EcoFasten™
An ESDEC Company

US Headquarters | 4141 W. Van Buren St., Ste. 2 | Phoenix, AZ 85009
US Branch | 976 Brady Ave., Ste. 100 | Atlanta, GA 30318

March 13, 2023

EcoFasten

4141 West Van Buren St.

Phoenix, AZ 85009

Attn.: John Hudson, Senior Director of Engineering, EcoFasten

Re: EcoFasten *ECO-65* Roof Deck Attachment Capacities

This letter provides details on the mechanical load test and certifies the structural capacity of the EcoFasten *ECO-65* for use as a roof attachment for flush mount railed solar systems. The *ECO-65* consists of an aluminum extrusion pedestal, an aluminum flashing, a stainless steel base, and a pair of 3/8" stainless steel studs used to connect compatible EcoFasten brackets. The *ECO-65* has holes in a square pattern about its center. The *ECO-65* is secured to the roof deck sheathing using eight (8) No. 15 structural wood screws in these holes. Screws shall be installed in accordance with the EcoFasten *ECO-65* installation guide. The *ECO-65* details and component dimensions are shown in Appendix A.

The structural capacities of the *ECO-65* base were determined from mechanical load testing along three respective load directions including uplift, compression, and lateral. These results were then analyzed to account for the increase in moment arm from the pedestal height. The capacity ratings are based on structural load tests performed using a Universal Instron Test Unit according to *ASTM D1761-20 "Standard Test Methods for Mechanical Fasteners in Wood and Wood Based Materials"*. For each load test, the *ECO-65* base was installed on a sample roof deck constructed from 2x4 rafters and an OSB roof deck sheathing with the following thicknesses: 7/16", 15/32", or 19/32", as shown in Figure 1. Deck sheathing was installed onto the roof rafters using 0.131" x 2.5" nails. The nailing schedules applied for the various sheathing thicknesses are as follows: 7/16" and 15/32" sheathing used 6" edge and 12" field spacing, and 19/32" sheathing used 6" edge and 6" field spacing, following guidelines from the *Florida Residential Building Code* Table R803.2.3.1. The moisture content and the specific gravity of the rafters were measured per *ASTM D2395-17 "Standard Test Methods for Density and Specific Gravity (Relative Gravity) of Wood and Wood-Based Materials"*. The recorded moisture content of the rafters among all sample roof decks was between 12% and 14% and the specific gravity was 0.42. The tested *ECO-65* base was affixed to the roof deck structure via eight #15 wood screws per the requirements specified by the *EcoFasten ECO-65 Installation Guide*. This certification conforms to the structural requirements of the following reference documents:

1. 2015/2018 International Building Code, by International Code Council, Inc
2. Aluminum Design Manual 2020, by the Aluminum Association, Inc.
3. ASTM B 557-10, Standard Test Method for Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products
4. ASTM A370-13, Standard Test Methods and Definitions for Mechanical Testing of Steel Products

The failure observed during uplift load testing was a mixture of wood screw withdrawal from the OSB deck, nail withdrawal from the rafter, and OSB rupture for all tested roof sheathing thicknesses. The wood screw withdrawal failure with a worst-case safety factor of 3.0 per ASTM D7147 is applied to the uplift peak load. For a 7/16" thick OSB deck the peak failure load was 558 lbs., which provides an **allowable uplift capacity of 186 lbs**. For a 15/32" thick OSB deck the peak failure load was 647 lbs., which provides an **allowable uplift capacity of 216 lbs**. For a 19/32" thick OSB deck the peak failure load was 850 lbs., which provides an **allowable uplift capacity of 283 lbs**.

The failure observed during compression load testing was crushing, due to bearing, of the OSB deck under the *ECO-65 Assembly* for all tested roof sheathing thicknesses. For the deck bearing failure, a safety factor of 2.54 per NDS 2018 is

applied to the peak load achieved from the average of eight (8) tests provided for the 7/16" thickness and the five (5) tests provided for the 19/32" and 15/32" thicknesses. For a 7/16" thick OSB deck the peak failure load was 620 lbs., which provides an **allowable compression capacity of 244 lbs**. For a 15/32" thick OSB deck the peak failure load was 724 lbs., which provides an **allowable compression capacity of 285 lbs**. For a 19/32" thick OSB deck the peak failure load was 848 lbs., which provides an **allowable compression capacity of 334 lbs**.

For the lateral load tests, the attachment base was tested without inclusion of the F-202 bracket. The lateral load was placed at the highest available position using a 3" EcoFasten L-foot. The lateral load test was performed with the Eco-65 installed on the worst-case roof deck using the minimum sheathing thickness of 7/16". The critical failure mode for lateral load was observed to be fastener withdrawal. The average of the withdrawal loads from eight (8) lateral load tests is 851 lbs. The F-202 bracket is 3/4" tall, and with this increase in moment arm by analysis, the ultimate load shall be 681 lbs. Using a safety factor of 3.0 per ASTM D7147 applied to this reduced lateral load the **allowable lateral capacity is 227lbs.**

Tables 1 summarizes the test results and allowable capacities of the ECO-65 Assembly along each rated load direction. Please note the provided test investigation and its associated results described herein were based on the load tests performed on the *ECO-65* as a stand-alone roof attachment. It is not the intention of this letter to rate or certify the selected rail system level performance or structural components other than those specifically delineated in this letter. This evaluation excludes the structural adequacy of the chosen PV modules, or underlying roof supporting members. For those, it shall be the responsibility of the designated system designer or project engineer to verify the structural capacity and adequacy regarding the applied or resultant loads of the chosen array configuration.

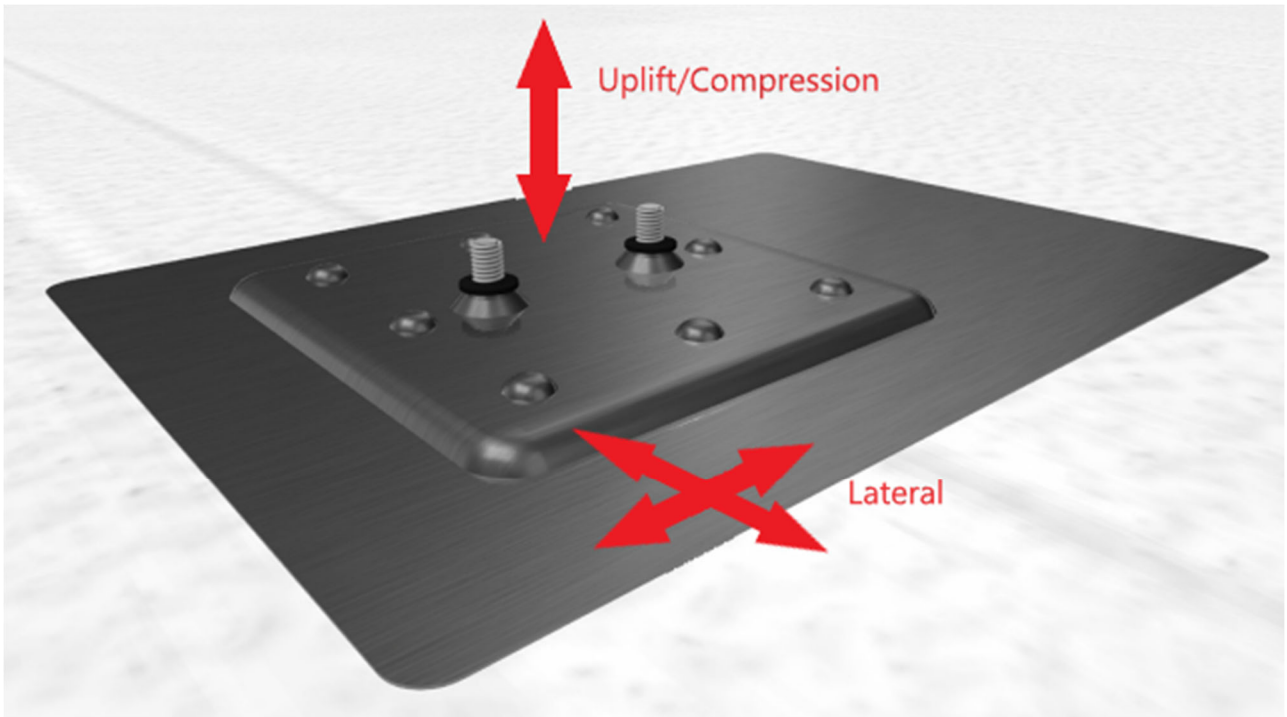

Figure 1: *EcoFasten ECO-65* and Applied Loading Directions

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Table 1: EcoFasten *ECO-65* Deck Attachment Allowable Capacities [1]							
Load Direction	**Minimum Sheathing Thickness (in) [7]**	**Test Quantity**	**Critical Failure Mode**	**Safety Factor [5]**	**Avg Ultimate Capacity (lbs.)**	**Max deviation from mean [4]**	**Allowable Capacity (lbs) [6]**
Uplift [2][3]	7/16	8	Fastener Withdrawal	3.0	558	16.1%	186
	15/32	8	Fastener Withdrawal	3.0	647	17.6%	216
	19/32	8	Fastener Withdrawal	3.0	850	14.8%	283
Compression [2][3]	7/16	8	OSB Bearing	2.54	620	27.1%	244
	15/32	5	OSB Bearing	2.54	724	17.6%	285
	19/32	5	OSB Bearing	2.54	848	14.8%	334
Lateral [3][8]	7/16	8	Fastener Withdrawal	3.0	681[9]	20.6%	227[9]

Table 1 Notes:

(1) Capacities apply to a minimum deck thickness of 7/16", 15/32", and 19/32" on rafters spaced no greater than 24" using #15 wood screws with full penetration of roof deck installed per the EcoFasten *ECO-65 Installation Guide.* Rafters and roof deck should be in sound structural conditions with no sign of rot, decay, previous installation, or pre-existing damages. Deck screws must be fully penetrating the sheathing.
(2) The Uplift and Compression directions are upward and downward perpendicular to the roof surface, respectively.
(3) Previous testing performed on products with 8 deck screws was used to rate the system in the uplift, compression, and lateral load directions.
(4) Deviation reflects the variance of the highest or the lowest test value from the group mean for the respective load direction. For load directions where deviation was larger than 10% after 5 tests, 3 additional tests are added per *ADM-2020* Appendix 1.
(5) Safety Factor is associated with the respective failure mode recorded and determined by the specific code reference document on Page 1.
(6) Allowable capacity is equal to Average Peak Load at Failure divided by its associated Safety Factor.
(7) Minimum Sheathing Thickness applicable for either OSB or Plywood deck construction.
(8) Lateral Loads apply to all tested sheathing thicknesses and compatible EcoFasten brackets no larger than 3" in height.
(9) Test loads reduced by analysis to account for an increase in moment arm from the ¾" F-202 Bracket of the *ECO-65*.

Sincerely,

COLORADO LICENSED
MATTHEW STEVEN KUZILA
0060762
Exp. 10/31/2023
PROFESSIONAL ENGINEER

Matthew S Kuzila, PE

Digitally Signed 3.13.2023

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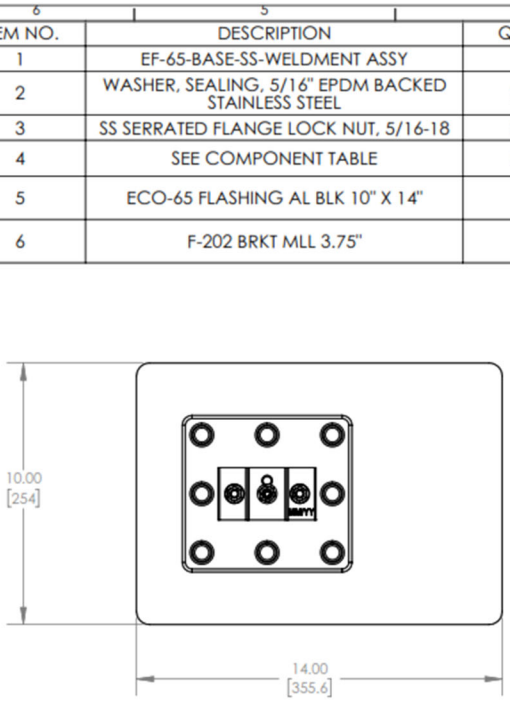
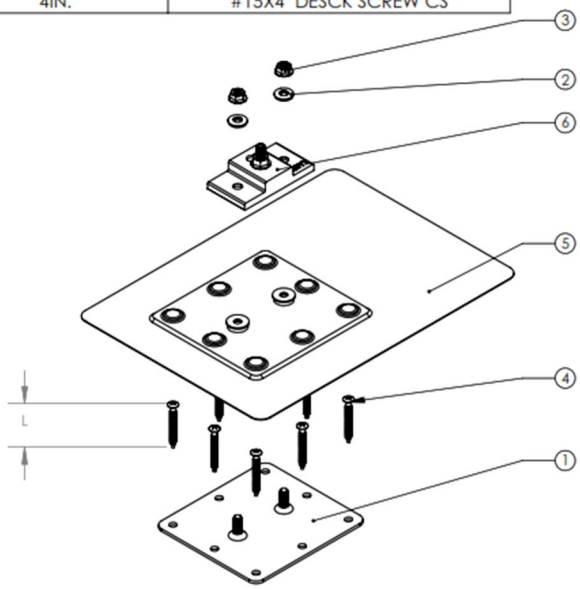
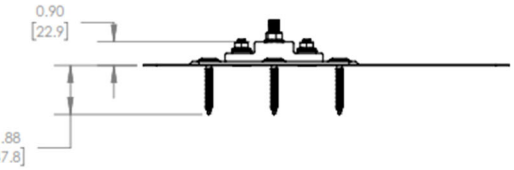
APPENDIX A: ENGINEERING DRAWING

ITEM NO.	DESCRIPTION	QTY.
1	EF-65-BASE-SS-WELDMENT ASSY	1
2	WASHER, SEALING, 5/16" EPDM BACKED STAINLESS STEEL	2
3	SS SERRATED FLANGE LOCK NUT, 5/16-18	2
4	SEE COMPONENT TABLE	8
5	ECO-65 FLASHING AL BLK 10" X 14"	1
6	F-202 BRKT MLL 3.75"	1

COMPONENT TABLE	
LENGTH, L	DESCRIPTION
2IN.	#15X2" DECK SCREW, CS
3IN.	#15X3" DECK SCREW, CS
4IN.	#15X4" DESCK SCREW CS







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THIRD ANGLE PROJECTION

DO NOT SCALE DRAWING

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DRAWN	RAD	12/10/2020
ENG APPR.	JH	01/13/2021

INTERPRET DIM AND TOLERANCE PER ASME Y14.5[M]-2009

DIMENSIONS TOLERANCES ARE IN:

INCHES	[MILLIMETERS]
.XX: +/- .050	.X: +/- 1.3
.XXX: +/- .050	.XX: +/- 1.3

ANGLES: +/- 5°

DESCRIPTION: ECO-65 BASE SS 6X5.5"

SIZE A | DWG. NO. | REV.

SCALE:1:5 | SHEET 1 OF 1