing felt, with a layer of trowel-grade roof mastic spread evenly underneath the additional felt layer.

I. Slates along valleys shall be cut in neat and straight lines. Valley slates are to be cut on the back side of the slate to maintain a chamfered slate edge along an open valley.

J. Contractor shall visually and manually inspect the slates when roof brackets are removed to make sure no slates were broken by the roof scaffolding. Upon completion, all slate shall be sound, unbroken, un-cracked, whole and clean, showing no exposed roof cement.

K. Individual slates that must be installed in the field of the roof after the installation is complete, such as where a roof bracket had been removed or where a repair has been made, shall be installed using stainless steel or copper slate hooks or the “nail and hidden bib” installation method where standard nailing is not possible. Slates thicker than 1/2” may require the “nail and bib,” rather than a slate hook fastener.

PART 5 - REFERENCE INFORMATION

5.1 ASTM REFERENCES

- ASTM A167 - Type 304 Terne coated stainless steel, 0.015 inch (0.38 mm) thick stainless steel core material, coated with 0.092 lb./sq. ft. (450 g/sq. m) Terne alloy on both sides.
- ASTM A666 - Type 304 stainless steel, soft annealed 2D finish (unless harder temper is required for forming or performance), 0.0156 inch (0.4 mm) thick
- ASTM B101 - Specification for Lead-Coated Copper Sheet and Strip for Building Construction
- ASTM B370 - Specification for Copper Sheet and Strip for Building Construction
- ASTM B749 - Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products
- ASTM C406 - Specification for Roofing Slate
- ASTM C920 - Specification for Elastomeric Joint Sealants
- ASTM C1311- Specification for Solvent Release Sealants
- ASTM D312 - Specification for Asphalt Used in Roofing
- ASTM D1079 - Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials
- ASTM D1970 - Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
- ASTM D2626 - Specification for Asphalt-Saturated and Coated Organic Felt Base Roofing Sheet.
- ASTM D2822 - Specification for Asphalt Roof Cement, Asbestos-Containing
- ASTM D3019 - Specification for Lap Cement Used with Asphalt Roll Roofing, Non Fibered, Asbestos, Fibered, and Non Asbestos Fibered
- ASTM D4022 - Specification for Coal Tar Roof Cement, Asbestos Containing
- ASTM D4586 - Specification for Asphalt Roof Cement, Asbestos-Free
- ASTM D4869 - Specification for Asphalt-Saturated Organic Felt Underlayment for Steep Slope Roofing.

5.2 SLATE GRADES

- A. ASTM C 406 Grade S1: Expected service life in excess of 75 years.
- B. ASTM C 406 Grade S2: Expected service life 40-75 years.
- C. ASTM C 406 Grade S3: Expected service life 20-40 years.

5.3 SLATE THICKNESSES, SIZES AND COLORS

A. Thicknesses

1. Standards; Nominal 3/16 inch (5 mm) to 1/4 inch (7 mm)
2. Quarters; Nominal 1/4 inch (7 mm) to 3/8 inch (10 mm)
3. Heavies; Nominal 3/8 inch (10 mm) to 1/2 inch (13 mm)
4. Extra Heavies; Nominal 1/2 inch (13 mm) to 3/4 inch (19 mm)

B. Standard Slate Sizes

1. 24"L X 14"W (610 mm X 356mm)
2. 24"L X 12"W (610 mm X 305 mm)
3. 22"L X 12"W (559 mm X 305 mm)
4. 22"L X 11"W (559 mm X 279 mm)
5. 20"L X 14"W (508 mm X 356 mm)
6. 20"L X 12"W (508 mm X 305 mm)
7. 20"L X 11"W (508 mm X 279 mm)
8. 20"L X 10"W (508 mm X 254 mm)
9. 18"L X 14"W (457 mm X 356 mm)
10. 18"L X 12"W (457 mm X 305 mm)
11. 18"L X 11"W (457 mm X 279 mm)
12. 18"L X 10"W (457 mm X 254 mm)
13. 18"L X 9"W (457 mm X 229 mm)
14. 16"L X 14"W (406 mm X 356 mm)
15. 16"L X 12"W (406 mm X 305 mm)
16. 16"L X 11"W (406 mm X 279 mm)
17. 16"L X 10"W (406 mm X 254 mm)
18. 16"L X 9"W (406 mm X 229 mm)
19. 16"L X 8"W (406 mm X 203 mm)
20. 14"L X 10" W (356 mm X 254 mm)
21. 14"L X 9"W (356 mm X 229 mm)
22. 14"L X 8"W (356 mm X 203 mm)
23. 14"L X 7"W (356 mm X 178 mm)
24. 12"L X 10"W (305 mm X 254 mm)
25. 12"L X 9"W (305 mm X 229 mm)
26. 12"L X 8"W (305 mm X 203 mm)
27. 12"L X 7"W (305 mm X 178 mm)
28. 12"L X 6"W (305 mm X 152 mm)

C. Vermont Slate Company Roofing Slate Colors

1. Dover Unfading Black
2. Hampton Unfading Black
3. Vermont Strata Gray
4. Vermont Gray/Black
5. Vermont Black
6. Vermont Semi-Weathering Gray
7. Vermont Semi-Weathering Gray/Black
8. Vermont Unfading Gray
9. Vermont Unfading Green
10. Vermont Unfading Gray/Green
11. Vermont Semi-Weathering Green
12. Vermont Variegated Purple
13. Vermont Unfading Purple
14. Vermont Semi-Weathering Purple
15. Unfading Mottled Green and Purple
16. New York Unfading Red

5.4. SLATE EXPOSURES AND HEADLAPS

When Using 3" and 4" Headlaps (showing Number of Slates per Square)

<u>Slate Size (in.)</u>	<u>Exposure (3" H.L.)</u>	<u>(Slates/Square)</u>	<u>Exp. 4" Headlap</u>	<u>(Slates/Square)</u>
6x10	3 1/2"	686	3"	800
7x10	3 1/2"	588	3"	686
8x10	3 1/2"	514	3"	600
6x12	4 1/2"	533	4"	600
7x12	4 1/2"	457	4"	515
8x12	4 1/2"	400	4"	450
9x12	4 1/2"	355	4"	400
10x12	4 1/2"	320	4"	360
7x14	5 1/2"	374	5"	412
8x14	5 1/2"	327	5"	360
9x14	5 1/2"	290	5"	320
10x14	5 1/2"	261	5"	288
12x14	5 1/2"	218	5"	240
8x16	6 1/2"	277	6"	300
9x16	6 1/2"	246	6"	256
10x16	6 1/2"	222	6"	230
12x16	6 1/2"	185	6"	192
9x18	7 1/2"	213	7"	221
10x18	7 1/2"	192	7"	199
11x18	7 1/2"	175	7"	187
12x18	7 1/2"	160	7"	171
10x20	8 1/2"	170	8"	180
11x20	8 1/2"	154	8"	164
12x20	8 1/2"	141	8"	150
14x20	8 1/2"	121	8"	129
11x22	9 1/2"	138	9"	146
12x22	9 1/2"	126	9"	134
14x22	9 1/2"	109	9"	115
12x24	10 1/2"	114	10"	120
14x24	10 1/2"	98	10"	103

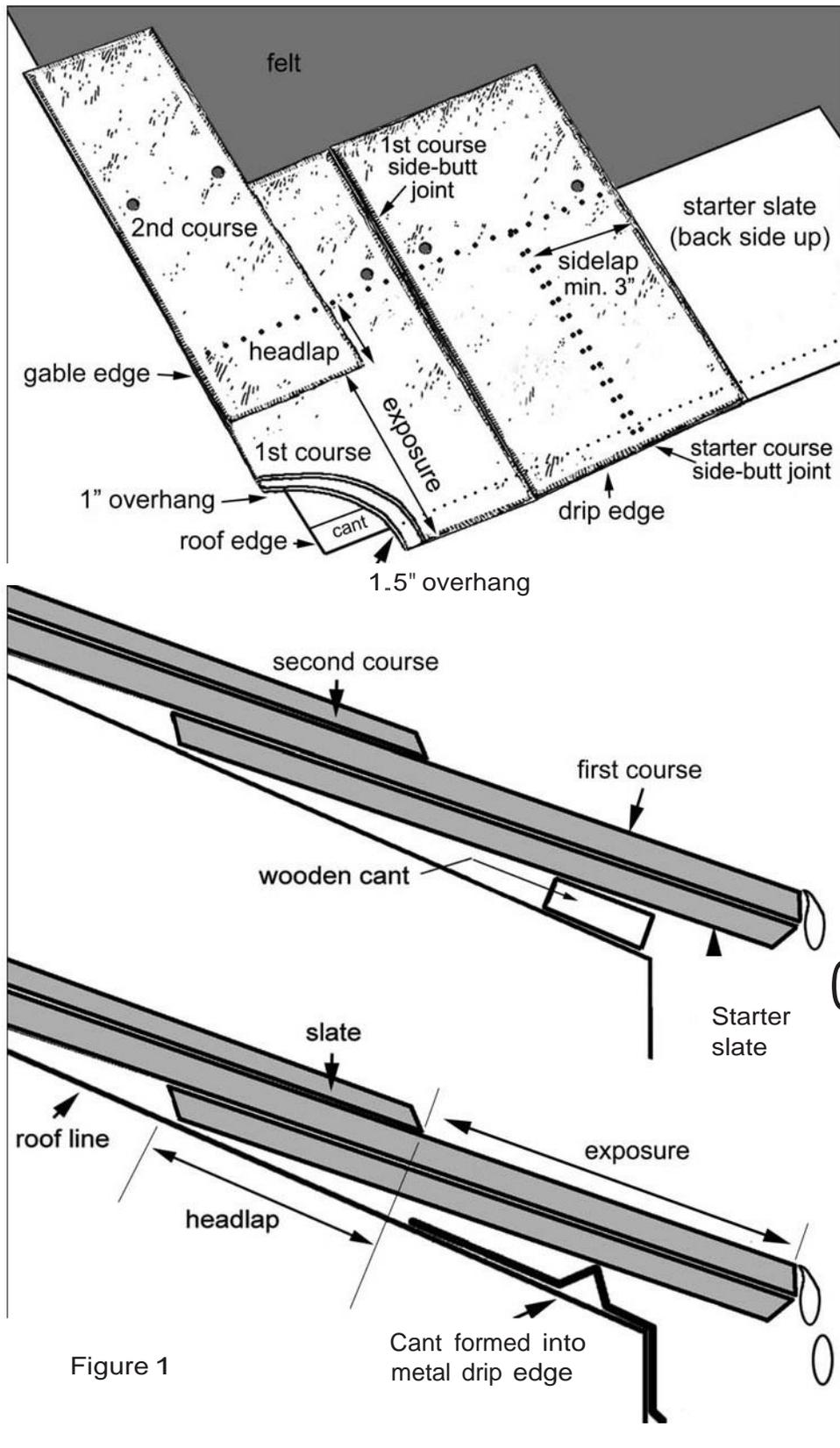


Figure 1