



NATIONAL CERTIFIED TESTING LABORATORIES

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PRODUCT APPROVAL SUPPORTING CALCULATIONS

185MD Single Hung Window (non-Impact)

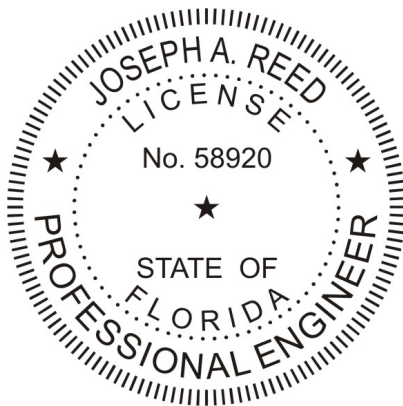
REPORT TO:

**MI WINDOWS AND DOORS, LLC
702 WEST MARKET ST
GRATZ, PENNSYLVANIA 17030**

REPORT NUMBER: NCTL-110-23258-1

REPORT DATE: 04/09/20

Revision 3: 09/15/20



A handwritten signature in black ink that reads "Joseph A. Reed". The signature is fluid and cursive, with a long horizontal stroke at the end.

Joseph A. Reed, PE
FL PE 58920
FL REG 33474

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Professionals In The Science of Testing



Scope

National Certified Testing Laboratories was contracted by MI Windows and Doors, LLC to evaluate alternate installation methods for their Series 185MD Single Hung Window (non-Impact). The evaluation is based on physical testing and product certifications.

The products considered in this report satisfy the requirements of the *Florida Building Code, Building 7th Edition (2020)* for the overall sizes and design pressures of the following product certifications and the installation methods presented in this report.

Series/Model	Product Certification	Size (W x H)	Performance
185MD Single Hung	CPD 18821	53" x 62"	+55/-63 psf
185MD Single Hung	CPD 18839	53" x 76"	+55/-55 psf
185MD Single Hung	CPD 18909	36" x 76"	+60/-70 psf

Reference standards utilized in this project include:

Florida Building Code, Building, 7th Edition (2020). International Code Council, 2020.

ANSI/AWC NDS-2018 National Design Specification (NDS) for Wood Construction. American Wood Council, 2018.

ADM1-2015 2015 Aluminum Design Manual. The Aluminum Association, Inc., 2015.

AISI S100-16 North American Specification for the Design of Cold-Formed Steel Structural Members, 2016. American Iron and Steel Institute, 2016.

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service. 07/2016.

NOA 16-1222.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section. 12/22/2016.

AAMA TIR A9-14 *Design Guide for Metal Cladding Fasteners*. American Architectural Manufacturers Association, 2014.



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.
- Joseph A. Reed, P.E. does not have, nor will acquire, a financial interest in any other entity involved in the approval process of the product.



Analyses

Summary of Test Results

The following table summarizes the various 185MD 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	Product Certification	Size (W x H)	Performance
185MD Single Hung	2184.03-106-11 (Revision 2, 05/08/20)	CPD 18821	53" x 62"	+55/-63 psf
185MD Single Hung	2184.01-106-11 (Revision 2, 05/08/20)	CPD 18839	53" x 76"	+55/-55 psf
185MD Single Hung	2184.02-106-11 (Revision 2, 05/08/20)	CPD 18909	36" x 76"	+60/-70 psf

Testing documented in Table 1 was conducted by Molimo, LLC in York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST11282).

As-Tested Installation Analysis

For air/water/structural testing, the test specimens were secured to a pine buck as summarized in Table 2. The as-tested installation methods are evaluated on page 6 to page 9 and the established design capacities are presented in Table 2.

Table 2 As-tested Anchorage Design Capacities

Test	Connection	Capacity
185MD Single Hung Window TAS 202	<u>Finless Install</u> #8 x 2" screws 3" from each corner and 10" on center through the frame into wood buck at the head and jambs.	118 lb
	<u>Flange Install</u> #8 x 2" screws 3" from each corner and 10" on center through the frame into wood buck at the head and jambs.	118 lb
	<u>Fin Install</u> #8 x 1-1/2" screws 3" from each corner and 9-1/2" on center through the fin into wood buck at the head, sill and jambs.	44 lb

The capacities presented in Table 2 will be used to prove acceptable alternate anchors and substrates for the windows.



Alternate Anchorages

Calculations on page 10 through page 12 determine the design capacity of alternate through-frame installation anchorages for the windows. The alternate anchorage capacities are summarized in Table 3.

Table 3 Alternate Anchorage Capacities for Through-Frame Installation (for Finless and Flange Frames)

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#10-16 TEKS Screw	153 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Limited by bearing capacity. 4. Install at as-tested spacing
Concrete	3/16" Tapcon	152 lb	1. Minimum $f'_c = 3,000$ psi. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Limited by bearing capacity. 5. Maximum 1x buck strip. 6. Install at as-tested spacing
CMU	3/16" Tapcon	135 lb	1. Minimum ASTM C90 CMU. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Limited by shear capacity. 5. Maximum 1x buck strip. 6. Install at as-tested spacing

Note: Maximum available length of 3/16" Tapcon anchor is 3-1/4". Use 1/4" x 4" Tapcon anchors if 1-1/2" minimum embedment not achieved with 3-1/4" anchor.

Calculations on page 13 determine the design capacity of alternate fin installation anchorages for the windows. The alternate anchorage capacities are summarized in Table 4.

Table 4 Alternate Anchorage Capacities for Fin Installations

Substrate	Anchor	Capacity	Comments
S-P-F	#10 x 1-1/2" Screw	64 lb	1. 1-1/4" minimum penetration 2. Limited by pull-over capacity. 3. Install at as-tested spacing
18 Gauge Steel Stud	#10-16 TEKS Screw	64 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Limited by pull-over capacity. 4. Install at as-tested spacing.



Anchorage Requirements

Because all alternate through-frame anchorages evaluated by this report have higher design capacities than the tested anchorages, the alternate-through frame anchorages proposed by this report may be used for the windows at the as-tested spacing.

Because all alternate fin anchorages evaluated by this report have higher design capacities than the tested anchorages, the alternate fin anchorages proposed by this report may be used for the windows at the as-tested spacing.

Calculations presented on page 14 to page 15 prove the window anchorages' design values are not exceeded by the specified maximum design pressure provided a #10 x 1-1/2" screw is used for fin installations to wood.

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Attachments

Appendix A – Revision Log (1 page)



As-Tested Installation – Fin to Wood

#8 x 1-1/2" Pan Head Screw

0.040" thick Aluminum Fin (6063-T5)

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

Allowable Tension of #8 x 1-1/2" Screw

$$W = 1.6(1.250")(82 \text{ lb/in}) \quad (\text{NDS, Table 12.2B})$$
$$W = 164 \text{ lb}$$

Pull-Over of #8 x 1-1/2" Screw

$$P_{\text{nov}} = C_{\text{pov}} t_1 F_{\text{tu1}} (D_{\text{ws}} - D_{\text{h}}) / \Omega$$
$$P_{\text{nov}} = 1.0(0.040")(22,000 \text{ psi})(0.314" - 0.164") / 3.0$$
$$P_{\text{nov}} = 44 \text{ lb}$$

Capacity of Connection is 44 lb



As-Tested – Through-Frame to Wood (Finless and Flange Frames)

#8 x 2" Flat Head Screw through-frame to wood

0.055" thick Aluminum Frame (6063-T5)

1/4" Maximum Shim Space

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

Allowable Shear of #8 x 2" Screw

$Z' = 118 \text{ lb}$ (See page 8 to page 9)

Bending of #8 x 2" Screw

$L = 1/4"$ (maximum shim space)

$S = \pi d^3/32 = \pi(0.131)^3/32 = 0.000221 \text{ in}^3$

$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(90,000 \text{ psi}) = 70,200 \text{ psi}$ (1.3 for weak axis bending)

$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)

$V = 2SF_b/L = (2)(0.000221 \text{ in}^3)(70,200 \text{ psi})/0.25" = 123 \text{ lb}$

Capacity of Connection is 118 lb



As-Tested – Through-Frame to Wood (Finless and Flange Frames) (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 $\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_e	=	3,350 psi
Thickness	=	1.500 in.

Side Member

Material	=	6063 T5 Aluminum
G	=	N/A
θ	=	90 $\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_{es}	=	27,500 psi
Thickness	=	0.055 in.

Calculations

Lateral Bearing Factors

D	=	0.131 in.
ℓ_m	=	1.500 in.
K_θ	=	1.25
K_D	=	2.20
R_e	=	0.122
R_t	=	27.27
k_1	=	1.3314
k_2	=	0.5536
k_3	=	14.30

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



As-Tested – Through-Frame to Wood (Finless and Flange Frames) (Continued)

Lateral Design Values, Z

Mode I _m	=	299	lbf	
Mode I _s	=	90	lbf	
Mode II	=	120	lbf	
Mode III _m	=	133	lbf	
Mode III _s	=	74	lbf	<===== Minimum Value
Mode IV	=	104	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'	=	118	lbf



Alternate Installation – Trough-Frame to Steel Stud (Finless and Flange Frames)

#10-16 TEKS Screw

0.055" thick Aluminum Frame (6063-T5)

1/4" Maximum Shim Space

Minimum 18 gauge 33 KSI Steel Stud

Allowable Shear of #10-16 TEKS Screw

$$P_{ss}/\Omega = 573 \text{ lb (ESR-1976)}$$

Bearing of #10-16 TEKS Screw on Frame

$$\begin{aligned} V_a &= 2DtF_u/n_u \\ V_a &= 2(0.190")(0.055")(22,000 \text{ psi})/3.0 \\ V_a &= 153 \text{ lb.} \end{aligned}$$

Bearing of #10-16 TEKS Screw on Steel Stud

$$\begin{aligned} V_a &= 2.7DtF_{tu}/\Omega \\ V_a &= 2.7(0.190")(0.0428")(45,000 \text{ psi})/3.0 \\ V_a &= 329 \text{ lb.} \end{aligned}$$

Tilting of #10-16 TEKS Screw in Steel Stud

$$\begin{aligned} V_a &= 4.2(t_2^3 D)^{1/2} F_{tu2}/n_s \\ V_a &= 4.2(0.0428"{}^3 \times 0.190")^{1/2} (45,000 \text{ psi})/3.0 \\ V_a &= 243 \text{ lb.} \end{aligned}$$

Bending of #10-16 TEKS Screw

$$\begin{aligned} L &= 1/4" \text{ (Maximum Shim Space)} \\ S &= \pi d^3/32 = \pi(0.140)^3/32 = 0.000269 \text{ in}^3 \\ F_b &= (1.3)(0.6F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 for weak axis bending)} \\ F_b &= M/S = (VL/2)/S \text{ (L/2 for guided bending)} \\ V &= 2SF_b/L = (2)(0.000269 \text{ in}^3)(71,760 \text{ psi})/0.25" = 155 \text{ lb.} \end{aligned}$$

Capacity of Connection is 153 lb.



Alternate Installation – Through-Frame to Concrete (Finless and Flange Frames)

3/16" Tapcon Anchor

1-1/2" Minimum Embedment; 2" Minimum Edge Distance

1/4" Maximum Shim Space

0.055" thick Aluminum Frame (6063-T5)

Minimum $f'_c = 3,000$ psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

$$V_a = 186 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$\begin{aligned} V_a &= 2DtF_u/n_u \\ V_a &= 2(0.188")(0.055")(22,000 \text{ psi})/3.0 \\ V_a &= 152 \text{ lb.} \end{aligned}$$

Bending of 3/16" Tapcon

$$\begin{aligned} L &= 1/4" \text{ (Maximum Shim Space)} \\ S &= \pi d^3/32 = \pi(0.145")^3/32 = 0.000299 \text{ in}^3 \\ F_b &= (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)} \\ F_b &= M/S = (VL/2)/S \text{ (L/2 for guided bending)} \\ V &= 2SF_b/L = (2)(0.000299 \text{ in}^3)(106,860 \text{ psi})/0.25" = 256 \text{ lb.} \end{aligned}$$

Capacity of Connection is 152 lb

Qualifies 1/4" Tapcon if longer length anchor is required to achieve minimum embedment.



Alternate Installation – Through-Frame to CMU (Finless and Flange Frames)

3/16" Tapcon Anchor

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

1/4" Maximum Shim Space

0.055" thick Aluminum Frame (6063-T5)

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

$$V_a = 135 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$V_a = 2DtF_u/n_u$$

$$V_a = 2(0.188")(0.055")(22,000 \text{ psi})/3.0$$

$$V_a = 152 \text{ lb.}$$

Bending of 3/16" Tapcon

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.145")^3/32 = 0.000299 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000299 \text{ in}^3)(106,860 \text{ psi})/0.25" = 256 \text{ lb.}$$

Capacity of Connection is 135 lb



Alternate Installation – Fin to Wood

#10 x 1-1/2" Pan Head Screw

0.050" thick Aluminum Fin (6063-T5) (Head dia. greater than 0.040" recess)

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

Allowable Tension of #10 x 1-1/2" Screw

$$W = 1.6(1.250)(95 \text{ lb/in}) \quad (\text{NDS, Table 12.2B})$$
$$W = 190 \text{ lb}$$

Pull-Over of #10 x 1-1/2" Wood Screw

$$P_{\text{nov}} = C_{\text{pov}} t_1 F_{\text{tu1}} (D_{\text{ws}} - D_{\text{h}}) / \Omega$$
$$P_{\text{nov}} = 1.0(0.050)(22,000 \text{ psi})(0.365" - 0.190") / 3.0$$
$$P_{\text{nov}} = 64 \text{ lb}$$

Capacity of Connection is 64 lb

Alternate Installation – Fin to Steel Stud

#10-16 TEKS Screw

0.050" thick Aluminum Fin (6063-T5) (Head dia. greater than 0.040" recess)

Minimum 18 gauge 33 KSI Steel Stud

Allowable Tension of #10-16 TEKS Screw

$$P_{\text{ts}} / \Omega = 885 \text{ lb} \quad (\text{ESR-1976})$$

Pull-Over of #10-16 TEKS Screw

$$P_{\text{nov}} = C_{\text{pov}} t_1 F_{\text{tu1}} (D_{\text{ws}} - D_{\text{h}}) / \Omega$$
$$P_{\text{nov}} = 1.0(0.050)(22,000 \text{ psi})(0.365" - 0.190") / 3.0$$
$$P_{\text{nov}} = 64 \text{ lb}$$

Pull-Out of #10-16 TEKS Screw

$$P_{\text{not}} = 0.85 t_{\text{cd}} F_{\text{u2}} / \Omega$$
$$P_{\text{not}} = 0.85(0.0428)(0.190)(45,000 \text{ psi}) / 3.0$$
$$P_{\text{not}} = 104 \text{ lb}$$

Capacity of Connection is 64 lb



Verify Design Capacity of Anchors

53 x 62 (+55/-63 psf)

Window Overall Size: 53" x 62"
Window Overall Area: $(53")(62")/144 = 22.8 \text{ ft}^2$
Window Overall Wind Load: $(63 \text{ psf})(22.8 \text{ ft}^2) = 1,436 \text{ lb}$

Flange and Finless

Installed Anchor Spacing: 10" head; 10" each jamb
Installed Anchors: 6 head + 2(7) jambs = 20 installed anchors
Minimum Anchor Capacity: 118 lb/anchor
Total Anchor Capacity: $(20 \text{ anchors})(118 \text{ lb/anchor}) = 2,360 \text{ lb} > 1,436 \text{ lb}$ **OK**

Fin

Installed Anchor Spacing: 9" head; 9" sill; 9" each jamb
Installed Anchors: 6 head + 6 sill + 2(7) jambs = 26 installed anchors
Minimum Anchor Capacity: 64 lb/anchor (Specify #10 screw for fin install)
Total Anchor Capacity: $(26 \text{ anchors})(64 \text{ lb/anchor}) = 1,664 \text{ lb} > 1,436 \text{ lb}$ **OK**

Alternate through frame anchorages (finless and flange frame) have capacities more than as-tested and are therefore qualified at the as-tested spacing.

53 x 76 (+55/-55 psf)

Window Overall Size: 53" x 76"
Window Overall Area: $(53")(76")/144 = 28.0 \text{ ft}^2$
Window Overall Wind Load: $(55 \text{ psf})(28.0 \text{ ft}^2) = 1,540 \text{ lb}$

Flange and Finless

Installed Anchor Spacing: 10" head; 10" each jamb
Installed Anchors: 6 head + 2(8) jambs = 22 installed anchors
Minimum Anchor Capacity: 118 lb/anchor
Total Anchor Capacity: $(22 \text{ anchors})(118 \text{ lb/anchor}) = 2,596 \text{ lb} > 1,540 \text{ lb}$ **OK**

Fin

Installed Anchor Spacing: 9" head; 9" sill; 9" each jamb
Installed Anchors: 6 head + 6 sill + 2(8) jambs = 28 installed anchors
Minimum Anchor Capacity: 64 lb/anchor (Specify #10 screw for fin install)
Total Anchor Capacity: $(28 \text{ anchors})(64 \text{ lb/anchor}) = 1,792 \text{ lb} > 1,540 \text{ lb}$ **OK**

Alternate through frame anchorages (finless and flange frame) have capacities more than as-tested and are therefore qualified at the as-tested spacing.



36 x 76 (+60/-70 psf)

Window Overall Size: 36" x 76"
Window Overall Area: $(36")(76")/144 = 19.0 \text{ ft}^2$
Window Overall Wind Load: $(70 \text{ psf})(19.0 \text{ ft}^2) = 1,330 \text{ lb}$

Flange and Finless

Installed Anchor Spacing: 10" head; 10" each jamb
Installed Anchors: 4 head + 2(8) jambs = 20 installed anchors
Minimum Anchor Capacity: 118 lb/anchor
Total Anchor Capacity: $(20 \text{ anchors})(118 \text{ lb/anchor}) = 2,360 \text{ lb} > 1,330 \text{ lb}$ **OK**

Fin

Installed Anchor Spacing: 9" head; 9" sill; 9" each jamb
Installed Anchors: 4 head + 4 sill + 2(8) jambs = 24 installed anchors
Minimum Anchor Capacity: 64 lb/anchor (Specify #10 screw for fin install)
Total Anchor Capacity: $(24 \text{ anchors})(64 \text{ lb/anchor}) = 1,536 \text{ lb} > 1,330 \text{ lb}$ **OK**

Alternate through frame anchorages (finless and flange frame) have capacities more than as-tested and are therefore qualified at the as-tested spacing.



Appendix A

Revision Log

<u>Identification</u>	<u>Date</u>	<u>Page & Revision</u>
Original Issue	04/09/20	Not Applicable
Revision 1	04/23/20	1-2, 14-15 Added 53x76 and 36x76 windows
Revision 2	05/12/20	3, 14-15 Revised based on revised test reports with corrected anchoring conditions for flange and finless
Revision 3	09/15/20	Revised for 2020 FBC