NATIONAL CERTIFIED TESTING LABORATORIES

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PRODUCT APPROVAL SUPPORTING CALCULATIONS

Builders Vinyl Tilt Single Hung Window

REPORT TO:

JELD-WEN WINDOWS & DOORS
3737 LAKEPORT BLVD
KLAMATH FALLS, OREGON

REPORT NUMBER: NCTL-110-23985-7
REPORT DATE: 02/03/21

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Scope

National Certified Testing Laboratories was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their Builders Vinyl Tilt Single Hung windows. The evaluation is based on physical testing and product certifications. Reference standards utilized in this project include:

Florida Building Code, Building. International Code Council.

ANSI/AWC *National Design Specification (NDS) for Wood Construction*. American Wood Council.

AISI S100 *North American Specification for the Design of Cold-Formed Steel Structural Members*. American Iron and Steel Institute.

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service.

NOA 16-1222.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section.

The anchorage analyses presented herein do not address the water resistance, water penetration or air infiltration performance of the installation method or the installed product. In addition, the analyses rely on the assumption that the building substrate is capable of withstanding incurred loads.

Certification of Independence

In accordance with Rule 61G20-3 Florida Administrative Code, National Certified Testing Laboratories hereby certifies the following:

- National Certified Testing Laboratories does not have, nor does it intend to acquire or will it acquire, a financial interest in any company manufacturing or distributing products tested or labeled by the agency.
- National Certified Testing Laboratories is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.
- Joseph A. Reed, P.E. does not have nor will acquire, a financial interest in any company manufacturing or distributing products for which the reports are being issued.
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Analyses

Summary of Test Results

The following table summarizes the various Builders Vinyl Tilt Single Hung window products and their corresponding performance levels which have been established by testing or product certification.

Table 1 Summary of Test Results

Series/Model	Test Report Number	Size (W x H)	Performance
Builders Vinyl Tilt Single Hung (Through Frame Install)	NCTL-110-16-114 (Rev -, 09/09/16)	36" x 72"	+50/-55 psf
Builders Vinyl Tilt Single Hung (Through Frame Install)	NCTL-110-16-134 (Rev -, 01/27/17)	48" x 77"	+50/-50 psf
Builders Vinyl Tilt Single Hung (Through Frame and Fin Install)	SJW2012-202 (Rev -, 10/29/12)	48" x 77"	+50/-50 psf
Builders Vinyl Tilt Single Hung (Through Frame and Fin Install)	SJW2013-049 (Rev -, 06/14/13)	52" x 75"	+50/-50 psf
Builders Vinyl Tilt Twin Single Hung (Through Frame Install)	SJW2012-184 (Rev -, 10/04/12)	84" x 57"	+50/-50 psf
Builders Vinyl Tilt Twin Single Hung (Fin Install)	SJW2012-185 (Rev 1, 10/03/12)	84" x 57"	+50/-50 psf
Builders Vinyl Tilt Triple Single Hung (Through Frame and Fin Install)	SJW2013-011 (Rev -, 02/21/13)	109" x 74"	+50/-50 psf

Testing documented in Table 1 was conducted by the National Certified Testing Laboratories laboratory in Everett, Washington (Florida Department of Business & Professional Regulation Test Lab No. TST9341, A2LA Certificate 3054.03) and the National Certified Testing Laboratories laboratory in York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST4744, A2LA Certificate 3054.01).

As-Tested Installation Analysis

For air/water/structural testing the test specimen was secured to a 2x Spruce-Pine-Fir buck. The as-tested installation methods are evaluated on page 4 to page 7. These capacities will be used to prove acceptable alternate anchors and substrates for the windows.

Alternate Anchorages

Calculations on page 8 through page 10 determine the design capacity of alternate installation anchorages for the window.

Anchorage Requirements

As-tested spacing must be maintained. It must be determined the anchorages are not overloaded for the approved window size and design pressures. Calculations presented on page 11 to page 13 show the anchor spacing requirements for the established limiting anchor capacities.

Anchorage requirements established by this report are accurately presented in Drawing D008499, D008450 and D009140.

Attachments

Appendix A – Revision Log (1 page)

As-Tested Installation – Nail Fin to Wood

#8 x 1-1/4" Pan Head Screw

0.062" thick Nail Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Tension of #8 x 1-1/4" Pan Head Screw

W = 1.6(1.250"-0.062")(82 lb/in) (NDS, Table 12.2B)
W = 156 lb

Allowable Pull-Over of #8 x 1-1/4" Pan Head Screw

Validated by Testing

Window	Design Pressure (psf)	Width (inch)	Height (inch)	Anchors at Head	Anchors at Sill	Anchors at Jambs	Max Load to Anchor (lb)
48x77	50	48	77	5	5	8	49
52x75	50	52	75	5	5	8	52
84x57	50	84	57	7	7	6	64
109x74	50	109	74	14	14	9	61

Test results prove anchor is OK for 64 lb.

Must maintain anchor spacing and anchor head size

Capacity of Connection is 64 lb

As-Tested Installation – Through Frame to Wood

#8 Pan Head Screw; 1-1/2" penetration to wood

0.060" thick Window Frame

1/4" Maximum Shim Space

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Shear of #8 Pan Head Screw

Z' = 98 lb (See Following 2 Pages)

Bending of #8 Pan Head Screw

L = 1/4" (maximum shim space)
$S = \pi d^3/32 = \pi(0.131)^3/32 = 0.000221\ in^3$
$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(90{,}000\ psi) = 70{,}200\ psi$ (1.3 weak axis factor)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000221\ in)(70{,}200\ psi)/0.25" = 124\ lb.$

Capacity of Connection is 98 lb

As-Tested Installation – Through Frame to Wood (Continued)

Lateral Design Strength of Wood Connections

Data

Fastener

Fastener	=	#8 Wood Screw	
Shank Dia	=	0.164	in.
Root Dia.	=	0.131	in.
F_{yb}	=	90,000	psi
Fastener length	=	2.000	in.

Main Member

Material	=	SPF	
G	=	0.42	
θ	=	90	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_e	=	3,350	psi
Thickness	=	1.500	in.

Side Member

Material	=	Vinyl (PVC)	
G	=	N/A	
θ	=	90	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_{es}	=	17,125	psi
Thickness	=	0.060	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.500	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.196	
R_t	=	25.00	
k_1	=	1.9318	
k_2	=	0.6066	
k_3	=	13.13	

As-Tested Installation – Through Frame to Wood (Continued)

Yield Mode	R_d
I_m, I_s	2.20
II	2.20
III_m, III_s, IV	2.20

Lateral Design Values, Z

Mode I_m	=	299	lbf	
Mode I_s	=	61	lbf	<====== Minimum Value
Mode II	=	118	lbf	
Mode III_m	=	130	lbf	
Mode III_s	=	72	lbf	
Mode IV	=	101	lbf	
C_D	=	1.6		
Wet Service Factor				
Fabrication/In-Service		Dry/Dry		
C_M	=	1.0		
In service temperature		T≤100˚F		
C_t	=	1.0		
C_g	=	1.0		
C_Δ	=	1.0		
Is fastener installed in end grain?		No		
C_{eg}	=	1.00		
Is fastener part of a diaphragm?		No		
C_{di}	=	1.0		
Is fastener toe-nailed?		No		
C_{tn}	=	1.00		
Z'	**=**	**98**	**lbf**	

Alternate Installation – Trough Frame to Steel Stud

#8 Grade 5 Screw

1/4" Maximum Shim Space

Minimum 18 gauge 33 KSI Steel Stud

Allowable Shear of #8 Grade 5 Screw

P_{ss}/Ω = 286 lb (AAMA TIR A9)

Bearing of #8 Grade 5 Screw on Frame

F_p = 10,000 psi
D = 0.164"
t = 0.060"
$V_a = F_pDt$ = (10,000 psi)(0.164")(0.060") = 98 lb

Bearing of #8 Grade 5 Screw on Steel Stud

$V_a = 2.7DtF_{tu}/3.0$
V_a = 2.7(0.164")(0.0428")(45,000 psi)/3.0
V_a = 284 lb.

Tilting of #8 Grade 5 Screw in Steel Stud

$V_a = 4.2(t_2^3D)^{1/2}F_{tu2}/n_s$
$V_a = 4.2(0.0428"^3 \times 0.164")^{1/2}$(45,000 psi)/3.0
V_a = 226 lb.

Bending of #8 Grade 5 Screw

L = 1/4" (Maximum Shim Space)
$S = \pi d^3/32 = \pi(0.116)^3/32 = 0.000153$ in^3
$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(100{,}000$ psi) = 78,000 psi (1.3 weak axis factor)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000153$ in$^3)(78{,}000$ psi)/0.25" = 96 lb.

Capacity of Connection is 96 lb.

Alternate Installation – Through Frame to Concrete

3/16" Tapcon Anchor

2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

Minimum f'_c = 3,000 psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 181 lb (NOA-No. 16-1222.06)

Bearing of 3/16" Tapcon Anchor on Frame

F_p = 10,000 psi
D = 0.170"
t = 0.060"
$V_a = F_pDt$ = (10,000 psi)(0.170")(0.060") = 102 lb

Bending of 3/16" Tapcon Anchor

L = 1/4" (Maximum Shim Space)
$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482$ in^3
$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137{,}000$ psi) = 106,860 psi (1.3 weak axis factor)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000482$ in$^3)(106{,}860$ psi)/0.25" = 412 lb.

Capacity of Connection is 102 lb

Alternate Installation – Through Frame to CMU

3/16" Tapcon Anchor

2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 135 lb (NOA-No. 16-1222.06)

Bearing of 3/16" Tapcon Anchor on Frame

F_p = 10,000 psi
D = 0.170"
t = 0.060"
$V_a = F_pDt$ = (10,000 psi)(0.170")(0.060") = 102 lb

Bending of 3/16" Tapcon Anchor

L = 1/4" (Maximum Shim Space)
$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482$ in^3
$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137{,}000$ psi) = 106,860 psi (1.3 for weak axis bending)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000482$ in$^3)(106{,}860$ psi)/0.25" = 412 lb.

Capacity of Connection is 102 lb

36x72 +50/-55 psf

Anchorage Requirements – Through Frame

Window Overall Size: 36" x 72"
Window Overall Area: (36")(72")/144 = 18.0 ft^2
Window Overall Wind Load: (55 psf)(18.0 ft^2) = 990 lb
Installed Anchors: 3 head + 0 sill + 2(4) jambs = 11 installed anchors
Minimum Anchor Capacity: 96 lb/anchor
Total Anchor Capacity: (11 anchors)(96 lb/anchor) = 1,056 lb > 990 lb **OK**

48x77 +50/-50 psf

Anchorage Requirements – Nail Fin

Window Overall Size: 48" x 77"
Window Overall Area: (48")(77")/144 = 25.7 ft^2
Window Overall Wind Load: (50 psf)(25.7 ft^2) = 1,285 lb
Installed Anchors: 5 head + 5 sill + 2(8) jambs = 26 installed anchors
Minimum Anchor Capacity: 64 lb/anchor
Total Anchor Capacity: (26 anchors)(64 lb/anchor) = 1,664 lb > 1,285 lb **OK**

Anchorage Requirements – Through Frame

Window Overall Size: 48" x 77"
Window Overall Area: (48")(77")/144 = 25.7 ft^2
Window Overall Wind Load: (50 psf)(25.7 ft^2) = 1,285 lb
Installed Anchors: 3 head + 0 sill + 2(7) jambs = 17 installed anchors
Minimum Anchor Capacity: 96 lb/anchor
Total Anchor Capacity: (17 anchors)(96 lb/anchor) = 1,632 lb > 1,285 lb **OK**

52x75 +50/-50 psf

Anchorage Requirements – Nail Fin

Window Overall Size: 52" x 75"
Window Overall Area: (52")(75")/144 = 27.1 ft^2
Window Overall Wind Load: (50 psf)(27.1 ft^2) = 1,355 lb
Installed Anchors: 5 head + 5 sill + 2(8) jambs = 26 installed anchors
Minimum Anchor Capacity: 64 lb/anchor
Total Anchor Capacity: (26 anchors)(64 lb/anchor) = 1,664 lb > 1,355 lb **OK**

Anchorage Requirements – Through Frame

Window Overall Size: 52" x 75"
Window Overall Area: (52")(75")/144 = 27.1 ft^2
Window Overall Wind Load: (50 psf)(27.1 ft^2) = 1,355 lb
Installed Anchors: 3 head + 3 sill + 2(7) jambs = 20 installed anchors
Minimum Anchor Capacity: 96 lb/anchor
Total Anchor Capacity: (20 anchors)(96 lb/anchor) = 1,920 lb > 1,355 lb **OK**

84x57 Twin +50/-50 psf

Anchorage Requirements – Nail Fin

Window Overall Size: 84" x 57"
Window Overall Area: (84")(57")/144 = 33.3 ft^2
Window Overall Wind Load: (50 psf)(33.3 ft^2) = 1,665 lb
Installed Anchors: 7 head + 7 sill + 2(6) jambs = 26 installed anchors
Minimum Anchor Capacity: 64 lb/anchor
Total Anchor Capacity: (26 anchors)(64 lb/anchor) = 1,664 lb ≈ 1,665 lb **OK**

Anchorage Requirements – Through Frame

Window Overall Size: 84" x 57"
Window Overall Area: (84")(57")/144 = 33.3 ft^2
Window Overall Wind Load: (50 psf)(33.3 ft^2) = 1,665 lb
Installed Anchors: 6 head + 6 sill + 2(6) jambs = 24 installed anchors
Minimum Anchor Capacity: 96 lb/anchor
Total Anchor Capacity: (24 anchors)(96 lb/anchor) = 2,304 lb > 1,665 lb **OK**

109x74 Triple +50/-50 psf

Anchorage Requirements – Nail Fin

Window Overall Size: 109" x 74"
Window Overall Area: (109")(74")/144 = 56.0 ft^2
Window Overall Wind Load: (50 psf)(56.0 ft^2) = 2,800 lb
Installed Anchors: 14 head + 14 sill + 2(9) jambs = 46 installed anchors
Minimum Anchor Capacity: 64 lb/anchor
Total Anchor Capacity: (46 anchors)(64 lb/anchor) = 2,994 lb > 2,800 lb **OK**

Anchorage Requirements – Through Frame

Window Overall Size: 109" x 74"
Window Overall Area: (109")(74")/144 = 56.0 ft^2
Window Overall Wind Load: (50 psf)(56.0 ft^2) = 2,800 lb
Installed Anchors: 13 head + 13 sill + 2(9) jambs = 44 installed anchors
Minimum Anchor Capacity: 96 lb/anchor
Total Anchor Capacity: (44 anchors)(96 lb/anchor) = 4,224 lb > 2,800 lb **OK**

Appendix A

Revision Log

Identification	Date	Page & Revision
Original Issue	02/03/21	Not Applicable