3M™ VHB™ Structural Glazing Tape

Technical Guide

3M™ VHB™ Structural Glazing Tape TECHNICAL GUIDE

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Introduction

This technical guide is intended to give guidance on the proper fabrication methods used in the assembly of a 3M™ VHB™ Tape structurally glazed curtain wall or commercial window system. Due to the variability of design and performance requirements associated with different applications, this guide should be considered as a reference document only and should not be considered as a comprehensive process guide or quality assurance program for all applications. Therefore, it is recommended that the customer contact a 3M Sales, Marketing or Technical Service Representative when considering the use of 3M™ VHB™ Structural Glazing Tape for a structural glazing application. Fabricators and installers also have a responsibly to follow industry accepted practices in the fabrication, handling/storage and installation of unitized curtain walls or commercial window units.

Technical Service

All 3M™ VHB™ Structural Glazing Tape projects require a thorough application assessment by a 3M Technical Service Representative prior to the initiation of each project. 3M requires the customer to work with a 3M Sales Representative and a Technical Service Representative to initiate a 3M™ VHB™ Tape structural glazing application. Each project must be reviewed and approved by 3M before the 3M™ VHB™ Structural Glazing Tape can be used on a project. Use the appropriate regional telephone number listed on page 31 to initiate the 3M™ VHB™ Structural Glazing Tape process. ***Be sure to ask for 3M™ VHB™ Structural Glazing Tape Sales, Technical or Marketing support.***

Product Portfolio

3M™ VHB™ Structural Glazing Tape G23F and B23F

3M™ VHB™ Structural Glazing Tape is a closed cell, double-sided acrylic foam tape that has the capability to develop very high bond strength and excellent long term holding power when bonded to glass and metal framework. It was developed to replace structural silicone sealants in structurally glazed curtain wall systems and commercial window units.

Construction:

Adhesive: High Performance Acrylic
Adhesive Carrier: Conformable Acrylic Closed Cell Foam
Thickness: 2.3 mm (0.090 in)
Density: 720 kg/m^3 (45 lb/ft^3)
Tape Color: Gray (G23F) or Black (B23F)
Liner: 0.125 mm (0.005 in) Red Polyethylene Film

Performance Properties: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

1. Peel Adhesion: 440 N/100 mm (25 lb/in width) (stainless steel, ASTM D 3330)
2. Normal Tensile: 480 kPa (70 lb/in^2) (aluminum T-block, ASTM D 897)
3. Dynamic Overlap Shear: 450 kPa (65 lb/in^2) (stainless steel, ASTM D 1002)

3M™ VHB™ Structural Glazing Tape 4972 (Brazil)

3M™ VHB™ Structural Glazing Tape 4972 is used exclusively in Brazil and other parts of South America for structural glazing. This product is very similar to the 3M™ VHB™ Structural Glazing Tape G23F with the primary difference being thickness of the acrylic foam tape. This tape has been successfully used for structural glazing applications in South America since 1990 which demonstrates the performance and long term durability of 3M™ VHB™ Structural Glazing Tape for this application.

Construction:

Adhesive: High Performance Acrylic
Adhesive Carrier: Conformable Acrylic Closed Cell Foam
Thickness: 2.0 mm (0.080 in)
Density: 720 kg/m^3 (45 lb/ft^3)
Tape Color: Gray
Liner: Green polyethylene film

Performance Properties: Typical results are comparable to 3M™ VHB™ Structural Glazing Tape G23F. This technical information and data should be considered representative or typical only and should not be used for specification purposes.

Adhesion Promoters –

Glass Adhesion Promoters: 3M™ Silane Glass Treatment AP115 3M™ Silane Primer (Europe)

Silane coupling agents are required when bonding 3M™ VHB™ Structural Glazing Tape to an uncoated glass surface. Glass is known to be a hydrophilic (water loving) surface and this characteristic makes the acrylic adhesive bond susceptible to change under high humidity conditions or when exposed to moisture. Simple surface treatment with a silane coupling agent diluted in a mixture of alcohol and water can help to reduce the "water loving" nature of the glass and enhance the tape bond in high moisture environments. 3M has tested silane coupling agents and has found 3-Glycidoxypropyl trimethoxysilane resin (Dow Corning Z-6040 Silane) to provide the best performance for this application. This silane coupling agent is available premixed and ready to use in various quantities from 3M.

Adhesion Promoters for Glazing Profiles: 3M™ Primer 94

3M™ Primer 94 is a one-part solvent based primer. It can be used to promote adhesion of 3M™ VHB™ Structural Glazing Tape to metal frames especially when the frame has been overcoated with paint. This primer may also be required on glass when a reflective or opacifying coating is present on the interior side of a glass panel. A 3M Technical Service Representative will help you determine if a primer is needed to achieve high bond strength of the tape to a metal frame or reflective coated glass.

3M™ Adhesion Promoter 111

3M™ Adhesion Promoter 111 (AP 111) is an isopropyl alcohol based solution used to promote adhesion of 3M™ VHB™ Structural Glazing Tapes to metal frames especially when the frame has been overcoated with polyvinylidene fluoride (PVDF) based paints. A 3M Technical Service Representative will help you determine if an adhesion promoter is needed to achieve high bond strength of the tape to a metal frame.

3M™ Primer 4297

3M™ Primer 4297 is an adhesion promoter that was developed to improve adhesion on a variety of plastic surfaces. It is very effective on unplasticized polyvinyl chloride (U-PVC) glazing profiles.

Glass Adhesion Promoter		
AP115	Silane Glass Treatment	118 ml (4 oz) spray bottle 3.8 L (1 gallon) bottle
Silane Primer	Silane Glass Treatment	1 L (0.26 gallon) bottle
Glazing Profile Adhesion Promoters		
Primer 94	Solvent based primer	0.66 ml (0.02 oz) single use ampule 237 ml (1/2 pint) can 0.95 L (1 quart) can 3.8 L (1 gallon) can 18.9 L (5 gallon) can 196.8 L (52 gallon) drum
AP111	Alcohol based adhesion promoter	250 ml (8.45 oz) bottle 3.8 L (1 gallon) can
Primer 4297	Solvent based primer	1 L (0.26 gallon) bottle

Abrasion Pads –

Scotch-Brite™ General Purpose Hand Pad 7447

These abrasive pads may be used to lightly abrade the metal frame bonding surface to increase bond strength of the tape to the metal frame. They can be used by hand or attached to a powered palm sander. Scotch-Brite™ abrasives are also available in wheel form allowing for efficient surface preparation of lineal profiles. Testing by a 3M Technical Service Representative will determine if abrasion is required to achieve a high bond strength on a specific metal frame finish.

Cleaning Materials –

A mixture of isopropyl alcohol (IPA) and water is generally recommended as a cleaning solution for glass and glazing profiles. A blend of 50:50 or up to 90:10 IPA and water is most common. These solutions may be available from 3M or purchased separately from a distributor. Alternative cleaning solutions may be utilized depending on project specific requirements. Two alternative cleaning solutions are listed below.

3M™ Adhesive Remover (Citrus Base)

This product can be effectively used to clean greasy or oily metals as well as adhesive residue. It is also effective in removing silicone contamination from glass surfaces. Cleaning with this product should always be followed by cleaning with an isopropyl alcohol and water mixture prior to tape bonding.

3M™ General Purpose Adhesive Cleaner 08984

Specially blended solvent provides easy cleanup of most types of adhesives, greases and oils, overspray, silicone, and waxes.

Introduction and Background

3M™ VHB™ Structural Glazing Tape is a high performance bonding material used to attach glass to structural glazing frames replacing dry-glazed (gasket, mechanical fasteners, pressure plate, etc.) or wet-glazed (structural silicone sealants) systems. 3M™ VHB™ Acrylic Foam Tapes have been demonstrated to be very capable bonding products since 1980, providing an often ideal combination of performance, durability, and ease of use. They have been successfully used in a wide variety of demanding industrial applications in areas such as commercial building construction and transportation markets. More specifically, they have been used in thousands of international applications as the primary bonding component for structural glazing of glass curtain walls and commercial windows since 1990. These real-world applications along with independent, third party test results demonstrate the capability of 3M™ VHB™ Structural Glazing Tape for this application.

Conventional wet-glazing methods of bonding the structural glazing glass panels to a metal frame employ either one-part or two-part structural silicone sealants. In these systems, a double-sided open cell foam tape (spacer tape) is typically used to give temporary holding of the glass and for creating the necessary open space (face clearance) for the structural sealant. The dimension of the spacer tape is determined based on the desired sealant bite and bead thickness. The bond should not be disturbed during the curing of silicone sealant, and it may take days to weeks to achieve handling strength and full cure.

3M™ VHB™ Structural Glazing Tape is an alternative bonding method that can provide the performance needed for the application, yet with significant benefits. 3M™ VHB™ Structural Glazing Tape replaces both spacer tape and structural sealant and there is no curing reaction involved in bond strength development.

Potential benefits include:

FASTER, MORE EFFICIENT PROCESS

- Immediate handling strength – no cure time, faster through-put and delivery
- Simplified process – no mixing or curing of liquid adhesives in customer facility, no tooling of structural sealant – reduced process variables/less risk
- Less than 5% waste – more accurate forecasting of materials and reduced overall costs compared to structural silicone process
- Reduced labor costs – no silicone testing, fewer process steps, no major 2-part equipment maintenance

IMPROVED APPEARANCE

- No color mismatch between structural silicone and spacer tape/gasket, no streaking or voids
- Clean look from interior side of glass; less space between glass and frame
- Consistent thickness and width – improved quality control

RELIABLE QUALITY

- Proven technology – history in construction applications since early 1980s
- In process non-destructive testing – ability to test all taped panels without deglazing
- No curing in customer facility – less variability and risk

European Technical Approval (ETA) and CE Mark

3M™ VHB™ Structural Glazing Tapes G23F and B23F have been granted a European Technical Approval (ETA) through independent testing according to the current European Technical Approval Guideline (ETAG 002) for structural glazing. 3M™ VHB™ Structural Glazing Tape G23F and B23F have also earned the CE mark. This attests that product characteristics fulfill all the prescribed details in the technical specification "European Technical Approval ETAG 09-0024 valid from 20 February 2009 to 20 February 2014."

3M™ VHB™ Structural Glazing Tape Properties and Performance

Structural glazing requires joining systems that meet the highest requirements for adhesive and cohesive strength, weathering resistance and durability. In addition to the performance, the long-term durability of 3M™ VHB™ Structural Glazing Tape is also critical for these applications. The typical physical properties and performance characteristics such as normal tensile strength, dynamic and static shear strength etc. are well known resulting in the establishment of simple, useful, and conservative design guidelines for tape performance that is used in design calculations. These design criteria provide sufficient performance for this application while incorporating safety factors typical of the industry.

Composition

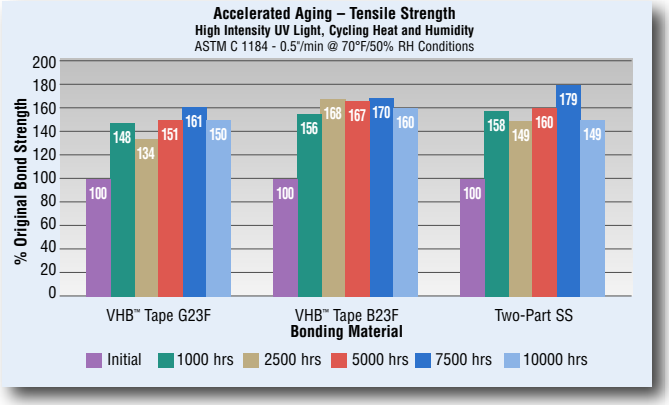
3M has been a technological leader in acrylate pressure sensitive adhesive (PSA) technology since the early 1960s. 3M™ Acrylic Foam Tapes and 3M™ Adhesive Transfer Tapes represent examples of 3M's proprietary state-of-the-art durable chemistry with long-term aging resistant polymer. The chemical bonds that make up the polymer chains consist of carbon-carbon single bonds that are highly resistant to energy in the form of heat or ultraviolet light, as well as chemical attack. In less durable foams or adhesives, such conditions could lead to cleaving of the polymer backbone and thus a weakening of mechanical properties. In the case of acrylic adhesives and foams, however, additional crosslinking is chemically favored over chain scission (cleavage). Rather than undergoing a process of decomposition, the acrylate materials tend to build modulus very slightly over extended exposures. This translates to a stronger, long lasting bond.

Durability

The ability of acrylic adhesives to withstand cold and hot temperatures, UV light exposure, humidity, and other environmental conditions has been documented through both real-life and accelerated aging studies. Accelerated aging tests are conducted by subjecting bonded samples to cycling heat, humidity and xenon arc UV lamp exposure, and measuring the dynamic tensile, shear and peel strength values.

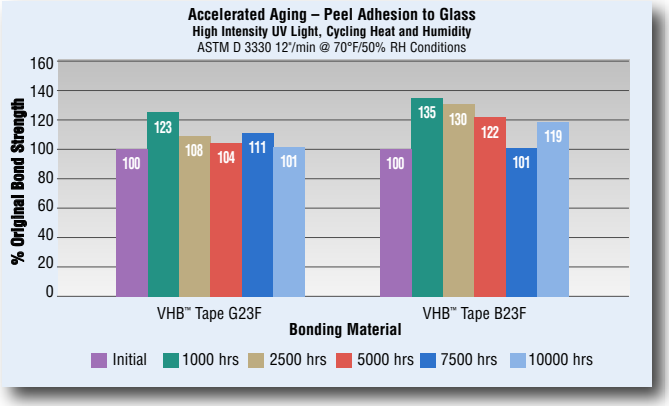
Accelerated aging was conducted at the 3M Weathering Resource Center in St Paul, MN, with exposure up to 10,000 hours duration. The objective of this test was to compare the durability and performance of 3M™ VHB™ Structural Glazing Tape to a two-part structural silicone sealant. The exposure used a 3M Proprietary test condition that has been found to be a good predictor of service durability and generally better than typical industry tests. Exposure was under high intensity UV light (Xenon Arc) with cycling heat and humidity. 3M™ VHB™ Structural Glazing Tapes G23F and B23F were bonded between glass and metal (black anodized aluminum) with UV exposure through 6 mm (0.25 in) clear float glass. Test configuration was 25 mm x 25 mm (1 in x 1 in) tensile (ASTM D897) and 25 mm (1 in) width peel mode (ASTM D3330). The same sample configuration was used for the two-part structural silicone sealant except the sealant thickness which was 9.5 mm (0.375 in). The peel test was only conducted on the tape samples.

A dynamic wind load acting on a curtain wall panel is best represented by a tensile strength test. The following graph compares the original tensile strength to that after different levels of exposure up to 10,000 hours.



These tests demonstrate the bond strength does not deteriorate below its original performance level, even after exposure of 10,000 hours in these extreme accelerated aging tests. It also demonstrates comparable performance of the 3M™ VHB™ Structural Glazing Tapes to the two-part structural silicone sealant.

The peel adhesion test demonstrates the adhesive bond strength of the 3M™ VHB™ Structural Glazing Tape to the substrate. Since UV light exposure occurs through the glass, a peel test of the tape off the glass substrate was conducted in this same study. It is critical to maintain a good adhesive bond to the glass substrate after years of exposure.



High peel strength as well as cohesive failure was maintained over the course of this peel test study.

The 3M™ VHB™ Structural Glazing Tapes performance in tensile and peel is relatively unchanged after 10,000 hours of extreme exposure to high intensity UV light (Xenon Arc) with cycling heat and humidity. According to the 3M service life predictability model for this test, there is a 50% chance that this 10,000 hour exposure in the 3M proprietary cycle is at least as harsh as 28 years in Miami, 29.6 years in Phoenix and 54.2 years in Minnesota, and 50% chance that the exposure is less harsh. However, a service life for the tape bond or the structural silicone sealant cannot be predicted from the testing because it continues to perform almost unchanged after the 10,000 hour exposure.

Overall Conclusions:

3M™ VHB™ Structural Glazing Tapes G23F & B23F exhibited excellent durability performance in extreme accelerated aging conditions that included high temperature, UV light and high humidity exposure. This test study also showed the comparable performance of these tapes to that of a product with a well known durability – the two-part structural silicone sealant. After 10,000 hours of accelerated exposure, the survival probabilities for all three glazing systems are identical, i.e., none have failed.

Note: 3M™ VHB™ Structural Glazing Tape 4972 was also tested in this study. This product is compositionally the same as 3M™ VHB™ Structural Glazing Tape G23F and only differs slightly by thickness. Accelerated aging results for the two tapes was similar demonstrating the performance and durability of 3M™ VHB™ Structural Glazing Tape 4972.

Moisture and Solvent Resistance

Water can hydrolyze not only the chemical bonds of every polymer backbone but also the bonding of an adhesive to the substrate's surface. This phenomenon may appear even at room temperature and may cause both cohesive and adhesive failure. Adhesion tests have been performed on 3M™ VHB™ Tape bonds of aluminum to aluminum that were subjected to over 10 years of submersion in 5% salt water and ordinary tap water. After testing, bright clean aluminum surfaces were observed underneath the adhesive bond. A combination of adhesive and cohesive failure modes was observed when the bond was broken which indicated very high performance levels. Long-term exposure to high humidity or water submersion can have the effect of making a polymer more resilient and tolerant of high elongation. A subsequent lowering in peak force is also measured after many days of exposure, usually on the order of 40%. This effect is typical as it parallels the increase in resilience and is the same trend often seen with silicone sealants, which are also recognized for their durability. Drying of the 3M™ VHB™ Tape bond, which occurs in a normal environmental cycle, shows that this effect is reversible and the bond returned to the original dry strength. Detailed investigations showed that even silicones experience a similar change in material properties after a continuous exposure to water. Therefore, efficient draining of the structural joint is essential for structural glazing constructions.

Any uncoated glass bonding application using a 3M™ VHB™ Structural Glazing Tape should always have the glass surface treated with silane solution as described in the "Surface Preparation of Glass" section of this manual (page 18).

After splashes or incidental contact with solvents such as fuels, alcohols, adhesive removers like MEK, and even weak acids or bases, no affect is measured on the bond performance. Some of these solvents may be included in window cleaning solutions. Adhesive/foam softens only after continuous submersion in harsh fuels or solvents.

Note: While 3M™ VHB™ Tape products may withstand occasional contact with these types of chemicals, continuous exposure is not recommended unless the tape is sealed or otherwise protected.

Structural Performance Tests

3M™ VHB™ Structural Glazing Tapes have been used worldwide in thousands of glazing applications in the construction industry. To further support consideration for structural glazing applications, performance tests were conducted at an independent, accredited 3rd party test facility (Winwall Technology Pte Ltd – Singapore) to evaluate 3M™ VHB™ Structural Glazing Tapes under stresses and environmental conditions that glass panels would typically experience in a glazed curtain wall system.

The glazed panels installed with 3M™ VHB™ Structural Glazing Tapes provided excellent performance overall compared to control panels glazed with structural silicone sealant. The first test sequence consisted of a PVB laminated glass panel bonded with 3M™ VHB™ Structural Glazing Tape 4972, an insulated glazed unit (IGU) bonded with 3M™ VHB™ Structural Glazing Tape G23F and an IGU bonded with a one-part structural silicone sealant. No failure was observed with either the 3M™ VHB™ Structural Glazing Tape glazed panels or the structural silicone sealant glazed panel in any of the tests including ASTM E 330 wind load structural tests at cold, ambient and hot temperatures, -25ºC, 32ºC and 70ºC (-13ºF, 90ºF and 158ºF) up to 2.9 kPa (60 psf), corresponding to a wind speed of 250 kph (155 mph). After this, pressures were gradually increased up to 8.4 kPa (175 psf) at ambient temperature conditions. At this point the laminated glass failed and blew out of the chamber. However, glass was still attached and bonded to the 3M™ VHB™ Structural Glazing Tape 4972 around the perimeter of the frame demonstrating the high strength of the tape.

A second test sequence patterned after the first test sequence was run consisting of two single pane tempered glass lites. One was bonded with 3M™ VHB™ Structural Glazing Tape G23F and the other with a one-part structural silicone sealant. The IGU panel bonded with 3M™ VHB™ Structural Glazing Tape G23F was also subjected to this second test sequence after surviving the first test sequence. No failure was observed with either the 3M™ VHB™ Structural Glazing Tape glazed panels or the structural silicone sealant glazed panel in any of the tests including ASTM E 330 wind load structural tests up to 10 kPa (210 psf), corresponding to a sustained wind speed of 467 kph (290 mph). This testing protocol also demonstrated that no air or water leakage can be obtained with proper assembly methods.

Results of 3rd party structural performance tests –

		Panels in 1st Test Sequence		Panels in 2nd Test Sequence		
Test Sequence	**Test Method**	**3M™ VHB™ SGT 4972 Laminated Glass**	**One-Part Structural Silicone IGU**	**3M™ VHB™ SGT G23F IGU**	**One-Part Structural Silicone 8 mm Tempered**	**3M™ VHB™ SGT G23F 8 mm Tempered**
Air Infiltration	ASTM E283 at 0.3 kPa (6.3 psf)	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel
Water Penetration	ASTM E331 at 0.7 kPa (15 psf)	No water leakage	No water leakage	No water leakage	No water leakage	No water leakage
Temperature Cycling	20 cycles -25°C to 70°C (-13°F to 158°F)	For each cycle, temperature is maintained at –25°C (–13°F) for 15 minutes and 70°C (158°F) for 15 minutes		Subjected to 40 cycles	For each cycle, temperature is maintained at –25°C (–13°F) for 15 minutes and 70°C (158°F) for 15 minutes	
Air Infiltration	ASTM E283 at 0.3 kPa (6.3 psf)	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel
Water Penetration	ASTM E331 at 0.7 kPa (15 psf)	No water leakage	No water leakage	No water leakage	No water leakage	No water leakage
Windload Structural	ASTM E330 -25°C, 32°C, 70°C (-13°F, 90°F, 158°F) hold for 1 minute	± 2.9 kPa (60 psf) 250 kph (155 mph)	± 2.9 kPa (60 psf) 250 kph (155 mph)	± 2.9 kPa (60 psf) 250 kph (155 mph)	± 2.9 kPa (60 psf) 250 kph (155 mph)	± 2.9 kPa (60 psf) 250 kph (155 mph)
Air Infiltration	ASTM E283 at 0.3 kPa (6.3 psf)	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel	No air leakage from panel
Windload Structural Maximum	ASTM E330 32°C (90°F) hold for 10 sec.	± 6 kPa (125 psf) 362 kph (225 mph)	± 6 kPa (125 psf) 362 kph (225 mph)	± 8 kPa (167 psf) 418 kph (260 mph)	± 8 kPa (167 psf) 418 kph (260 mph)	± 8 kPa (167 psf) 418 kph (260 mph)
Windload Structural Destructive	Maximum Pressure (±) 32°C (90°F)	Glass burst at -8.4 kPa (-175 psf) 426 kph (265 mph)	> -8.4 kPa (-175 psf) 426 kph (265 mph)	> 10 kPa (210 psf) 465 kph (290 mph)	> 10 kPa (210 psf) 465 kph (290 mph)	> 10 kPa (210 psf) 465 kph (290 mph)

Subject to 2X cycling tests

Note: The limit of the test chamber was 10 kPa (210 psf). Panels were designed for a 2.9 kPa (60 psf) design pressure. Testing beyond this design pressure demonstrates a conservative safety factor used for 3M™ VHB™ Structural Glazing Tapes.

This mock-up test summary is just one of many which have been successfully completed since the introduction of structural glazing with 3M™ VHB™ Tape in 1990. 3M™ VHB™ Structural Glazing Tapes have proven their performance in other mock-up tests with and without silicone weather sealants, in protective glazing tests including hurricane impact and pressure cycling, bomb blast, and seismic tests. Please contact 3M for more information on these tests including 3rd party mock-up test reports.

Introduction

A 3M™ VHB™ Structural Glazing Tape curtain wall system is based on the adhesive tape acting as the primary bonding component between the glass and the structural glazing frame. The windload forces acting on the facade are transferred through the 3M™ VHB™ Structural Glazing Tape to the structure of the building. The 3M™ VHB™ Structural Glazing Tape must maintain its strong bonding performance and strength in order to support the glass panels during windload and other environmental related events. 3M™ VHB™ Structural Glazing Tape is usually considered for four-sided or two-sided shop-glazed structural glazing applications, and is the only 3M™ VHB™ Tape suitable for structural glazing applications. A curtain wall or commercial window system designed for 3M™ VHB™ Structural Glazing Tape should only be assembled in a well controlled factory environment. Years of testing and real life applications demonstrate the high performance capability of this adhesive tape to meet the demanding requirements of this application. It is important to note that whenever a 3M™ VHB™ Structural Glazing Tape project is initiated a comprehensive process control plan must be completed that includes review of the project by 3M, adhesion testing, training of the fabricator and in-process audits – all to promote a successful project.

> ***Note:*** specific process and quality control procedures must be followed on all 3M™ VHB™ Structural Glazing Tape projects in order to obtain a 3M™ VHB™ Structural Glazing Tape Application Warranty.

Design Considerations – Adhesion

Adhesion is the molecular force of attraction between unlike materials, similar to a magnetic force. The strength of attraction is determined by the surface energy of the material. The higher the surface energy, the greater the molecular attraction – the lower the surface energy, the weaker the attractive forces. Greater molecular attraction results in increased interfacial contact between an adhesive and a substrate. In other words, on a high surface energy material the adhesive can more easily flow or "wet" the surface to obtain a stronger bond.

A glass surface is generally considered to be a high energy surface. However, surface coatings such as reflective coatings on the glass will change the surface energy of the glass and in turn the adhesion performance. Likewise, coatings or paint on metal frames will also change the surface energy of a normally high energy surface like bare aluminum. Thus, it is important to have a 3M Technical Service Representative review each 3M™ VHB™ Structural Glazing Tape project and conduct adhesion tests to determine the appropriate surface preparation method for each structural glazing substrate. This will help to ensure that high bond strength of the 3M™ VHB™ Structural Glazing Tape exists to both bonding surfaces. Any change in substrate material (e.g., paint color) or source of supply will require a new adhesion test before the change may be implemented.

Structural Joint Design

Typical structural glazing profiles with 3M™ VHB™ Structural Glazing Tape are shown in Figure 1.

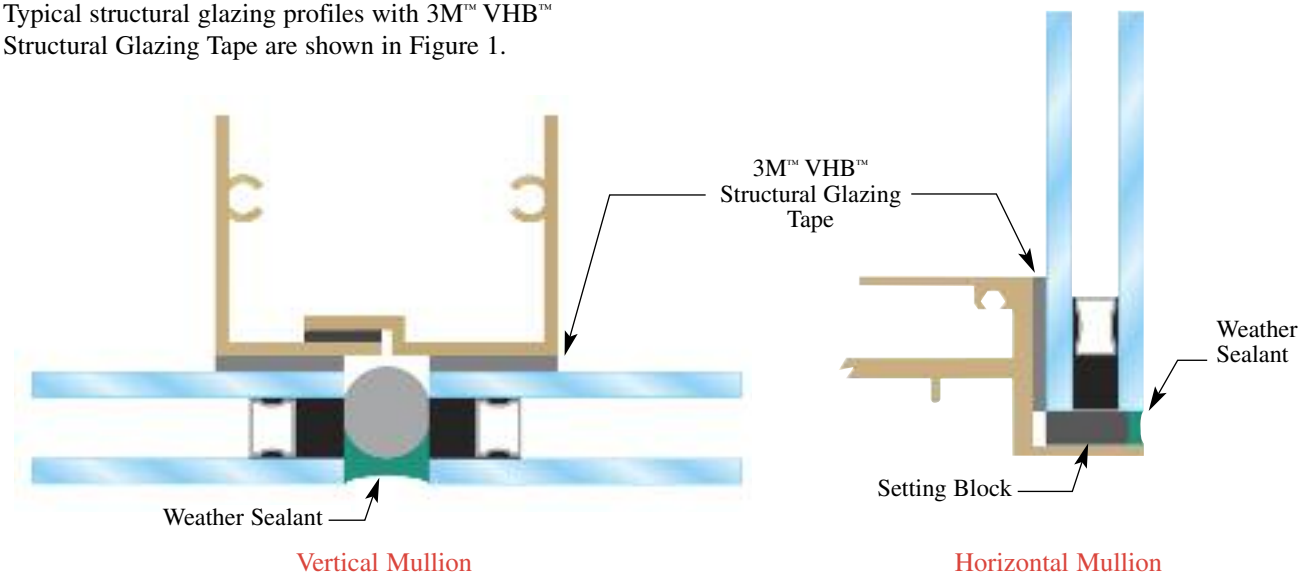


Figure 1: Glazing sections with 3M™ VHB™ Structural Glazing Tape as the primary bonding component

Design Considerations – Tape Width

The appropriate tape width is determined based on wind load and/or dead load calculations depending on the design of the structural glazing system.

In structural glazing systems without deadload support, the weight of the glass places a constant load on the adhesive tape. A static load and dynamic load calculation must be performed for these applications.

Laminated or insulated glass should always have static (deadload) support as part of the framing system. When the deadload is supported, a dynamic load calculation is required to determine the appropriate tape width for the application. For monolithic – single pane glazing applications, deadload support is still recommended but it is up to the local governmental regulations, the fabricator/structural engineer and the 3M Technical Service Representative to allow a non-supported 3M™ VHB™ Structural Glazing Tape project.

Tape Width – Dynamic Loads

The minimum tape width for a structural glazing application is dependent on three factors:

1. The design strength of the bonding agent (3M™ VHB™ Structural Glazing Tape)
2. Design pressure (dynamic wind load) requirement for the building
3. Size of the glass panel

The adhesive tape must be the appropriate width to securely fasten the glass panel and allow the wind load to be transferred to the building structure.

For dynamic tensile or shear loads (such as windloads), a design strength of 85 kPa (12 psi or 8435 kg/m²) is used for 3M™ VHB™ Structural Glazing Tape. This design strength guideline provides an industry-appropriate safety factor and was established based on material property testing as well as ASTM dynamic load testing for curtain wall applications. More than twenty years of application success also supports the use of this design guideline for this application.

The Trapezoid Rule is the industry recognized calculation used for determining the appropriate bonding agent width for a structural glazing application. This calculation is commonly used to determine "structural bite" for structural silicone sealant glazing applications and is also applicable for 3M™ VHB™ Structural Glazing Tape applications. This calculation and examples are shown in the next column:

$$\text{Tape Width (mm)} = \frac{0.5 \times \text{panel short edge length (mm)} \times \text{windload (kPa)}}{\text{Tape design strength (85 kPa)}}$$

Example: 1200 mm x 2400 mm lite of glass designed to withstand a windload of 2.9 kPa

$$\text{Tape Width (mm)} = \frac{0.5 \times 1200 \text{ mm} \times 2.9 \text{ kPa}}{85 \text{ kPa}} = 21 \text{ mm} \blacktriangleright \text{round up} \blacktriangleright \mathbf{25\ mm}$$

Note: Always round up to the nearest whole number divisible by 5 and never round down for metric (mm) calculations.

$$\text{Tape Width (mm)} = \frac{0.5 \times \text{panel short edge length (mm)} \times \text{windload (kg/m}^2\text{)}}{\text{Tape design strength (8435 kg/m}^2\text{)}}$$

Example: Same as previous conditions with a 295 kg/m² windload

$$\text{Tape Width (mm)} = \frac{0.5 \times 1200 \text{ mm} \times 295 \text{ kg/m}^2}{8435 \text{ kg/m}^2} = 21 \text{ mm} \blacktriangleright \text{round up} \blacktriangleright \mathbf{25\ mm}$$

$$\text{Tape Width (inches)} = \frac{0.5 \times \text{panel short edge length (ft)} \times \text{windload (psf)}}{12 \text{ in/ft.} \times \text{tape design strength (12 lbs/in}^2\text{)}}$$

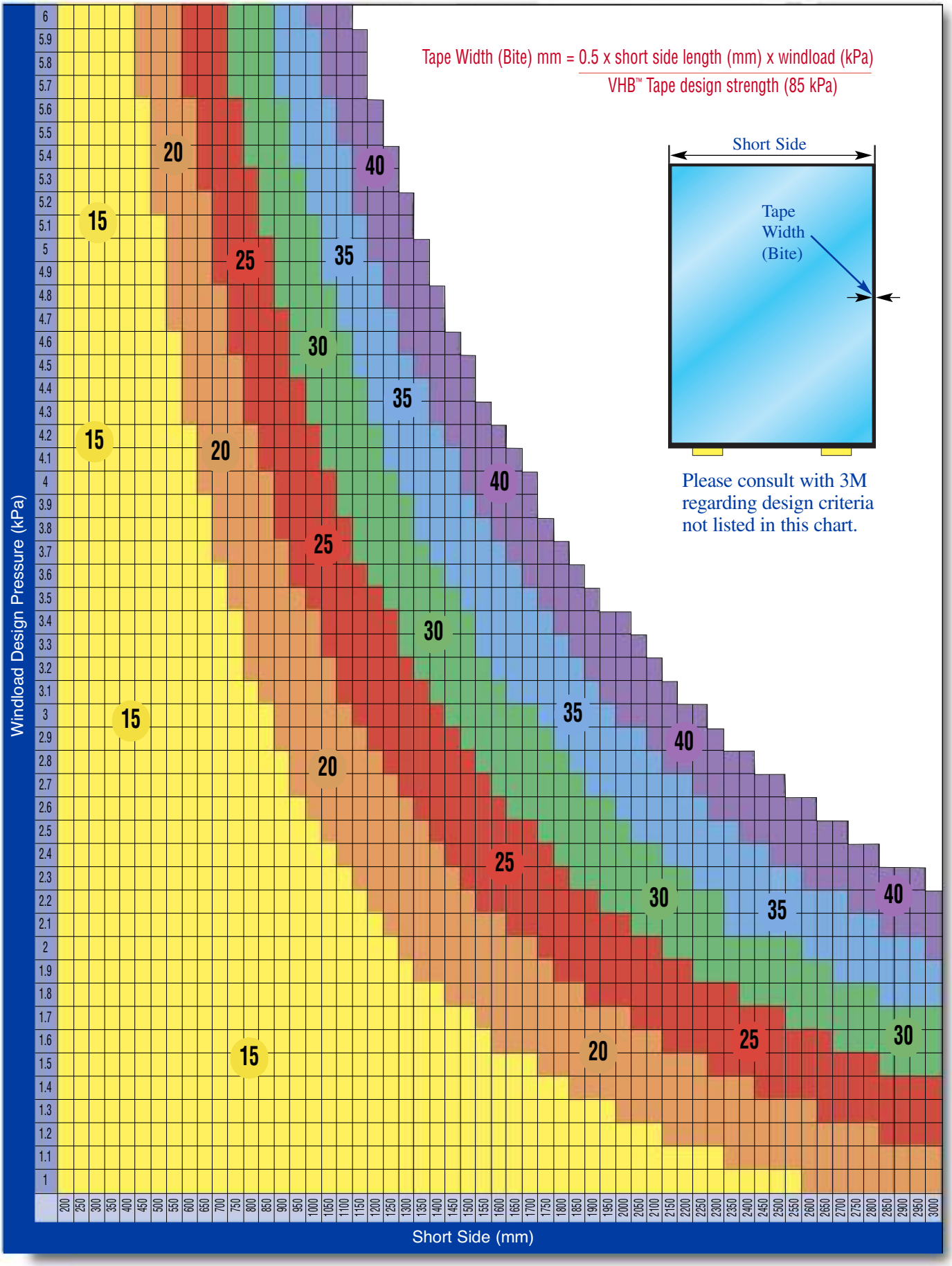
Example: 4' x 6' lite of glass designed to withstand a 60 psf windload

$$\text{Tape Width (inches)} = \frac{0.5 \times 4 \text{ ft} \times 60 \text{ lbs/ft}^2}{12 \text{ in/ft} \times 12 \text{ lbs/in}^2} = 0.83'' \blacktriangleright \text{round up to nearest } 1/8'' \blacktriangleright \mathbf{7/8''}$$

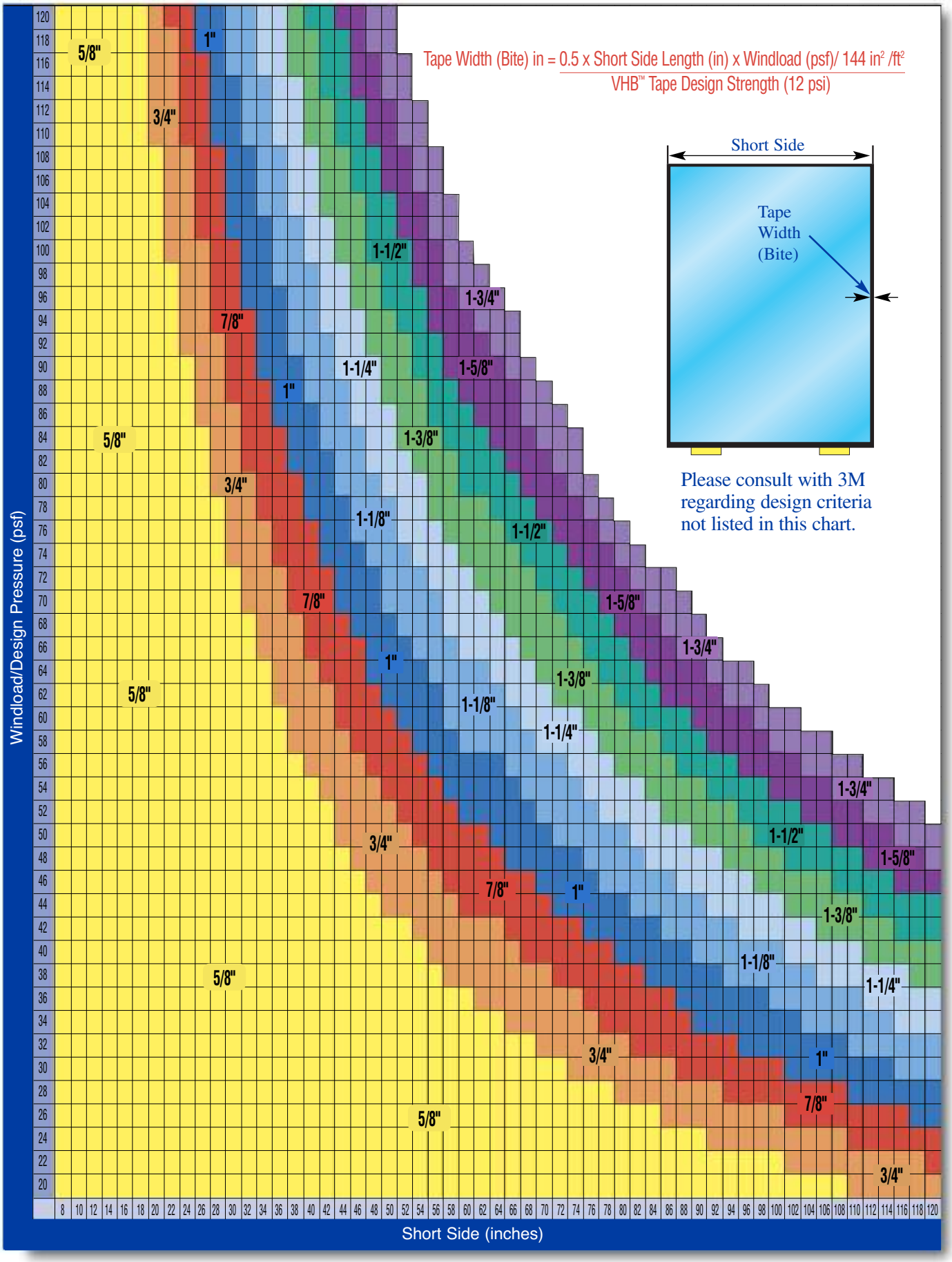
Note: Always round up to the nearest 1/8" and never round down.

This dynamic load calculation should be done to determine the appropriate VHB™ Structural Glazing Tape width for each glass panel size in the glazing application. The static load calculation must also be performed if the application is for an unsupported monolithic glass application.

Tape Width (Bite) Calculator (metric)



Tape Width (Bite) Calculator



Tape Width – Static Loads (Deadload)

Structural glazing applications utilizing unsupported monolithic glass require a static load calculation to determine the appropriate width of 3M™ VHB™ Structural Glazing Tape. A design strength guideline of 1.7 kPa (0.25 psi or 1.75 x 10^{-4} kg/mm²) should be used for static load calculations. This means that 60 cm² of tape per 1 kg (4 sq in of tape per 1 lb) should be used to support static loads.

Important: Both static load and dynamic load calculations should be performed on unsupported structural glazing applications. The calculation resulting in the wider tape width should be used as the appropriate tape width for the application.

The following static load calculation is used to determine the appropriate tape width.

$$\text{Tape Width (mm)} = \frac{\text{glass panel weight (kg)}}{\text{Glass perimeter (mm)} \times \text{tape design strength } (1.75 \times 10^{-4}\ \text{kg/mm}^2)}$$

Example: 1000 mm x 1500 mm lite of monolithic glass with a weight of 10 kg/m²

$$\text{Tape Width (mm)} = \frac{(1\ \text{m} \times 1.5\ \text{m})\ (10\ \text{kg/m}^2)}{2\ (1000\ \text{mm} + 1500\ \text{mm})\ (1.75 \times 10^{-4}\ \text{kg/mm}^2)} = 17\ \text{mm} \blacktriangleright \text{round up} \blacktriangleright \mathbf{20\ mm}$$

Note: Always round up to the nearest whole number divisible by 5 and never round down.

Important: A dynamic load calculation should also be performed along with the static load calculation. For example, if the 1000 mm x 1500 mm glass panel above was designed to withstand a 1.4 kPa windload, the following dynamic load calculation should be performed:

$$\text{Tape Width (mm)} = \frac{0.5 \times 1000\ \text{mm} \times 1.4\ \text{kPa}}{85\ \text{kPa}} = 8.2\ \text{mm} \blacktriangleright \text{round up} \blacktriangleright \mathbf{10\ mm}$$

In this example the static load calculation resulted in wider tape width (20 mm) compared to the dynamic load calculation (10 mm). Thus, to satisfy the static load and dynamic load requirements, the wider tape width of 20 mm should be used for the application.

$$\text{Tape Width (inches)} = \frac{\text{glass panel weight (lbs.)}}{\text{Glass perimeter (in)} \times \text{tape design strength (0.25 psi)}}$$

Example: 3' x 4' lite of monolithic glass with a weight of 2 lbs/ft²

$$\text{Tape Width (inches)} = \frac{(3\ \text{ft} \times 4\ \text{ft})\ (2\ \text{lbs/ft}^2)}{168\ \text{in} \times 0.25\ \text{lbs/in}^2} = 0.57'' \blacktriangleright \text{round up} \blacktriangleright \mathbf{3/4''}$$

Note: Always round up to the nearest 1/4" and never round down.

Design Considerations – Differential Movement and Face Clearance

3M™ VHB™ Structural Glazing Tape performs well in applications where two bonded surfaces like glass and an aluminum frame experience movement relative to each other as a result of thermal expansion and contraction. 3M™ VHB™ Structural Glazing Tape can tolerate shear movement up to 3 times its original thickness (300% shear strain). This means the 2.3 mm (0.090") thick 3M™ VHB™ Structural Glazing Tapes G23F or B23F can safely experience shear strain up to 6.9 mm (0.27"). The 2.0 mm (0.080") 3M™ VHB™ Structural Glazing Tape 4972 can safely experience strain up to 6 mm (0.24").

	3M™ VHB™ Structural Glazing Tape G23F & B23F	3M™ VHB™ Structural Glazing Tape 4972
Tape Thickness	2.3 mm (0.090")	2.0 mm (0.080")
Allowable Shear Strain	x 300%	x 300%
Allowable Movement	6.9 mm (0.27")	6.0 mm (0.24")

The curtain wall system designer should calculate the amount of joint movement and mismatch possible between the glass panel and metal frame and determine if this will result in less than 300% shear strain on the 3M™ VHB™ Structural Glazing Tape. An example of thermal expansion movement and the associated calculation is listed below:

$$\text{Total \% strain} = \sqrt{(\text{panel short edge \% shear strain})^2 + (\text{panel long edge \% shear strain})^2}$$

where

$$\text{\% shear strain} = 100 \times (\text{frame length}) \times \frac{(\text{frame CTE} - \text{glass CTE}) \times (\text{max temp change})}{\text{tape thickness}}$$

The % strain in shear calculation listed above should be calculated for both the short edge and long edge length. The values calculated for each panel edge is then used to calculate the total % strain on the tape. The maximum temperature change should be calculated from the application temperature to the greater temperature extreme – hot or cold.

Example: For a 1500 mm x 2500 mm glass lite bonded to an aluminum frame, 3M™ VHB™ Structural Glazing Tape G23F was applied in a factory environment with a temperature of 20°C. The building project is located in a hot temperature zone where the maximum temperature of the building exterior may reach 85°C on a calm sunny day. The coefficient of thermal expansion (CTE) for glass is 9.0 x 10^{-6}/°C and for aluminum is 24 x 10^{-6}/°C. The thickness of the tape is 2.3 mm.

Short edge % strain =
100 (1500 mm) ($24x10^{-6}$/°C – $9x10^{-6}$/°C) (85°C - 20°C)/2.3 mm = 64%

Long edge % strain =
100 (2500 mm) ($24x10^{-6}$/°C – $9x10^{-6}$/°C) (85°C - 20°C)/2.3 mm = 106%

Total % strain = $\sqrt{(64)^2+(106)^2}$ = **124%**

Example: For a 5 ft x 8 ft glass lite bonded to an aluminum frame, 3M™ VHB™ Structural Glazing Tape G23F was applied in a factory with a temperature of 70°F. The project building is located in a hot temperature zone where the maximum temperature of the building may reach 185°F on a calm sunny day. The coefficient of thermal expansion (CTE) for glass is $5x10^{-6}$/°F and for aluminum is $13.3x10^{-6}$/°F The thickness of the tape is 0.090".

Short edge % strain =
100 (60 in) ($13.3x10^{-6}$/°F – $5x10^{-6}$/°F) (185°F - 70°F)/0.09 in = 64%

Long edge % strain =
100 (96 in) ($13.3x10^{-6}$/°F – $5x10^{-6}$/°F) (185°F - 70°F)/0.09 in = 102%

Total % strain = $\sqrt{(64)^2+(102)^2}$ = **120%**

Both of these values are well within the design limit of 300% for 3M™ VHB™ Structural Glazing Tape. These calculations only account for movement due to thermal changes. Other sources of movement in the glazing system such as building settling, slab deflection, seismic events, mismatch during assembly, etc. should also be considered by the architect or glazing system designer to verify that they are within the design limit of 300% shear strain.

Materials Involved in Glazing

Structural glazing in general involves the bonding of glass to a supportive load bearing metallic frame, with additional components to aid in building movement and to provide a seal from moisture/air entry. There are a variety of glass types and metallic frames available for structural glazing applications.

Substrate Materials – Glass

3M™ VHB™ Structural Glazing Tapes form a durable bond to clear float glass, but opaque or reflective coatings for thermal insulation on multifunctional glasses must also be considered.

For "hard coating", pyrolytic coatings of metal oxides are applied on the float glass just after the float process when the glass is still very hot. This makes the coatings very durable and appropriate for structural glazing. Alternatively, magnetron or “soft coatings” (coatings applied off-line after glass has cooled) consist of thin layers of noble metals (e.g. silver in low E coatings), which are not resistant to environmental influences like oxygen and acid rain. This causes surface corrosion and a gradual loss of adhesion. A few glass suppliers have made great progress in developing new generation soft coatings which are resistant to these influences and may be suitable for structural glazing.

The wide variety of glass coatings requires special attention in adhesion testing. The adhesion of 3M™ VHB™ Structural Glazing Tape on any glass coating must be checked by a 3M Technical Service Representative on each individual project. If possible, it is preferred to apply the 3M™ VHB™ Structural Glazing Tape to the uncoated side of the glass panel.

It is important to avoid excessively warped glass lites when bonding with 3M™ VHB™ Structural Glazing Tape. Quality glass manufacturers typically have less warpage in their finished product than is specified in ASTM or other standards for glass flatness. Please contact a 3M Sales or Technical Service Representative for further information.

Substrate Materials – Metal Frames

The most typical frame material used in structural glazing systems is aluminum. High grade stainless steel (316) is occasionally used in structural glazing systems as well. The different types of structural frames suitable for 3M™ VHB™ Structural Glazing Tape include alodine aluminum, anodized aluminum, thermal set paint/coated aluminum and stainless steel. Mill finish aluminum is typically not used for structural glazing applications. In some cases non-typical surface finishes may be specified for a 3M™ VHB™ Structural Glazing Tape project. Always consult with a 3M Technical Service Representative for guidance in these cases.

A flat frame profile void of surface irregularities (along the frame length and at the joint seams) is required for 3M™ VHB™ Structural Glazing Tape applications. The bond area of the profile should be flat and parallel to the glass surface to promote good adhesive contact. Mismatch in frame corner joints should be limited to <0.5 mm (0.020"). If frames are welded, the welds should be leveled in the bond area and <0.5 mm (0.020”). Ideally weld bead should be abrasively removed.

The width of the flat bonding surface must be adequate to accommodate the calculated minimum tape width (bite) required for the glazing panel. It is best to use a frame that will accommodate the tape width yet leave little or no bare glass exposed over the metal frame (see Figure 1). The frame profile should also allow for the application of a perimeter weather sealant. Some standard structural silicone sealant glazing profiles may not be suitable for use with 3M™ VHB™ Structural Glazing Tape.

3M’s technical assessment process (page 31) will characterize the adhesion of the 3M™ VHB™ Structural Glazing Tape to the substrate but do not in any way confirm the durability of the substrate. Please contact a 3M Sales or Technical Service Representative for further information.

Project Review and Warranty Process

3M™ VHB™ Structural Glazing Tape Sales, Marketing and Technical Service Representatives are available to assist the customer to determine the suitability of 3M™ VHB™ Structural Glazing Tape for structural glazing applications. All 3M™ VHB™ Structural Glazing Tape projects must be reviewed on a project-specific basis by a 3M Technical Service Representative to begin the 3M™ VHB™ Structural Glazing Tape application process. The project review and associated adhesion testing must be successfully completed along with fabricator training and process control and audit documentation before 3M will issue a 3M™ VHB™ Structural Glazing Tape Application Limited Warranty. A project initiation form is included on page 33 of this manual. Additional forms are available from a 3M™ VHB™ Structural Glazing Tape Sales, Marketing or Technical Service Representative. It is important to complete the entire project initiation form to ensure that 3M will be able to accurately assess the 3M™ VHB™ Structural Glazing Tape project. Required information in this form includes design windload values for the building, glass dimensions and the structural details related to the glazing system.

3M will conduct adhesion testing and provide bonding performance information of 3M™ VHB™ Structural Glazing Tape to the substrates and will also provide training to the fabricator personnel in application procedures to maximize tape bonding performance. The warranty program is only offered for those projects handled by approved 3M customers who strictly adhere to and follow 3M specifications and instructions, and is subject to certain conditions.

Project Review and Process Flow

The 3M™ VHB™ Structural Glazing Tape project review and process flow is outlined below:

1. **Initial Inquiry:** A typical project starts with a current or prospective customer contacting 3M regarding an interest in using 3M™ VHB™ Structural Glazing Tape for a specific project, curtain wall or commercial window unit. The inquiry may come from a fabricator, designer, engineer/architect or building owner. A 3M Sales, Marketing or Technical Service Representative works with the customer to complete a project initiation form (page 33) which begins the 3M™ VHB™ Structural Glazing Tape application process. The customer then submits designs and drawings to 3M for review.

2. **Initial Project Review:** 3M Technical Service and Marketing Representatives perform initial project assessment to determine general suitability of 3M™ VHB™ Structural Glazing Tape for the specific project.

3. **Submission of Substrates:** If initial project design review is found acceptable, representative substrate materials (glass and frame) must be submitted to perform a complete technical evaluation of the project including adhesion testing. The 3M Sales Representative requests and obtains adequate samples of all appropriate substrate materials and submits a Technical Service Request (TSR) to the 3M Technical Service Representative.

   Samples to be submitted:

   Samples of all the substrates (frame and glass) that will be joined with 3M™ VHB™ Structural Glazing Tape should be submitted to the 3M Sales or Technical Service Representative upon request to conduct the necessary adhesion and surface preparation analysis. The number of samples required and dimensions are given below. Be sure to identify the bonding surface of each substrate.

   Glass panel samples: 300 mm x 300 mm (12" x 12") – 2 pieces
   Frame extrusions: 300 mm (12") length – 8 pieces

4. **Adhesion Testing:** The 3M Technical Service Representative performs appropriate adhesion testing of actual or representative materials to measure performance and provide requirements for surface preparation of the substrates. This may take up to four weeks from receipt of drawings and samples.

5. **Technical Report:** The 3M Technical Service Representative fills out the project application documents and requirements using results from the technical review. The technical report and initial project requirements are provided to the customer.

6. **Project Initiation:** The customer reviews the technical report and initial project requirements and agrees to terms including training, fabrication requirements and process auditing.

7. **Training:** The 3M Technical Service Representative develops training materials with specific 3M™ VHB™ Structural Glazing Tape application techniques plus any project-specific instructions. A local 3M Sales, Technical Service or Marketing Representative delivers on-site training before full scale production begins. It is common to build a mock-up at this point in the process prior to the start of production. A 3M representative must be present during an initial mock-up build in the customer facility.

8. **Process/Quality Control:** Once production begins, a 3M Sales, Technical Service or Marketing Representative conducts period on-site audits of actual assembly process to ensure 3M process and quality control requirements are followed during the production process.

9. **Project Communications:** Customer communicates to 3M representatives the production schedule and estimated project completion. 3M representatives and customer work together to ensure process requirements are met and to mutually agree to any process deviation should it be necessary.

Additional Testing Requirements

Additional, non-standard testing may be required depending on the needs of the customer or the demands of the project.

Please consult your 3M Sales or Technical Service Representative at the beginning of the project to determine if 3M is capable of such testing services. 3M may charge a service fee for non-typical testing outside of 3M internal testing capabilities. Any statement made on behalf of 3M relating to an architectural drawing, product formulation, engineering design, end-use specification or similar document is limited to the knowledge of product properties as determined by laboratory testing of material produced by 3M. Any comments relating to any subject other than such product properties are offered only to call to the attention of the engineer, architect, formulator, end-user or other person considerations that may be relevant in his/her independent evaluation and determination of the appropriateness of such design, drawing, specifications, document or formula.

3M ASSUMES NO RESPONSIBILITY FOR AND SHALL NOT BE LIABLE FOR THE ADEQUACY OR PROPRIETY OF ANY MATERIALS USED FOR A PROJECT OR THE PROJECT ITSELF, OR FOR ANY STRUCTURAL DESIGN ELEMENTS IN THE PRINTS/SPECIFICATIONS PROVIDED BY CUSTOMER FOR THE PROJECT, AND 3M EXPRESSLY DISCLAIMS ANY WARRANTY OR RESPONSIBILITY WHATSOEVER FOR SUCH MATERIALS, PROJECT OR STRUCTURAL DESIGN ELEMENTS.

Application Procedure for 3M™ VHB™ Structural Glazing Tape

Factory Glazing

Factory or "shop" glazed curtain walls or commercial windows are assembled as individual units (glass and frame bonded panels) in a controlled environment. This allows for proper surface preparation and tape application procedures to be maintained as well as the implementation of quality and process control programs. Factory glazed systems are usually the only glazing systems approved for 3M™ VHB™ Structural Glazing Tape projects.

A key benefit of a factory glazed 3M™ VHB™ Structural Glazing Tape system is the ability to assemble and handle the glazed panels the same day. This is due to the immediate handling strength of the 3M™ VHB™ Structural Glazing Tape.

If the outdoor temperature is below 15ºC (60ºF) it is required that the assembled panels be kept in the warmer, controlled environment of the factory shop for 24 hours before exposing the panel to the colder temperatures.

Site Glazing

Site or "field" glazing is a method where the glass lites are bonded to the metal frames at the construction site. This fabrication technique is not recommended for 3M™ VHB™ Structural Glazing Tape projects. Stick-built systems are an example where glass is installed in the field and are typically not suitable for 3M™ VHB™ Structural Glazing Tape. Please consult a 3M representative if site gazing is to be considered for a 3M™ VHB™ Structural Glazing Tape project.

Application Techniques

This application procedure outlines general process requirements for fabricating 3M™ VHB™ Structural Glazing Tape glass panel units. It is important to follow these techniques along with the recommendations in the project-specific 3M™ VHB™ Structural Glazing Tape technical report from 3M to ensure good bonding performance. Fabrication will only start after production personnel have been properly trained by a qualified 3M representative. The procedures in this document are not intended to be a complete and comprehensive quality assurance program as project situations may vary from project to project. The basic steps involved in a 3M™ VHB™ Structural Glazing Tape process are:

1. Establish appropriate work area
2. Surface preparation – glass and metal frame
3. Tape application
4. Joining of parts
5. Pressure application
6. Weather sealant application

The Work Environment

It is important to establish an appropriate work area before assembly of the structurally glazed units. The workplace should be free from excessive dust, dirt and other airborne contaminants. The 3M™ VHB™ Structural Glazing Tape will bond strongly to the surface it contacts. Should this be a layer of dust, dirt, grease, oils, etc., then an inadequate bond will be made to the component surface.

The workplace should be at a minimum temperature of 15°C (60°F) and free from sources of wide temperature variations such as open loading doors. All substrates for bonding and the 3M™ VHB™ Structural Glazing Tape should be conditioned at a minimum temperature of 15°C (60°F) in covered, weatherproof conditions for a minimum of 12 hours or until it is verified that the substrates are at or above the minimum temperature requirement. 3M™ VHB™ Structural Glazing Tape is a viscoelastic adhesive, which forms a bond by "wetting" or making intimate contact with the surfaces to which it is applied. When temperatures are low, this wetting process is slower and it takes more time to reach full bond strength with complete wetting-out of the surface. If the temperature of the 3M™ VHB™ Structural Glazing Tape roll or the components is below 15°C (60°F), then the initial wetting may be so low that full bond strength may not develop before the panel is erected and put under load. Similarly, once the initial bond is made, the 15°C (60°F) minimum is still required, so that the adhesive can continue to flow until full bond strength is achieved. Approximately 90% of full bond strength is achieved when the fabricated panels are held overnight at 15°C (60°F) or above.

Rapid variations of temperature in the workplace should also be avoided; many workshops have end-doors or roller shutters to allow vehicle entry for deliveries, etc., and opening these can cause a major change in both temperature and humidity which may have a negative impact on the bonding process.

The Work Surface

The work surface for bonding should be an appropriate size to accommodate the largest glass panel components to be constructed as a single assembly. The work surface should be stable, of a convenient height and should offer an even, flat surface over the entire area. Examples of work surfaces are a simple workbench, a work table with wheels for mobility or even an assembly station with conveyer type wheels, rollers or belts at the surface to transport the units through the production process. If several benches are used together under a large frame, it is important that they all be of equal height and stability. The operator must be able to apply pressure to all parts of the frame where the tape will form a bond. Several benches of variable height and construction brought together are not acceptable. When benches are at different heights the frame/glass will not rest squarely on the bench or be completely supported by the table surface. Application pressure applied at one end of the frame/glass may “bow” the panel, or create an opposing separation force at the other end of the frame/glass, thus breaking the previously made bond. Figures 2 and 3 are examples of typical work surfaces.

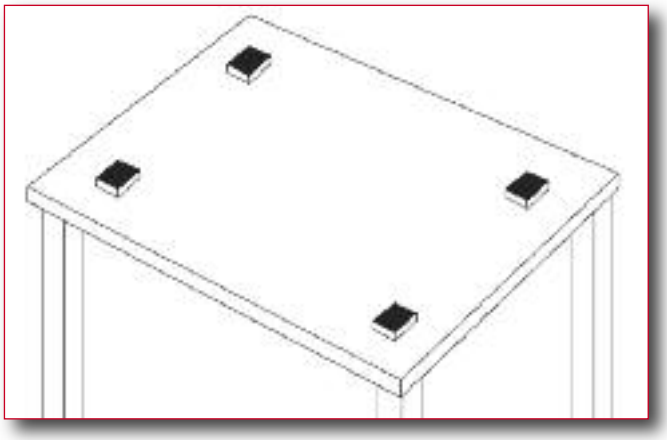


Figure 2: Workbench with support blocks for glass placement

The workbench should be covered with a material which will not damage or contaminate the frame and the glass. The workbench should be kept clean of dust, dirt, oils, silicones and other contaminants. If possible it should be used solely as a 3M™ VHB™ Structural Glazing Tape application area. Support blocks may be used to elevate the glass. Wood or another non-damaging material may be used for supporting the glass.

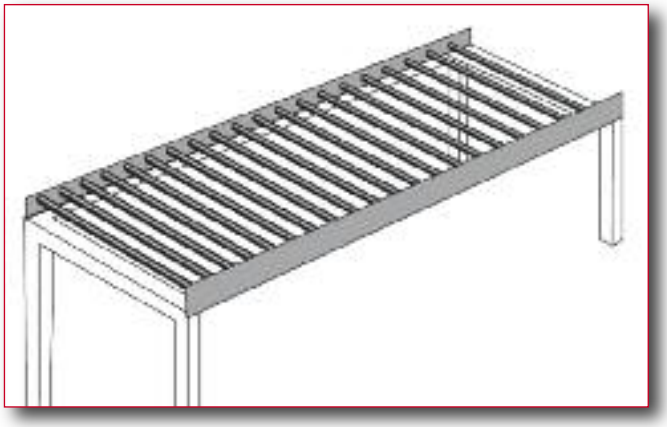


Figure 3: Roller assembly table

Surface Preparation

Proper surface preparation is the critical first step in the fabrication process. Proper preparation of a surface prior to the application of a pressure sensitive tape is a key factor in ensuring maximum bond strength. Contaminants act as a barrier between the adhesive and substrate. Even a fingerprint on an otherwise clean surface may impair adhesion. Care must also be taken to examine surfaces for moisture, particularly during periods of high humidity as it is possible for an invisible film of water to be present.

Each project reviewed and approved by 3M will involve adhesion testing of the actual project substrates (glass and frame). A technical report will summarize this testing and will require a specific surface preparation method for each substrate.

Surface Preparation of Glass

Be sure to remove any loose debris from the glass surface before starting the glass preparation procedure.

Silane Treatment of Uncoated Glass:

Uncoated glass is hydrophyllic (water loving). In high humidity or frequent water contact applications, the 3M™ VHB™ Structural Glazing Tape adhesive bond can be "undercut" by moisture migrating between the adhesive and the glass surface. Over time, this may weaken the bond and can lead to adhesive failures from the glass. To prevent this and to change the hydrophyllic nature of glass it is necessary to treat an uncoated glass surface in the bonding area with 3M™ Silane Glass Treatment AP115 or 3M™ Silane Primer. Please note the 'USE BY' or expiration date on the bottle to assure the silane solution is not beyond this date.

The product data sheet will also have additional details and guidelines regarding the proper use of the silane solutions. For proper glass treatment, clean the bonding area of the glass surface, the area around the perimeter, with a 50 - 90% solution of isopropyl alcohol (IPA) in water. Important: IPA is a flammable solvent and all appropriate safety procedures advised by the manufacturer should be followed when working with this cleaning agent. Silicone contamination around the perimeter of glass is also possible especially with insulated glass units. Silicone contamination must be removed prior to the application of the silane solution to the glass and application of 3M™ VHB™ Structural Glazing Tape. Refer to the silicone manufacturers instructions for proper removal of silicone contamination or use 3M™ Adhesive Remover (Citrus Base) or 3M™ General Purpose Adhesive Cleaner 08984 for removal of silicone residue from bond area.

1. **Cleaning:** Use a clean, soft absorbent, lint-free disposable cloth moistened with the IPA/water mixture. Pour this solution onto the cloth. Do not dip the cloth into the cleaning solution as this will contaminate the cleaning agent. Alternatively, the IPA/water solution may be sprayed onto the surface and wiped with the clean cloth.

   Wipe the glass in one direction moving around the perimeter making sure the entire bond area is thoroughly cleaned. A white cloth works best for this cleaning procedure as the removed contaminants will be visible on the cloth. Continue this procedure until no contaminants are visible on the cloth or glass surface. Once the cloth has been used, it should be disposed of in accordance with federal, state and local rules and regulations.

   Immediately wipe the cleaned area with a fresh, clean and dry cloth. Wipe around the perimeter in one direction until the surface is completely dry.

   This procedure is commonly known as the "two cloth" cleaning method.

2. **Priming:** After the surface has been thoroughly cleaned, follow with the application of the 3M™ Silane Glass Treatment AP115 or 3M™ Silane Primer.

   Moisten a clean, soft absorbent, lint-free cloth with the 3M™ Silane Glass Treatment AP115 or 3M™ Silane Primer and wipe over the area to be bonded in one direction. Do not dip the cloth into the silane solution as this may cause contamination. Alternatively, the silane solution may be sprayed onto the surface and wiped with the clean cloth around the perimeter of the glass. Experience has shown that only a very thin layer (monolayer) of silane gives the best and most consistent results.

   In an effort to achieve a monolayer, the primed area should be wiped a second time (in one direction) with a fresh, clean, lint free, dry cloth immediately after initial application. The glass should appear clear with no visible residue, wetness or streakiness.

   Figure 4 shows an example of treating the glass with the silane solution.

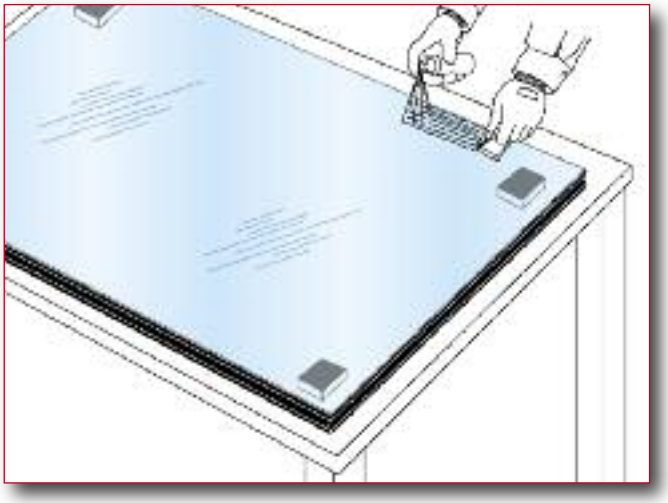


Figure 4: Treatment of glass with silane solution

3M™ Silane Glass Treatment AP115 and 3M™ Silane Primer are clear solutions and should not cloud or discolor glass. If clouding occurs it is due to excessive solution being applied to the glass. If this happens it is best to wipe aggressively over the treated area with a dry, clean cloth to remove the residue. This must be done prior to tape application.

Surface treatment of coated glass will vary due to the different types of materials and processes used for coating glass. The fabricator will need to refer to the project-specific 3M technical report for the appropriate surface preparation method used on a coated glass surface.

Surface Preparation of Metal Frames

Aluminum is the most commonly used frame material for structural glazing systems although high grade stainless steel is occasionally used. The variability in metal finishes (anodization type, paint type and color) necessitates the testing of this substrate to determine the appropriate surface preparation method. The fabricator should refer to the project specific 3M technical report for proper guidelines on how to prepare the metal substrate surface to achieve acceptable bonding performance. The basic surface preparation process for metal frames is listed below but this does not replace surface preparation requirements in the project-specific 3M technical report.

1. **Abrasion (if required per the 3M technical report)**

   If the frame is powder coated or enamel coated, the painted surface may need to be lightly abraded in the bonding area with a Scotch-Brite™ Hand Pad. When abrading, it is important to have a finely abraded surface. Very small scratches in the surface, generated with a multi-directional motion rather than straight-line motion, are most desirable. A surface with many micro-scratches can have up to 40% additional surface area, translating to higher ultimate strength and greater initial adhesion. The use of a Scotch-Brite™ General Purpose Hand Pad 7447 is good for achieving the proper level of abrasion. Tools such as a random orbit, hand or power palm sander will assist on large jobs. Avoid grinding a surface with coarse abrasive materials, since they may create too rough of a texture for the adhesive to adequately flow onto the surface. When using abrasive paper, the grit value should be finer (higher number) than 320 grit. Abrasion is only needed in the area of the frame where the 3M™ VHB™ Structural Glazing Tape will make contact – the bonding area. After abrasion, always clean the surface with the IPA/water solution described below in the Surface Cleaning section and be certain that all loose particles are removed prior to tape application.

2. **Surface Cleaning**

   The bonding area of the structural glazing frame must always be cleaned before tape application. On surfaces where there appears to be little or no contamination, a light oily film or other light contamination may be present. Use the 50 - 90% solution of isopropyl alcohol (IPA) in water for surface cleaning. Use a “two cloth” cleaning procedure when cleaning the bonding area of the metal frame with the IPA/water solution. Once the part is clean and dry, tape bonding should begin shortly after to minimize the potential for recontamination. The only exception to this is if a primer is required per the project specific requirements in the 3M technical report. Priming of the frame will follow the IPA/water cleaning step.

   Where heavy oils or grease are present, a “degreasing” solvent such as 3M™ Adhesive Remover (Citrus Base) or 3M™ General Purpose Adhesive Cleaner 08984 are suggested to remove the oil. This should always be followed by the “two cloth” IPA/water cleaning procedure to help ensure that any solvent residue or film is removed.

   Note: These cleaner solutions contain greater than 250 g/l of volatile organic compounds (VOC). Please consult your local air quality regulations to be sure the cleaner is compliant. When using solvents, be sure to follow the manufacturer’s precautions and directions for use when handling such materials.

3. **Priming (if required per the 3M technical report)**

   Priming a surface can significantly improve initial and ultimate adhesion to many materials such as painted metal surfaces or coated glass because of their low surface energy or the additives they may contain. A primer creates a new, higher energy surface for bonding with the 3M™ VHB™ Structural Glazing Tape. The project specific 3M technical report will state if a primer is required for adequate bonding performance of 3M™ VHB™ Structural Glazing Tape.

   3M™ Primer 94 or 3M™ Primer 4297 can be applied either with a brush, clean cloth or dauber bottle. Avoid applying excess primer where “puddling” may occur. The primer should be allowed to dry leaving a tack free film. Once dry, tape bonding should be started to minimize the potential for recontamination.

   3M™ Adhesion Promoter 111 should be applied to a clean cloth and then applied to the frame bonding surface. The “two cloth” cleaning method should be employed with this adhesion promoter. It is important not to leave a pool of this adhesion promoter solution on the substrate surface. There should be no visible residue left on the surface after the proper application of 3M™ Adhesion Promoter 111. Once dry, tape bonding should be started to minimize the potential for recontamination. Figure 5 shows an example of this primer being applied to a frame profile.

Figure 5: Application of adhesion promoter

Note: 3M™ Primer 94, 3M™ Adhesion Promoter 111 and 3M™ Primer 4297 contain greater than 250 g/l of volatile organic compounds (VOC). Please consult local air quality regulations to determine if there are any restrictions on using these primers.

A list of suppliers of primer applicators is provided under Equipment Suppliers on page 28.

3M™ VHB™ Structural Glazing Tape Application

3M™ VHB™ Structural Glazing Tape may be applied to either the glass or frame surface first. It is best to apply the tape to the glass if a clean sight line (minimal or no visible air entrapment – or bubbles) is desired. However, applying the tape to the frame first may bring additional process benefits. A reflective glazing application may be suitable for this since the tape will not be visible behind the glass. Application of the tape should occur very shortly after the two bonding surfaces have been prepared as outlined in the Surface Preparation section of this technical guide. A 3M Sales or Technical Service Representative will help to determine the best tape application method based on the project specific requirements and fabrication environment.

1. Tape Application and Pressure Application

The tape should be handled at the edges or by the protective liner with effort made to avoid contact with the exposed and tacky bonding surface. Excessive contact with the bonding surface may contaminate the tape and reduce bonding performance. Apply the tape to the glass or metal frame surface aligned with the edge starting in one corner working down the entire length of the bond area. Leave a small amount of tape extending over the edge on both ends (Figure 6).

Figure 6: Tapered corner

Repeat this procedure along the entire periphery of the glass or metal frame. It is best to apply light pressure to the tape as it makes first contact with the glass or metal frame to avoid air entrapment (bubbles) between the tape and bonding surface. A small roller, squeegee or even fingers may be used for this step. The tape can be "butt" jointed at the corners or overlapped and cut at a 45º angle. Figures 7, 8 and 9 illustrate proper application of 3M™ VHB™ Structural Glazing Tape by hand or with a tape applicator.

Figure 7: Hand tape application

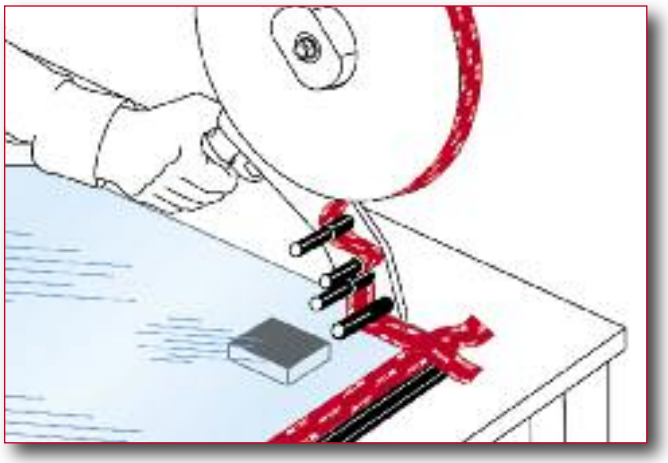


Figure 8: Tape applicator on glass

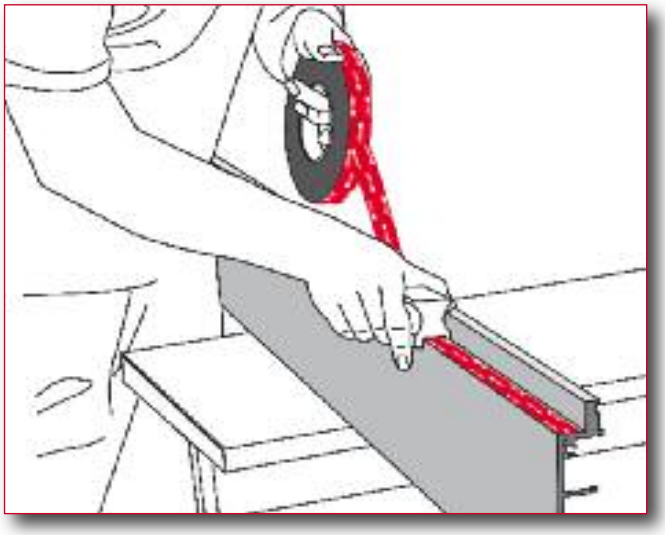


Figure 9: Tape applicator on metal frame

After application of the tape, pressure is applied to the tape around the entire periphery with a rubber roller (manual or automated) or squeegee to ensure proper surface contact (Figure 10).

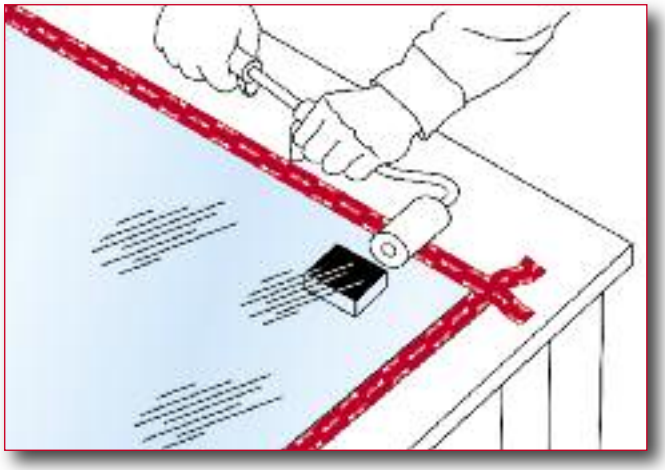


Figure 10: Initial pressure application

2. Tape Cutting and Splicing

3M™ VHB™ Structural Glazing Tape should be cut using a proper utility knife with a stable and sharp blade. Retractable knives with long cutting blades work well for tape cutting. Tape corners can be finished utilizing a butt splice or miter cutting procedure (Figures 11, 12 and 13). A simple miter cutting tool can be fabricated or may be available from 3M. After cutting through both layers of tape carefully remove the excess pieces left over the edge (Figure 12). Take care to only contact the edge of the tape that will remain bonded to the glass. Once the excess tape is removed carefully align the two cut edges so they make contact. Apply finger and roller pressure to the tape in the direction from the middle of the tape length moving towards the tape seam (Figure 13).

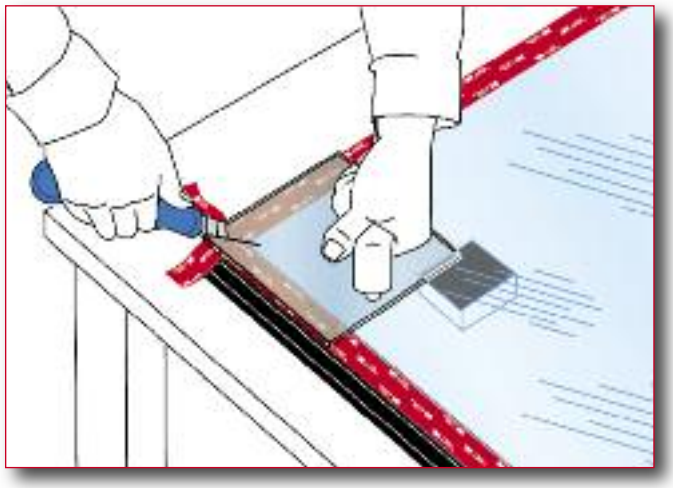


Figure 11: Miter cutting procedure with miter cutting tool

Figure 12: Tape waste removal

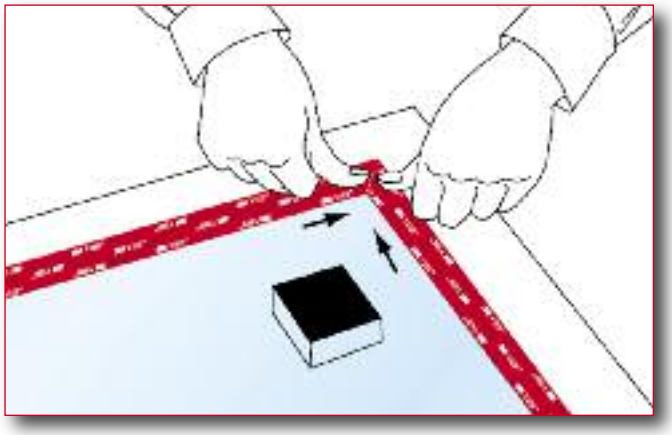


Figure 13: Corner finishing

To achieve a good quality result it is recommended to replace the knife blade frequently. A dull blade may tear the tape and result in a poor quality joint seam. Take care not to press the knife blade too hard through the tape onto the glass as this could result in scratching of the glass surface.

A butt splice can be used for corner splicing or when the 3M™ VHB™ Structural Glazing Tape roll ends in the middle of a glass edge or frame. Use the same general splicing procedure as shown in Figures 11 and 12. The tape is overlapped and a cut is made at 90° instead of a 45°. Remove the tape waste taking care to only touch the edges of the tape that will remain bonded to the glass. Carefully bring the cut edges of the tape together in proper alignment forming the butt splice. Apply finger or roller pressure moving towards the splice from both sides of the seam.

3. Joining of Parts and Final Pressure Application

A key benefit of the 3M™ VHB™ Structural Glazing Tape fabrication process is immediate handling strength. This feature requires that the glass and frame must be in proper alignment when first contact is made in the bonding process. Simple techniques and tools are utilized in the fabrication process to ensure proper alignment is achieved when the glass first contacts the frame. Figure 14 shows a possible way to stage the structural glazing frame and glass on the workbench. The structural glazing metal frame is placed first on the table with the previously prepared bonding surface up.

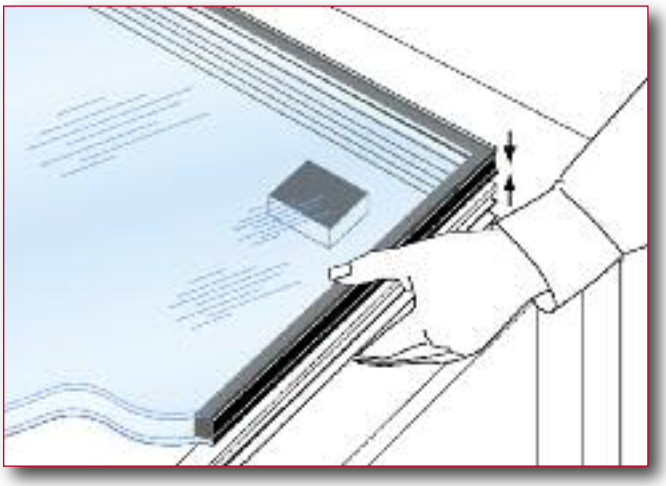


Figure 14: Lifting frame to contact tape on glass

The glass support blocks are placed inside the perimeter of the frame. Next, the glass is placed on the support blocks with the tape (inside surface) facing down. The liner is then removed and the frame is lifted up to make contact with the exposed, tacky tape surface.

A unitized curtain wall will likely require that the glass panel be set onto the fully assembled metal frame. The unitized curtain wall section typically accommodates more than one glass panel. Powered vacuum lifters are commonly utilized for setting large glass panels into unitized curtain wall sections. An example of setting glass into a unitized curtain wall frame is shown in Figure 15.

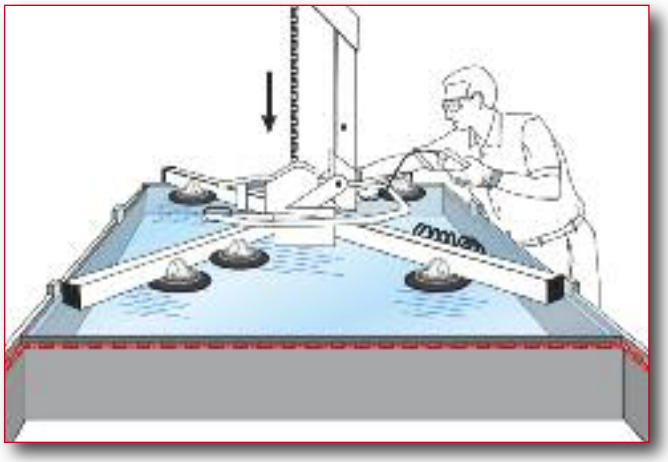


Figure 15: Glass placed into unitized frame

The glass should be sized such that when it is bonded to the frame there is a gap between the edge of the glass and the deadload support fin of the structural glazing frame around the entire perimeter of the glass. This will leave a space to fill with an appropriate sealant to form a weather seal for the assembled unit. Spacers or shims of appropriate thickness placed around the frame perimeter prior to joining the parts together can help to provide this uniform gap around the perimeter of the glass for the weather sealant. These will also act to aid in proper alignment of the glass to the frame. The spacers should be taller then the glass is thick to allow them to be removed easily from the assembly once the parts are joined together. Spacers are useful for glazing systems that have a lip extending around the entire perimeter edge of the glass. A simple spacer or alignment tool is shown in Figure 16.

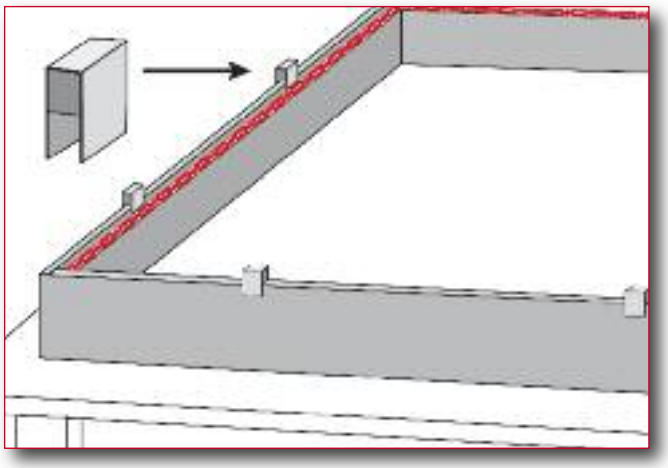


Figure 16: Temporary spacers in position for maintaining glass alignment

If spacers are not available or an alternative frame style is used a technique known as “pig-tailing” may be used to properly align the glass with the frame (Figures 17 and 18). This technique involves removing about a 10 cm (4") long section of the tape protective liner from each corner of the glass in both directions. This section of liner is then folded inward or outward – like a loose “pig-tail”. The frame is then positioned to make contact with the tape/glass. Alignment will still be possible because most of the tape is still covered by the protective liner. Once proper alignment is achieved, apply light pressure to the corners where the protective liner has been removed from the tape. The frame should remain in place after the light pressure application. The loose “pig-tail” of liner can then be grasped to remove the remainder of the liner by carefully pulling it from under the frame. This technique is only recommended for light weight frame systems or monolithic glass.

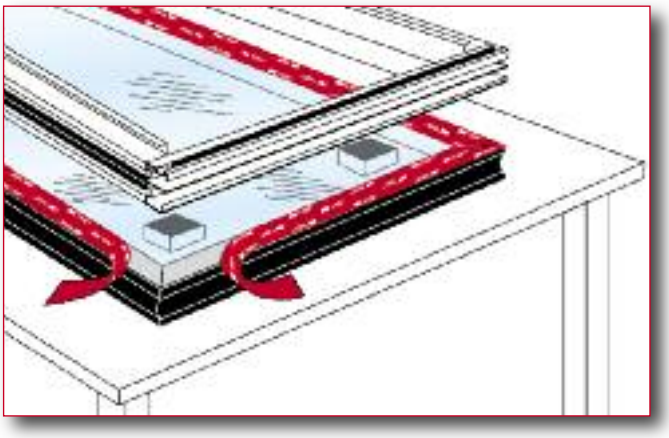


Figure 17: “Pig-tailing” technique

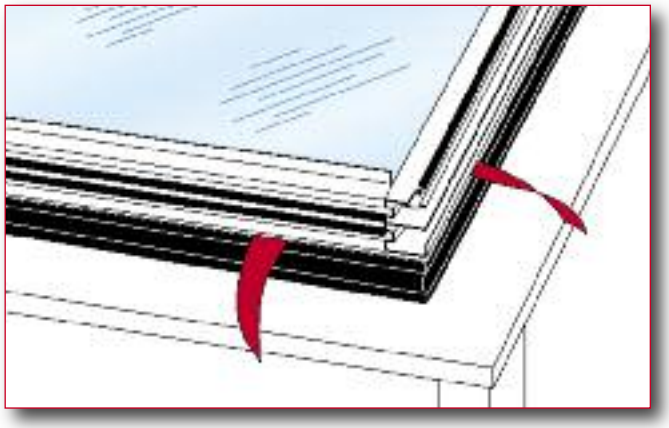


Figure 18: Frame set on glass and liner

Once the glass and frame are bonded together final application pressure must be applied around the entire perimeter of the glass and frame – over the entire bonding area. There are several ways to accomplish this. One way is to remove the support blocks so the frame is resting on the table with the glass up. 3M approved equipment is available and must be utilized to ensure that a roll down pressure of at least 1 kg/cm² (15 psi) is applied over the entire bonding area. Figure 19 depicts the use of an appropriate pressure applicator. Alternatively, final application pressure may be applied using a pressure clamping tool outfitted with a flat pressure plate or roller ends. The clamp or rollers are placed over the glass and frame and locked in place applying a “pinching” pressure to the assembly. The pressure clamp is then pulled around the entire perimeter. The clamp must be checked to ensure a minimum of 1 kg/cm² (15 psi) of pressure is being applied to the assembled parts.

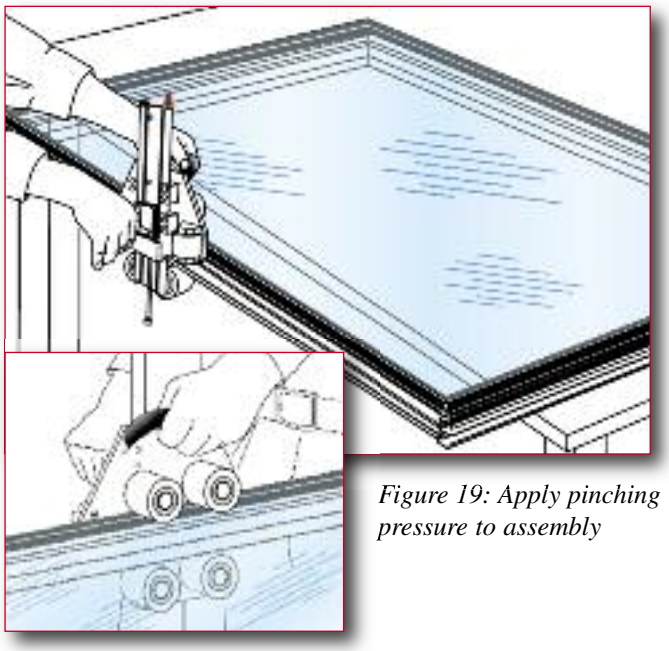


Figure 19: Apply pinching pressure to assembly

A vacuum table is also an option for applying pressure to the assembled curtain wall or commercial window unit. This pressure application technique involves drawing a negative pressure on the interior side of the glazed unit resulting in a temporary compressive force on the 3M™ VHB™ Structural Glazing Tape. Please consult with a 3M representative for further information on this pressure application technique.

The methods described above for tape and pressure application are fairly simple methods for panel fabrication with 3M™ VHB™ Structural Glazing Tapes. Equipment is also available that can be used to automate or semi-automate the application of tape and the application of pressure. 3M approved pressure application equipment must be used for the final pressure application step. Please consult a 3M Sales, Marketing or Technical Service Representative for more information on automation of the 3M™ VHB™ Structural Glazing Tape bonding process.

Weather Sealant Application

A neutral-curing (non-acidic) silicone sealant should be applied around the entire perimeter of the glass once it's bonded to the structural glazing frame (Figures 20-23). This will act as a weather sealant and help to protect the 3M™ VHB™ Structural Glazing Tape from potentially aggressive glass cleaning agents and should be done while the glazed units are still in the shop if possible. Sealant may be applied immediately after final pressure application to the assembled units. Use an appropriate sealant that has the required performance and durability for the application. It is important to apply the sealant around the entire perimeter of the glass to establish a proper seal. Acid curing silicone sealants are known as "acetoxy cure" silicone sealants and should be avoided.

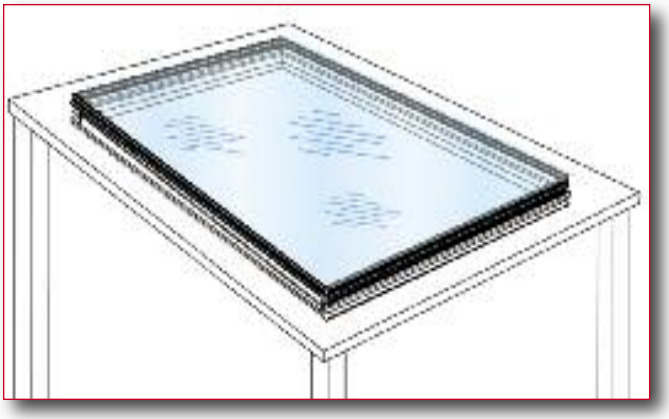


Figure 20: Frame bonded to glass

Figure 21: Weather sealant application

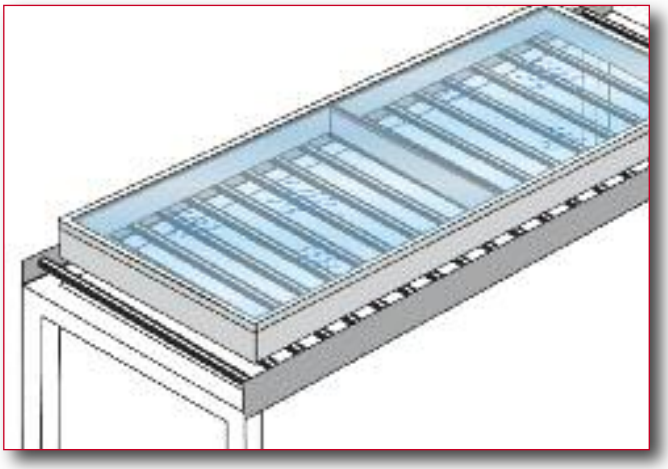


Figure. 22: Unitized curtain wall - glass bonded to frame

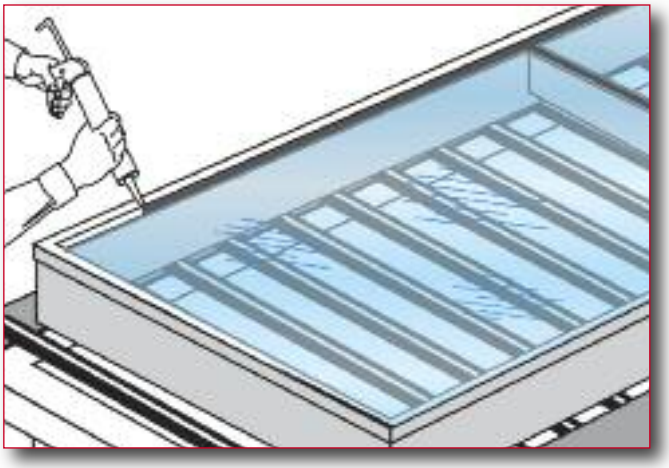


Figure. 23: Weather sealant application – unitized curtain wall

A backer rod may be placed in the weather sealant gap prior to filling with silicone sealant. The backer rod is typically a size (diameter) approximately 25% greater than the joint cavity and must be placed as deep as possible into the weather sealant gap. This is to ensure that the majority of the glass edge has weather sealant between it and the metal frame.

Masking tape may be used on the glass face and the outside edge of the metal frame to keep excess weather sealant from contacting these areas to ensure an aesthetically pleasing finished product. Remove the masking tape before the sealant skins over (within about 15 minutes after application of the sealant).

Important: When using silicone sealants, be careful to avoid contaminating other pre-bonded parts or works areas where 3M™ VHB™ Structural Glazing Tapes will be applied. It is best to have the silicone sealant applied in an area away from where tape is being applied and surfaces are being cleaned. It should also be done by someone who is not involved in surface cleaning or tape application activities.

Bond Build Rate

After proper application of the tape as previously described, the bond strength will increase as the adhesive flows and makes more intimate contact with the bonding surface. There is no curing reaction taking place. At room temperature (21ºC/70ºF), approximately 50% of the ultimate strength will be achieved in 0 to 20 minutes after pressure application, 75% after approximately 1 hour, 90% after 24 hours and 100% after 72 hours. In some cases, bond strength can be increased and ultimate bond strength can be achieved more quickly by exposure of the bond to elevated temperatures (e.g. 50ºC/122°F) or when the surfaces are either abraded or primed. In these cases ultimate bond strength may be achieved in as little as one hour.

After assembly the glazed units can be handled immediately and stacked for storage or shipment. They should remain in an environment at a minimum temperature of 15ºC (60ºF) for 24 hours before the assembled units have significant forces acting on the 3M™ VHB™ Structural Glazing Tape joint.

Storage, Shipping, Handling and Installation of Glazed Units

Curtain wall or commercial windows systems glazed with 3M™ VHB™ Structural Glazing Tape are designed to prevent stress loads from exceeding the allowable design strength and movement values as described in the Design Considerations section of this Technical Guide when structural glazed systems are installed in buildings facades. The storage, shipping and handling of curtain wall or commercial window units must also be considered because the applied stress loads on the 3M™ VHB™ Structural Glazing Tape may be different. The stress loads during these activities, although temporary, should be evaluated to develop appropriate storage, shipping and handling techniques that will avoid excessive stress beyond 3M design guidelines and minimize damage to the unit.

It is expected that both the fabricator and installer adhere to industry-recognized practices in the fabrication, storage, shipping and installation of curtain walls or commercial window units. Such practices will help maintain a safe work environment and minimize the chance of damage to the glazed unit during each stage.

Storage and Crating: Storage and crating of glazed units can create situations where excessive loads are applied to glazed units and the 3M™ VHB™ Structural Glazing Tape. Horizontal stacking of a structurally glazed unit directly upon another unit, without support, should be avoided as this may causes excessive stress on the frame system and the 3M™ VHB™ Structural Glazing Tape bond. If horizontal storage or crating is necessary each unit should be stacked independently from adjacent units to avoid excessive stress and torsional mullion movement. Crates or pallets with multiple glazed units should be lifted by the support structure and not by the glazed units.

Vertical storage and crating of glazed units create a situation that shifts the static load of the glass lite on the 3M™ VHB™ Structural Glazing Tape from the horizontal mullion to the vertical mullion. This may create a condition where static load stresses from the glass lite may exceed 3M design guidelines. If glazed units are to be stored vertically, properly sized edge blocks should be placed along the vertical sides of the glass to support the dead load of the glass lite. Edge blocks should consist of an appropriate silicone, EPDM or neoprene rubber material and tested or verified to be compatible with the perimeter weather sealant. 3M generally suggests the use of edge blocks on the vertical glass edges to minimize or prevent excessive torsional stresses during the lifting and installation of the curtain wall or commercial window unit onto the building facade. In addition, edge blocking may also be used to accommodate significant building sway or seismic movement. In either situation, the designer of the curtain wall or commercial window unit is responsible for proper sizing, selection and placement of edge blocks.

Installation: Improper hoisting, lifting and installation of curtain wall and commercial window units may impart excessive stresses, beyond 3M's maximum stress design loads for 3M™ VHB™ Structural Glazing Tape. Safe lifting practices must be utilized at all times. Improper use of lift equipment, including straps, slings or cables may result in overloading, excessive speed (e.g., taking up slack with a sudden jerk, shock loading), or sudden acceleration/ deceleration of the unit. Each of these situations may create stresses beyond 3M design guidelines and cause physical damage to the glazed unit.

During the installation process, techniques which avoid extreme torsional twisting and high impact/excessive stress loads should be used, especially during cold weather periods when installation or exposure temperatures are below -15°C (5°F). For example, impacting mullions directly with heavy hammers for alignment purposes should be avoided. Proper care should be taken during the entire glazing process and after installation to minimize damage or breakage of the glass and glazing profiles.

Lifting a unitized curtain wall with a powered vacuum lifter applied to single lite of glass (in a unit with multiple lites of glass) is an unsafe practice which should be avoided. Doing so will place the entire load (the remaining glass lites and frame system) onto the 3M™ VHB™ Structural Glazing Tape placed around the perimeter of the single glass lite. This has the potential of creating stresses beyond 3M design guidelines. Unitized curtain walls or commercial window units should generally be lifted by the anchor brackets or hooks attached to the frame.

Techniques used to adjust/align and fasten glazed units to floor slab anchor brackets or into window openings should be done in a manner that avoids excessive torsional twisting or joint separation of the glazing profiles between the vertical and horizontal mullions.

After installation, high impact or shock loads should be avoided where the glazed units will experience continued exposure to temperatures below -15°C (5°F). Captured glazing mullions or pressure plates should be considered if high impact stress loads could occur in extreme cold temperature environments.

These guidelines are considered sound practices for storage and handling of structurally glazed curtain wall or commercial window units. Ultimately, it is the responsibility of the fabricator and installer to adhere to industry-recognized practices (directly and indirectly) in the fabrication, storage, shipping and installation of curtain wall or commercial window units. The implementation of these techniques will help reduce the risk of personal injury or damage/failure of the glazed units.

Sloped Glazing

Sloped glazing is a type of structural glazing used for non-vertical applications, for example, skylights. The calculations for a sloped glazing application will vary slightly from the conventional calculations listed earlier in this technical guide. Please contact a 3M representative to help determine the suitability of 3M™ VHB™ Structural Glazing Tape for a sloped glazing application. Local building codes may also influence the design and testing requirements of a sloped glazing system.

Protective Glazing

3M™ VHB™ Structural Glazing Tape has been tested for use in protective glazing systems including missile impact/hurricane pressure cycling, seismic event, and bomb blast. 3M™ VHB™ Structural Glazing Tape is only one component of a system that includes the framing system, glass and laminate. Bomb blast systems also involve intricate systems to absorb and dissipate the high energies associated these type of events. The unique energy absorbing/stress relaxation characteristics of viscoelastic 3M™ VHB™ Structural Glazing Tape demonstrates the potential to consider it for these types of applications. 3M does not provide “approval” for these types of systems as the system designer is usually required to test specialized designs. 3M Technical Service Representatives are available to offer consultation if a protective glazing system utilizing 3M™ VHB™ Structural Glazing Tape is being considered for an application.

Glass Replacement and Remedial Glazing

Glass breakage may occur during any phase of a construction project or after the project has been completed. It is important to consider how the system will be replaced or re-glazed in the event of glass breakage. This may vary from project to project dependent on the design of the glazing system. Always contact your 3M representative for specific advice on this process. Listed below are some general guidelines on the replacement or re-glazing of a 3M™ VHB™ Structural Glazing Tape structurally glazed unit.

Replacement Glazing Due to Glass Breakage

The following procedure is specific for a 3M™ VHB™ Structural Glazing Tape structurally glazed system. The application should be verified as a 3M™ VHB™ Structural Glazing Tape project and the original project specific 3M technical report should be available for reference. Contact your 3M representative if this information is not available. Prior to deglazing an assessment should be made by a 3M representative along with other building and contractor representatives to determine the cause of failure. A written record of this inspection should be retained by all appropriate parties.

It is recommended to replace the entire frame and glass panel unit, if possible, with a newly fabricated unit. If this is not possible, follow the deglazing procedure described below.

1. Cutting through the 3M™ VHB™ Structural Glazing Tape bondline is the most effective way of separating the glass lite from the structural frame. This will require special tools such as piano wire (Figure 24), an automatic sealant cutter (Figure 25), or a sharp blade to cut through the 3M™ VHB™ Structural Glazing Tape. Use a lubricant such as liquid soap to quicken cutting through the tape. Care should be exercised to avoid damaging of the frame surface or the glass if they are to be used in the re-glazed unit.

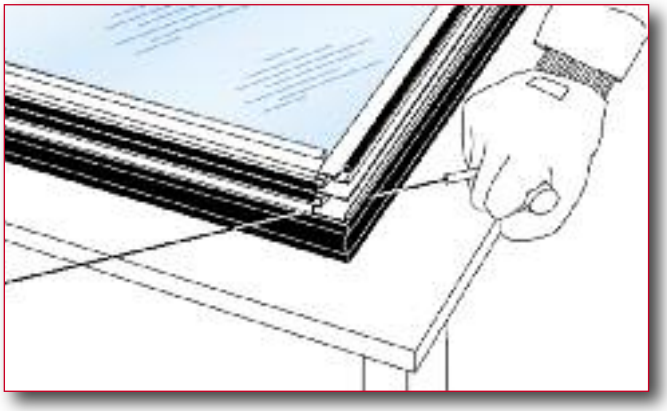


Figure 24: Cutting through tape with “Piano Wire”

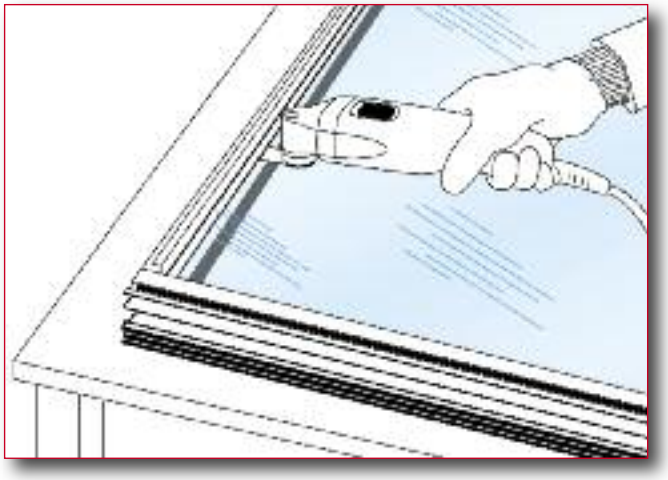


Figure 25: Automatic sealant cutter

2. Residue removal – The 3M™ Stripe Off Wheel (part # 07498) is a special rubber disk which mounts to a standard corded or cordless electric drill and can be used to remove the adhesive residue from the glass panel and metal frame (Figure 26). When the rotating disk is brought in contact with the adhesive residue, it lifts and removes the adhesive from the surface. The wheel will not damage the surfaces if used properly. It may help to remove the bulk of the adhesive residue with a razor or sharp knife before using the Stripe Off Wheel. Another alternative is to grasp a portion of the adhesive residue and attempt to stretch and release the tape from the frame or glass. This should be attempted before cutting the adhesive residue and often results in a complete and clean removal.

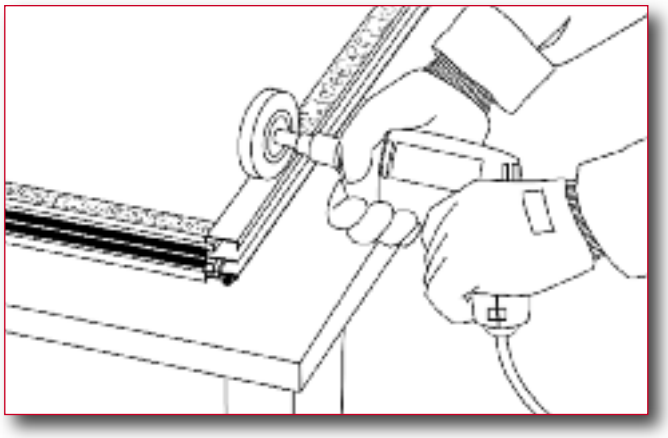


Figure 26: 3M™ Stripe Off Wheel

Note: Follow manufacturer's safety instructions and precautions for tool operation and use. 3M™ Adhesive Remover (Citrus Base) or 3M™ General Purpose Adhesive Cleaner 08984 can be utilized to remove the last residue. Follow solvent manufacturer's precautions and directions for using cleaners.

3. Clean the glass and frame surface with the "two cloth" cleaning procedure utilizing the IPA/water solution described earlier in this technical guide. The original project specific 3M technical report should also be referenced to determine if priming or abrasion is required for maximum bonding performance. Be sure that all the adhesive residue and sealant residue are removed before re-glazing.
4. Apply 3M™ VHB™ Structural Glazing Tape to the glass or frame as described in the 3M™ VHB™ Structural Glazing Tape Application section of this document. Be sure to use the correct width of tape based on the appropriate structural calculations for the application.
5. Place the glass into the structural glazing frame. It may be best to use the "pig-tailing" method described earlier in this document. Temporary and removable spacers should be placed along the deadload support fin and around the perimeter of the structural glazing frame to assure that a consistent gap is maintained between the edge of the glass and frame for application of silicone weather sealant.
6. Application of pressure – apply a minimum of 1 kg/cm² (15 psi) roll down pressure along the entire perimeter of the re-glazed unit to ensure that the tape has made good contact with both the glass and frame surfaces. The glass lite should fit properly into the structural frame without forcing. There should be no evidence of excessive visible gaps or distortions. If this cannot be accomplished, the structural frame will need to be removed and replaced with a new, structurally sound frame.
7. Temporary fasteners should be used to hold the re-glazed glass lite in place for a minimum of 24 hours assuming a minimum temperature of 15°C (60ºF) at the tape bondline.
8. Remove the temporary fasteners and temporary spacers along the bottom edge of the glass. Apply a bead of silicone weather sealant around the entire edge of the glass as described earlier in the Weather Sealant Application section of this technical guide.

Replacement Glazing Due to System Failure

Please consult a 3M representative if the re-glazing project includes a major remedial operation to help determine the cause of the system failure. It is important to document dates and project specific details related to the system failure to determine the best remedial solution.

Equipment Suppliers

Designetics
888-886-8477
www.designetics.com
(Dauber bottles, primer applicators)

Dakota Automation
605-886-9724
www.dakotaautomation.com
(Automated tape applicators)

Straub Design
952-886-9724
www.straubdesign.com
(Hand applied tapers, automated tape applicators)

Rockler
800-279-4441
www.rockler.com
(J-rollers for pressure application)

Vulkan Technic
www.vulkantechnic.de
(Pressure applicators, tape applicators, corner miters, cutters and custom equipment)

Fein
www.feinus.com
(Deglazing tools)

Erdman Automation Corp.
763.389.9475
www.erdmanautomation.com
(Automated tape applicators, pressure applicators, glass lay-in tables, weather sealant applicators and custom equipment)

Quality Assurance and Warranty Documentation

The 3M™ VHB™ Structural Glazing Tape project checklist and a project initiation form is provided on the following pages. Adhesion test results and application specific guidelines and instructions are generated by 3M for each 3M™ VHB™ Structural Glazing Tape project. Training and audit documents are also provided by 3M and must be available from the contractor, fabricator or owner in the event of a warranty claim or inspection for review by 3M and/or the local building official.

The customer should retain these documents for the length of the warranty period for projects with an application warranty. Contact your 3M Sales Representative for questions related to these documents or the quality control process. 3M is available to assist in the implementation of a quality control program.

Supporting Literature

	3M Literature Number
Design Guide for Structural Glazing & Architectural Panels	70-0709-4039-3
3M™ VHB™ Tapes Design Guide	70-0709-3830-6

Technical Data Sheets

3M™ VHB™ Structural Glazing Tapes Data Sheet	70-0709-3999-9
AP115 Silane Glass Treatment	70-0709-4001-3
AP111 Adhesion Promoter	70-0709-3983-3
Primer 94	70-0709-3853-8
Surface Cleaning and Priming Products	70-0707-6193-0

Technical Bulletins

Structural Performance Tests of 3M™ VHB™ Structural Glazing Tape	70-0709-4067-4
Structural Performance & Design Stress Proof Tests of 3M™ VHB™ Structural Glazing Tape	70-0709-3991-6
Structural Performance Tests of Architectural Metal Panels	70-0709-3967-6
Surface Preparation for 3M™ VHB™ Tape Applications	70-0704-8701-5
Glass Bonding and Silane Coupling Agents	70-0702-9983-2
3M™ VHB™ Tape Durability	70-0709-3862-9
VHB™ Tape Cold Temperature Performance	70-0707-3991-0
Disassembly of VHB™ Tape Bonded Materials	70-0707-6190-9
VHB™ Tape Removal Systems	70-0707-6190-6

European Technical Approval

ETA - 09/0024 3M VHB Structural Glazing Tape G/B 23F	www.eota.eu/

White Papers

Acrylic Foam Structural Glazing Tapes (Austin/Manert) – *11DBMC International Conference on Durability of Building Materials and Components ISTANBUL, Turkey 11-14 May 2008*	http://11dbmc.org
Evaluating the Performance and Durability of Acrylic Foam Tapes for Structural Glazing Applications (Austin/Salmon) – *PSTC Tech 33, Las Vegas, NV, May 12-14, 2010*	www.pstc.org
Relating Artificial Weathering Testing To Service Life Estimation Of Acrylic Foam Structural Glazing Tape Systems (Austin/Burns) – *PSTC Tech 32, Orlando, FL, May 11-15, 2009*	www.pstc.org
Useful Design Criteria For Acrylic Foam Tapes In Demanding Industrial Applications (Kremer) – *PSTC Tech 28, Baltimore, Maryland, May 4-6, 2005*	www.pstc.org

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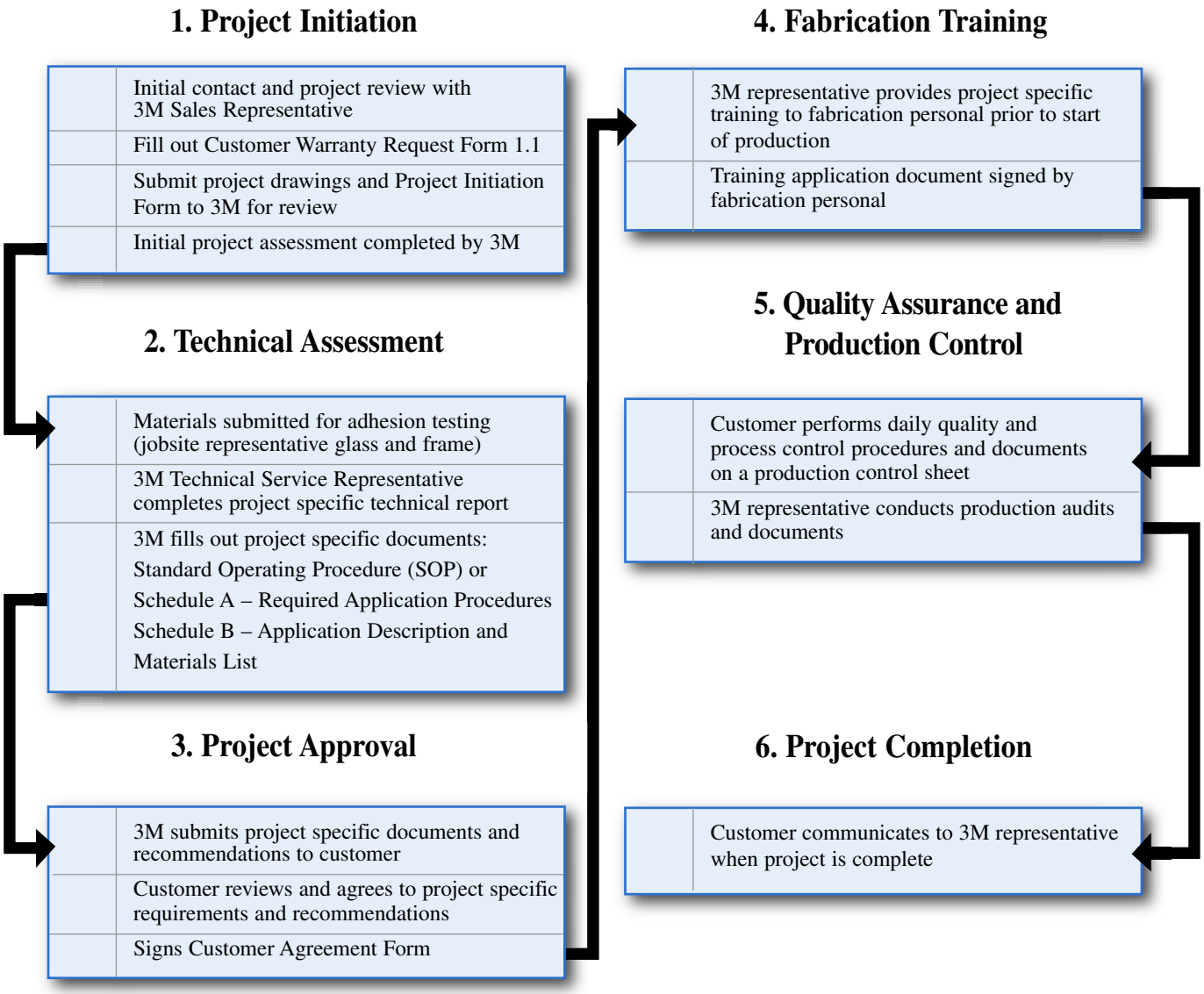
3M™ VHB™ Structural Glazing Tape Project Checklist

The following checklist activities must be completed for 3M™ VHB™ Structural Glazing Tape projects. Check off on each item below by filling in a date of completion for each activity. Copy the document and submit to 3M representatives.



For additional information on 3M™ VHB™ Structural Glazing Tapes and associated applications please visit **www.3m.com/vhb/structuralglazing**

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3M™ VHB™ Structural Glazing Tape Application

Project Initiation Form

Project Initiation Form to be completed by 3M Sales, Marketing or Technical Service Representative, and Customer. Document returned to 3M to initiate the Initial Project Assessment.

Date of Request _____ 3M Contact (Initiator): _____

Field Location: _____ Phone Number: _____

Customer (Fabricator) Name: _____

Customer Contact: _____ Customer Phone: _____

Customer Address: _____

Building (Project) Name: _____

Building Address: _____

Building Height: _____ Number of Floors: _____

General Contractor (if relevant): _____

Consultant/Control Office (if relevant): _____

Architect and Firm (if relevant): _____

Project Materials

Glass Type: ☐ Insulated (IG) ☐ Laminated ☐ Monolithic Stepped Glass: ☐ Yes ☐ No

Glass Finish: ☐ Uncoated ☐ Coated – Coating Type: _____

Glass Bonding Side: ☐ Coated Side ☐ Uncoated Side

Glass Manufacturer: _____

Frame Type (model): _____ Frame Manufacturer: _____

Frame Material: ☐ Aluminum ☐ Stainless Steel

Frame Finish: ☐ Anodized – Color: _____

☐ Painted – Color and Type: _____

☐ Bare

Does the frame provide deadload support? ☐ Yes ☐ No

Note: *The frame must provide deadload support for insulated glass (IG) lites as well as other glass types depending on thickness and mass (weight).*

Project Specific Design Parameters

Design Required Windload (Design Pressure): _____ Hurricane/Typhoon Area? ☐ Yes ☐ No

Glass Lite Dimensions

Glass Lite #	Width (mm/in.)	Height (mm/in.)	Quantity/Project	Vision or Spandrel	Thickness (include both lites and space if IG)	Mass (Weight) of Glass Lite
1						
2						
3						
4						
5						
6						
7						

Estimated Project Volume (total length of tape): Lineal meters (ft./yds.) _____

NOTE: *width of tape will be determined by project specific calculations*

Other Considerations (seismic region, etc.): _____

Has the customer/fabricator previously been trained for 3M™ VHB™ Structural Glazing Tape projects? ☐ Yes ☐ No

NOTE: Customer assumes responsibility for meeting local business codes

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Global 3M Contact Information for 3M™ VHB™ Structural Glazing Tape:

Asia Pacific (APAC)

Australia	61 2 9498 6666
China	(86-21)22102408
Hong Kong	(852) 2806 6387
India	91 80 22231414
Indonesia	62-21-5203401
Japan	81-3-3709-8245
Korea	082-02-3771-4046
Malaysia	60-3-7806 2888
New Zealand	64-9-4774040
Philippines	63-2 878-3674
Singapore	65-6450-8888
Taiwan	886-2-37013350
Thailand	662-260-8577

Europe, Middle East and Africa

Austria	0043-1-86686 - 0
Belarus	00375-172-222-4607
Belgium	0032 325075-11
Bulgaria	00359-2-9601911
Croatia	00385-1-2499-750
Czech Republic	00420-261-380-111
Denmark	0045-4348-0100
Egypt	0020-2-5259007
Estonia	00372-6400430
Finland	00358-9-52521
France	00358-9-52521
Germany	02131/14-0
Greece	0030-210-6885256
Hungary	0036-1-270-77.77
Israel	00972-9-961-5000
Italy	0039-02-70351
Kazakhstan	007-3272-509944
Latvia	00371-2282750
Lithunania	00370-2-629783
Netherlands	003171-5-450-450
Norway	0047-63-847-500
Pakistan	0092-21-111-2255-36
Poland	0048-22-739-60-00
Portugal	00351-21-313-4500
Rumania	0040-21-202-8000
Russia	007-495-784-74-74
Saudi Arabia	00966 1 4650052
Serbia	00381-11-313 25 50
Slovakia	00421-2-4910-5222
Slovenia	00386-1-2003-630
Spain	00349-900-210584
Sweden	0046-8-922100
Switzerland	0041-44-724-90-90
Turkey	0090-216-538-07 77
Ukraine	0038-044-490-5777
United Arab Emirates	00971-4-3670777
United Kingdom	0044-1-344-858000

Latin America

Argentina	+ 54-11-4469-8200
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Central America	+506-277-1160
Chile	+56-2-410-3305
Colombia	+571-416-1666
Ecuador	+593-4-280-0777
El Salvador	+503-22100830
Guatemala	+ 502-2379-3636
Mexico	+52-55-5270-0400
Panama	+507-302-8100
Paraguay	+607-245- 61-2076
Peru	+57-315-779-2817
Venezuela	+58-212-957-8111
LA Regional Business Contact	+1-651-503-7293
LA Regional Technical Contact	+57-310-262-6174

North America

Canada	1-800-364-3577
United States	1-800-362-3550

Certification/Recognition

MSDS: 3M is not required to prepare an MSDS for these products which are not subject to the MSDS requirements of the Occupational Safety and Health Administration's Hazard Communication Standard, 29 C.F.R. 1910.1200(b)(6)(v). When used under reasonable conditions or in accordance with the 3M directions for use, these products should not present a health and safety hazard. However, use or processing of the products in a manner not in accordance with the directions for use may affect their performance and present potential health and safety hazards. TSCA: These products are defined as articles under the Toxic Substances Control Act and therefore, are exempt from inventory listing requirements.

Product Use

All statements, technical information and recommendations contained in this document are based upon tests or experience that 3M believes are reliable. However, many factors beyond 3M's control can affect the use and performance of a 3M product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application. All questions of liability relating to this product are governed by the terms of the sale subject, where applicable, to the prevailing law.

Limited Warranty

3M warrants for 24 months from the date of manufacture that 3M™ VHB™ Tape will be free of defects in material and manufacture. 3M MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. This limited warranty does not cover damage resulting from the use or inability to use 3M™ VHB™ Tape due to misuse, workmanship in application, or application or storage not in accordance with 3M recommended procedures. AN APPLICATION WARRANTY EXPRESSLY APPROVED AND ISSUED BY 3M IS AN EXCEPTION. THE CUSTOMER MUST APPLY FOR A SPECIFIC APPLICATION WARRANTY AND MEET ALL WARRANTY AND PROCESS REQUIREMENTS TO OBTAIN AN APPLICATION WARRANTY. CONTACT 3M FOR MORE INFORMATION ON APPLICATION WARRANTY TERMS AND CONDITIONS.

Limitation of Remedies and Liability

If the 3M™VHB™ Tape is proved to be defective within the warranty period stated above. THE EXCLUSIVE REMEDY, AT 3M'S OPTION, SHALL BE TO REFUND THE PURCHASE PRICE OF OR TO REPAIR OR REPLACE THE DEFECTIVE 3M™ VHB™ TAPE. 3M shall not otherwise be liable for loss or damages, whether direct, indirect, special, incidental, or consequential, regardless of the legal theory asserted, including but not limited to tort, contract, negligence, warranty, or strict liability.

3M

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