INDEX

1. Product Information

Eternit, the manufacturer of the base roofing slate used with the SUNSLATE™, provides these guidelines for the installation of roofing slates to assist the applicator in effecting an efficient and workman-like application. Although this manual provides details for typical conditions encountered on slate applications, all application details are beyond the scope of this text. When encountering any conditions not illustrated in this manual, please contact Atlantis Energy, Inc. for assistance.
Eternit's Roofing Slates provide a limited 50-year warranty. All materials utilized in the construction, including fasteners, flashing, felts, underlayments and penetrations should be selected to provide the same life. The installer must use all of the electrical materials (SUNSLATES™, cables, junction boxes, inverters, connecting technique) specified in this manual and project documents. Artificially concentrated sunlight shall not be directed on the module. Failure to conform to these Installation Guidelines will void the Atlantis Energy or Eternit Warranty.

	Eternit Slate	SUNSLATE™
Headlap (A)*	5"	5"
Exposure (B)*	11 3/8"	11 3/8"
Starter Height (C)*	16 1/2"	16 1/2"
Slate Height (D)*	28 3/8"	28 3/8"
Storm Anchor Location (Hook)*	7 7/8"	7 7/8"
Slates/Square	77	77
Weight/Square	500 lbs.	720 lbs.
Slates/ Crate**	56	22
Squares/ Crate**	0.73	0.28
Weight/ Crate**	380 lbs.	230 lbs.

* Refer to **figure 7**
The crate dimensions are **2'-6" x 1'-2" x 1'-6" (LxWxH).

2. SUNSLATE™ and SUNSLATE™ string (field) electrical characteristics

The electrical characteristics are within ±10 percent of the indicated values of Isc, Voc and Pmax under standard test conditions (1000 W/m^2 irradiance, 25 degC (77 degF) cell temperature and AM 1:5 spectrum) Under normal conditions, the SUNSLATE™ is likely to experience conditions that produce more current and/or voltage then reported at standard test conditions. Accordingly, the value of Isc and Voc marked on the SUNSLATE should be multiplied by a factor 1.25 when determining component voltage ratings, conductor ampacities, fuse size and the size of controls connected to the PV output.

2.1 SUNSLATE™ electrical characteristics

There are six (6) crystalline PV cells, connected in series, in each SUNSLATE™.

Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	12.51	2.91	3.56	4.29	4.77
SX-D1	11.40	2.85	3.48	4.00	4.45
SM-5M	11.88	2.98	3.54	3.98	4.57

2.2 SUNSLATE™ string (field) electrical characteristics

When running a 48 Volts DC nominal utility-connected PV system, each series string (field) must have either 18, 19 or 20 SUNSLATES™. It is not always possible to start and finish one series string within a single course of roof tiles. When transitioning from one course of tiles to the next to complete a series string, a special cable, called a 'twister cable' is supplied by Atlantis Energy.

A string of 18 SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	225.18	52.38	64.08	4.29	4.77
SX-D1	205.20	51.3	62.64	4.00	4.45
SM-5M	213.84	53.64	63.72	3.98	4.57

A string of 19 SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	237.69	58.20	67.64	4.29	4.77
SX-D1	216.60	54.15	66.12	4.00	4.45
SM-5M	225.72	56.62	67.26	3.98	4.57

A string of 20 SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	250.20	58.20	71.20	4.29	4.77
SX-D1	228.00	57.00	69.60	4.00	4.45
SM-5M	237.60	59.60	70.80	3.98	4.57

2.3 Battery charging systems

The following configuration applies, one series string (field) will have:

12 Volts DC nominal 6 (six) SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	75.06	17.46	21.36	4.29	4.77
SX-D1	68.40	17.10	20.88	4.00	4.45
SM-5M	71.28	17.88	21.24	3.98	4.57

24 Volts DC nominal 12 (twelve) SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	150.12	34.92	42.72	4.29	4.77
SX-D1	136.80	34.20	41.76	4.00	4.45
SM-5M	142.56	35.76	42.48	3.98	4.57

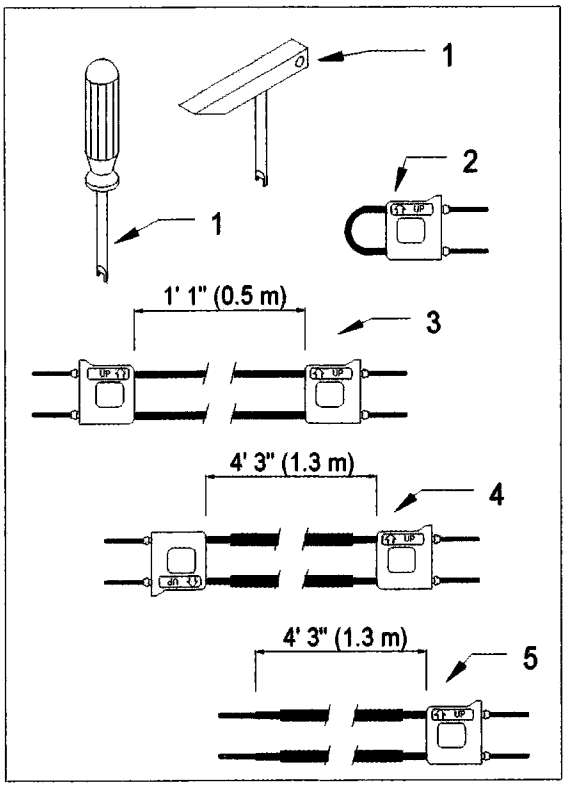
48 Volts DC nominal 24 (twenty-four) SUNSLATES™ in series

SUNSLATE™ Model	Pmax Watts	Vmax Volts	Voc Volts	Imax Amps	Isc Amps
AR-H1	300.24	69.64	85.44	4.29	4.77
SX-D1	273.60	68.40	83.52	4.00	4.45
SM-5M	285.12	71.52	84.96	3.98	4.57

Atlantis Energy recommends that all system components, including batteries and electronic devices be listed by a Nationally recognized laboratory.

3. Tools and materials used for installing the SUNSLATES™ Roof.

Figure 1



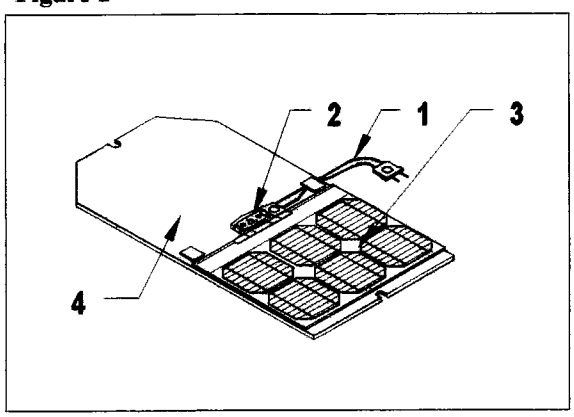
SUNSLATES™ tools and cables:

1. Connection opener
2. Bridge cable
3. SUNSLATE™ inner-connecting cable
4. SUNSLATE™ Twister cable
5. Field cable

Roofing tools:

- Roofers hammer
- Flat bar
- Hand tile scribe
- Chalk line
- Tile cutter
- Drill ∅1"

Figure 2

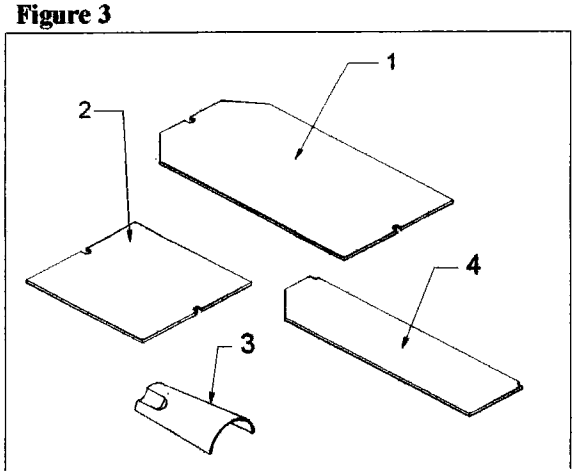


SUNSLATES ™

1. Interconnecting cable
2. Junction box
3. Solar module
4. Slate

Dimensions:	28 3/8"x 15 3/4"	77 ea. /100 Sq.Ft.
Exposed surface: 11 3/4 x 15 3/4"		

Figure 3



1	Slate	28 3/8" x 15 3/4"	77 ea. /100 Sq.Ft.
2	Starter slate	1[illegible]"x 15 3/4"	77 ea. /100 Sq.Ft
3	Ridge cap	17 5/8" x 7 3/4"	9 ea. / 10 ft.
4	Half slate	28 3/8" x 7 5/8"	

Hooks (125 mm) - 5"
Nails - 0.121" x 1" Galvanized steel or copper
Metal flashing

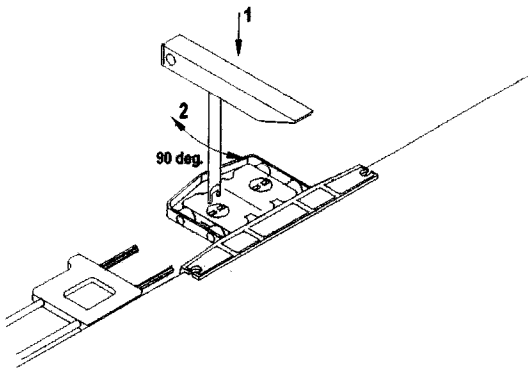
Wooden battens:

- 2x2 vertical batten
- 1x4 horizontal batten

4. SYSTEM

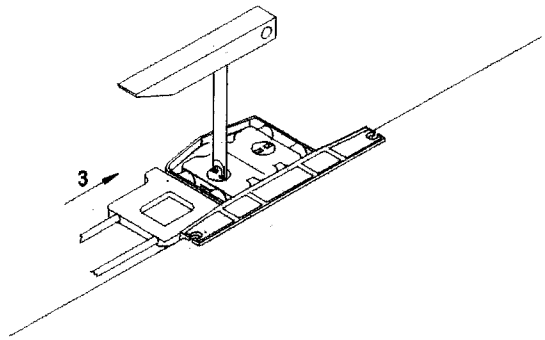
4.1 Field (String) - The building (roof) on which the SUNSLATES ™ are installed is setup from SUNSLATE fields (strings). All the fields are installed with an equal number of SUNSLATES ™ in them. The field has a beginning (bridge cable) and an end (field connecting cable). When installing the field, always start (first SUNSLATE from the string) with field connecting cable (which goes through the roof into the building) and end with the bridge cable. The "System Design" document (see appendix 2), will show how many fields are needed and the position of every field.

4.2 SUNSLATES ™ connections.

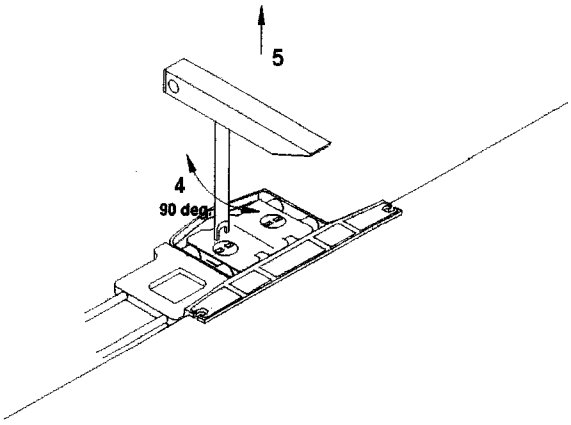


To open connector

1. Place the tool in the junction box
2. Turn the tool 90 degrees. **OPEN**



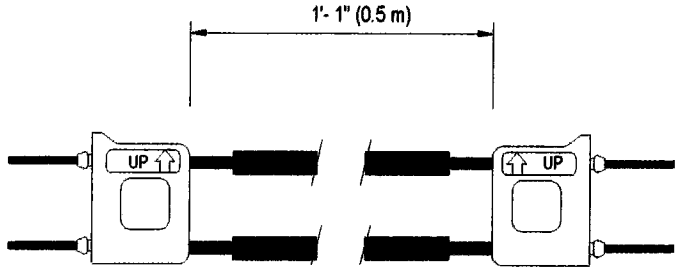
3. Place the cable in the junction box
   Be sure to fully seat connector.
   Gasket at base of pins must snap in.



To close connector

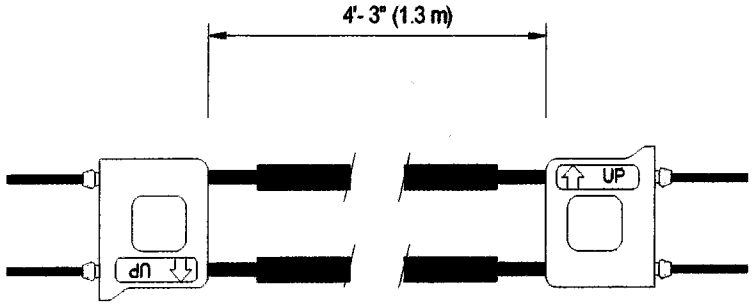
4. Turn the tool 90 degrees. **CLOSED**
5. Remove the tool.

4.3 SUNSLATE™ to SUNSLATE™ horizontal cable (SUNSLATE™ inner-connecting cable)



The number of SUNSLATES ™ in the field will be specified in the "System Design" document (see appendix2) for the particular project (the most common number of SUNSLATES ™ in a field is 18, 19 or 20 for crystalline cells). One SUNSLATE includes the interconnecting cable for the connection between the modules.

4.4 Rows to row cable - Twister cable



The function of the Twister cable is for row to row Connections inside the SUNSLATES™ field. We use the Twist cable when one field does not fit in one row and has to be connected with the next row (**figure 4**) of SUNSLATES™. (The roof plan shows the row to row connection location).

Before installing the next row of SUNSLATES™, the installer has to check that all of the junction boxes are in a closed position, and check the field voltage (see field checking example - page 4).

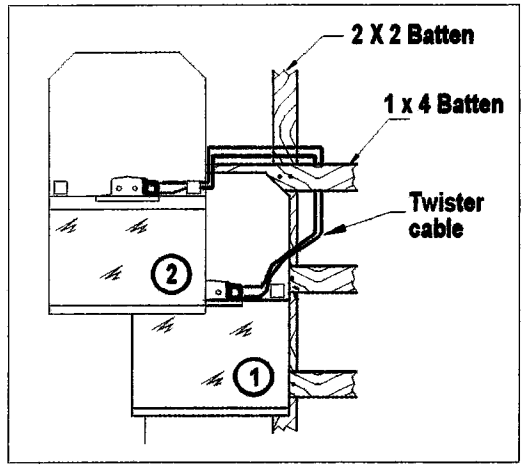
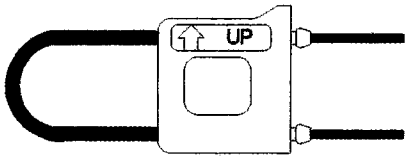


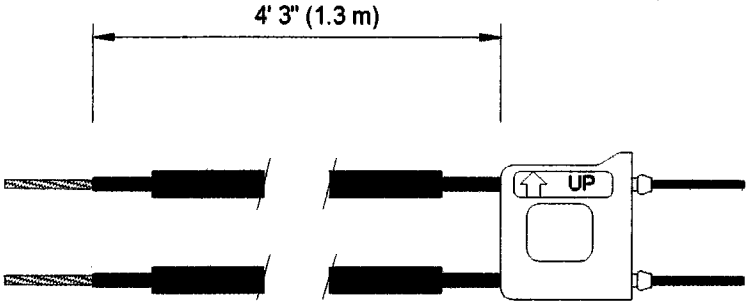
Figure 4

4.5 Bridge cable



The function of the Bridge is to close the electrical circuit of the SUNSLATES™ field. It is connected to the first SUNSLATE™ of the field.
The Bridge is also used for field testing (see point 5).

4.6 Field to junction box connection



The field cable is placed at the beginning of the field (the first SUNSLATE™) and after checking the field voltage (see field checking example - page 4) the cable is placed through a hole (min ∅ 0.5") on the roof - then the installation of the next field may begin. The field cable has two wires – a positive and a negative end.

The electrician will make the connections under the roof (in the building). The field cable, which has been placed by the roofer through the hole on the roof, has to be connected in a junction box to a standard NM-B nonmetallic sheathed cable. That cable must be connected in the inverter. Seal the hole in the roof from the inside with the fire stopping expanding foam or silicon seal. (**figure 5**)
The field cable has to be secured with a cable lamp, for strain relief, on to the nearest 2x2 vertical batten.
The electrician (installer) shall refer to section 690-8 of the National Electric Code for an additional multiplying factor of 125 percent (80 percent derating) which may be applicable.

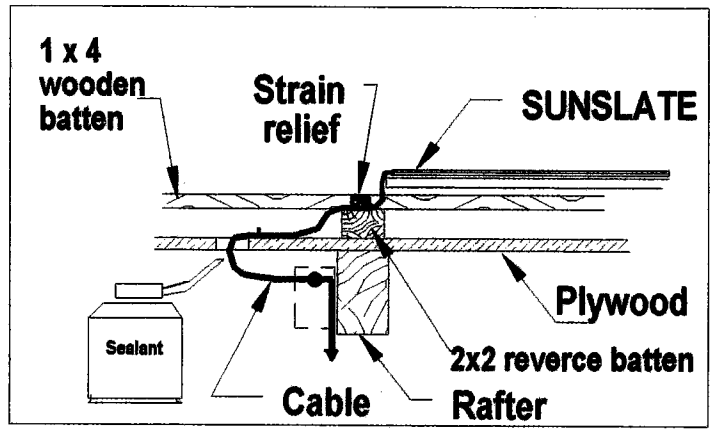


Figure 5

CAUTION! You must not connect more than three (3) field cables in parallel in a junction box between the inverter. Make sure that the DC positive goes to the positive terminal of the inverter and the DC negative goes to the negative terminal of the inverter by testing the field polarity.

5. Field checking (Row-Checking).

The most common error made is that the SUNSLATES™ junction box is not in a closed position. The installer must do row - checking.
Every field must be checked for open circuit voltage before the row is covered.
The checking is made with a simple DC voltmeter:
When checking you must know the SUNSLATE open circuit voltage (Voc) which is shown in the "System Design" document (see appendix 2)" on the first page. The most common Voc for crystalline cells is 3.7 [VDC], however, that number may change slightly with the SUNSLATE™ temperature change from the Sun irradiation. Therefor, when we measure the fields, we must be sure that all the fields Voc are the same or the difference is not greater than 3 [VDC]. Shadows from instruments or cables over the SUNSLATE™ will cause the voltage to drop, be sure that there are no shadows when testing the field.

Example:
If one field is 20 SUNSLATES ™ in series, the Voc = 3.7x20 ± 3 [VDC] = 74±3 [VDC]
If all the fields have Voc= 74 [VDC], then everything is properly connected. If one of the fields has Voc= 70 [VDC] and all the others have Voc= 74 [VDC], then one SUNSLATE is badly connected and the roofer has to go back and check the bad field for 1) a junction box which is not closed or 2) a bad SUNSLATE. If the bad field does not give any Voc then there is a bad connection in the field and the series circuit is not closed.

To find the bad SUNSLATE the easiest way is to start checking the field by dividing it by two (disconnect, put a bridge cable on the left part and check the voltage of that part). You have to calculate the Voc for all the variations.

Example

20 SUNSLATES ™ Voc=74 [VDC]	10 SUNSLATES ™ Voc =37 [VDC]
5 SUNSLATES ™ Voc =18.5 [VDC]	3 SUNSLATES™ Voc =11.1[VDC]
2 SUNSLATES ™ Voc =7.4 [VDC]	1 SUNSLATES ™ Voc =3.7 [VDC]

6. Roof installation

6.1 Roofing Slates

Eternit's Roofing Slates are non-asbestos fiber reinforced cement slates produced to a uniform thickness of 4 mm (3/ 16"). Eternit Slates are produced under compression with an integrated color finish. The SUNSLATE™ employs the Eternit slate as a base with photovoltaic cells glass laminated to it and then is used as a standard roofing slate.

The actual slate sizes, and properties are listed in Table 1, Figures 6 and 7. Normal production processes will result in slight changes of color between production lots simulating the beauty of natural slates. Care should be taken to mix bundles to provide a dispersed appearance. In addition, Eternit Slates will age and eventually attain a variegated matte look and rough texture which approximates the appearance of natural slate.

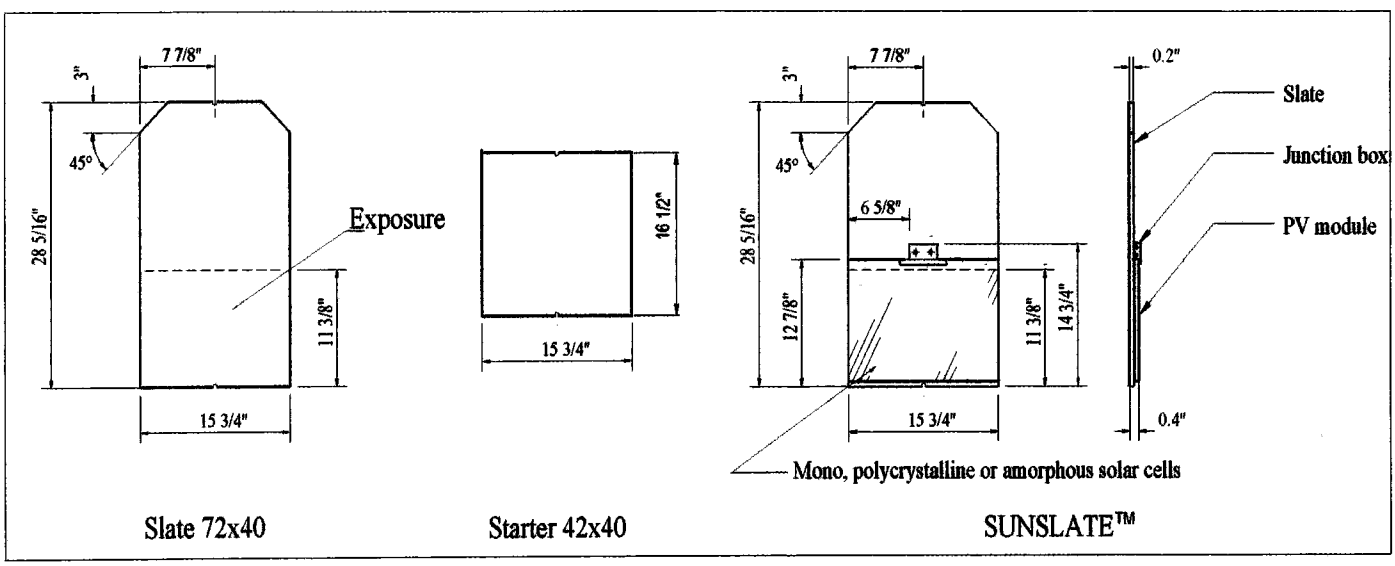


Figure 6

SHEATHING -- American Plywood Association rated, exterior grade, thickness to be determined by the roof span and the required design loads but not less than 15/32" for standard roofs and not less than 5/8" for Class A roofs.

ROOFING FELT AND HEADLAP -- Slates may be utilized on roofs with a minimum slope of 3" per foot. Roof slopes less than 5" per foot require a headlap of 4" and two layers of 30 lb. Felt, to maintain Class A rating. Slopes of 5" and greater may use a 2" headlap and one layer of 30 lb. felt. In some areas an underlayment of an approved modified bitumen or other high performance underlayment may be desired as an upgrade. Please contact Eternit regarding any upgraded underlayment product prior to installation.

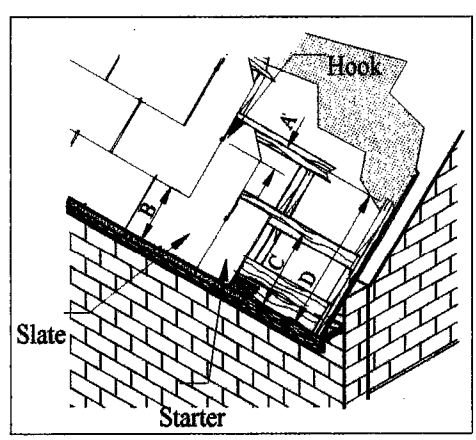


Figure 7

FLASHING -- Non-corroding metal, as specified by the National Slate Association. The type to be selected is subject to local conditions.

FASTENERS (STORM ANCHORS) -- Shall be made of galvanized steel, approximately 5" long with a 1/8" diameter shaft and with 1/4" offset bend (see **Figure 8**). The anchors are positioned in the center top notch of the slate to provide quick and accurate alignment. The storm anchors have been designed to significantly increase the wind resistance of the Eternit Slate and SUNSLATES™ and are required for the warranty to be in effect. Storm anchors are available from Eternit, Inc.

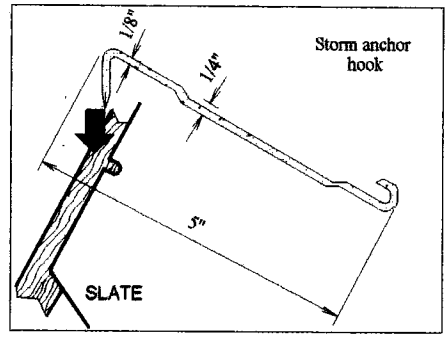


Figure 8

6.2 STORAGE AND HANDLING

Storage

The SUNSLATESTM and roofing slates are delivered in crates.
The crate dimensions are 2'-6" x 1'-2" x 1'-6" (LxWxH).
Store Eternit Slates and SUNSLATES™ in a clean, dry, well ventilated area protected from the weather and other trades. As soon as the slates have been delivered and stored under cover, split the plastic wrap to allow for ventilation to prevent excessive water condensation. If the slates should get wet in storage, efflorescence is likely to occur. Mild efflorescences of the slates will usually disappear over a period of time. Severe efflorescences may require special treatment. Contact the Technical Department at Eternit Inc. or Atlantis Energy Inc. for details.

Cutting Tools

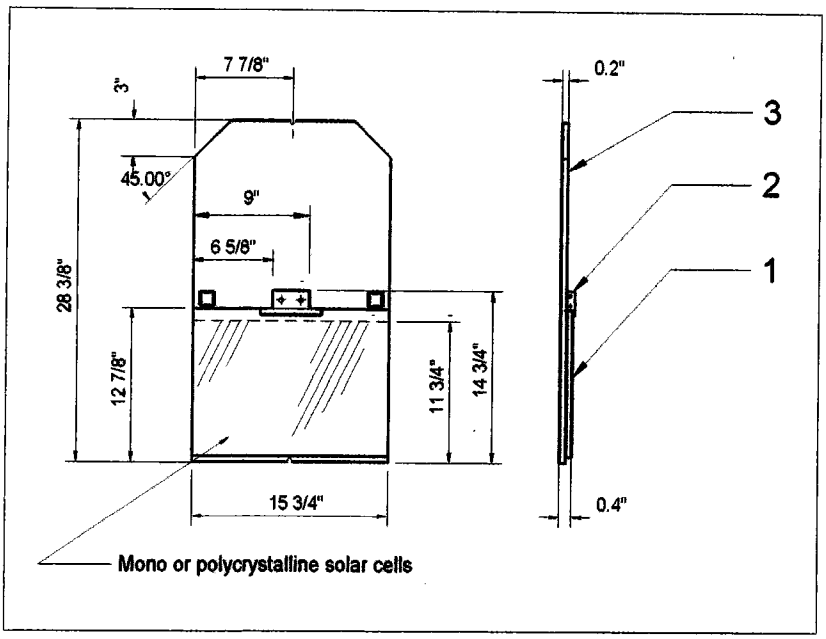
Unlike other mineral fiber cement slates, Eternit Slates can be cut and punched with a slater's hammer.

For rapid and efficient cutting, punching and notching, a portable slate cutting machine may be utilized. Interior cuts in the slate can be accomplished with a pin punch and hammer. Individual slates can be faced,scored and snapped over a straight edge. Eternit Slates can be field cut to provide an interesting feature to the completed roof utilizing a slater's cutter.

6.3 Uninstalling and replacing a SUNSLATE™

Before disconnecting the SUNSLATE™ the DC disconnect switch at the inverter must be in OFF position. Bend the hook which holds the slate at the bottom with the roofers hammer, then slide the slate down until you see the SUNSLATE™ junction box. Open the connectors and pull out the inner-connecting cables, the SUNSLATE™ will then slide down and can be removed. Replace with new SUNSLATE™ by sliding it up between the slates and then connect the inner-connecting cables (see 4.2). The hook has to be then bent back to secure the slate.

7. Application



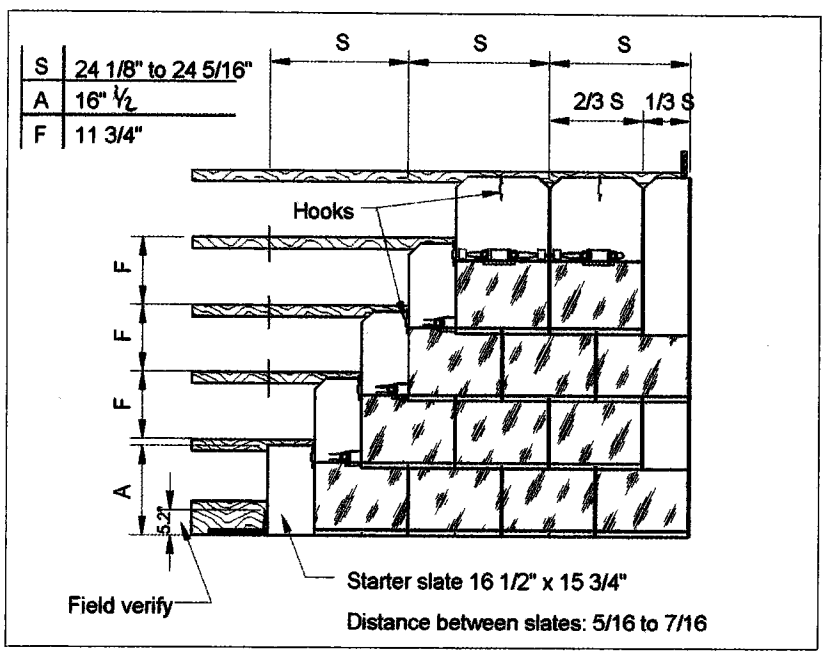
SUNSLATES ™ are a roofing and façade material, which uses solar energy to produce electrical power for the building's use. SUNSLATES ™ are composed from 1) a solar module, 2) junction box and 3) ***Eternit*** slate. The solar module and the junction box are laminated together and then glued to the surface of the slate. SUNSLATES ™ are installed by the technique (double overlap system) provided from the ***Eternit*** Company. SUNSLATES ™ are a light concrete roofing material and have passed all of the roofing tests made by the ***Eternit*** Company. SUNSLATES ™ are a UL listed product.

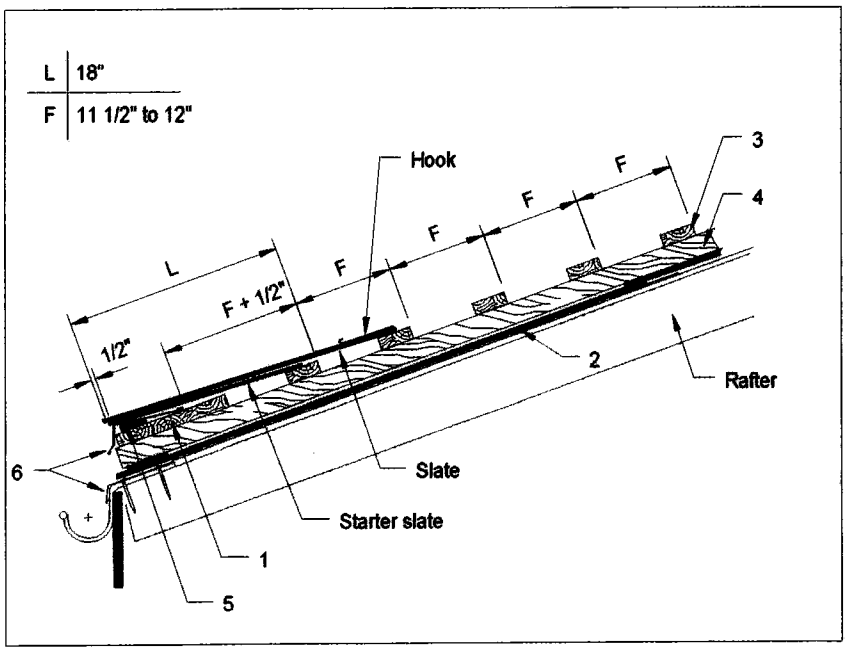
Installation of the double overlap system

The double overlap system is a method of cladding thin panels fixed to battens. This method of cladding is characterized by the fact that at every point on the surface there are at least two layers of slate.
To get a good water and airtightness, an underlay of roofing-felt, battens and counter (reverse) battens are necessary.

Reverse Battens:
Fix battens to conform to chalk lines securing at not more than 24" on center using 0.121" x 1 1/4" corrosion resistant nail or #10 x 1 1/2" plated deck screw.

Battens:
Fix reverse battens to conform to chalk lines securing at not more than 11 3/8"on center using 0.121" x 1 1/4" corrosion resistant nail or #10 x 1 1/2" plated deck screw.





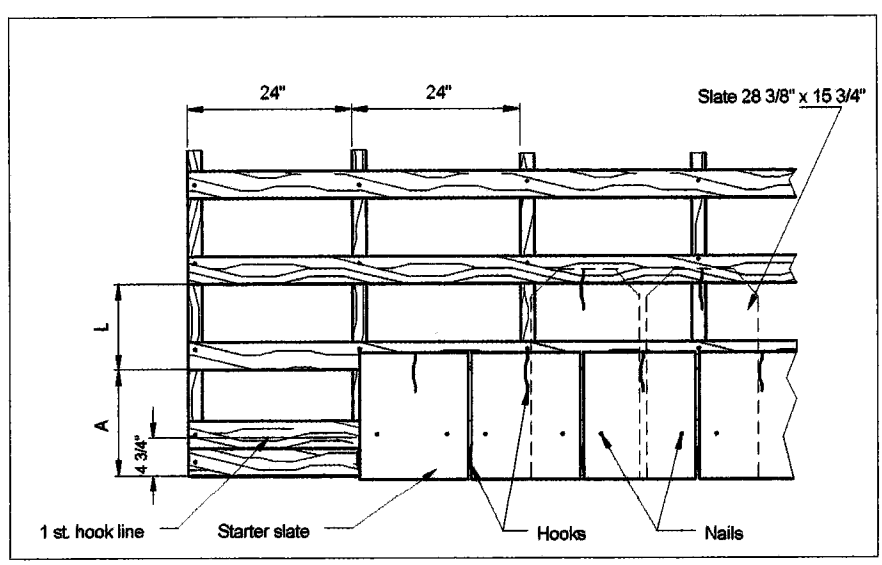
For every whole slate/ SUNSLATE there has to be one hook.
The half or cut slate and the slates, which are on the edges of the roof/façade, have to be nailed or screwed to the battens.
Do not nail the SUNSLATE unless they are cut or are placed on the edge of the roof.
The hook must be nailed directly to the battens. If the hook has a tilt in the battens direction the space between slates will get bigger with every next slate.
If the row is not straight, use a chalk line to mark the position of the hook.

1. Starter batten - 1x8 or two 1x4
2. Plywood – 5/8 or 1 /2 CDX
3. Batten – 1 /4
4. Reverse batten – 2x2
5. Cant strip
6. Drip edge

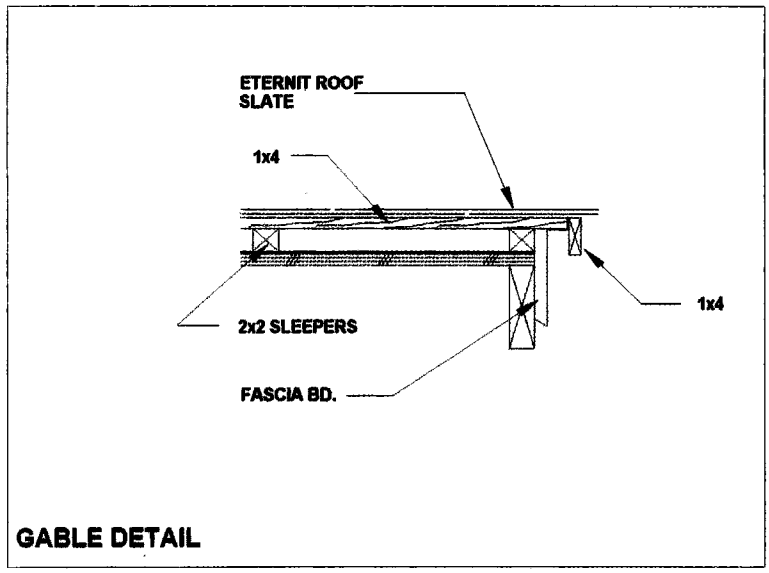
Every slate on the roof has to be strengthened by a hook.

Fixing the starters and the first course

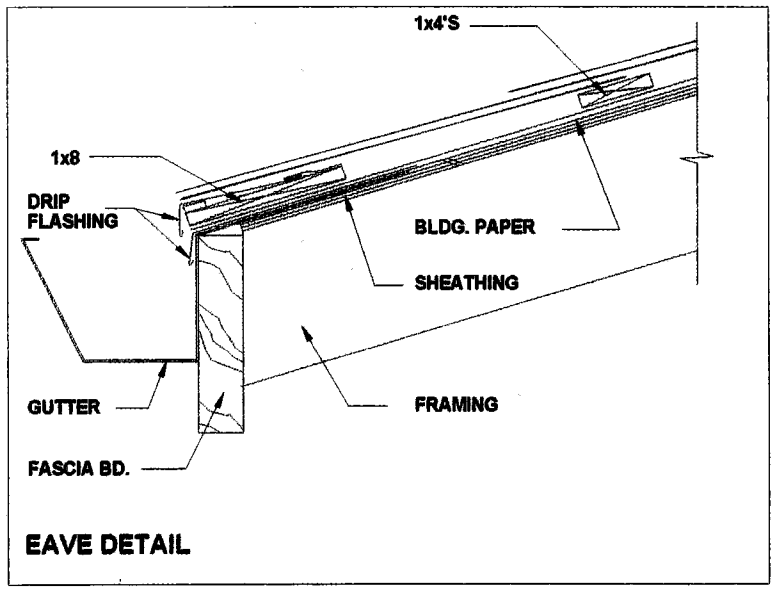
The starter slates and first row of hooks are the most important to ensure an aligned roof. The eaves course slate is a full slate whose length has been reduced by the gauge, i.e. actual length of eaves course slate is gauge plus lap. The starter course slate is secured by two nails and a hook on the top. Before installing the whole row, make sure that the hook line, for the hooks between the starters, is marked with chalk line. The distance between the slates must not be smaller then one hook thickness and not bigger then 1¼ hook thickness. After installing the starters measure the straightness of the first row of hooks with a chalk cord and a waterlevel.
The first course has to be installed using the first row of hooks and then nailing the slate hook.



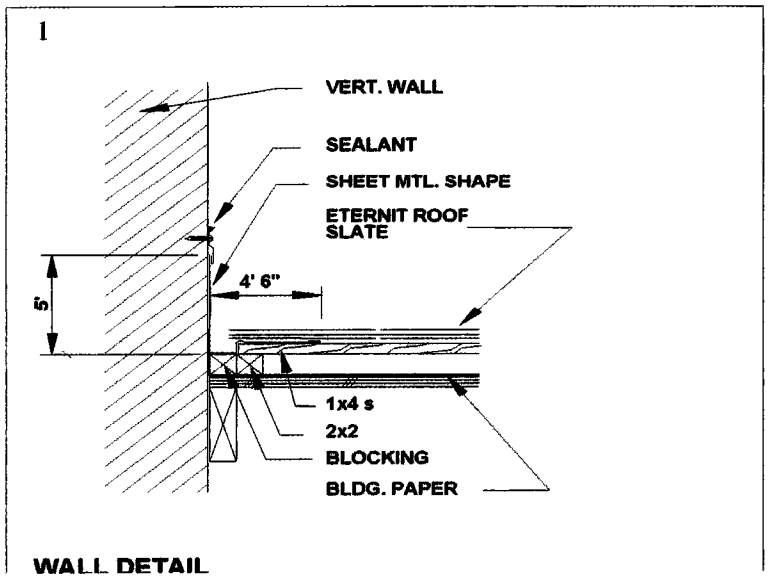
8. Details

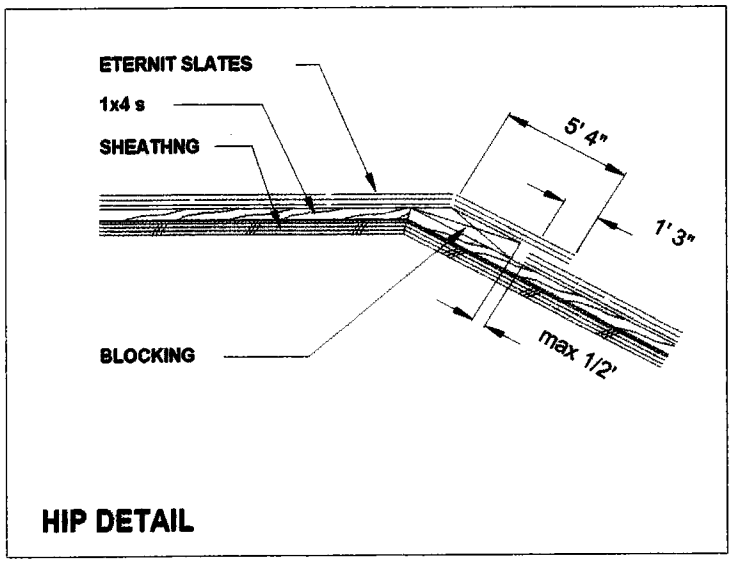


Gable detail



Eave detail

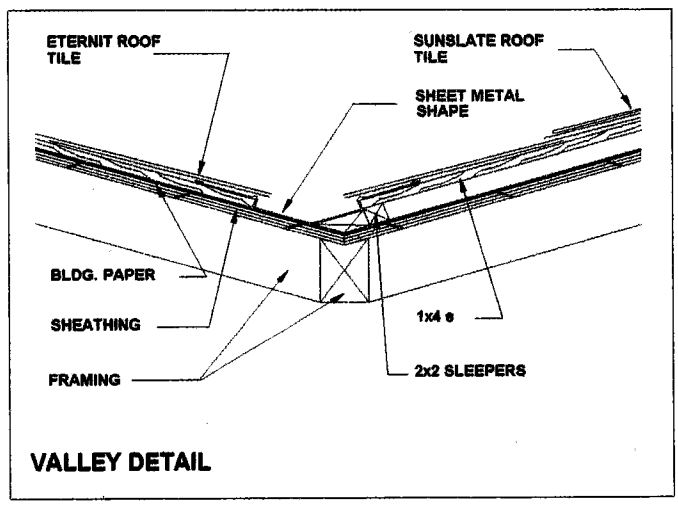


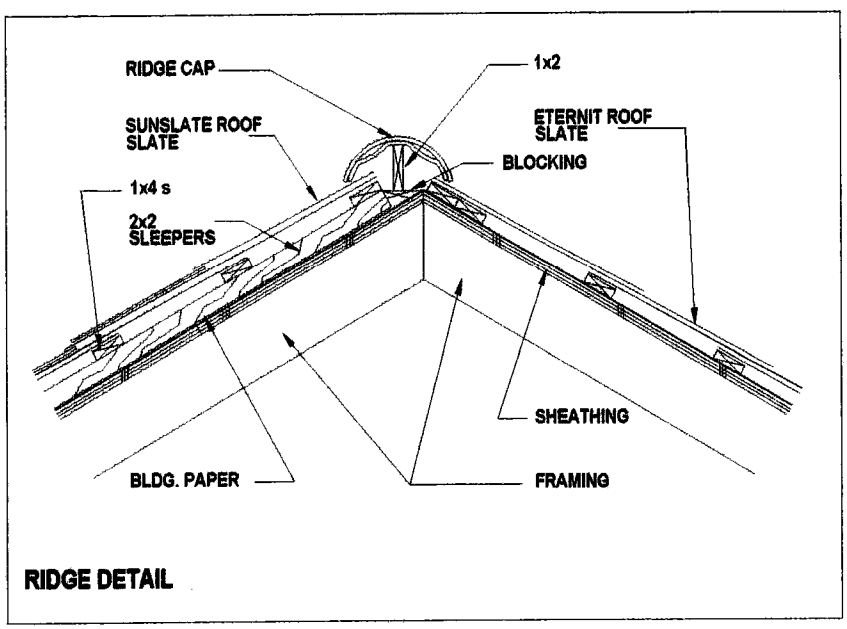


Hip detail

Valley detail

The valley flash should be produced from copper sheet and be of a width sufficient to allow a minimum 4" slate lap at each side, 5" flash exposure at the ridge and an increase opening of 1/8" per foot of flash per side (as an example, a 20' long valley would require an opening of 10" at the eave thereby requiring the copper flash to be 18"- 20x1/8" = 2 ½"x2sides = 5", 5"+5" ridge opening = 10", 10"+8" slate lap (4" each side) = 18"). The minimum overlap of the valley is 6". Secure the flash to the roof deck metal cleats spaced a maximum 12" on center. **The copper flash should not be punctured by any nails or fasteners except at the ridge.**





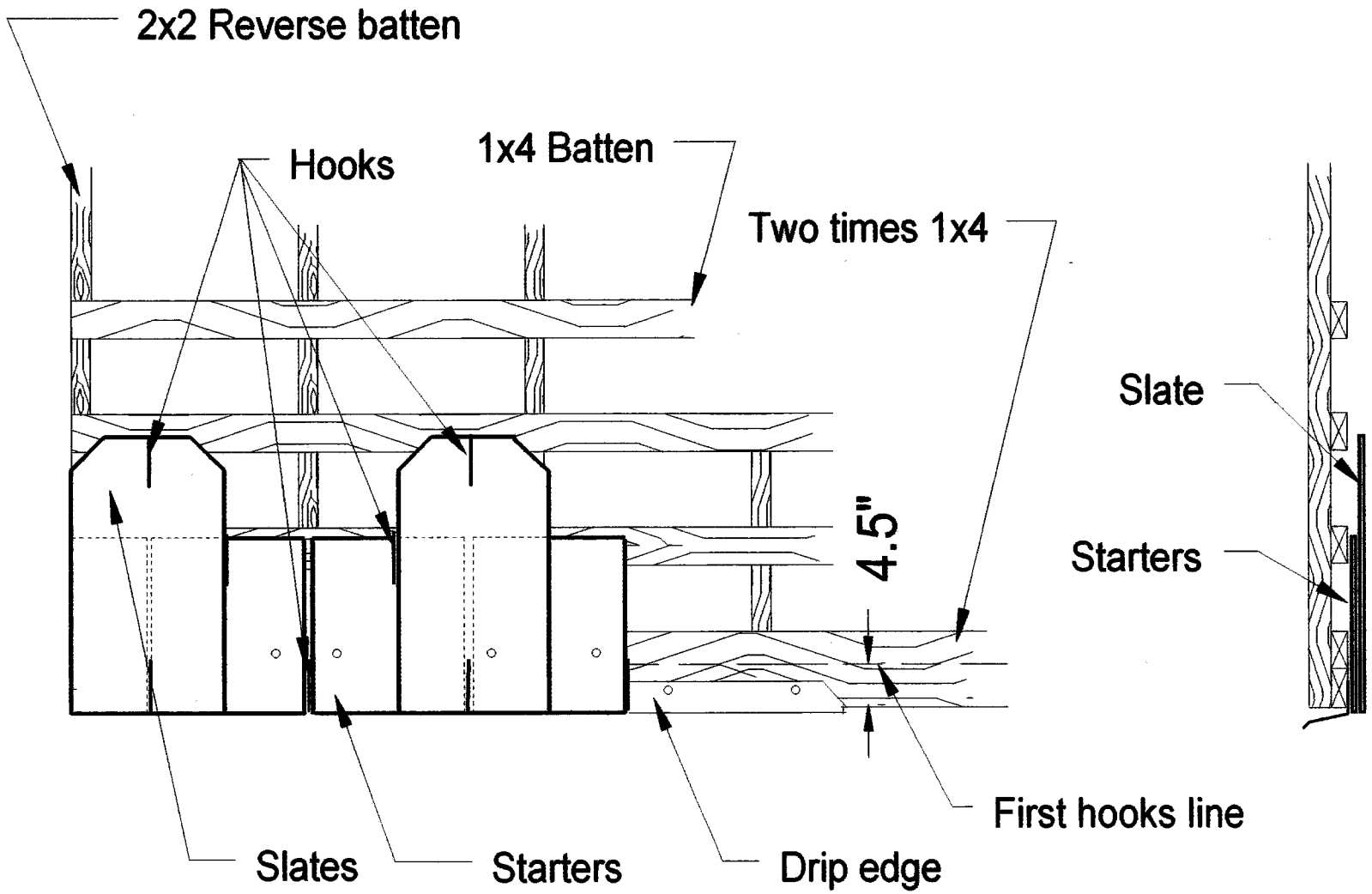
Ridge detail

NOTES:

Appendix 1

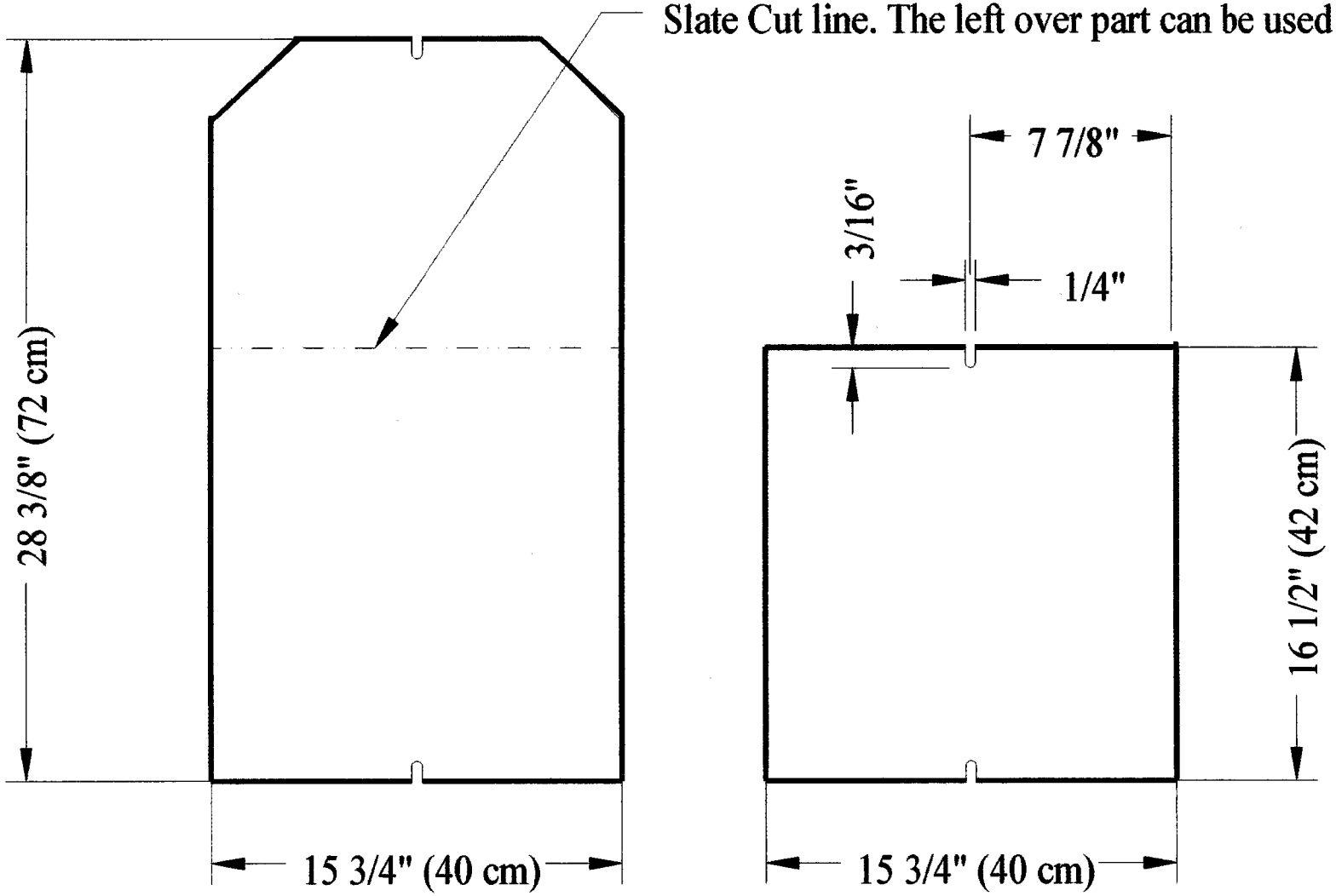
Used terms in this manual:

	Description	Unit
Standard test conditions (STC)	Irradiance 1000W/m^2, 25degC and AM 1:5 spectrum	
Pmax	Maximum power point at STC	Watts
Voc	Voltage open circuit at STC	Volts
Vmax	Voltage at maximum power point at STC	Volts
Isc	Short circuit current at STC	Amps
Imax	Current at maximum power point at STC	Amps
Field	String. Number of SUNSLATES™ connected in series.	
String	Field. Number of SUNSLATES™ connected in series.	
Inverter	A device that converts the DC to AC	
DC	Direct current	
AC	Alternating current	



SPECIFICATIONS	CONTRACT NO.		COMPANY: Atlantis Energy, Inc.
	DRAWN BY: TMG	DATE: 11/18/97	
Starter to 1x4 - 1 3/4 coated deck screw	CHECKED BY		TITLE: Starters
Drip edge to 1x4 - 8d galvenized nail	DESIGNED BY: TMG		SIZE: A; FSCM NO.; DWG NO. / FILE NAME
	DESIGN ACTIVITY		
	CUSTOMER		SCALE: NTS; DATE; SHEET: 1 of 1

Making Starter slates from normal slate



SPECIFICATIONS	CONTRACT NO.		COMPANY: Atlantis Energy, Inc.
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	CHECKED BY: SC		TITLE
	DESIGNED BY		SIZE: A / FSCM NO. / DWG NO. / FILE NAME: 21BH44-55
	DESIGN ACTIVITY		
	CUSTOMER		SCALE: NTS / DATE / SHEET: 1 of 1