



WAUSAU

WINDOW AND WALL
SYSTEMS



ACOUSTIC PERFORMANCE OF WINDOWS AND CURTAINWALL



Some sounds are welcome, other sounds are not - A **well-designed building envelope** provides necessary attenuation, while maintaining views and a connection with the outdoors - Even in a crowded city, near a major airport's flight path, or adjacent to a busy highway or rail line.

Wausau acoustic window and curtainwall systems can promote wellness, help occupants maintain focus on the task at hand, or simply allow a quiet night's sleep - Without compromising functionality or energy efficiency.

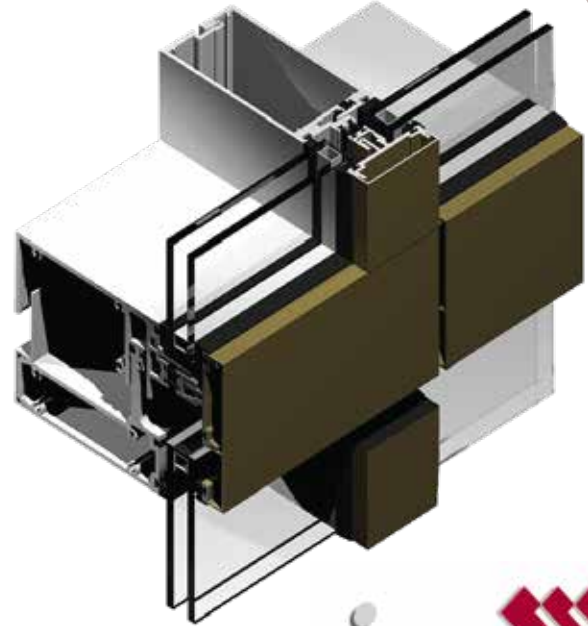
More than **100 archival acoustic test reports** on various frame-glass combinations are available from Wausau to inform product selection decisions.

www.wausauwindow.com 1.877.678.2983

Whether the design goal is basic code compliance or a **higher level of comfort** for occupants, Wausau's window and curtainwall systems help ensure peace and quiet.



2250i INvent Casement



7250i-HR INvision



INvent (pictured above)
 INvent -XLT
 INvent Retro
 INvent Simulated Double-Hung
 INvent.PLUS™
 INvent -HP Hurricane
 INvent -BHM Blast Hazard

INvision -HR (pictured above)
 INvision-HRX
 INvision -UW
 INvision i-UW
 INvision 950-SG Can System
 INvision -BHM Blast Hazard
 INvision -RX



CODES AND REGULATIONS

New York City closely regulates zoning changes on sites that are subject to unacceptable noise levels. Extensive study has shown Outdoor-Indoor Transmission Class (OITC) to be appropriate in defining requirements for windows and curtainwall. Design teams are cautioned that DEP may require project-specific testing for proof of compliance. An appropriate level of conservatism should be applied to product selection to account for inherent test-to-test repeatability.

Noise Attenuation Requirements - Residential Dwellings and Community Facilities New York City Department of Environmental Protection (DEP) June 2012					
Vehicular Noise Level	70 < L ₁₀ ≤ 73	73 < L ₁₀ ≤ 76	76 < L ₁₀ ≤ 78	78 < L ₁₀ ≤ 80	80 < L ₁₀
Required Attenuation	(I) 28 dBA	(II) 31 dBA	(III) 33 dBA	(IV) 35 dBA	36 + (L ₁₀ - 80) dBA
Required attenuation applies to composite window-wall assemblies based on OITC values of individual components. Vision areas usually represent the controlling value. Commercial office spaces and meeting rooms require attenuation 5 dBA less in each category. Alternative ventilation may be required, since attenuation necessitates operating windows in the closed position. L ₁₀ represents the sound pressure level that is exceeded for 10% of the measurement period.					

California Title 24 requires buildings that provide habitable space be designed to ensure that interior noise levels do not exceed 45 dBA, if sited where day-night average sound level (L_{dn}) is greater than 60 dB. For these applications, window and curtainwall performance must be considered in expert acoustical analysis during permitting.

Befitting the therapeutic environment, LEED® awards up to two points for Healthcare-v4.1 EQc9: "Acoustic Performance" credits after rigorous determination of exterior noise levels, acoustic design of the total building envelope, and measurement of "as-built" sound pressure levels. In a learning setting, under the Schools-NC-v4 EQp3: "Minimum Acoustical Performance" prerequisite, windows must have an STC rating of 35 or higher unless lower ratings can be justified by noise levels.

Other acoustical requirements may apply to buildings of various occupancies under the jurisdiction of the International Green Building Code, the U.S. Department of Housing and Urban Development, or the U.S. Federal Aviation Administration, among other authorities.

ARCHIVAL ACOUSTIC TEST RESULTS

IMPORTANT NOTES:

Do not apply archival acoustic test results on small IGUs to projects utilizing large IGUs, as differences in glass size and aspect ratio may appreciably affect applicability.

Due to limitations in size and available low-e coatings, as well as the potential for visual distortion, Wausau includes no "double laminated" acoustic glass in these test results.

Any interpretation of acoustic test reports should be done in light of the inherent reproducibility of the ASTM E 90 test method employed. For OITC test results, low frequencies are of particular interest. Section 14 "Precision and Bias" of ASTM E 90 states in part, "14.1 Precision... From round robin testing on copies of the reference specimen described in Specification E 1289, it has been determined that the reproducibility standard deviation is 2dB or less at all frequencies from 125 to 4000Hz. 14.2 Bias - There is no bias in this test method since the true value is defined by the test method."

Using reproducibility of 2 dBA across the tested frequency spectrum yields an expected range of ±2 dBA in calculated OITC. (Sample calculations are available upon request)

Due to test-to-test variation, Wausau typically bases proposals on the acceptance of existing test reports as proof of compliance to acoustical performance specifications for previously tested frame/glass combinations. Wausau can make no acoustical performance guarantees relative to results of project-specific testing if required. Neither can Wausau make guarantees regarding acoustic performance of untested frame/glass combinations.

Refer to FAQs for further clarification.

www.wausauwindow.com
Download guide specifications, details and performance information

Representative Acoustic Test Results - Windows								
Small Sealed Insulating Glass Units (IGUs)								
Less than 15 sqft largest lite size - Tested per ASTM E90								
Test Unit Description			Largest Lite in Test Specimen	IGU Makeup			Overall Performance	
Glass Type	Configuration and Series	No. of Lites	Width x Height Approx. DLO (in.)	Exterior (in.)	Spacer(s) (in.)	Interior PVB Dim. (in.)	STC	OITC
Standard 1" Double IGUs 1/2" Spacers	Fixed over Project-Out Awning INvent 2250i	2	44 x 39	1/4	1/2	1/4	34	28
	Fixed Beside PO Casement 2250	4	25 x 49	1/4	1/2	1/4	35	28
	Double-Hung 9250 Self-Balancing Historical	2	42 x 25	1/4	1/2	1/4	32	28
	Double-Hung TDL 9250 Self-Balancing Historical	24	10 x 12	1/4	1/2	1/4	29	28
	Double-Hung 3150-DHT	2	41 x 32	1/4	1/2	1/4	33	28
	Single Sliding 410i-HS	2	26 x 41	1/4	1/2	1/4	33	28
	Double Sliding 4100-HS	2	26 x 40	1/4	1/2	1/4	32	28
Fixed over Double Sliding 4100-HS	4	26 x 53	1/4	1/2	1/4	34	28	
Unbalanced Double IGUs and Non-Standard Spacers	Fixed Beside PI Casement INvent 2250i	2	3 x 43	1/4	1/2	5/16	39	34
	Fixed Beside PO Casement INvent 2250i	2	31 x 43	1/4	1/2	5/16	39	33
	Casement over Fixed INvent 4250i-OS Offset	2	23 x 68	1/4	1/2	5/16	38	32
	Fixed Beside PI Casement INvent 4250i	2	31 x 43	1/4	1	5/16	40	34
	PO Casement INvent 8300i Historical	1	19 x 54	5/16	7/16	1/4	36	32
	Fixed Beside PO Casement INvent 8300i Historical	2	22 x 56	1/4	7/16	5/16	37	32
Fixed Beside PI Casement INvent 8300i Historical	2	22 x 56	1/4	7/16	5/16	38	32	
Laminated Double IGUs and Non-Standard Spacers	Fixed Beside PI Casement INvent 2250i-XLT	2	19 x 56	1/4	1/2	9/16 Lam 0.060 PVB	41	34
	Fixed Beside PI Casement INvent 2250i-XLT	2	19 x 56	3/8	1/2	9/16 Lam 0.060 PVB	40	33
	Fixed Beside PI Casement INvent 2250i	2	31 x 43	5/16	5/8	7/16 Lam 0.060 PVB	41	35
	Fixed Beside PI Casement INvent 4250i	2	31 x 44	5/16	1	7/16 Lam 0.060 PVB	42	34
Triple IGUs	Double-Hung 9250 Self-Balancing Historical	2	42 x 25	1/4	7/16	5/16 Lam 0.060 PVB	34	30
	Fixed Beside PI Casement INvent 2250i	2	31 x 43	1/4 1/4	7/16 3/8	5/16	39	31
Triple IGUs	Fixed Beside PI Casement INvent 2250i-XLT Retro	2	31 x 43	1/4 1/4	7/16 3/8	5/16	40	33

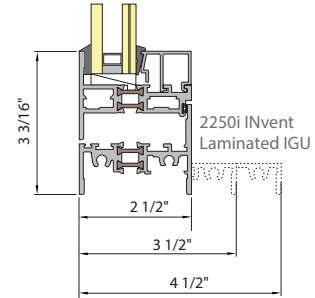
Test results will vary

Representative Acoustic Test Results – Window Wall and Balcony Doors								
Large Sealed Insulating Glass Units (IGUs)								
Greater than 15 sqft largest lite size - Tested per ASTM E90								
Test Unit Description			Largest Lite in Test Specimen	IGU Makeup			Overall Performance	
Glass Type	Configuration and Series	No. of Lites	Width x Height Approx. DLO (in.)	Exterior (in.)	Spacer(s) (in.)	Interior PVB Dim. (in.)	STC	OITC
Standard 1" Double IGUs 1/2" Spacers	PI Casement Visuline 4250i-V	1	41 x 66	1/4	1/2	1/4	33	28
	PO Terrace Door TD-4250i	2	36 x 74	1/4	1/2	1/4	34	30
	Sliding Glass Door CrossTrak 5250i-XLT Inside Slide	2	34 x 70	1/4	1/2	1/4	33	28
	Sliding Glass Door CrossTrak 5250i-XLT Outside Slide	2	34 x 70	1/4	1/2	1/4	33	28
Unbalanced Double IGUs and Non-Standard Spacers	Fixed Window Wall INvent 2250i	1	44 x 56	1/4	7/16	5/16	36	30
	Fixed Beside PI Casement INvent 4250i	2	35 x 75	5/16	1	1/4	38	30
	PI Casement Visuline 4250i-V	1	41 x 66	1/4	7/16	5/16	36	32
	PI Casement Visuline 4250i-V	1	41 x 66	1/4	1/2	5/16	37	32
	Fixed and PI Casement INvent 4250i	6	53 x 68	1/4	1/2	3/8	37	32
	Fixed and PI Casement INvent 4250i	6	53 x 68	5/16	1/2	3/8	37	32
	PO Terrace Door TD-4250i	1	28 x 73	1/4	1/2	5/16	38	34
Laminated Double IGUs and Non-Standard Spacers	Fixed Beside PI Casement INvent 4250i	2	35 x 75	5/16	1	7/16 Lam 0.060 PVB	42	33
	Fixed Beside PI ADA Casement INvent 4250i	2	35 x 75	5/16	1	7/16 Lam 0.060 PVB	42	34
	PI Casement Visuline 4250i-V	1	41 x 66	1/4	1/2	5/16 Lam 0.060 PVB	38	32
	PI Casement over Fixed INvent 4250i-XLT VX	2	37 x 63	1/4	1/2	7/16 Lam 0.030 PVB	38	33
	PI Casement over Fixed INvent 4250i-XLT VX	2	37 x 63	5/16	1/2	9/16 Lam 0.060 PVB	41	36
	Fixed and PI Casement INvent 4250i	6	53 x 68	1/4	1/2	7/16 Lam 0.060 PVB	39	32
	Fixed and PI Casement INvent 4250i	6	53 x 68	5/16	1/2	7/16 Lam 0.060 PVB	39	33
	Fixed and PI Casement INvent 4250i	6	53 x 68	1/4	1/2	9/16 Lam 0.060 PVB	39	33
	Fixed and PI Casement INvent 4250i	6	53 x 68	5/16	1/2	9/16 Lam 0.060 PVB	39	34
Sliding Glass Door CrossTrak 5250i-XLT	2	34 x 70	5/16	5/8	7/16 Lam 0.060 PVB	39	33	

Representative Acoustic Test Results –Curtainwall
 Large Sealed Insulating Glass Units (IGUs)
 Greater than 15 sqft largest lite size - Tested per ASTM E90

Test Unit Description			Largest Lite in Test Specimen	IGU Makeup			Overall Performance	
Glass Type	Configuration and Series	No. of Lites	Width x Height Approx. DLO (in.)	Exterior (in.)	Spacer(s) (in.)	Interior PVB Dim. (in.)	STC	OITC
Standard 1" Double IGUs 1/2" Spacers	Fixed Curtainwall 6250 SuperWall Captured	2	36 x 74	1/4	1/2	1/4	31	26
	Fixed Curtainwall INvision 7250i-UW Captured	2	36 x 74	1/4	1/2	1/4	32	26
	Fixed Curtainwall INvision 6250i-HRX Captured	2	36 x 74	1/4	1/2	1/4	32	26
	Fixed Curtainwall INvision 6250i-HRX SSG	2	36 x 74	1/4	1/2	1/4	32	26
	Fixed Curtainwall 9250 SuperWall Deep Covers	2	36 x 74	1/4	1/2	1/4	31	25
	Fixed Curtainwall INvision 5500i-SG	2	36 x 73	1/4	1/2	1/4	33	28
	PO Awning 4250-Z Curtainwall Insert Vent	1	32 x 70	1/4	1/2	1/4	34	29
Unbalanced Double IGUs and Non-Std Spacers	Fixed Curtainwall INvision 7250i-HR Captured	2	59 x 112	3/8	1/2	1/4	32	29
	Fixed Curtainwall INvision 7250i-UW Captured	6	57 x 66	1/4	1/2	5/16	34	30
	Fixed Curtainwall INvision 5500i-SG	2	36 x 73	1/4	1/2	5/16	36	31
Laminated Double IGUs and Non-Std Spacers	Fixed Curtainwall 9250 SuperWall Deep Covers	2	36 x 74	1/4	7/16	7/16 Lam 0.060 PVB	37	31
	Fixed Curtainwall 6250 SuperWall Captured	2	36 x 74	1/4	3/4	7/16 Lam 0.060 PVB	35	32
	Fixed Curtainwall INvision 8250i-HRX Captured	2	36 x 74	1/4	3/4	9/16 Lam 0.060 PVB	39	33
Triple IGUs	Fixed Curtainwall 7250 HP Wall	2	36 x 74	1/4 1/4	3/4 1/2	1/4	35	26
	Fixed Curtainwall 7250 HP Wall	2	36 x 74	1/4 1/4	5/8 5/8	1/4	35	26

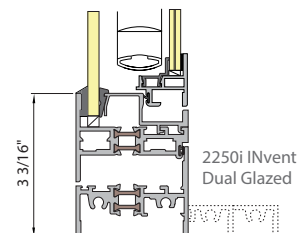
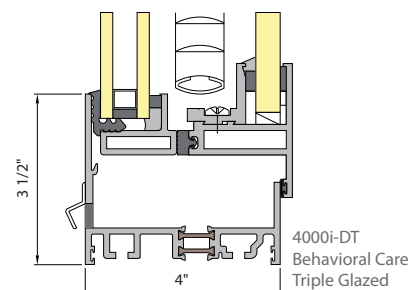
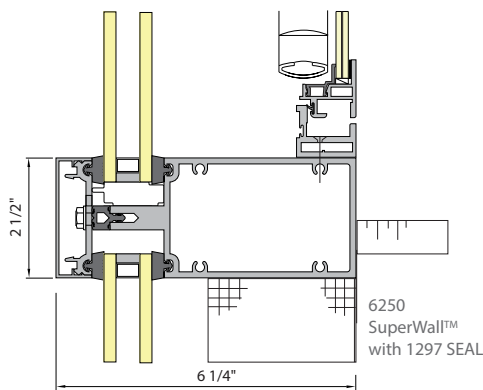
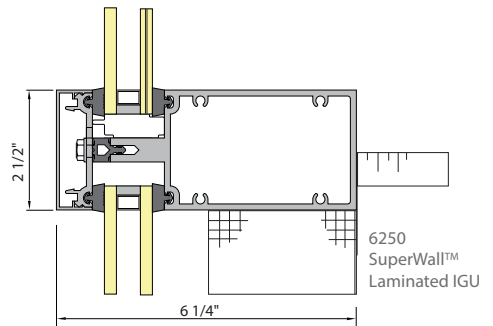
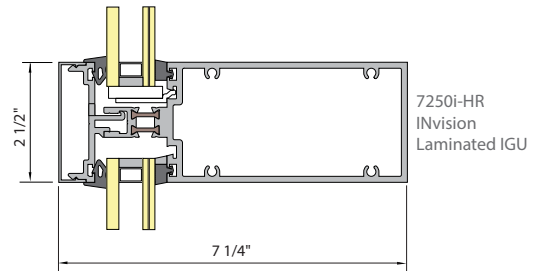
PRODUCT DETAILS



Test results will vary

Representative Acoustic Test Results with Interior Access Doors
 Dual and Triple Glazed
 Unsealed Air Space - Tested per ASTM E90

Test Unit Description			Largest Lite in Test Specimen	Glass Makeup			Overall Performance	
Glass Type	Configuration and Series	No. of Lites	Width x Height Approx. DLO (in.)	Exterior PVB Dim. (in.)	Unsealed Air Space (in.)	Interior PVB Dim. (in.)	STC	OITC
Dual Glazed	Fixed Beside PI Casement INvent 2250i	2	20 x 56	1/4	1-1/2	1/4	42	30
	Fixed Over PO Awning 2250	2	42 x 37	1/4 Lam 0.030 PVB	1-1/2	1/4	41	32
	Fixed Over PO Awning 2250	2	42 x 37	3/8 Lam 0.030 PVB	1-3/8	1/4	43	35
	Double-Hung 3150-DHT	2	41 x 32	1/4	15/16	3/16	37	31
	Double-Hung 3150-DHT	2	41 x 32	1/4 Lam 0.030 PVB	7/8	3/16	38	32
	Double Sliding 4100-HS	2	26 x 40	1/4	7/8	3/16	34	31
	Double Sliding 4100-HS	2	26 x 40	1/4	7/8	1/4 Lam 0.030 PVB	35	31
Triple Glazed Std IGU tested 1/4-1/2-1/4 Interior Accessory Windows (IAWs) as noted	Fixed Beside PI Casement INvent 2250i	2	20 x 56	Std IGU	1-1/8	1/4	43	31
	Fixed Beside PI Casement INvent 2250i-XLT	2	29 x 42	Lam IGU 0.060 PVB	1-1/8	1/4	45	34
	Fixed Over PO Awning 2250	2	44 x 38	Std IGU	1-3/8	5/16 Lam 0.060 PVB	41	32
	Fixed Beside PI Casement 4000i Hospital	2	23 x 40	Std IGU	2-1/2	1/4	47	33
	Fixed Beside PI Casement 4000i-DT Behavioral Care	2	23 x 40	Std IGU	2-1/4	1/2 Lexan	49	37
	Fixed Beside PI Casement 4000i-DT Behavioral Care	2	23 x 40	Std IGU	2-1/4	7/16 Lam 0.060 PVB	48	37
	Fixed Curtainwall with IAW 6250 SuperWall with SEAL	2	36 x 74	Std IGU	2-3/8	1/4	45	36
	Fixed Curtainwall with IAW 6250 SuperWall with SEAL	2	36 x 74	Std IGU	2-1/8	7/16 Lam 0.060 PVB	46	36
	Fixed Curtainwall with IAW 6250 SuperWall with SEAL	2	36 x 74	Std IGU	5-1/16	1/4	47	40
Fixed Curtainwall with IAW 6250 SuperWall with SEAL	2	36 x 74	Std IGU	6-1/2	7/16 Lam 0.060 PVB	53	43	



ACOUSTIC PERFORMANCE OF WINDOWS AND CURTAINWALL FREQUENTLY ASKED QUESTIONS (FAQS)

1. How are sounds and noise measured?

The **decibel (dB)** is a logarithmic measure of sound pressure level. Because decibels are logarithmic, they cannot be added, subtracted or multiplied with ordinary arithmetic. Small differences of less than ± 3 dB in sound pressure level or transmission loss are barely perceptible.

Pitch or frequency is expressed in **Hertz (Hz)** or cycles per second. Low-frequency noises carry much more energy than high-frequency sounds, and therefore, are more difficult to absorb. As a relatively lightweight material, glass performs much better at higher frequencies.

Transmission Loss (TL) is a measure of a material's or assembly's sound attenuation at a specific frequency. For STC or OITC testing, a Transmission Loss Curve is generated over the frequency range or spectrum that can be perceived by the human ear.

2. How are windows and curtainwall rated for acoustic performance?

Sound Transmission Class (STC) is a single-number rating system for acoustical performance, developed primarily for the typical **interior** noise spectrum. STC is the most-commonly specified measure of acoustical performance - higher is better.

Outdoor-Indoor Transmission Class (OITC) is a single-number rating system for acoustical performance, developed primarily for the typical **exterior** noise spectrum. TLs are measured at somewhat lower frequencies than in STC testing. The formula to calculate OITC from TL test results is:

$$\text{OITC} = 100.14 - 10 \log \sum_r 10^{((L_r - \text{TL}_r + A_r)/10)} \quad (\text{dBA})$$

Where: L_r = reference source spectrum,
 A_r = A-weighting adjustment, and
 TL_r = specimen TL at each one-third octave frequency band.

For many high-performance glass types, more than 80% of total sound pressure energy is transmitted at one-third octave band frequencies of 200 Hz or below.

Acoustical consultants determine required performance levels by starting from exterior sound intensity data. This is a complex process, requiring consideration of the noise source (rail vs. traffic vs. aircraft), time-weighted exposure averages, and attenuation due to distance. Interior occupancy plays a major part in determining the required OITC rating or octave band transmission losses. Other laboratory test-based rating systems include Weighted Sound Reduction Index (Rw) and Exterior Wall Noise Rating (EWNRR).

Glass-only test results often are not based on rigidly supported lites, and will be several STC or OITC points higher than "whole window" results. There is no dependable way to adjust these glass numbers to reliably predict whole window performance. Unlike thermal performance, there are no commercially available computer modeling tools that are capable of accurately predicting acoustical performance. Test-to-test variation can be considerable.

3. How can the acoustic performance of windows be improved?

Improvement in acoustical performance is achieved by adding glazing mass, increasing air space and improving damping through the addition of a laminated interlayer. Of course, maintaining an air-tight assembly to reduce "flanking" noise is critical, especially at high frequency. Thin, heat-treated glass makeups with more than one lite laminated may introduce unexpected visual distortion, coating limitations or other design issues. Thin laminated glass is also subject to size limitations in fabrication.

Adding another layer of glass at the expense of air space is typically ineffective - A 1-1/2" triple insulating glass unit (IGU) will perform similarly to a 1-1/2" double IGU. Incremental improvement can sometimes be attained by "unbalancing" the IGU, for example, using a 1/4" inner lite in combination with a 5/16" outer lite.

4. What design differences do not usually affect acoustic performance?

The location of laminated lites (interior or exterior) within the assembly makes no significant difference in acoustical performance, nor does heat strengthening or tempering, however effects of differences in glass lite size and aspect ratio can be very significant, as indicated in the representative acoustic performance tables presented herein.

The addition of sound-absorbing foam between the lites of a dual-glazed system can improve STC 1 to 2 points, but only if high-frequency noise transmission is the controlling factor in STC calculations.

For any given air-tight, rigidly supported, glass-air space combination; frame design and glazing method make little difference in acoustical performance as measured by OITC, nor do integral ventilators. Air and argon in the space of an IGU perform the same as well.

5. Other questions?

Contact Wausau's architectural engineers at info@wausauwindow.com.

From cost-competitive architectural windows to custom-engineered high-performance curtainwall, new construction to historically accurate renovation, sustainable designs to resilient protection – Wausau helps you achieve your design vision and construction goals, on time and within budget with support from our experienced technical team and a warranty of up to 10 years.



UCLA Luskin Conference Center · Hornberger + Worstell · Bohlin Cywinski Jackson · Photo Credit: Matthew Millman



- 📍 7800 International Drive. Wausau, WI 54401
- 📞 1.877.678.2983
- ✉ info.wausauwindow.com
- 🌐 wausauwindow.com

“SuperWall, INvent, INvision, Visuline, CrossTrak and SEAL” are trademarks of Apogee Wausau Group, Inc. All rights reserved. © 2022 Apogee Wausau Group, Inc.

