Carl Putnam, P.E.

Evaluation Report

CPER - 101

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Revised: n/a

Office 434.384-2514 | Fax 434.384.6027

Euramax International, Inc. d/b/a Amerimax Home Products
450 Richardson Drive
Lancaster, PA 17603
(717) 299-3701
www.equinoxroof.com
Ron Wilson
Vice President of Sales
rwilson@amerimax.com

Evaluation Subject:

Equinox Extruded Aluminum Rotatable Louvers for Shade Structures

1.0 Scope:

Product Category: Structural Component

Subcategory: Roof Deck

This report shows this product complies with the 2010 Florida Building Code 1504.1, 1504.9 and Section 1609. This rotating louver system has been tested in accordance with TAS 202.

2.0 Uses: Equinox Aluminum Louvers are metal rotatable roof panels to be used for outdoor recreational living, carports or exterior commercial use.

3.0 Description:

3.1 Louver: The 6063T5 aluminum louver is an extruded shape shown in Detail F1 and in Appendix E of the test report cited in 6.1.

3.2 End Cap: A380 cast aluminum end cap shown in Detail F5.

3.3 Mounting Rail: 6061T6 aluminum extruded mounting rail shown in Detail F3.

3.4: Header: 6061T6 0.125”x2”x8” aluminum extruded header shown in Detail F2. Other headers may be used but equivalent fastening of the mounting rail must be demonstrated.

3.5 Fasteners: #12 and #14 sheet metal screws.

4.0 Design and Installation:

4.1 Design: Use Table 1 in to determine allowable span for 20 psf live loads and appropriate wind condition.

5.0 Conditions of Use:

5.1 Equinox Louvers are for outside recreational living spaces (patio covers), carports and exterior commercial spaces.

5.2 Figures 1609A, B and C will determine relevant local wind speed

5.3 Supporting structure shall be justified by a Florida design professional.

5.4. Louvers are permitted in HVHZ

6.0 Evidence Submitted:

6.1 ATI Test Report # D7097.01-109-18r2

6.2 Louver span calculations

6.3 Extruded Aluminum Louver Die Drawing

6.4 Cast Aluminum End Cap die drawing

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Table 1 LOUVER SPANS FOR COMMERCIAL AND PATIO STRUCTURES for 2010 FBC

Roof Design Load (psf)	Equinox Extruded Aluminum Louvers	Wind Speed (mph) 120	130	140	150	160	170	180
Allowable spans for Group R-3 occupancy structures								
20	Wind Exposure B	13'-3"	13'-3"	13'-3"	13'-3"	13'-3"	0'-0"	0'-0"
	Wind Exposure C	13'-3"	13'-3"	13'-3"	13'-3"	13'-3"	11'-6"	11'-1"
	Wind Exposure D	13'-3"	13'-3"	13'-3"	12'-11"	12'-4"	10'-10"	10'-5"
Allowable Spans for all other structures								
20	Wind Exposure B	13'-3"	13'-3"	13'-3"	13'-3"	13'-3"	0'-0"	0'-0"
	Wind Exposure C	13'-3"	13'-3"	13'-3"	13'-3"	13'-3"	8'-0"	7'-8"
	Wind Exposure D	13'-3"	13'-3"	13'-3"	12'-11"	12'-4"	7'-6"	7'-2"

Notes

1 Live/Wind spans are limited by deflection of 60 as permiited by footnote a in Table 1604.3 2010 FBC
2 Deflections for 170 and 180 mph winds for R-3 structures are limited by L/80 as per 2010 FBC 1615.3.1 #8
3 Deflections for 170 and 180 mph winds for non R-3 structures are limited by L/240 as per 2010 FBC 1615.3.1 #2
4 The weight of the louver is 1.9 plf or 2.9 psf.
5 These tables are only to be used for exterior shade structures such as patio covers, carports or outdoor dining areas.
6 Topographic Factor, Kzt, of 1 is assumed (ASCE7-10 Fig 26.8-1)
7 Wind pressures assume a maximum mean roof height of 15'
8 Span is the Louver length plus the aluminum mounting rail on both sides, this is usually the inside to inside dimension of the supporting headers
9 Panels are allowed in HVHZ
10 Exposure B is not allowed in HVHZ

This worksheet determines the allowable spans for a panel using raw data from transverse load test

Louver Specs Panel := "Equinox Extruded Louver"

Width := 8·in DL := 1.918·plf per die drawing Elouver := 10100·ksi t := 0.065·in

$I := 0.437 \cdot in^4$ determined in "Patio Cover Blade Allowable Shear and Bending" 3/27/2013 by Randy Kissell

Define user functions

maxi(amaxi, bmaxi) := if(amaxi > bmaxi, amaxi, bmaxi) Chooses the max value between 2 numbers

mini(amaxi, bmaxi) := if(amaxi > bmaxi, bmaxi, amaxi) Chooses the min value between 2 numbers

Raw Testing Data from Architectural Testing Inc. D7097.01-109-18r2

$$Pres := \begin{pmatrix} 10 & 10 & 5 \\ 20 & 20 & 10 \\ 30 & 30 & 15 \\ 40 & 35 & 20 \\ 50 & 40 & 25 \\ 60 & 45 & 30 \\ 70 & 50 & 35 \\ 80 & 55 & 40 \\ 90 & 60 & 40 \\ 100 & 65 & 40 \\ 110 & 70 & 40 \\ 120 & 75 & 40 \\ 130 & 80 & 40 \\ 140 & 85 & 40 \\ 150 & 85 & 40 \\ 160 & 85 & 40 \\ 170 & 85 & 40 \end{pmatrix} \cdot psf \qquad \Delta raw := \begin{pmatrix} 0.17 & 0.77 & 0.85 \\ 0.33 & 1.52 & 1.59 \\ 0.49 & 2.20 & 2.26 \\ 0.65 & 2.53 & 2.9 \\ 0.82 & 2.85 & 3.49 \\ 0.98 & 3.11 & 3.93 \\ 1.13 & 3.43 & 4.52 \\ 1.29 & 3.75 & 5.05 \\ 1.44 & 4.01 & 5.05 \\ 1.59 & 4.24 & 5.05 \\ 1.75 & 4.49 & 5.05 \\ 1.9 & 4.73 & 5.05 \\ 2.06 & 5.04 & 5.05 \\ 2.24 & 5.34 & 5.05 \\ 2.4 & 5.34 & 5.05 \\ 2.62 & 5.34 & 5.05 \\ 2.8 & 5.34 & 5.05 \end{pmatrix} \cdot in$$

$$ndata := \begin{pmatrix} 16 \\ 13 \\ 7 \end{pmatrix}$$

max data point, after this number all data repeated

i := 0 .. 2 j := 0 .. 16 i3 := 0 .. 1

$$L := \begin{pmatrix} 92 \\ 140 \\ 163 \end{pmatrix} \cdot in \qquad k_i := 0 .. ndata_i$$

SF := 2

dcrit := 60

MaxSpan := max(L) = 13.583 ft

$$V := \frac{\left(Pres_{ndata_0,0} \cdot Width\right) \cdot L_0}{2} = 217\,lbf$$

use short span to determine allowable shear

$$M := \frac{\left(Pres_{ndata_1,1} \cdot Width\right) \cdot (L_1)^2}{8 \cdot SF} = 482 \cdot lbf \cdot ft$$

use middle span to determine allowable moment

Determine Coefficient of Deflection: The coefficient, C, from the deflection equation

def = C wL^4 / EI , for a single span, perfect pin and roller jointed ends this value is 5/384 or 0.013.

$$coeff_j := \Delta raw_{j,2} \cdot \frac{Elouver \cdot I}{\left(Pres_{j,2} \cdot Width\right) \cdot (L_2)^4}$$

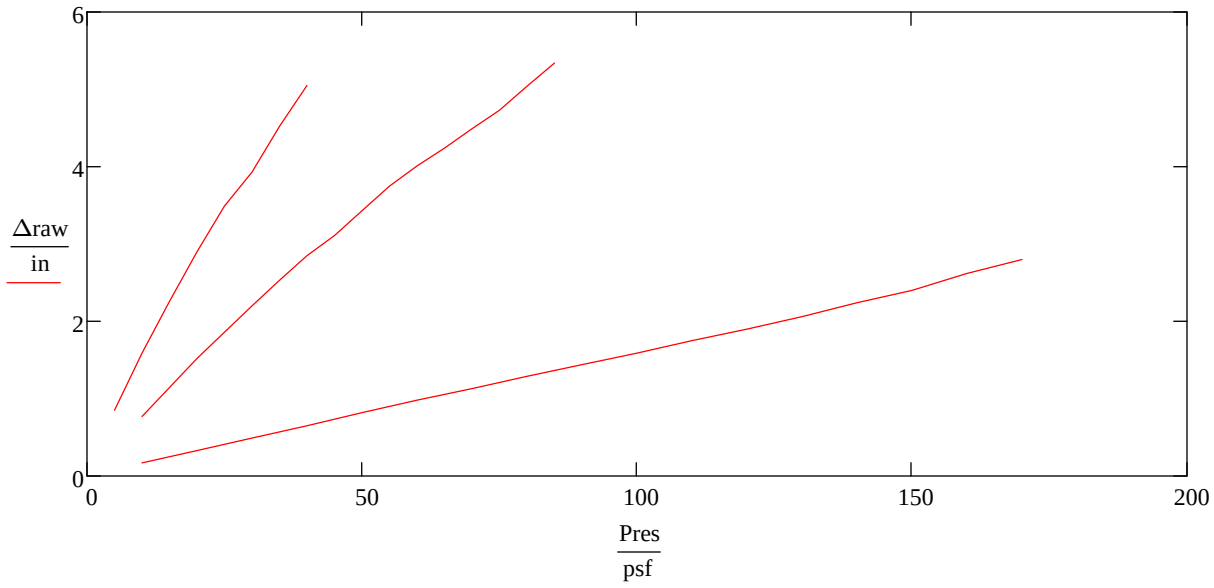
single span, pin jointed span

$$CoeffTheory := \frac{5}{384} = 0.01302$$

$$Coeff := \frac{\sum_{k1=0}^{ndata_2} coeff_{k1}}{ndata_2 + 1}$$

use long span to determine deflection coefficient

Coeff = 0.016 average coefficient CoeffTheory = 0.013



$i0 := 0 .. ndata_0$ $i1 := 0 .. ndata_1$ $i2 := 0 .. ndata_1$

Define Loads

$nf := 41$ number of live loads

$n := 0 .. nf - 1$ live load counter $Imp := 1.0$ Importance factor, all structures are Type II

Load Combinations used is in accordance with IBC 2009 1605.3.1. Equation 16-9 and Equation 16-11 will control.

Design Loads

$LL_n := if[n > 0, (10 + 1.\cdot n)\cdot psf, 10\cdot psf]\cdot Imp$

$LLh_{0,n} := LL_n$ $max(LL) = 50\cdot psf$

Determine Dead and Live loads per lineal foot

$w_n := (LL_n)\cdot Width + DL$ $wLL_n := LL_n\cdot Width$

$LL =$

	0
0	10
1	11
2	12
3	13
4	14
5	15
6	16
7	17
8	18
9	19
10	20
11	...

$\cdot psf$

Determine max spans for all allowable stresses

Top in compression

$Lshear_n := \frac{V}{0.5\cdot w_n}$ $Ldef_n := \sqrt[3]{\frac{Elouver\cdot I}{Coeff\cdot wLL_n\cdot dcrit}}$ $LbendT_n := \sqrt{\frac{8\cdot M}{w_n}}$

$Lsnow_n := mini(Ldef_n, Lshear_n)$ $Lsnow_n := mini(LbendT_n, Lsnow_n)$ $Lsnow_n := mini(MaxSpan, Lsnow_n)$

Ldef =

	0
0	16.8
1	16.3
2	15.8
3	15.4
4	15
5	14.7

ft

LbendT =

	0
0	21.2
1	20.4
2	19.7
3	19.1
4	18.5
5	18

ft

Lshear =

	0
0	51
1	47
2	44
3	41
4	39
5	36

ft

6	14.4
7	14.1
8	13.8
9	13.6
10	13.3
11	...

6	17.5
7	17.1
8	16.6
9	16.3
10	15.9
11	...

6	35
7	33
8	31
9	30
10	28
11	...

LL =

	0
0	10
1	11
2	12
3	13
4	14
5	15
6	16
7	17
8	18
9	19
10	20
11	...

·psf Lsnow =

	0
0	13.6
1	13.6
2	13.6
3	13.6
4	13.6
5	13.6
6	13.6
7	13.6
8	13.6
9	13.6
10	13.3
11	...

ft

Max Spans Based on Snow Loads for

Panel = "Equinox Extruded Louver"

Wind Loads are determined by procedure explained in ASCE 7-10 Section 30.8 and Figure 30.8-1.

$nm := 7$ $nw1 := 0 .. nm - 1$ $nw2 := nm .. 2 \cdot nm - 1$ $nw3 := 2 \cdot nm .. 3 \cdot nm - 1$ $nw := 0 .. 3 \cdot nm - 1$

$WS_0 := 120 \cdot mph$ $WS_1 := 135 \cdot mph$ $WS_2 := 140 \cdot mph$ $WS_3 := 150 \cdot mph$ $WS_4 := 160 \cdot mph$ $WS_5 := 170 \cdot mph$

$WS_6 := 180 \cdot mph$ $WSh_{0,nw1} := WS_{nw1}$ $WSh_{0,nw1+nm} := WS_{nw1}$ $WSh_{0,nw1+2 \cdot nm} := WS_{nw1}$

deflection limit $dwind_{nw,0} := if\left(WSh_{0,nw} > 169 \cdot mph, 80, 60\right)$

$dwind_{nw,1} := if\left(WSh_{0,nw} > 169 \cdot mph, 240, 60\right)$

Deflection limits change for HVHZ

Wind Directionality Factor Table 26.6-1 $Kd := 0.85$

ASCE7 Table 30.3-1 **Table 30.3-1** Exposures B and C (C&C)

$KzB := 0.7$ $KzC := 0.85$ $KzD := 1.03$

ASCE7 Fig 26.8-1 Topographic factors are outside the scope of this report

$Kzt := 1.0$

$WSh_{0,nw1+nm} := WS_{nw1}$

ASCE7 30.3.2 $qz_{nw1} := 0.00256 \cdot KzB \cdot Kzt \cdot Kd \cdot \left(WS_{nw1}\right)^2 \cdot 14.959 \cdot \frac{lb}{ft^3} \cdot 0.6$

$qz = \begin{pmatrix} 13.2 \\ 16.7 \\ 17.9 \\ 20.6 \\ 23.4 \\ 26.4 \\ 29.6 \end{pmatrix} \cdot psf$

14.959 lb/ft^3 is a hidden constant used for unit conversion in the ASCE 7 equation 30.3-1 that MathCAD requires to be explicitly stated. I also use the 0.6 factor here for the Vult windspeeds

$qz_{nw1+nm} := qz_{nw1} \cdot \frac{KzC}{KzB}$ $qz_{nw1+2 \cdot nm} := qz_{nw1} \cdot \frac{KzD}{KzB}$

added 0.6 factor (from Eqtn 16-12 and 13) here

	0
0	13.2
1	16.7
2	17.9
3	20.6
4	23.4

$MinP := 0.6 \cdot 16 \cdot psf$

ASCE7 26.9.1 $G := 0.85$

ASCE7 Fig 30.8-1 angle = 0 , Area>4a^2 $CN := 1.2$

$qz =$

4	23.4
5	26.4
6	29.6
7	16
8	20.2
9	21.8
10	25
11	...

$\cdot psf$

Added 0.6 (for Vult) into qz already. This requires me to use 0.7 instead of 0.42 wind load factor (for deflection) into these equations, Table 1604 footnote f.

$wW_{nw} := maxi(qz_{nw} \cdot G \cdot CN, MinP) \cdot Width + DL$ $wW2_{nw} := maxi(qz_{nw} \cdot G \cdot CN, MinP) \cdot 0.7 \cdot Width$

$Lwshear_{nw} := \frac{V}{0.5 \cdot wW_{nw}}$ $Lwdef_{nw,i3} := \sqrt[3]{\frac{Elouver \cdot I}{Coeff \cdot wW2_{nw} \cdot dwind_{nw,i3}}}$

$LwbendT_{nw} := \sqrt{\frac{8 \cdot M}{wW_{nw}}}$ Top/bot in compression

$Lwshear =$

	0
0	40
1	33
2	31
3	27
4	24
5	22
6	20
7	34
8	28
9	26
10	23
11	20
12	18
13	16
14	29
15	23
16	22
17	19
18	17
19	15
20	14

ft

$LwbendT =$

	0
0	18.8
1	17.1
2	16.5
3	15.6
4	14.7
5	13.9
6	13.2
7	17.4
8	15.7
9	15.2
10	14.3
11	13.5
12	12.7
13	12.1
14	16
15	14.4
16	13.9
17	13.1
18	12.3
19	11.7
20	11.1

ft

$Lwdef =$

	0	1
0	17.1	17.1
1	15.8	15.8
2	15.5	15.5
3	14.8	14.8
4	14.2	14.2
5	12.3	8.6
6	11.9	8.2
7	16.1	16.1
8	14.9	14.9
9	14.5	14.5
10	13.8	13.8
11	13.3	13.3
12	11.6	8
13	11.1	7.7
14	15.1	15.1
15	13.9	13.9
16	13.6	13.6
17	13	13
18	12.4	12.4
19	10.9	7.5
20	10.4	7.2

ft

Wind Exposure

$WS =$

120
135
140
150
160
170
180

$\cdot mph$ Exp B

$WS =$

120
135
140
150
160
170
180

$\cdot mph$ Exp C

$WS =$

120
135
140
150
160
170
180

$\cdot mph$ Exp D

$Lw_{nw,i3} := mini(Lwdef_{nw,i3}, Lwshear_{nw})$

$Lw_{nw,i3} := mini(LwbendT_{nw}, Lw_{nw,i3})$

$Lw_{nw,i3} := mini(MaxSpan, Lw_{nw,i3})$

Set Lw = 0 for Exposure B in WS>169 mph (HVHZ)

$Lw_{nw1,i3} := if(WS_{nw1} > 169 \cdot mph, 0, Lw_{nw1,i3})$

These loading conditions are discussed in detail in the Design Forces: Wind Loads section

Wind Rating (mph)

Exp B $WS = \begin{pmatrix} 120 \\ 135 \\ 140 \\ 150 \\ 160 \\ 170 \\ 180 \end{pmatrix} \cdot mph$

Exp C $WS = \begin{pmatrix} 120 \\ 135 \\ 140 \\ 150 \\ 160 \\ 170 \\ 180 \end{pmatrix} \cdot mph$

Exp D $WS = \begin{pmatrix} 120 \\ 135 \\ 140 \\ 150 \\ 160 \\ 170 \\ 180 \end{pmatrix} \cdot mph$

$Lw =$

	0	1
0	13.6	13.6
1	13.6	13.6
2	13.6	13.6
3	13.6	13.6
4	13.6	13.6
5	0	0
6	0	0
7	13.6	13.6
8	13.6	13.6
9	13.6	13.6
10	13.6	13.6
11	13.3	13.3
12	11.6	8
13	11.1	7.7
14	13.6	13.6
15	13.6	13.6
16	13.6	13.6
17	13	13
18	12.3	12.3
19	10.9	7.5
20	10.4	7.2

ft

$V = 217\,lbf$ allowable shear

$M = 482\,lbf \cdot ft$ allowable moment

$Coeff = 0.0162$ deflection coefficient

Max Spans Based on Wind Loads for $Panel = "Equinox\ Extruded\ Louver"$

$LsnowX_{0,n} := Lsnow_n$ $LwX_{i3,nw} := Lw_{nw,i3}$

$LsnowX =$

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.3	13.1	12.9	12.7	...

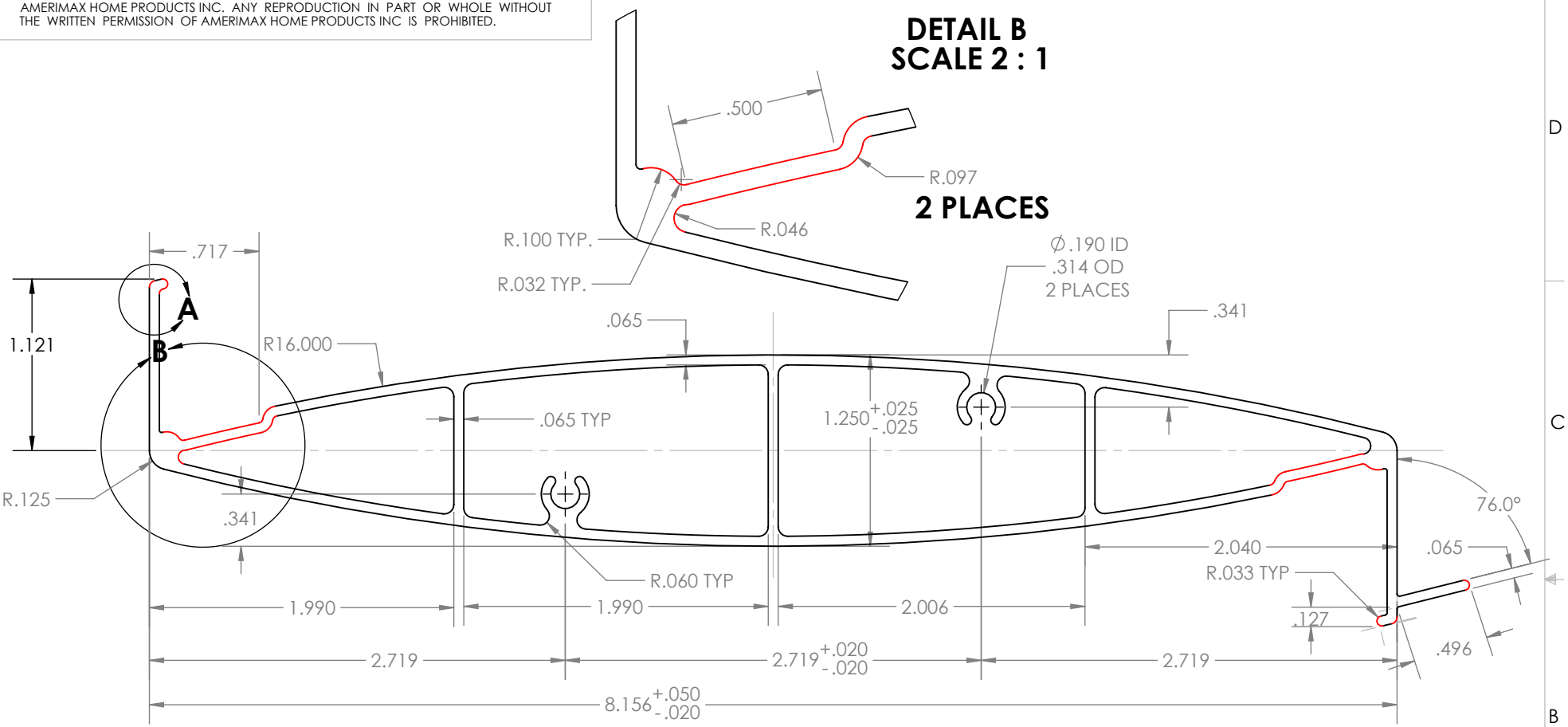
ft

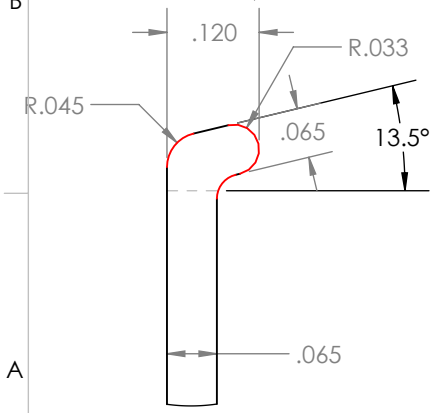
$LwX =$

	0	1	2	3	4	5	6	7	8	9	10	11	12
0	13.6	13.6	13.6	13.6	13.6	0	0	13.6	13.6	13.6	13.6	13.3	11.6
1	13.6	13.6	13.6	13.6	13.6	0	0	13.6	13.6	13.6	13.6	13.3	...

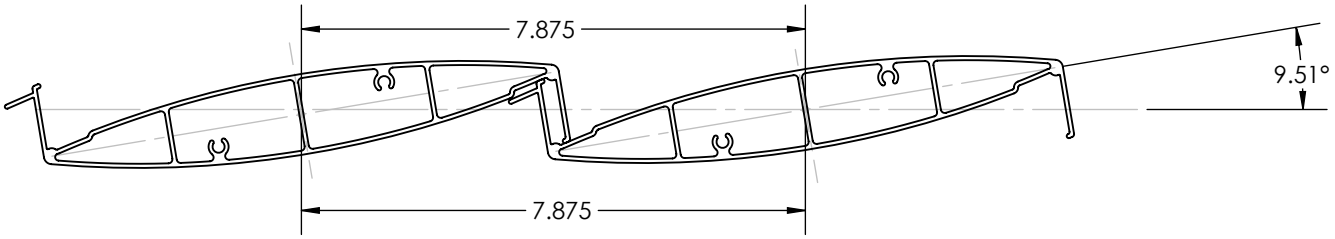
ft

$min(dwind) = 60$ $max(dwind) = 240$





DETAIL A
SCALE 4 : 1
2 PLACES



ASSEMBLY: NTS

NOTE: LENGTH TO BE +.125 -0.000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ± .002" ANGLES	CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE	AMERIMAX HOME PRODUCTS INC	
	APPROVALS / DATE		
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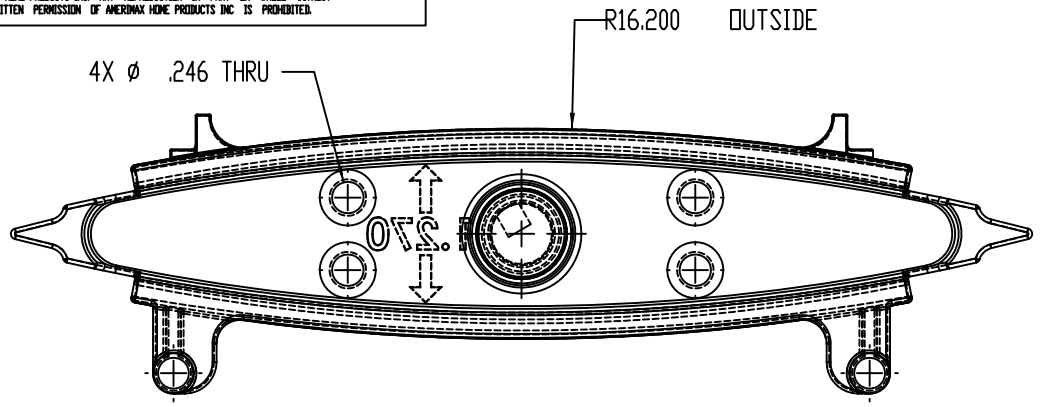
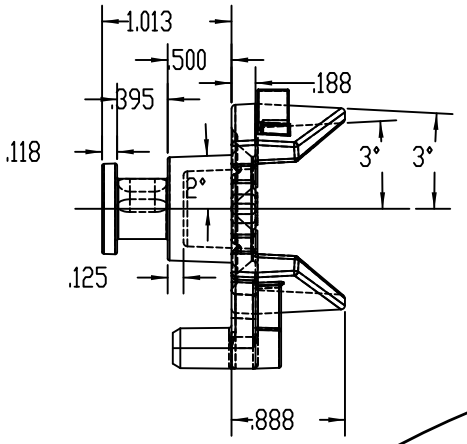
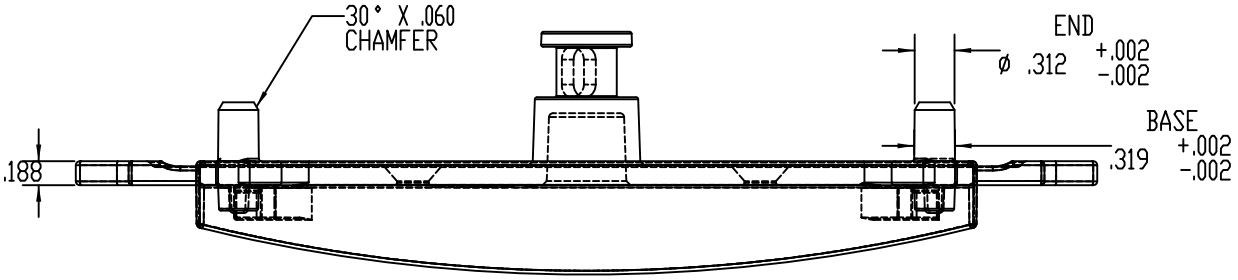
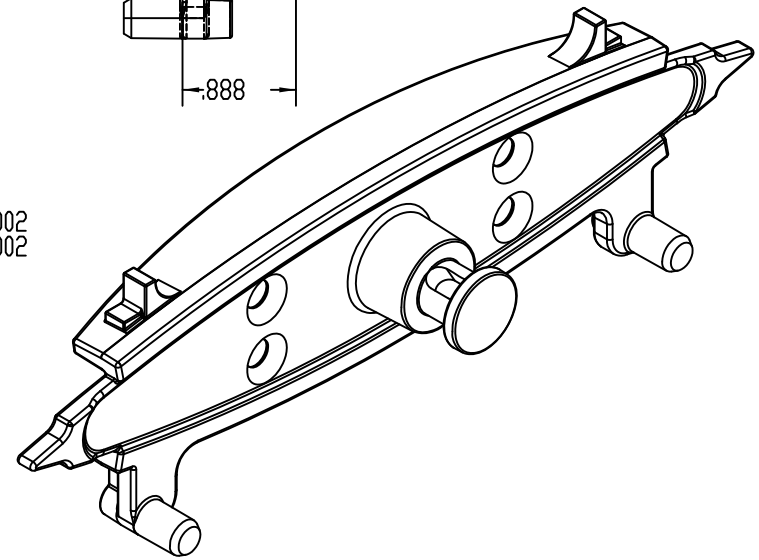
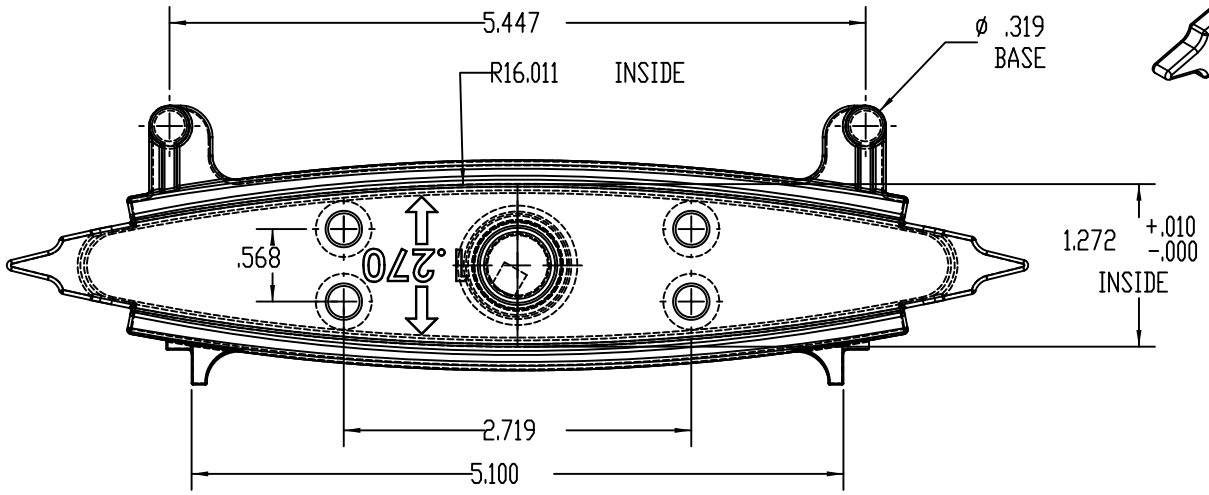
	CHECKED		
MATERIAL ALUMINUM .065 WALL	SIZE A CAD FILE: T:\0000 Equinox\0 Current 01-22-2013\		
DO NOT SCALE DRAWING	QUAL ENG / SCALE 1:1 / DWG. NO. Sheet1 / SHEET 1 OF 1		
	3/4/2014		











UNLESS OTHERVISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS	CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE	AMERIMAX HOME PRODUCTS INC
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MATERIAL ALUMINUM	CHECKED	
DO NOT SCALE DRAWING	SIZE B; CAD FILE: T:\0000 Equinox\0 Current 01-22-2013\; QUAL ENG; SCALE 1:1; DWG NO Sheet1; SHEET 1 OF 1	

10/15/2013