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Quality Control Technical Manual

GE Silicones Construction Sealants

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Contents

Introduction

Purpose

The purpose of this manual is intended to provide guidelines to construction professional and assists in the development of quality assurance program for the application of GE Silicone Sealants in structural glazing and weatherproofing applications. However, this manual cannot be considered a comprehensive quality assurance for all situations as construction projects may vary.

About Momentive Performance Materials

Momentive Performance Materials was created from the sale of GE Advanced Materials to Apollo Management, L.P. in December 2006. We are the world's second-largest producer of silicones and silicone derivatives and a global leader in the development and manufacture of products derived from quartz and specialty ceramics. Silicones are a multi-functional family of materials used in thousands of products and serve as a critical ingredient in many construction, transportation, personal care, electronic, consumer and agricultural uses. Industries served include aerospace, agriculture, appliances, automotive, construction, electronics, furniture and furnishings, healthcare, home care, industrial, lighting, packaging, personal care, plastics, semiconductor, telecommunications, tire, transportation, and water purification.

www.momentive.com
www.gesealants.com

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A. Product Overview

Structural Glazing Silicone Sealant

To meet the varied requirements of different construction applications, Momentive Performance Materials has developed a full range of silicone construction sealants, each offering the ideal property profile for its intended use. The information in this section will enable you to choose the best silicone sealant for your project.

The performance and proven reliability of GE Silicone Construction Sealants have made them the sealants of choice for construction projects throughout the world. You will find the variety of GE Silicone Construction Sealants maximizes your design freedom for both new construction and remedial projects.

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GE UltraGlaze SSG4000 Sealant

For both field and in-shop glazing applications requiring the ultimate strength, GE UltraGlaze SSG4000 (1-part) structural sealant is the ideal choice. It is a high modulus and exhibits excellent adhesion to many construction substrates.

GE UltraGlaze SSG4800J Sealant

This structural sealant was developed to meet increased demands for a fast curing, one-part product for structural applications.

GE UltraGlaze SSG4400 Sealant

This is a 2-part structural sealant engineered for use in structural glazing applications such as factory glazing of curtainwall units and modules for unitized and panelized systems.

GE Construction SCS1200 Sealant

The highest strength acetoxy-cure sealant, for structural glazing and premium general purpose applications. Provides outstanding adhesion and long-life.

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High Performance Weatherproofing Silicone Sealant

GE SilPruf SCS2000 Sealant

The easy-to-apply, high performance, low modulus silicone sealant for use as a weatherseal in both conventional and structural glazing applications.

GE UltraPruf II SCS2900 Sealant

One-part, low modulus, neutral cure sealant designed for high performance weatherproofing applications with ±50% movement capability.

GE SilPruf NB SCS9000 Sealant

A new generation of 100% silicone sealant specially formulated to reduce or eliminate dirt pick up, surface streaking and substrate staining. Meets the non-staining requirements of ASTM <C1248> on limestone.

GE Silglaze N10 Sealant

One-part, neutral cure sealant suitable for non-structural glazing curtainwall joints, window glazing, showroom glazing and general weatherseal applications.

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Specialty Weatherproofing Silicone Sealant

GE Tosseal 83 Sealant

One-part, neutral cure, mildew resistant silicone sealant. Effectively seals around bathroom plumbing fixtures and can be used for sealing ceramic tiles.

GE Tosseal 811/817 Sealant

Specially developed for application in concrete joints that are subject to relatively high joint movement such as roads, highways, car parks and warehouses.

GE Pensil 300 Firestop Joint Sealant

One-part neutral cure silicone sealant for use as a component in fire-rated joint systems for vertical and horizontal joints.

GE Multisil SCS5500 Sealant

One-part, neutral cure non-corrosive, silicone sealant specially design for adhesion on polycarbonate plastic sheet with ±50% movement capability.

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SilPure Weatherproofing SPUR Sealant

GE SilPure SPS1000HM SPUR Masonry Sealant

One-part sealant based on silylated organic polymer. SilPure SPS1000HM does not contain solvents, isocynates, silicones or PVC. It is a high modulus weather sealant compatible to most building substrates material and suitable for all building joints, metal seams, capping, roofing, modular housing, and freight containers, as well as interior applications.

GE SilPure SPS7000 SPUR Adhesives

One-part sealant based on silylated organic polymer. SilPure SPS7000HM does not contain solvents, isocynates, silicones or PVC. SilPure SPS7000 sealant can be used in incidental food contact where FDA regulations apply.

GE SilPure SPS8000 SPUR Clean Room Sealant

One-part sealant based on silylated organic polymer specially design for clean room application. SilPure SPS8000HM does not contain solvents, isocynates, silicones or PVC. Free of low volatiles siloxanes and can be used in incidental food contact where FDA regulations apply.

Adhesion Promoters

GE Silicone Primers SS4004, SS4044, and SS4179

All primers are VOC compliance, one-component products requiring no mixing and are ready-to-use as easily pourable solvent solutions to promote adhesion on difficult-to-bond substrates. It will dry at room temperature and ambient humidity.

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B. Technical Information

B1. Design Criteria

There are several properties relating to the optimum function of sealants in building applications that must be addressed to ensure the proper specification and selection of sealants for the job.

Adhesion refers to the ability of the sealant to bond to building substrates. The wide varieties of substrate materials as well as environmental conditions directly affect adhesion properties. See Project Review section for information about adhesion testing.

Cohesion refers to the ability of the sealant to withstand extremes of expansion and contraction without tearing. Silicone sealants are particularly suited for this, as they remain flexible and physically stable as compared to organic sealants.

Modulus refers to the relationship of stress and strain of the sealant in bonded joints. It indicates the sealant's ability to absorb movement. A low-modulus material transmits a lower force to the bonded substrate than a high-modulus material for a given movement.

Hardness in sealants is generally measured on a Shore-A durometer scale. Higher durometer sealants are preferred for structural glazing applications. Silicone sealants do not harden at low temperatures nor soften at high temperatures.

UV Resistance refers to a sealant's ability to retain its original performance properties after long-term UV exposure. Silicone sealants being inorganic, do not deteriorate, crack or shrink when exposed to ultraviolet (sun) light.

B2. Sealant Selection

Variation in joint design requires specific performance criteria from sealants. Because of this, Momentive Performance Materials offers a complete line of high performance sealants, giving the design professional the ability to specify sealants with the maximum performance profile for specific applications.

There are a number of factors involved in the selection of proper sealant, but the primary factor is the substrate involved and the inherent movement characteristics of that substrate.

Few construction joints are in fact static – most joints are subject to varying degrees of movement, Because of this, silicone sealants, with their inherent flexibility, offer the best solution in most types of joint-sealing applications.

- Stone and glass are subject to little thermal movement
- Masonry and concrete usually have moderate thermal movement
- Metal and plastic are subject to the most pronounced thermal movement

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Key criteria when specifying the proper sealants:

1. What substrates are involved in the joint area?
2. Will the substrate(s) exhibit high, medium or low movement (expansion and contraction)?
3. Will the application require long or short tooling time for the sealant?
4. Is the length of cure time important? (In-shop glazing application, for example, glazed units must often be moved very quickly for efficient unit production.)
5. Is the length of tack-free time an important factor (e.g., disturbing the surface of the sealant prematurely, smudging, etc.)?
6. Does the application require translucent sealants or colors?

B3. Project Review Service

To better serve the industry, Momentive Performance Materials offers a Project Review / Testing Service. This service provides professional technical assistance to aid you in the specification and selection of the proper sealant for your project. The project review is required for all structural glazing applications because of the rigorous performance criteria they must meet.

Proper testing can be performed in a test chamber at our laboratory, or on test panel joints at the building site. Momentive Performance Materials may recommend both types of testing depending on the requirements of the application. Our construction experts are available to assist whenever and wherever you need them.

1. **Specification Review**: Momentive Performance Materials will review project specifications to confirm proper product selection criteria and requirements.

2. **Drawing Review**: Momentive Performance Materials will review all shop drawings and details to confirm the required contact width of the sealant bead and other pertinent performance criteria.

3. **Laboratory Testing**: Momentive Performance Materials will perform laboratory testing of all substrates, which either come in contact with or are in close proximity to the sealant. On remedial projects, Momentive Performance Materials, monitored job site can be substituted.

4. **Project Report**: Momentive Performance Materials will provide a written report covering the test results, product recommendations and substrate preparation requirements.

B4. Extended Project Warranty

Momentive Performance Materials is able to offer extended project warranty for structural glazing and weatherseal (new and remedial) projects. To obtain this warranty, all four elements of the Project Review Service must be satisfactory completed. For warranty details, please kindly contact the nearest Momentive Performance Materials representative for assistance.

C. Drawing Reviews

C1. Structural Glazing

Structural glazing is a system of bonding glass to a building's structural framing members, utilizing a high strength, high performance silicone sealant specifically designed and tested for structural glazing.

In structural glazing applications, dynamic wind loads are transferred from the glass, by the structural silicone sealant, to the perimeter structural support. The net results of this glazing technique are either four-sided systems, which yield an unobstructed glass surface, or two-sided systems, where horizontal or vertical accents can be achieved.

For each structural glazing project, Momentive Performance Materials drawing review service must be utilized for review of sealant dimensions and compatibility.

C2. Advantages Of Structural Glazing

- Allows for broader architectural design flexibility
- Increases the thermal efficiency of buildings because the exterior exposure of metal framing is either reduced or eliminated
- Reduces or eliminates water and air infiltration
- Reduces the potential for thermal breakage of glass

C3. Sealant Design Definitions

Only high strength silicone sealants, specifically designed and tested for structural glazing, shall be used in structural glazing applications. High strength sealants generally have high modulus characteristics. Before defining modulus, the following terms must be understood.

- Elastic limit
- Stress
- Strain
- Hooke's law
- Break strength or stress
- Bond line

Elastic limit → The greatest stress which can be applied to a sealant without leaving a permanent deformation upon completion release of the load.

Stress → Load in pounds (P) acting on sealant bead divided by the area of sealant bead on which the load is acting (A). Unit is measured as PSI (Pounds per Square Inches).

Strain → (Express in %) → Calculated by dividing the amount of sealant bead is extended (inches) by the original bead dimension. Can also be called "elongation".

Hooke's Law → States that the amount of extension (displacement) of a sealant bead is proportional to the stress applied.

Break strength or break stress → Stress (PSI) developed at point of sealant failure = maximum load divided by the area on which the load acts.

Bond line = Contact area → The area of sealant is bonded to the substrate.

Modulus → Modulus is usually expressed in terms of stress at a specific strain or elongation. To the design professional, modulus is a key consideration because too much strain (elongation) may allow excessive flexural, or bending of the glass, when a building is subjected to high wind loads. With insulating glass, excessive flexural may cause edge seal failure or primary seal rapture.

A high modulus sealant reduces the amount of strain (elongation) and therefore, the amount of flexural (bending) of glass. A low modulus sealant implies high strain (elongation).

C4. Significance Of A Safety Factor

The term "safety factor" as applied to structural glazing is the ratio of a sealant's ultimate strength (usually in tension) to the most commonly used design stress 20 psi. Safety factor of 5:1 and 6:1 have proven adequate since the inception of structural glazing and are the most commonly specified. Considering the number of variables, which can be, encountered in a structurally glazed assembly and the potential liability to all participants in the project, the higher the safety factor the more tolerant of errors the system becomes.

Some of the variables, which may affect the sealant strength after application, are:

- Sealant shelf life
- Compatibility of sealant and substrates
- Proper surface preparation (cleaning and, if required, priming)
- Application of sealant to insure proper surface contact, avoiding air entrapment and air voids
- Proper cure time prior to the moving of factory-assembled units or removal of temporary clips in field applications
- Environmental conditions during application and cure such as dust, wind, temperature, rain, etc.
- Batch-to-batch variations in metal finishes (paint or anodizing)

Any of these variables can affect the ultimate strength of the assembly.

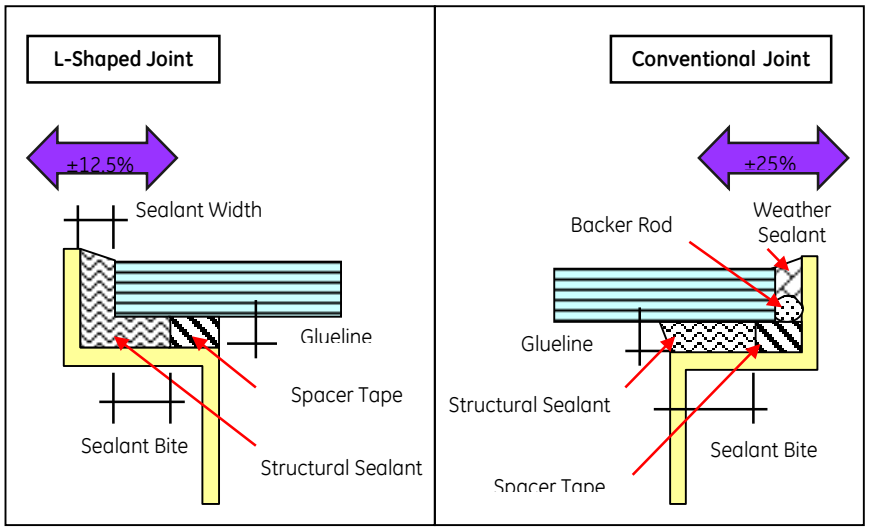
C5. Drawing Reviews

All shop drawings showing the glazing details involving structural sealants shall be submitted to Momentive Performance Materials for review. Structural sealant contact width and thickness calculations will be done by Momentive Performance Materials based on the glazing system, glass size and design wind load.

Documentation of the print review stating the recommended sealant grades and calculated structural sealant dimensions required must be received from Momentive Performance Materials prior to the commencement of assembly work. Momentive Performance Materials is not responsible for calculating movement for joint width considerations. This is the responsibility of the design engineers. Momentive Performance Materials will provide the sealants movement capability and make recommendations on how wide a joint should be for a given expected movement.

C6. Structural Sealant Joint Design

The maximum design stress on the structural silicone sealant shall not exceed 20 psi for materials have a minimum strength of 100 psi. This shall provide a safety factor of not less than 5:1. Structural silicone sealant shall have a minimum modulus of elasticity to limit the movement of the joint width to no more than 25% of the glass thickness of the outboard lite.



Sealant bite = Glueline ≥ 6mm

Sealant Bite/Glueline ≥ 1

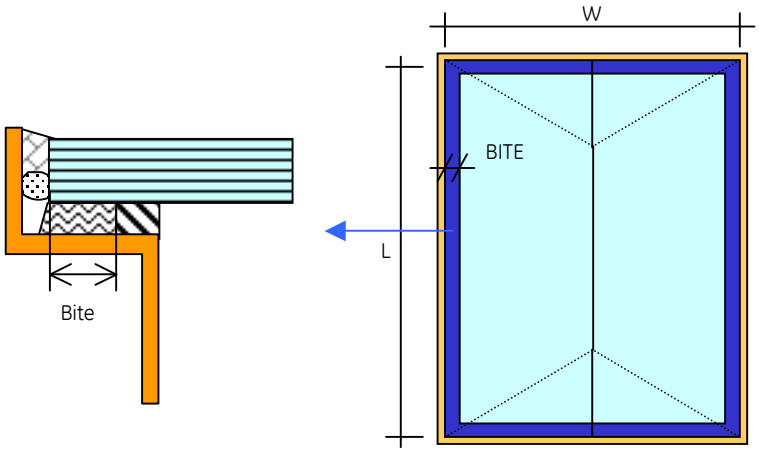
C7. Structural Sealant Bite Calculation

The recommended minimum structural sealant bite and thickness shall not be less than 6mm. The structural sealant bite to thickness ration shall be between 1:1 and 3:1.

The minimum structural sealant bite is calculated with the equation:

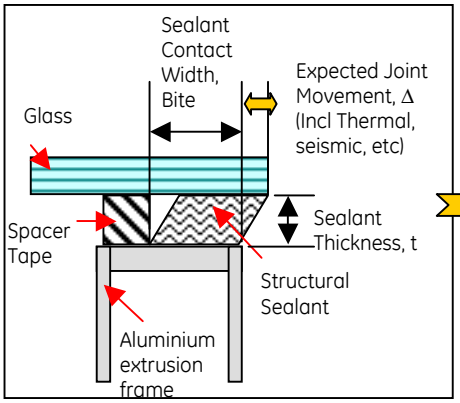
$$\text{Bite} = \frac{\text{DWL (kPa) x LSS (mm)}}{\text{SDS (140kPa) x 2}}$$

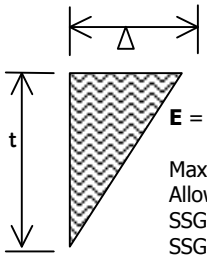
where,
DWL = Design Wind Load
LSS = Longest Short Span
SDS = Sealant Design Stress



C8. Structural Sealant Thickness Calculation

Structural sealant thickness controls the allowable movement of the glass unit within the frame.





E = Sealant under extension
Max elongation
Allowed up to 140kPa:
SSG4400 = 12.5%
SSG4000/4800J = 15%

$E^2 = t^2 + \Delta^2$ ---------- (1)

$E = t \times (1 + \text{max elong \%})$

$= t \times (1+ 0.125) = 1.125\ t$ ----------(2)

Substitute (2) into (1):

$(1.125t)^2 = t^2 + \Delta^2$

$(1.125^2 - 1)\ t^2 = \Delta^2$

$$\mathbf{t = \Delta / (0.515)}$$

Hence, for t = 6mm, Δ = 3.09mm

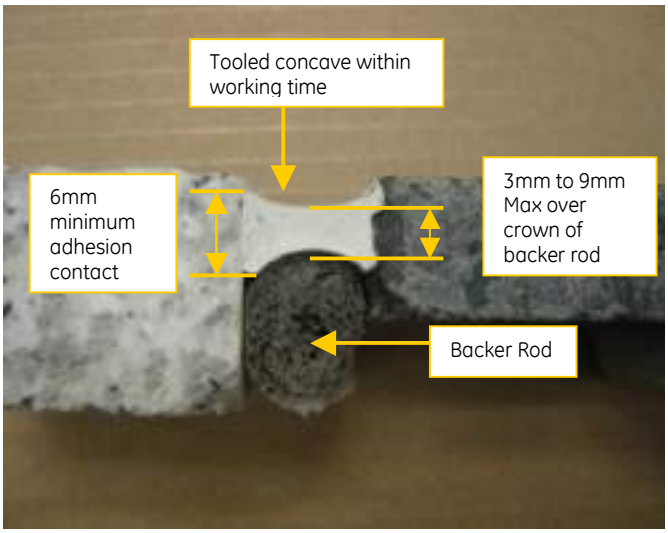
Note:
Recommended minimum structural sealant thickness shall not be less than 6mm

C9. Weatherseal Sealant Joint Design

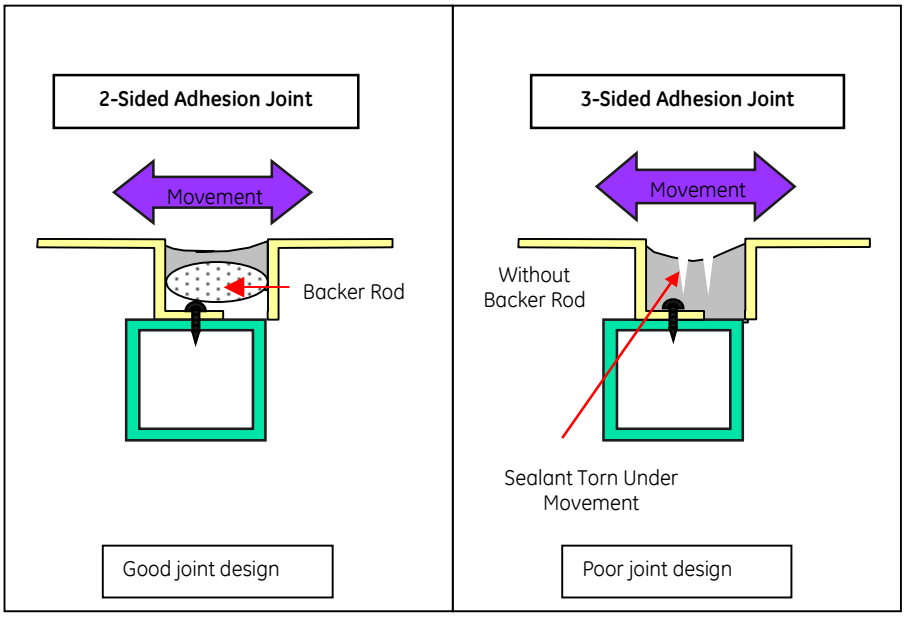
Successful use of any sealant depends on proper pairing of joint design with sealant capabilities. Good joint design, along with proper application of a quality sealant that meets the requirements of the job, is one of the most critical areas for improving sealant performance.

Recommended Good Joint Design

- 2-Sided Adhesion Joint
- Joint Width/Joint Depth = 2
- Joint Depth = 6mm to 10 mm
- Joint Width = 12mm to 20 mm
- Tool within working time
- Closed cell PE materials as backer rod but are subject to puncture and gassing, which may cause out-gassing and bubbling on sealant bead. Use blunt object to insert.
- Flexible open-cell PE Foam backer rods do not out-gas or cause bubbling and are a recommended filler material.
- Make sure no gap in joint
- Backer rod shall be 25% wider than joint width. Round shape for best result.



All the weatherseal joints are acceptable with recommended 2:1 ratio, minimum 6mm thickness for optimal sealant performance. It should also be ensured that proper backing and spacer tape material should be used to prevent 3-sided adhesion.



D. Substrate Testing

Project Substrates Testing

All substrates that are in contact with structural sealant as shown in the shop drawing glazing details must be submitted to Momentive Performance Materials for peel adhesion and compatibility testing according to ASTM C-794 and ASTM C-1087 test method respectively. Judging from case to case, Momentive Performance Materials will also conduct non-stain test for porous substrate to determine the potential of silicone fluid migration into porous substrates such as marble, granite, limestone, and sandstone. If requested, Momentive Performance Materials will also conduct delamination test for laminated glass.

D1. Substrate Requirement For Testing

At least 1 piece of each type of substrate sample measuring minimum 300 mm length x 100 mm wide or equivalent area is required to provide sufficient area for the peel adhesion test. Substrate samples must be of the exact finish as the substrate that will be used in the project. Samples must be resubmitted for retesting if any changes occurred in the substrate material, type or finishing from the sample submitted for testing.

Prior to assembly, all documentation from Momentive Performance Materials as to adhesion tests results, cleaning solvent recommendation, compatibility of spacers, gaskets, setting blocks and any other accessories must be received.

All recommendations from the test report must be incorporated into the project glazing Quality Control procedures. All test reports must be properly filed into the project file and must be available for reference at all times.

a. Aluminium Extrusions

Aluminium extrusions that will be in contact with structural silicone sealant must be in accordance with the sample extrusions submitted to Momentive Performance Materials for peel adhesion testing. All aluminium extrusions shall be marked for the specific project and size, shape and type of finish.

b. Glass

Glass that will be in contact with structural silicone sealant must be in accordance with the sample glass submitted to Momentive Performance Materials for peel adhesion testing. Glass received shall be marked for the specific project, size and type.

Insulating Glass must be verified that the secondary seal is silicone, and is compatible with the other materials and sealants used in the system. Insulating glass secondary seals should be checked for minimum, contact width requirements.

c. Spacers, Gaskets, and Setting Blocks

When at all possible, spacers, gaskets and setting blocks should be of silicone rubber. Generally, neoprene and EPDM are not recommended. Random samples shall be submitted to Momentive Performance Materials for compatibility testing. All materials received shall be marked for the specific project, size, shape and compound.

D2. Peel Adhesion Test

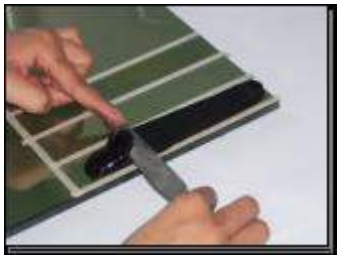
The objective of this test is to determine ability of sealant to adhere on the surface substrates using a modified <ASTM C-794> peel adhesion test method.

Step 1:
Determine the ability of sealant to adhere on the surface of substrates.

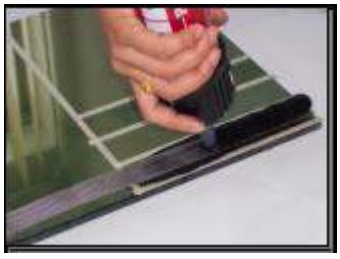
Step 2:
Place a strip of masking tape 25 mm wide
Clean substrate with cleaning solvent (IPA, MEK, Toluene etc) and left it dry for approximately 30 minute.

Step 3:
Apply primer and left it dry for between 30-50 minute.

Step 4:
Apply sealant onto surface of substrate for 2mm thickness



Step 5:
Press wire-gauze strip on the applied sealant
Apply sealant on wire-gauze for 2 mm thick

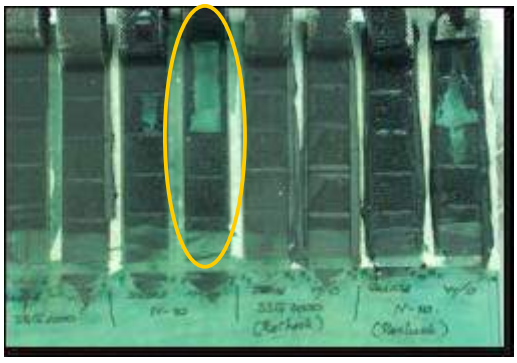


Step 6:
Left it cure at 23± 3deg.C and 50%RH for 10 days.
Perform adhesion test.

Step 7:
Immerse in water for 1 days and 7 days
Perform adhesion test

Step 8:
Evaluation results

Good Adhesion – Cohesive Failure



Failed at Substrate Surface -Adhesion Failure

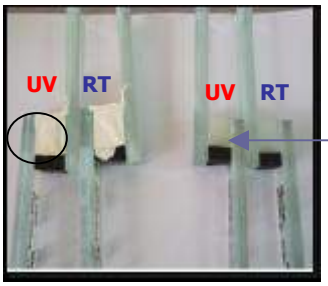
D3. Compatibility Test (UV Resistance)

The objective of this test is to determine ability of sealant to retain its original performance properties after long-term UV exposure using a modified <ASTM C-1087> test method.

Step 1:
Clean glass surface with cleaning solvent
Let it dry for 30 minutes

Step 2:
Place bond breaker tape to cover 1 inch on top of glass surface

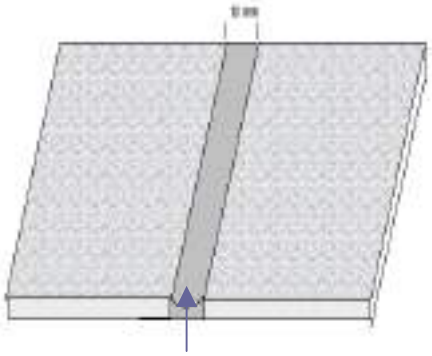
Step 3:
Place the accessory sample at the center of glass
Apply sealant with 3.2mm thickness



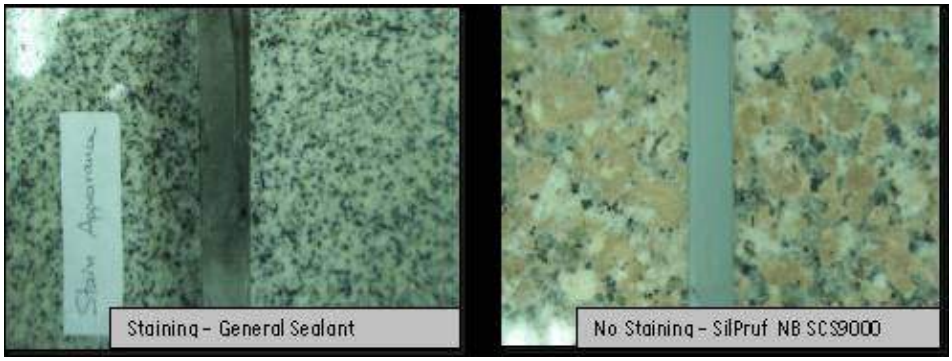
Sealant in contact with EPDM gasket shown incompatibility

D4. Stain Test

The objective of this test is to determine whether sealant will stain porous substrate when expose to weather.

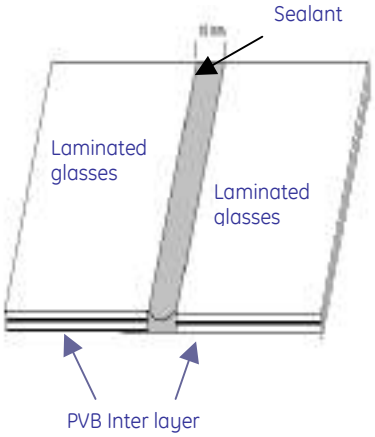


- The joint surface of substrate to receive sealant must be free of dust by brushing or grinding before wiping out with cleaning solvent
- Sealant is gun to the entire joint between the two substrates to a depth of 6mm with the edge of frame
- Allow sealant to cure for 7 days @ 23±2^{0}C and 50±5% relative humidity
- The test sample shall be left expose to weathering for 1 month, 3 months and 6 months.
- Record any color change if there is any variation from the original sealant specimen color



D5. Delamination Test

The objective of this test is to determine whether sealant will cause delamination to the laminated glass when exposed to weathering.



- Clean the surface of the tested substrate with cleaning solvent
- Apply sealant onto the 10mm width joint between the two laminated glass
- Allow sealant to cure for 7 days @ 23±2^{0}C and 50±5% relative humidity
- After cured, the test sample shall be left expose to weathering for 1 month, 3 months and 6 months.
- Record any delamination occurred.

Delamination – Starburst effect

E. Cleaning Procedures

E1. Surface Preparation For Sealant Adhesion

The use of proper materials and the following cleaning procedures are critical for sealant adhesion. No sealant will maintain long-term adhesion to any substrate if the surface is not cleaned and/or prepared properly before the sealant is applied.

1. Always use clean, fresh solvent as recommended by Momentive Performance Materials in the adhesion test report. Commonly used solvents for cleaning substrates prior to wet sealing with silicone are:
    - Iso Propyl Alcohol (IPA) – Only pure industrial grade IPA shall be used (99.9% wt, purity)
    - Methyl Ethyl Ketone (MEK)
    - Xylene
    - Toluene
    - Acetone

    > The above solvents are suggested only as readily available and commonly used materials. With each specific application, the end user must determine the effectiveness of each particular combination of solvent/substrate & sealant chosen. As always adhesion testing is recommended prior to sealing.

2. Always use clean, white, lint-free cloths, or other approved wiping materials.

3. Always use clean, narrow-blade putty knife, or similar.

4. Use adhesion promoters when required.

E2. Recommended Cleaning Procedures

1. Remove all loose material such as dirt and dust, plus any oil, frost, and other contaminants from the substrates where structural silicone sealant adhesion is required.

2. Clean surface using a **"two rag wipe"** technique: Wet one cloth with solvent and wipe the entire surface area, then with a second cloth, wipe the wet solvent from the surface before it evaporates. Allowing the solvent to dry will redeposit any contaminants.

3. When cleaning deep, narrow joints, wrap the cleaning cloth around a clean, narrow-blade putty knife. This permits force to be applied to the surface to be cleaned.

4. Clean only as a much area as can be sealed in one hour.

5. Change to clean rags frequently, as they become soiled.

6. Once the surface is clean, it is important to keep it clean. Touching the surface, for example, contaminates the surface and requires the cleaning procedure to be repeated.

7. Keep the glazing area free of dust and do not allow dust and debris to be deposited on the cleaned surface.

8. Keep the period of time between cleaning to the next process, ie. priming (where required) and/or sealant application to not more than 20minutes.

E3. Important Points On Using Solvents:

1. Do not dip wipe cloths into solvent. This can contaminants the solvent. Pour or pump the solvent onto the cloth.

2. Always use clean containers for solvent use and for solvent storage.

3. Smoking, sparks, welding and flames of any type must not be permitted in the areas or the vicinity where solvents are being used.

4. Follow all precautions on the solvent warning label.

F. Priming Procedures

Priming

Primer or adhesion promoter, when properly used, helps assure strong and consistent sealant adhesion to surfaces to which it may be difficult to bond. Adhesion test results from Momentive Performance Materials will outline if any primer or adhesion promoter is required on a specific substrate.

Momentive Performance Materials offers three (3) types of standard primer:

Property	SS4004	SS4044	SS4179
Color	Pink	Clear, Colorless	Clear, Colorless
Specific Gravity	0.85	0.85	0.91
Solids Content, %	16	16	6.5
Solvent(s)	Acetone, Isopropanol, Toluene, N-butanol	Acetone, Isopropanol, Toluene, N-butanol	Ethye Acetate
Flash Point	-12^{0}C (10^{0}F)	-12^{0}C (10^{0}F)	-3^{0}C (27^{0}F)
Dry Time, Minutes	60	60	15

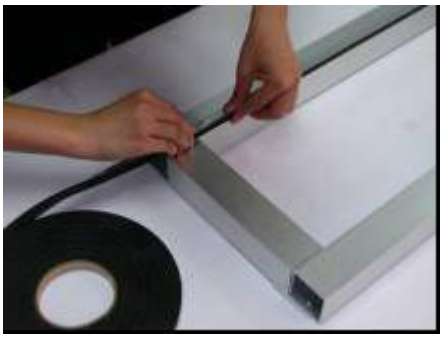
SS4004P and SS4044P primer helps promote adhesion to metal, aluminium, copper, steel, stainless steel, ceramic, and glass. Bright pink color easy visual determination of uniform application.

Meanwhile, SS4179 promote adhesion to metal, aluminium, copper, steel, stainless steel and difficult-to-bond plastic substrates.

F1. Recommended Priming Procedures

The following procedure is used to prepare the unit for sealant:

1. Mask joint edges (pressure-sensitive masking tape works well) to prevent material from being applied over the face of adjacent surfaces.



2. Apply a thin film of adhesion promoter to the joint surface with either a natural bristle brush, a clean lint-free cloth, or other approved wiping materials. DO NOT puddle adhesion promoter in glazing pockets.

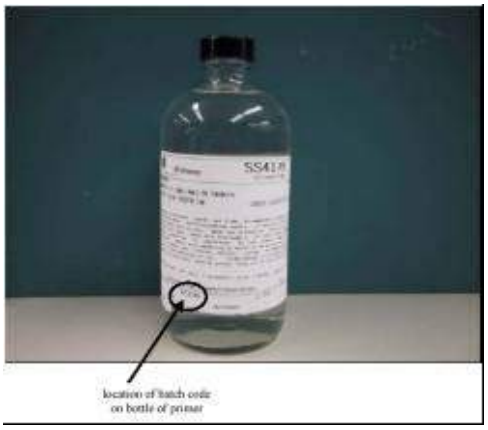
3. Allow the adhesion promoter to dry before applying the sealant. Drying time depends on ambient conditions. Most adhesion promoters contain fast evaporating solvents so that waiting time should be short (approximately 5-15 minutes). Looking at the surface at a slight angle can assist the user to determine if the adhesion promoter is still wet if the surface appears shiny. Do not apply sealant on a primed surface that is still wet.

4. Keep the glazing area free of dust and do not allow dust and debris to be deposited on the primed surface while waiting for the primed surface to dry out completely.

F2. Batch Code

It is always recommended to record batch no of primer in project documentation to facilitate tracking and/or identification should any issues arise.

Also, inventory should be used on an FIFO (first in, first out) basis, to reduce possibility of out-of shelf life product.



F3. Storage Condition

Primer shall be stored in the original unopened container at 27^0C and below. Containers must keep tightly closed when not in use.

F4. Estimated Primer Coverage Rates

Coverage rates of SS4179, SS4044P and SS4004P (pink tinted) primers depend on the porosity and adsorptive characteristics of the substrates. The coverage rates shown below provide a reasonable estimate of the amount of primer required for both single and double faced joint surfaces to be primed.

300 SQ. FT. Per GAL. RATE → porous brick, limestone, rough concrete

	Lineal Ft./Gal. Coverage		Lineal Ft./Pint Coverage	
Application width	**ONE FACE**	**TWO FACES**	**ONE FACE**	**TWO FACES**
¼ inch [3 sq.in/ft.]	14,400	7,200	1,800	900
½ inch [6 sq.in/ft.]	7,200	3,600	900	450
¾ inch [9 sq.in/ft.]	4,800	2,400	600	300
1 inch [12 sq.in/ft.]	3,600	1,800	450	225

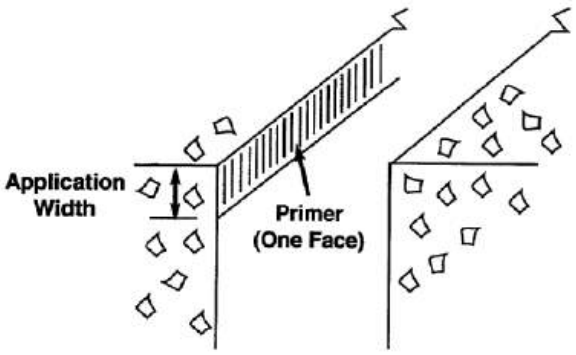
500 SQ. FT. Per GAL. RATE → concrete, dense brick, dense stone

	Lineal Ft./Gal. Coverage		Lineal Ft./Pint Coverage	
Application width	**ONE FACE**	**TWO FACES**	**ONE FACE**	**TWO FACES**
¼ inch [3 sq.in/ft.]	24,000	12,000	3,000	1,500
½ inch [6 sq.in/ft.]	12,000	6,000	1,500	750
¾ inch [9 sq.in/ft.]	8,000	4,000	1,000	500
1 inch [12 sq.in/ft.]	6,000	3,000	750	375

700 SQ.FT. Per GAL. RATE → paints, plastics, metals

	Lineal Ft./Gal. Coverage		Lineal Ft./Pint Coverage	
Application width	**ONE FACE**	**TWO FACES**	**ONE FACE**	**TWO FACES**
¼ inch [3sq.in/ft.]	33,600	16,800	4,200	2,100
½ inch [6sq.in/ft.]	16,800	8,400	2,100	1,050
¾ inch [9sq.in/ft.]	11,200	5,600	1,400	700
1 inch [12sq.in/ft.]	8,400	4,200	1,050	525

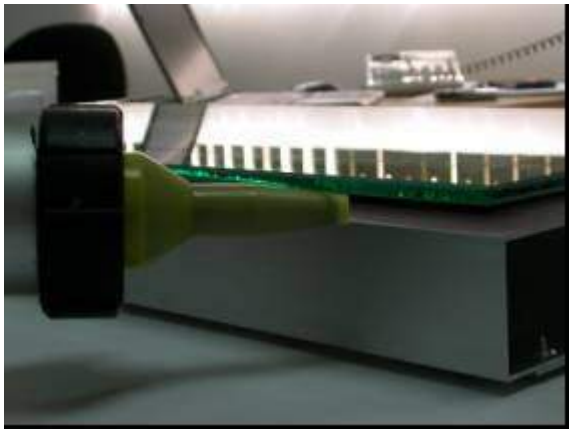
NOTE: Due to surface irregularities, application techniques, and other variables, coverage rates are approximate only and no warrantee applies to actual coverage obtained. Trial installations are recommended to obtain coverage rates under actual use conditions.

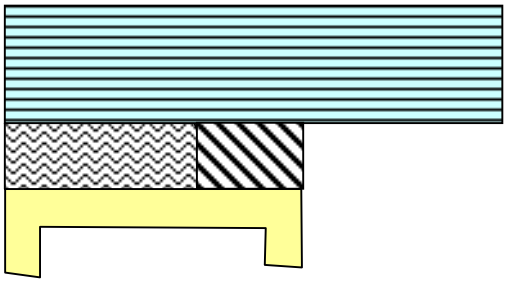


G. Sealant Application Procedures

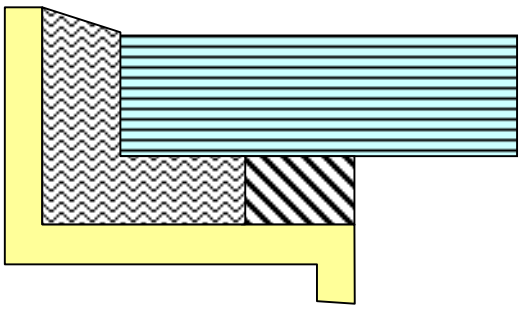
G1. Sealant Application Procedures

1. Apply the sealant slowly and carefully, pushing the bead ahead of the nozzle. Do not "drag" the sealant across the glazing pocket as this will result in incomplete cavity filling and air bubbles.





Conventional joint



L – Shaped joint

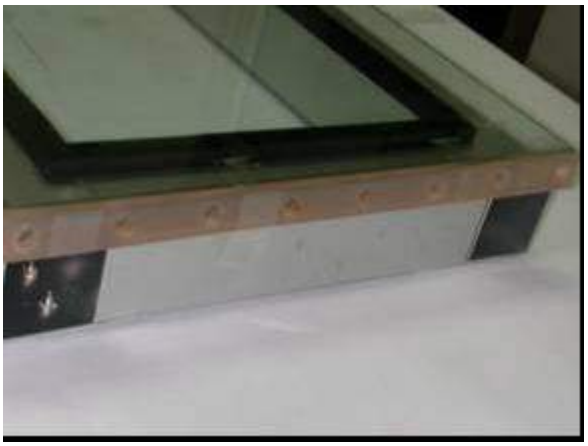
2. It is important, especially for glazing using clear or lightly tinted glass, to ensure that the sealant applicator is able to see clearly the sealant filling up the entire cavity as he/she is applying.

3. It is recommended that a separate bright light be used to shine into the cavity being filled as it is being filled so that the applicator can see clearly the filling process.

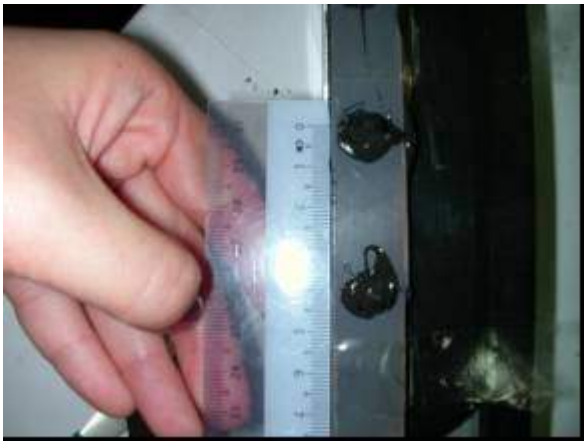
4. In cases when the sealant application is done from the inside of the curtainwall (aluminium extrusion side), a mirror should be used as a tool for the applicator to view the filling process.

5. It is good practice to use a Teflon coated strip to act as a backer and guide for the open edge of the glass and aluminium cavity.

6. This strip should be wider than the structural sealant glue-line and should be held firmly in place during the sealant application.

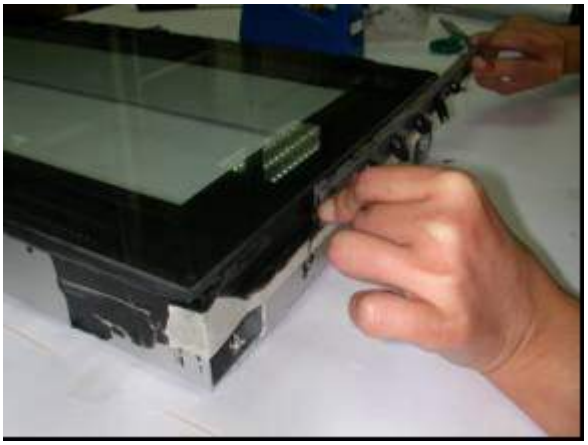


7. Holes of diameters slightly smaller than the sealant glue-line should be predrilled in the Teflon coated strip at spacing between 30mm (for filling using a manual caulking gun) to 50mm (for filling using a pneumatic air gun) along the entire strip.



8. The sealant should be pumped into the cavity through the predrilled holes making sure that the section for one hole to the next is completely filled before moving to the next hole.

9. Tooling should be done neatly, forcing the sealant into contact with the sides of the joint, helping to eliminate any internal voids and assuring good substrate contact.



10. Do not tool the sealant with soap or detergent solutions.

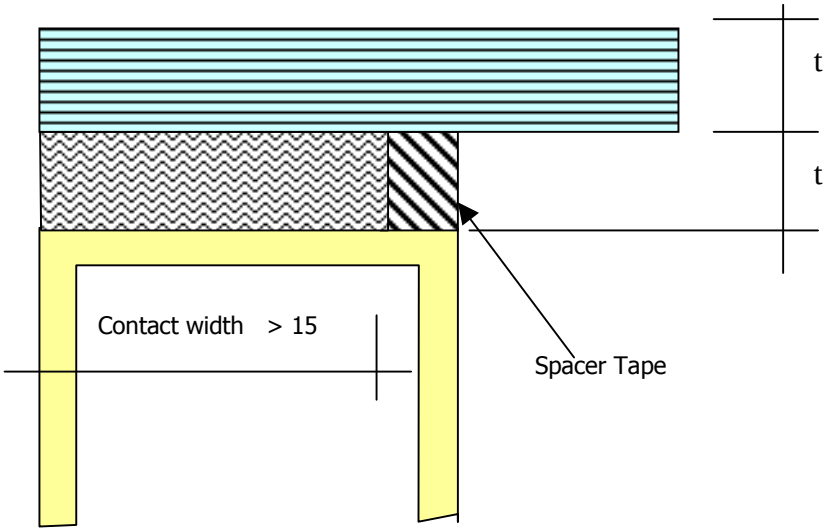
11. If masking tape is used, remove it immediately after the joint has been tooled.

12. Clean up as much uncured silicone as possible with rags. If some silicone remains, a solvent will usually aid in clean up.

13. To remove cured silicone, remove as much as possible with a razor blade or other sharp object or use GE Silicone Remover, GE Silopren TP3888 and GE Silopren TP3884.

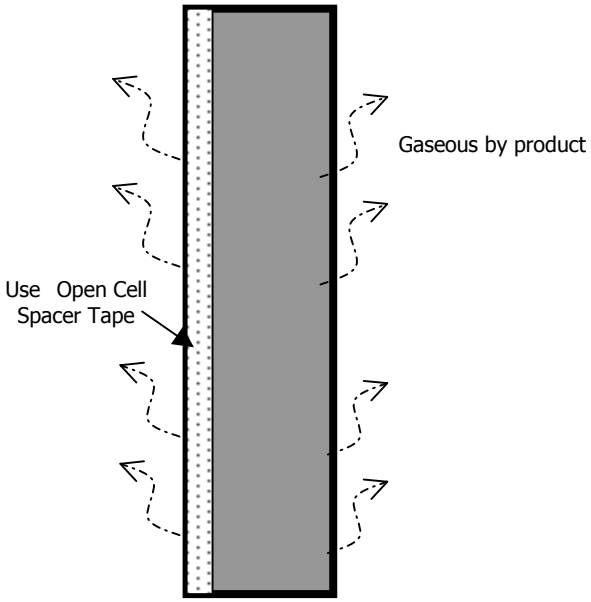
G2. Glazing Large Contact Width

When glazing clear or lightly tinted glass with large contact width (>15mm), the following steps should be taken to minimize air voids and bubbles within the sealant:

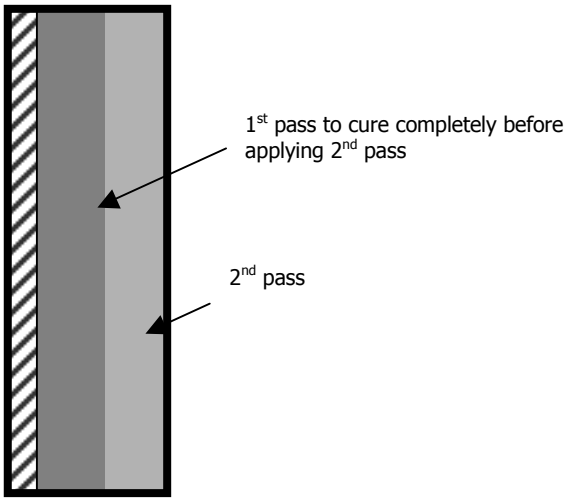


- **Utilize 2-component silicone for re-glazed large contact width**

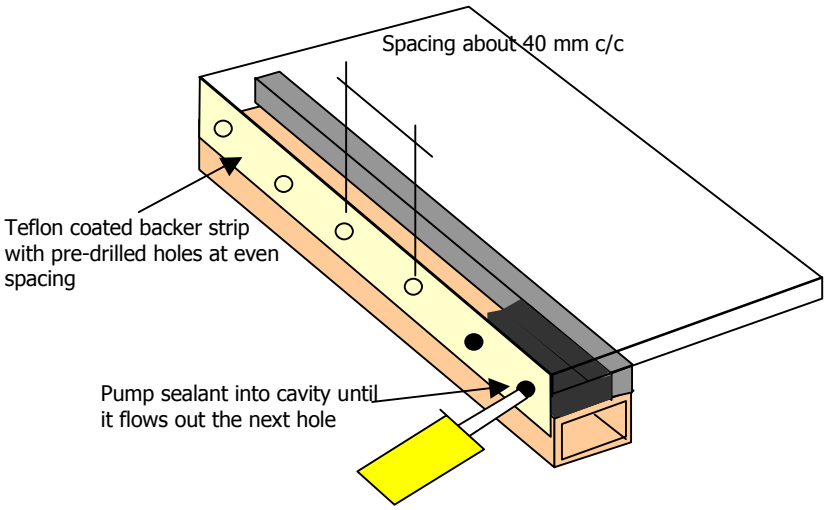
- **IF 1-COMPONENT SEALANT MUST BE USED,**
  - Control storage conditions of sealant until time of use, <27^{0}C
  - Apply thin layer (2mm) of sealant onto glass side, allow minimum 24 hours to cure before re-glazing. (This will mask bubbling which may occur)
  - Install open cell (breathable) spacer tape



- Install silicone in two successive passes, allowing full cure of first pass before application of 2nd pass.

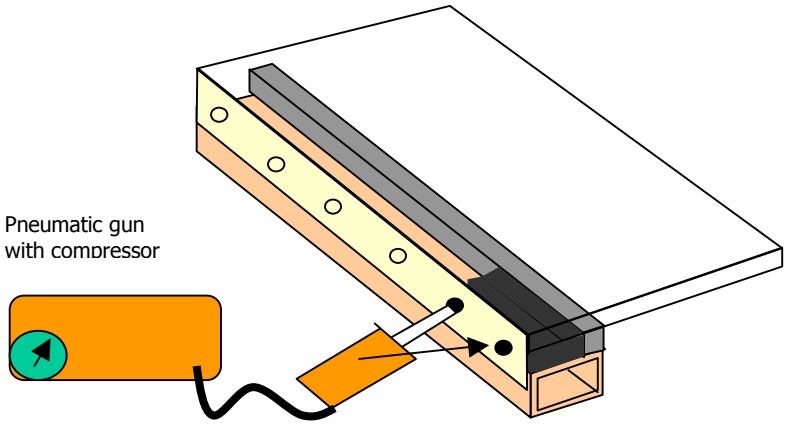


- Use a Teflon coated strip as a backer at the open edge on the cavity to be filled

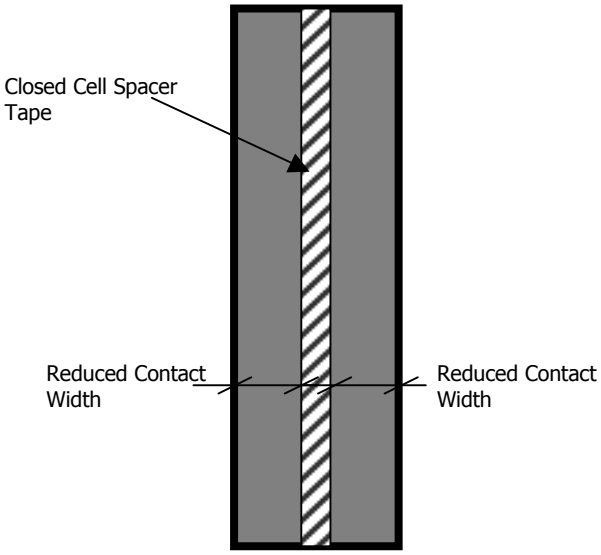


- Schedule and install silicone during cooler time of the day (i.e. morning/ evening, non sunny day). Application is best done when the substrate temperatures are less than 43^0C, i.e. ambient temperature during application should not be > 35^0C.

- Use pneumatic gun and apply with extra care to complete cavity



- Where installation of sealant can be from inside (vision area, et al), place double sided glazing tape (in lieu of gasket) down center of sealant bead (effectively changing large "contact width" into average size).

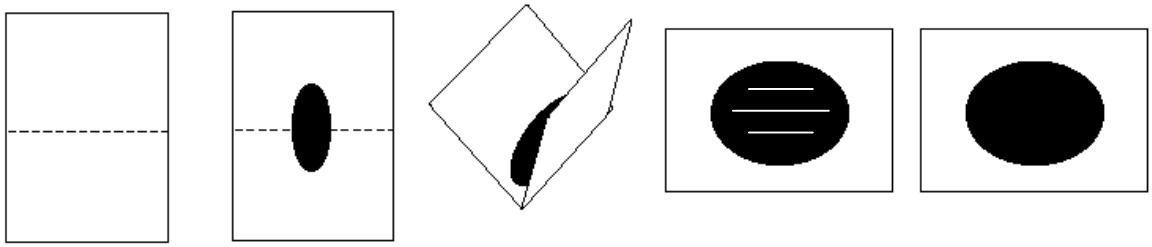


Quality Control: In-Shop Material Testing

G3. Product Mixing Check– "Butterfly Test"

GE UltraGlaze SSG4400, a 2-component structural sealant must be thoroughly mixed by the static mixers in the pumping equipment. The mix should be checked periodically during production, and must be checked after the mixers have been purged and production is just starting. To check the quality of the mix, the following **"Butterfly"** test procedure may be used:

- Have pumping equipment in a mode which is "ready" for production.
- Lay out a piece of paper (approx. 300mm x 600mm) and dispense a bead of silicone (approx. 12mm deep x 20mm wide x 50mm long) down the center of the paper.
- Fold the paper in half so the silicone is in the center of the crease - push on the bead so the silicone is flattened out to approx. 3mm to 6mm thick.
- Pull the paper apart and visually examine the GE UltraGlaze SSG4400. There should be no white, gray or dark black lines in the silicone. If any of these conditions exist, pump more silicone through the mixers and repeat the above procedure. If the condition persists, it may be necessary to clean the gun and/or replace the static mixers. Refer to the pump manufacturers instructions. Improperly seated check and ball valves, leaky valves, and/or worn packing can cause abnormalities in mixing.
- Air bubbles should not be present in the silicone. Air bubbles are an indication of a leaky follower plate. Any maintenance done on the pump should be recorded in the Pump Maintenance Log.



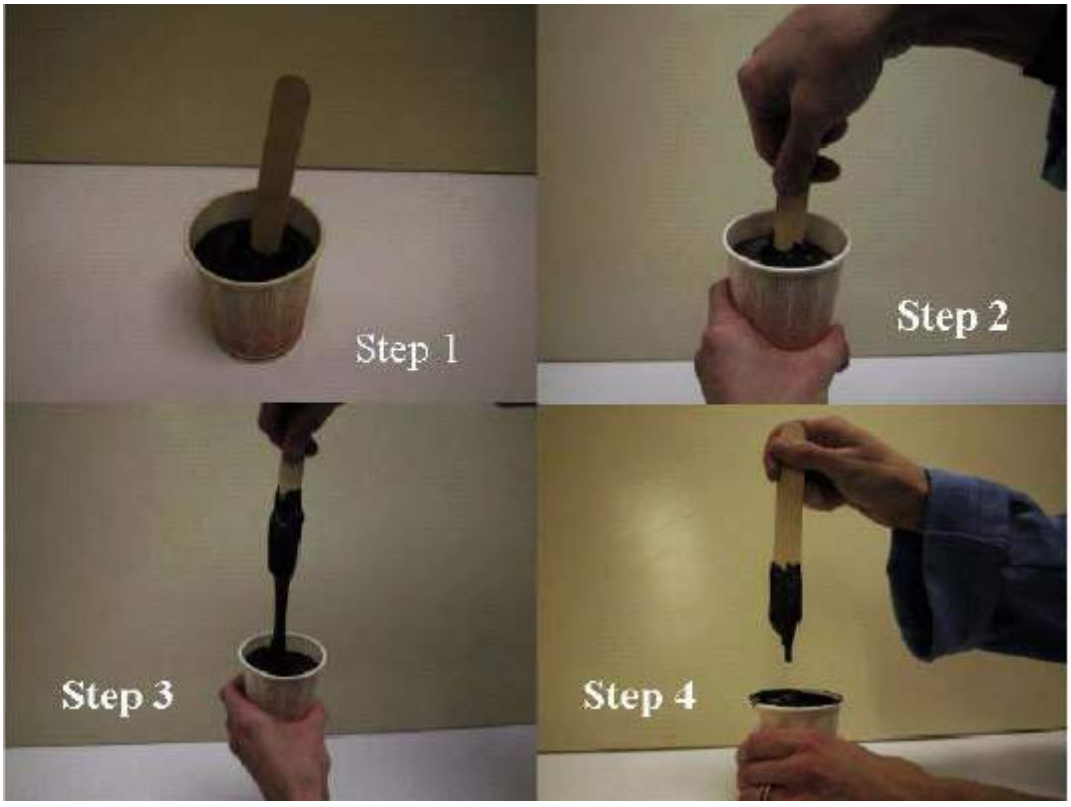
G4. Snap Time Check

The ratio at which the silicone is mixed is extremely important. The quantities of part A and part B should be closely monitored to ensure the proper amount of each component is used.

The following procedure will give an indication of the cure rate of the silicone.

- Fill a small cup with the mixed silicone approximately 3/4 full.
- Place a tongue depressor in the center and to the bottom of the cup
- After 15 minute and 5-minute intervals thereafter. Pull on the tongue depressor and release. If the tongue depressor snaps back, the GE UltraGlaze SSG4400 has reached its "snap time".

The snap test is subjective and snap times will vary from individual to individual. The test will inform a given individual of a change. Snap time can vary from 25 minutes to 120 minutes, depending upon the mix ratio and on the person testing. A change of more than 15 minutes could indicate a change in mix ratio (which can be confirmed by the Weight Ratio Check). Record all necessary information in the GE UltraGlaze SSG4400 Test Log provided.



G5. Ratio Check By Weight

Before starting sealant application using two-component pumping/mixing equipment, a ratio check of the weight of Part A to weight of Part B is to be done to assure proper mixing ratio.

To following procedure describes the steps required:

- Have the pumping equipment in a mode which is 'ready' for production.
- Dispense and collect Part A and part B from the Ratio Check Manifold.
- Weight the two components separately (be sure to exclude the weight of the empty container) with a digital scale and record the data.
- Calculate the mix ratio (Base-to-Catalyst) by weight.

Example

Weight of Part A = 125 grams
Weight of Part B = 10 grams
Current mix ratio by weight = 125:10 = 12.5:1
Current snap time = 60 minutes

Desired snap time = about 30 minutes
Adjust mix ratio by weight to 9:1
Adjust pump mixing to give:
Weight of Part A = 125 grams
Weight of Part B = 13.9 grams

Weight ratio to volume ratio correlation

9:1	by weight	6.4:1	by volume
10:1	by weight	7.2:1	by volume
11:1	by weight	7.9:1	by volume
11.5:1	by weight	8.2:1	by volume
12:1	by weight	8.6:1	by volume
12.5:1	by weight	8.9:1	by volume
13:1	by weight	9.3:1	by volume

- For GE UltraGlaze SSG4400 tested at 25^{0}C, @ 50% R.H.

Mix Ratio by weight Part A = Base : Part B = Catalyst	Mix Ratio by Volume Part A = Base : Part B = Catalyst	Snap Time (min)
10 : 1	7.2 : 1	26
11 : 1	7.9 : 1	30
12 : 1	8.6 : 1	36
13 : 1	9.3 : 1	44

Mix Ratio by weight Part A = Base : Part B = Catalyst	Temperature, ^{0}C	R.H. , %	Snap Time (min)
12 : 1	10	30	61
12 : 1	15	35	53
12 : 1	20	40	45
12 : 1	25	45	36
12 : 1	30	50	31

G6. In-House Adhesion Testing

In-house adhesion testing should be performed to verify that good adhesion is being developed using the surface preparation recommended by Momentive Performance Materials for in-shop glazing. ALL LOTS OF METAL SHOULD BE TESTED FOR ADHESION as follows:

- Prepare surfaces as recommended by Momentive Performance Materials
- Run and tool a bead 3mm to 6mm thick, 25mm wide.
- Allow the sealant to cure (SSG4400 to cure a minimum of 24 hours, 48 hours is preferred; SSG4000 and SSG4800J to cure a minimum of seven (7) days).
- Beads 6mm and thicker will require longer cure times.
- Cut sealant at bond line to form a tab to pull on. Pull sealant tab in direction of the uncut bond line. Sealant will fail cohesively if good adhesion is developed.

Sealant failed by cohesion in peel adhesion test

Pull sealant tab in direction of uncut bond line

- Then allow silicone to cure 7 - 10 days and immerse in water. For long-term durability, check adhesion after 1 and 7 days water immersion.
- Record adhesion test results, temperature, relative humidity, and any other pertinent information in the Tensile Adhesion Test Log.

ASTM C794 Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants may also be used in place of the above procedure.

G7. In-House Cure Time Check

Trial glazing using small section of actual coated aluminium and coated glass to be used in the project should be conducted using the recommended structural sealant before the commencement of mass production.

This trial should be used to verify the structural sealant application and to ascertain an accurate cure time for the combination of product, sealant bead size, temperature and relative humidity.

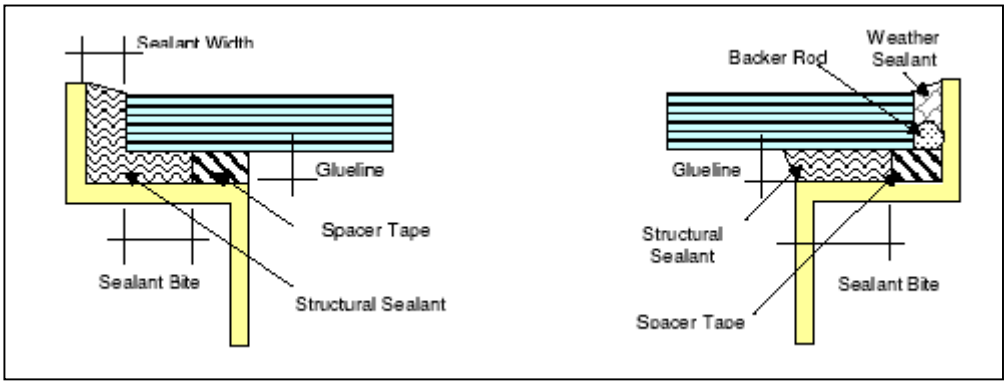
1. Prepared 5 to 10 sets of test substrates of the actual surface finish cut to 300mm lengths to form the glazing detail in the submitted shop drawings.

2. Clean the aluminium and glass substrates according to the recommendation from Momentive Performance Materials

3. If primer is recommended in the test report, apply the primer according to the recommendation from Momentive Performance Materials

4. Apply the spacer tape according to the glazing detail in the shop drawing submitted. The material, type and dimensions of the spacer tape should be according to the approved shop drawings

5. Check that the space between the spacer tape and the edge of the aluminium frame is equal to or greater than the recommended structural sealant contact width as recommended in the print review by Momentive Performance Materials. If this spacer is insufficient, change the spacer tape and update the shop drawing accordingly.



6. Install the glass in the aluminium frame leaving the correct sealant width according to the glazing details in the submitted shop drawings

7. Pump in the recommended structural sealant grade.

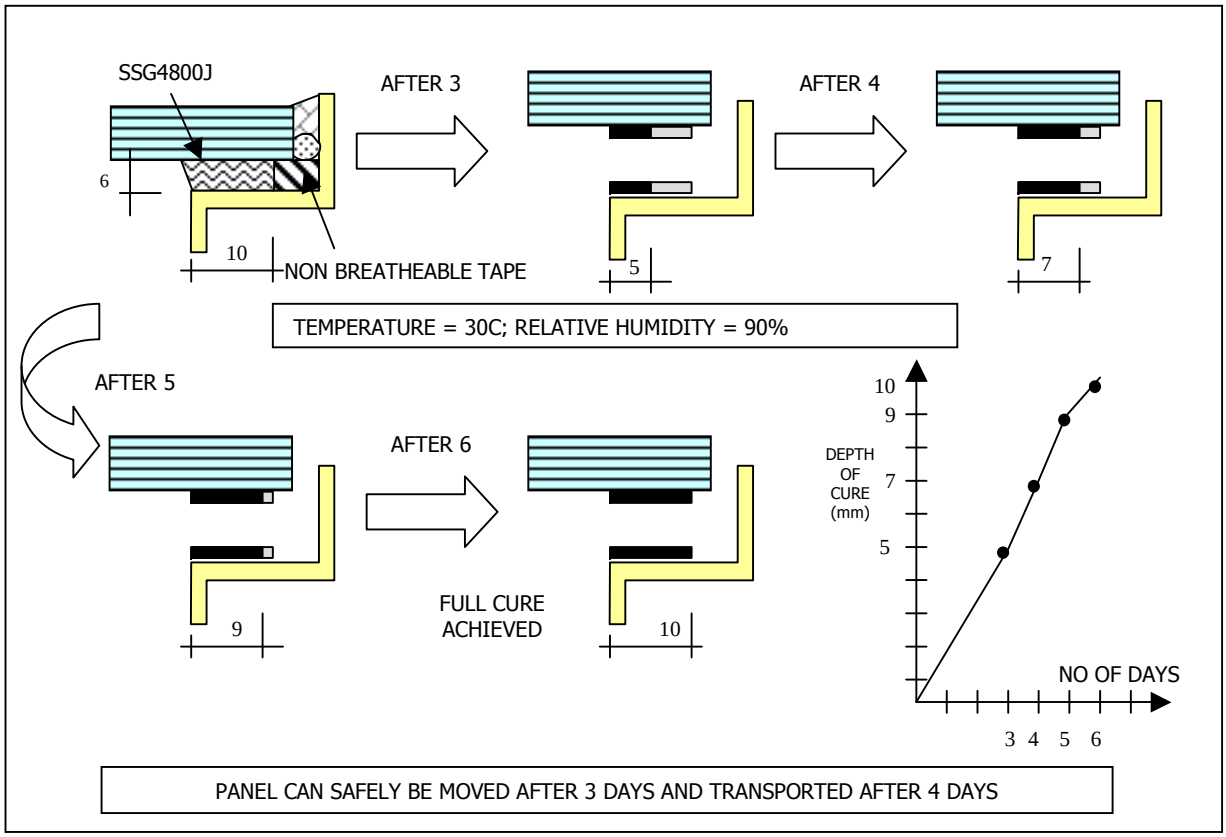
8. Repeat until at least 5 sets of the trial glazing samples are completed.

9. Allow the sealant to cure and note the temperature and relative humidity. At temperature of 27^0C or above or relative humidity of ±70% or above
    a. Allow at least 1 day to cure for **GE UltraGlaze SSG4400**
    b. Allow at least 3 days to cure for **GE UltraGlaze SSG4800J**
    c. Allow at least 7 days to cure for **GE UltraGlaze SSG4000**

10. When the recommended minimum cure time for the specific structural sealant product used is reached, cut the sealant in the middle between the glass and aluminium.

11. If the sealant has not fully cured, check the depth of cure by measuring the depth of cured sealant on the glass and aluminium. Record the number of days since sealant application and the depth of cure of the 2 substrates.

12. Check for adhesion to the glass and aluminium by performing the peel adhesion test as recommended by Momentive Performance Materials. Record the percentage of adhesion on both substrates.



13. Repeat the test daily after this to ascertain the number of days required until the sealant is fully cured and 100% adhesion on both substrates is achieved.

14. The results ascertained in the trial will form the accurate data on number of days required for full cure and 100% adhesion for the combination of product, sealant bead size, glazing details, temperature and relative humidity specific to this project.

15. This result should form part of the Project QC Procedures and should be made available for all applicators and glaziers for reference throughout the fabrication period.

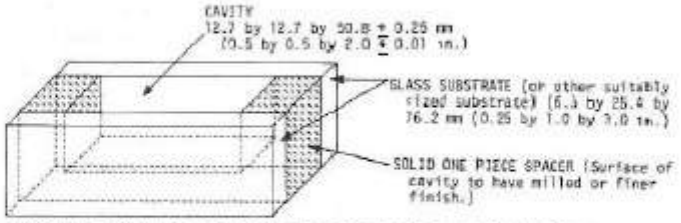
16. Major deviations from the result found during glazing and mass production must be made known to Momentive Performance Materials immediately.

G8. In-House H-Tensile Adhesion Test

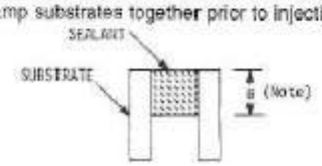
Another useful test that can be performed as part of the QC Procedures is the in-house H-Tensile adhesion test. This test will verify the cured properties of the structural sealant based on the specific combination of product, sealant bead size, temperature and relative humidity in the factory.

1. Assemble three (3) H-Tensile samples as diagram shown below.

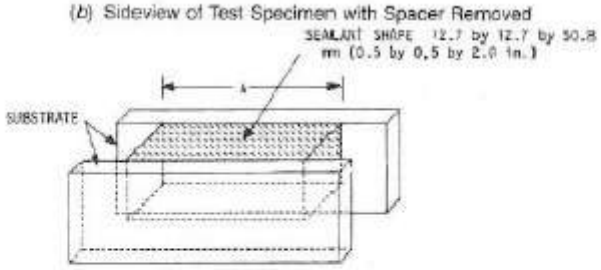
Diagram of the H-Tensile Sample Assembly



(a) Glass Substrate and Spacer Assembled to Form a Sealant Cavity (Tape or clamp substrates together prior to injecting the sealant.)



(b) Sideview of Test Specimen with Spacer Removed



(c) End view of Test Specimen with Spacer Removed

NOTE 1—Dimension B in Fig. 1(c) is known as the sealant edge bite or sealant contact depth.

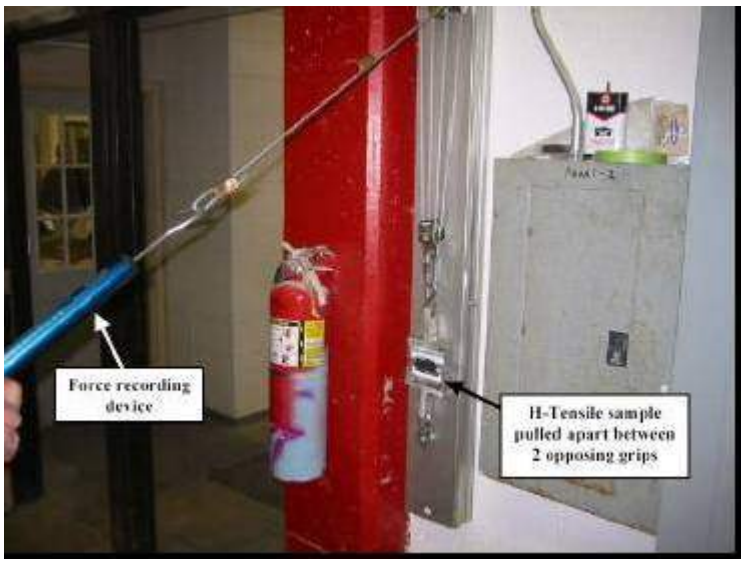
FIG. 1 Sealant Test Specimen

(see also ASTM C1135 Std. Test Method for Determining Tensile Adhesion Properties of Structural Sealants)

2. Allow the sealant to cure GE UltraGlaze SSG4400 to cure a minimum of 4 hours, GE UltraGlaze SSG4000 and GE UltraGlaze SSG4800J to cure fully, usually a minimum of fourteen (14) days but could require longer cure times depending upon shop temperature and relative humidity conditions).

3. After cure time, place the samples in a rig designed to hold the sample assembly and use a measuring device (a fish scale will do) to pull the sample(s).

4. Use a slow continuous build-up of force when pulling (i.e., do not jerk the sample in a rapid motion). As a reference, the rate-of-pull on a standard tensile machine is set at 50mm/min.



5. Record the adhesive bond strength (force to pull), temperature, relative humidity, and any other pertinent information in a Tensile Adhesion Test Log.

ASTM C1135 Test Method for Determining Tensile Adhesion Properties of Structural Sealants may also be used in place of the above procedure.

H. Batch Code Reading

Batch Codes

Sealant received shall be verified as the type recommended by Momentive Performance Materials for the application and verified as the type ordered. Batch Number, and Use Before Date, should be recorded for each incoming shipment.

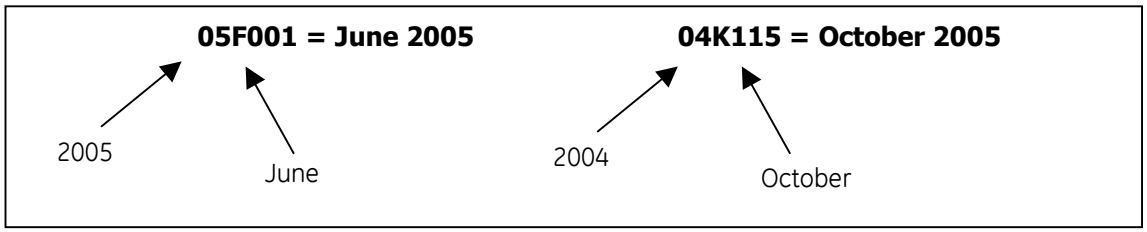
The Shop Manager and Assembly Supervisor must ensure that the silicone sealants are stored a cool and dry place. Only the daily quantity should be in taken from storage and used on the FIFO procedure (FIRST IN / FIRST OUT).

GE Sealants product batch code system is a 6 character series of 2 numbers followed by 1 letter (followed by 3 numbers). Example 05F001.The first two numbers refer to the year of manufacture (05 = 2005). The letter refers to the month of manufacture

Month (note: the letter I and L are not used)

A = January	D = April	G = July	K = October
B = February	E = May	H = August	M = November
C = March	F = June	J = September	N = December

Two examples:



Batch code can used to assist in determination of the date of manufacture of the product. Using the date of manufacture and knowing the shelf life on the product as printed in product data sheet; one can determine whether or not a product is within its warrantable shelf life range.

Container	**Look for marking**
Cartridge	Laser marked directly onto the cartridge tube along the bottom edge
Sausage	on the printed sticker label on each sausage pack
Can, jars	on the printed label, usually on the bottom left of the label (see photo)
Pails, drums	on the printed label, usually on the bottom left of the label

GE UltraGlaze® SSG4400 has separate batch codes for the "A" Component and "B" Component.

The batch code of GE UltraGlaze® SSG4000/SSG4800J that is/are being used in 300 ml cartridges or 591.5 ml aluminium foil sausage packs can be found on the carton and each individual cartridge.

location of batch code
on bottle of primer

J. Regular Checks and Tests During Mass Assembly

J1. Testing Frequency & Criteria

The table below gives a recommended testing frequency and minimum requirements required for each test to be done during mass assembly.

Test	Sealant to be performed on	Frequency	Minimum Requirements
Peel Adhesion	Both 1 & 2 part sealants on each different substrate	One peel on each substrate every day	20 pounds per square inch and minimum 95% adhesion
Cure Time	Both 1 & 2 part sealants on actual glass, aluminium and spacer tape glazing detail	One master sample before the start of mass fabrication for each detail and for each season. Subsequently once a month during mass fabrication	Cure time between master sample and subsequent checks should not differ by more than 20 minutes
H-Tensile	Both 1 & 2 part sealants on each different substrate	One test on each substrate every week after full cure. 24 hours for SSG4400 and 7 days for SSG4000 and SSG4800J	Ultimate H-Tensile Strength = 50 kg
Weight Ratio	SSG4400	Daily	9:1 to 13:1
Snap Time	SSG4400	Every Pump Start Up	20 to 40 minutes for 10:1 ratio at 30°C 90% RH. Consult GE for other mix ratios.
Butterfly	SSG4400	Every Pump Start Up	No Streaking

J2. Finished Unit Testing – Deglazing Test

A dry adhesion test on a few finished units is recommended. In order to carry out this test, the finished unit has to be deglazed. The suggested deglazing sample size is

1 out of the first 10 frames (Frames 1 to 10)
1 out of the next 40 frames (Frames 11 to 50)
1 out of the first 50 frames (Frames 51 to 100)
1 of each subsequent 100 frames (remaining frames)

The deglazing procedure is as follows:

1. Check the print review to determine the correct structural sealant contact width and thickness as recommend by Momentive Performance Materials

2. Check the adhesion test report by Momentive Performance Materials to determine the recommended cleaning solvent and primer

3. Record the project name, frame and glass identification numbers and the type of surface finish

4. Record the batch codes of the recommended primer and grade of structural sealant in the Deglazing Test Record Sheet.

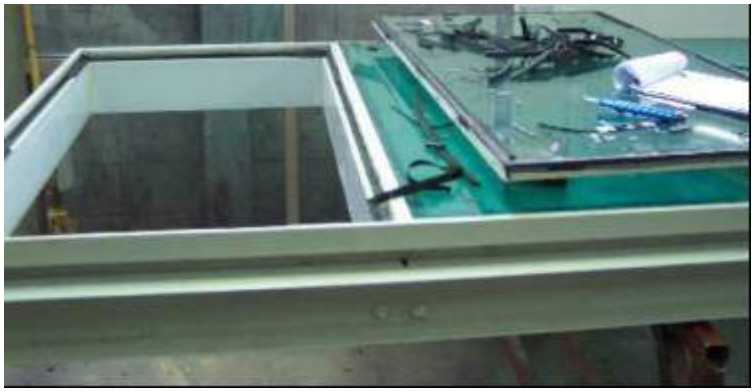
5. Record the number of days since the sealant has been applied and the temperature and relative humidity in the factory. Check that there is sufficient cure time before proceeding with the deglazing test.

6. Make a cut through the sealant silicone at the perimeter of the unit, leaving approximately 2mm to 3mm thickness of silicone on the substrate. Exercise caution so as not to damage the substrate finish in any manner, which could potentially interfere with the re-glazing later.

7. Remove the glass by using a group of suction cups or similar method.

8. Remove or cut the internal gasket/tape around the perimeter of the aluminium unit such that the edges of structural sealant contact width are not adhering to any gasket or spacer tape.

9. Cut a tab of sealant from the substrate large enough for the fingers to exert a pulling force from.



10. Pull the open end of the bead 180^0 backwards with force and check the sealant adhesion on the substrate. If the sealant adhesion is good (>85%), cut across the bead and pull again. Check for adhesion and report process for the entire frame.

11. If the adhesion is not good (<85%), stop glazing and trouble shoot all the glazing process to identify and solve the problem. Call Momentive Performance Materials representative for assistant.

12. Records the results for each frame noting the percentage sealant adhesion on the substrate. Note any bubbles or voids within the sealant.

13. Records any other relevant comments such as new applicators, new glaziers, factory cleanliness, etc.

14. Repeat the deglazing process on the glass substrate.

15. The test area can be repaired with GE UltraGlaze SSG4400 or GE UltraGlaze SSG4800J/4000.

J3. Logging Of Fabricated Units

A suggested method of logging unit data after assembly is as follows:

- Number and tag each unit and record all pertinent information on the Unit Fabrication Log provided.
- When installing units in the field, record the location of each unit. Building elevation drawings reduced to A3 size are convenient to use.

J4. Storage Of Finished Units

Once the units have been glazed with GE UltraGlaze SSG4400, they should experience NO MOVEMENT for a period of 4 hours.

After 4 hours the units may be placed into a vertical position for storage provided they are blocked and/or stored in a manner that ensures the sealant will not be stressed or loaded by any means.

Units glazed with GE UltraGlaze SSG4000/SSG4800J should not see any movement, which will cause the sealant to deform while the sealant is curing. Cure times will vary with system design and bead dimensions.

Contact Momentive Performance Materials for cure times on your specific project. It is further recommended that the units glazed with GE UltraGlaze SSG4400 be stored in a controlled environment to complete the curing process for a minimum period of 48 hours (2 days).

K. Field Testing

The applicator must perform the proper surface preparation and sealant application procedures onsite. Momentive Performance Materials provides the proper recommendations for these steps. The applicator shall verify substrate adhesion prior to the commencement of actual installation.

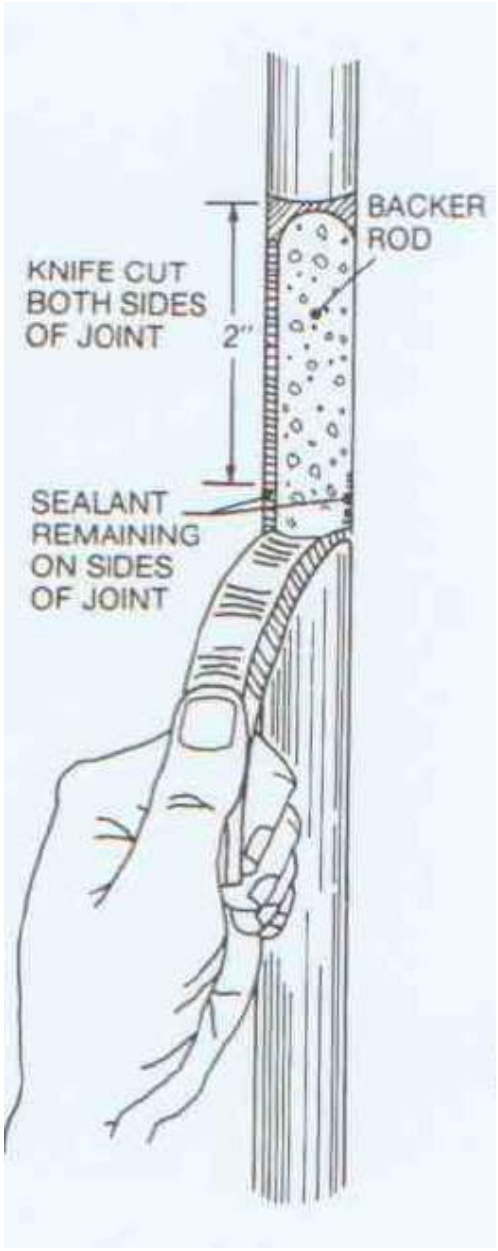
K1. Post Application Field Adhesion Test

(As published by SWI, March 1980)

As a check for adhesion, a hand pull test must be run on the job site after sealant is fully cured. (Usually within 14 to 21 days).

The hand pull test procedure is as follows:

1. Make a knife cut horizontally from one side of the joint to the other.
2. Make two vertical cuts approximately two inches long, at the sides of the joint, meeting the horizontal cut at the top of the two inch cuts.
3. Grasp the two inch piece of sealant firmly between the fingers and pull down at a 90^0 angle or more, and try to pull the uncut sealant out of the joint.
4. If adhesion is proper, the sealant should tear cohesively in itself before releasing adhesively from the substrate.



Note:
Adhesion may be adversely affected by:

1. Moisture in or on the substrate during sealant application and cure.
2. Contaminated or weak surfaces.
3. Poor application technique.

K2. Repair of sealant in adhesion test area

1. Sealant may be replaced in test area easily, by merely applying more sealant in the same manner it was originally installed (assuming good adhesion was obtained).

2. Care should be taken to assure that the new sealant is in contact with the original, and that the original sealant surfaces are clean, so that good bond between the new and old sealant will be obtained.

3. ACTUAL JOB SITE TEST APPLICATIONS ARE THE BEST MEANS FOR A GLAZIER TO BE CERTAIN THAT PROPER SEALANT ADHESION AND SUBSEQUENT PERFORMANCE WILL RESULT FROM HIS WORK.

4. These tests, installed on-site, can determine compatibility with actual substrates used on the job site and the type and degree of preparation required for adhesion.

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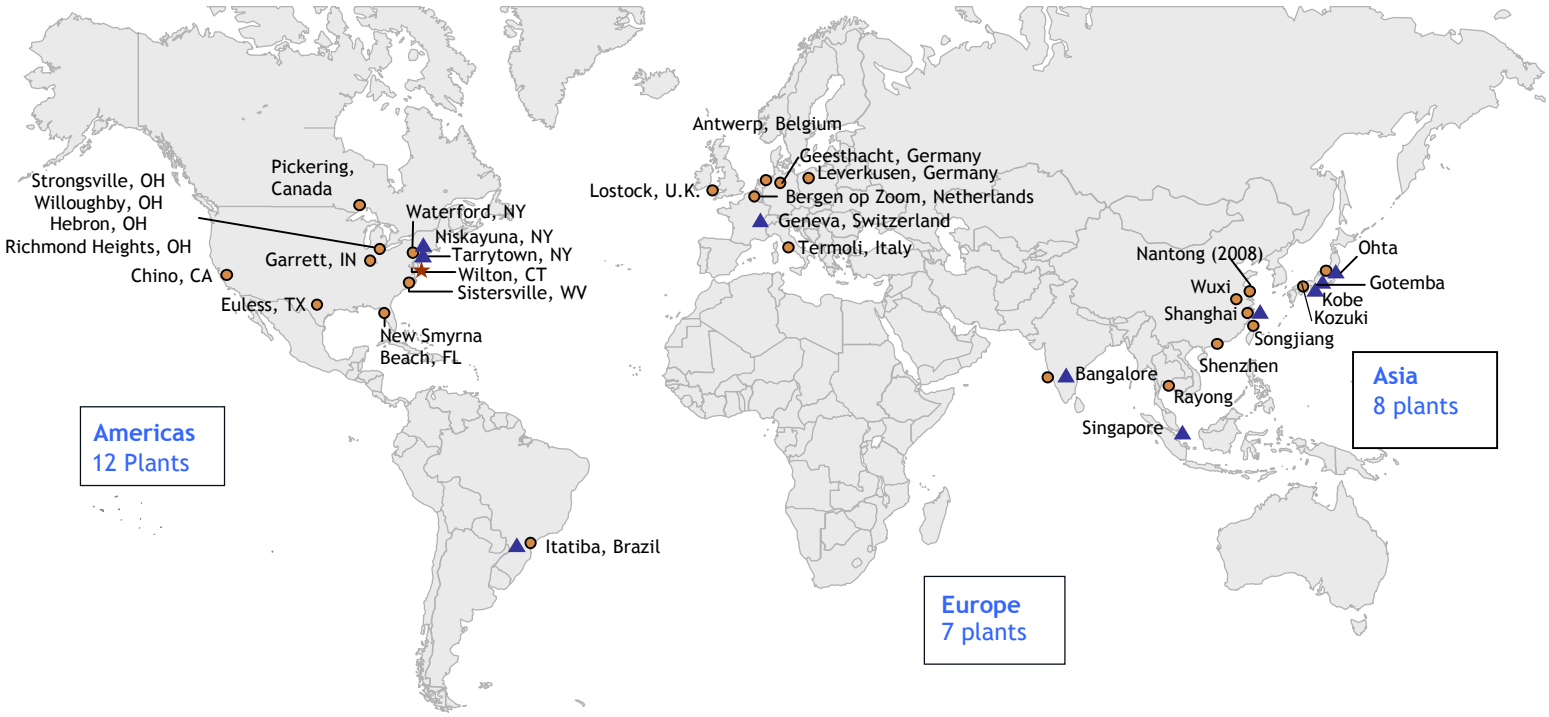
Momentive Locations



World Headquarters
Momentive Performance Materials
187 Danbury Road
Wilton, CT 06897, USA
Phone: 800.295.2392
Phone: +607.786.8131
Fax: 607.754.7517
Fax: +607.786.8309

Latin America
Rodovia Eng. ConstÃ¢ncio Cintra, Km 78,5
Itatiba, SP 13255-700
Brazil
Phone: + 55.11.4534.9650
Fax: + 55.11.4534.9660

Europe, Middle East, Africa and India
Leverkusen
Phone: 00.800.4321.1000
Fax: + 311.164.241750

Pacific
Akasaka Park Building
5-2-20 Akasaka
Minato-ku, Tokyo 107-6112 Japan
Phone: + 81.3.5544.3100
Fax: + 81.3.5544.3101

Singapore
#01-02, 81 Science Park Drive,
The Chadwick, Singapore Science Park 1,
Singapore 118257
Phone: + 65.6496.2121

China
#227 Li Bing Road,
Zhang Jiang Hi-Tech Park,
Pudong New Area, Shanghai
201203 China
Phone: + 8621.3860.4500
Fax: + 8621.5079.3707