

HIGH PERFORMANCE BUILDING SOLUTIONS

# Insulating glass technical manual

EMEA1

**DOW**<sup>®</sup>

**DOWSIL**<sup>™</sup>

technologies by 

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## Introduction

Insulating glass is a key component of modern façade construction. Insulating glass brings many benefits to curtainwall functionality. With today's high cost of energy, the thermal performance of a building façade has become very important. The use of insulating glass in façade construction allows the design profession to construct buildings with large vision areas that are aesthetically appealing as well as thermally efficient.

Insulating glass (IG) units consist of two or more glass panes which are separated along the perimeter by a spacer and sealant system. The cavity between the panes of glass may be filled with dry air or an inert gas. Many types of glass can be used including laminated glass, coated glass or spandrel glass. These components are selected to meet the specific coloration, reflectivity, light transmission and sound transmission requirements of the IG unit.

Insulating glass is also used in silicone structural glazing which is a method utilizing silicone adhesive to attach glass to the structure of a building. The performance of insulating glass in structural glazing applications is critical due to the loads, stresses and extreme environmental factors impacting the façade. For these requirements to be fulfilled, both the construction of IG units and the manufacturing of the individual components must meet very high standards of quality. From the glass production and coating application, through the manufacturing of spacer bars and sealants, to the final assembly of insulating glass products, quality must be consistently maintained through the implementation of special application and quality control procedures.

The selection of the proper materials is a key element of successful IG performance. Dow provides high performance sealants which are specifically designed for the production of insulating glass.

The *Dow insulating glass technical manual* is intended to provide guidelines and considerations for IG manufacturers, not only for the use of DOWSIL™ insulating glass sealants, but also as a source of additional information about IG production. No claim is made as to its completeness or accuracy of the statements made in this manual. It was prepared by Dow based on the company's best current knowledge and experience in sealant manufacturing and IG production. Dow makes no claim as to the performance of IG units based on information provided in this document.

## Important information

The information contained herein is offered in good faith based on Dow's research and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information shall not be used in substitution for customer's tests to ensure that DOWSIL™ products are fully satisfactory for your specific applications. Dow's sole warranty is that the product will meet its current sales specifications. Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

Dow specifically disclaims any other express or implied warranty of fitness for a particular purpose or merchantability. Unless Dow provides you with a specific, duly signed endorsement of fitness for use, Dow disclaims liability for any incidental or consequential damages. Suggestions of use shall not be taken as inducements to infringe any patent.

## **DOWSIL™ product offering**

Dow offers a full line of high performance silicone and butyl sealants. Each sealant is developed and tested for a specific application and should only be used as intended unless specifically approved by Dow.

Specific product information is available at [dow.com/construction](http://dow.com/construction).

### **Insulating glass sealants**

The DOWSIL™ Sealants offered for insulating glass applications are described below. These products are intended for IG production only and are not approved for use as structural glazing sealants. A typical structural glazing application would be the attachment of glass to a metallic frame.

#### **DOWSIL™ 3362 Insulating Glass Sealant**

DOWSIL™ 3362 Insulating Glass Sealant is a two-component, fast cure, neutral-curing silicone sealant intended for use as a secondary seal in dual sealed IG units. DOWSIL™ 3362 Insulating Glass Sealant has been granted a European Technical Assessment based on independent testing in accordance with the current European structural glazing guideline ETAG 002. DOWSIL™ 3362 Insulating Glass Sealant is appropriate for use in IG units used in structural glazing applications. The product has been granted a CE label based on this approval. The sealant is available in two different curing agent viscosity types: HV and HV/GER. For more information, please refer to the product data sheet.

#### **DOWSIL™ 3363 Insulating Glass Sealant**

DOWSIL™ 3363 Insulating Glass Sealant is a high strength secondary two-part IG silicone sealant specifically designed for high strength applications, where conventional sealants with lower strength would lead to increased joint sizes.

DOWSIL™ 3363 Insulating Glass Sealant has a design strength of 0,21 MPa, which enables economical joint sizes in highly demanding insulating glass (IG) applications such as: high wind in super tall buildings, hurricane loads, cold bended glass in IG or high impact loads such as bomb blast. Smaller joint dimensions also support productivity, as smaller secondary sealant joints can be filled faster than larger joints. DOWSIL™ 3363 Insulating Glass Sealant is ideal as secondary sealant for triple glazed units as the climatic loads in triple IG can be quite high. It is also suitable for

double glazed units and meets EN 1279 part 2 and 3 requirements for gas-filled IG units.

DOWSIL™ 3363 Insulating Glass Sealant can be used in IG applications for structurally glazed facades. It is UV resistant, provides long-term durability and excellent adhesion to glass and IG spacers.

DOWSIL™ 3363 Insulating Glass Sealant has been granted a European Technical Assessment in accordance with the current European structural glazing guideline ETAG 002. The product has been granted a CE label based on this approval.

#### **DOWSIL™ 3364 Warm Edge IG Sealant**

DOWSIL™ 3364 Warm Edge IG Sealant is a two-part silicone sealant, which combines low thermal conductivity and excellent performance allowing for durable bonding applications.

In thermally high performing facades, the edge seal of the glass is typically the weak point where heat loss can still be observed. DOWSIL™ 3364 Warm Edge IG Sealant helps optimize this weak point. Its use can positively impact the U-value of the total façade by up to 5% and help reduce the risk of condensation as it contributes to increasing surface temperatures. It is, therefore, a good solution that removes the need to change designs for toggle systems, structural glazing façades, glass corners, captive facades and even windows. A patented technology meeting ETAG 002 and CEKAL requirements, it is well suited for insulating glass for use in structural glazing applications. For insulating glass units already produced using a high performing warm edge spacer, DOWSIL™ 3364 Warm Edge IG Sealant can positively impact the overall performance even further. (Please also refer to the Dow/SWISSPACER Study, available on request).

DOWSIL™ 3364 Warm Edge IG Sealant has a significantly lower thermal conductivity (0.19 W/mK) when compared to standard organic (0.4 W/mK) and silicone sealants (0.35 W/mK). This low thermal conductivity in turn decreases the Psi value\* and U-value for the insulating glass unit in windows and façades. The use of DOWSIL™ 3364 Warm Edge IG Sealant can lead to a further reduction of the heat flow through the edge of the IGU and consequently, a reduction of the heat losses through a façade.

\*Psi value: linear heat transmission at the edge of the glass [W/mK] according to EN ISO 10077-2:2012-06

# DOWSIL™ product offering (continued)

## Container offered for two-part IG sealants

	25 kg Pail	250 kg Drum
DOWSIL™ 3362 Insulating Glass Sealant — Base	-	Yes
DOWSIL™ 3362 Insulating Glass Sealant — Catalyst	Yes	Yes
DOWSIL™ 3363 Insulating Glass Sealant — Base	-	Yes
DOWSIL™ 3363 Insulating Glass Sealant — Catalyst	Yes	Yes
DOWSIL™ 3364 Warm Edge IG Sealant — Base	-	Yes*
DOWSIL™ 3364 Warm Edge IG Sealant — Catalyst	Yes	-

\* 175kg

## DOWSIL™ 3793 Insulating Glass Sealant

DOWSIL™ 3793 Insulating Glass Sealant is a one component, neutral curing silicone sealant intended for use as a secondary seal in dual sealed IG units. DOWSIL™ 3793 Insulating Glass Sealant is appropriate for use in IG units used in structural glazing applications.

## DOWSIL™ 3545 Insulating Glass Sealant

DOWSIL™ 3545 Insulating Glass Sealant is a one component, neutral curing silicone sealant intended for use as a secondary seal in dual sealed IG units. DOWSIL™ 3545 Insulating Glass Sealant is not appropriate for use in IG units used in structural glazing applications but is appropriate for use in UV edge exposed non-structural IG units.

## DOWSIL™ 335 Butyl Sealant

DOWSIL™ 335 Butyl Sealant is a heat applied, Polyisobutylene for use as the primary seal in double or triple glazed insulating glass in commercial and residential applications. It is suitable for high performance glazing systems, particularly where elevated temperatures are anticipated in warmer climates.

Suitable for insulating glass designs using warm-edge spacers and standard spacers, manufactured from plastic, metal or combinations of both, DOWSIL™ 335 Butyl Sealant is available in two colors; black and special black. Special black is matched to DOWSIL™ 3362 Insulating Glass Sealant and DOWSIL™ 3363 Insulating Glass Sealant for a homogeneous colour and improved aesthetics at the glass edge and has a temperature resistance of up to 95-100°C.

## Structural glazing silicone sealants

The following DOWSIL™ silicone sealants are offered for structural glazing applications. Only the DOWSIL™ Structural Glazing Silicone Sealants indicated below are permitted for use as structural glazing adhesives. For more information on the proper use of silicone sealants in structural glazing applications, please refer to the *Dow silicone structural glazing technical manual (EMEA)* which is available at [dow.com/construction](http://dow.com/construction). Structural glazing sealants may also be used as insulating glass sealants. Please contact your Dow Technical Specialist for more information.

### DOWSIL™ 993 Structural Glazing Sealant

DOWSIL™ 993 Structural Glazing Sealant is a two-component, fast cure, neutral-curing silicone sealant intended for structural bonding of glass, metal and other panel materials. When compared to conventional one-component silicone sealants, the fast cure properties of DOWSIL™ 993 Structural Glazing Sealant allow increased production of structurally glazed curtainwall units. DOWSIL™ 993 Structural Glazing Sealant is a high modulus sealant with excellent adhesion to a wide range of materials. DOWSIL™ 993 Structural Glazing Sealant has been granted a European Technical Assessment based on independent testing in accordance with the current European structural glazing guideline ETAG 002. The product has been granted a CE label based on this approval.

### DOWSIL™ 994 Ultra-Fast Bonding Sealant

DOWSIL™ 994 Ultra-Fast Bonding Sealant is a two-component high strength silicone. Its ultra-fast curing properties can enable significant improvement in the speed of productivity, particularly in continuous production processing, automated fabrications, and specific bonding designs. It has excellent adhesion to glass, metal and a variety of different substrates including plastics.

DOWSIL™ 994 Ultra-Fast Bonding Sealant has been granted a European Technical Assessment based on independent testing in accordance with the current European structural glazing guidelines ETAG 002.

### DOWSIL™ 895 Structural Glazing Sealant

DOWSIL™ 895 Structural Glazing Sealant is a one component, neutral-curing silicone sealant intended for structural bonding of glass, metal and other materials. DOWSIL™ 895 Structural Glazing Sealant is a high modulus sealant with excellent adhesion to a wide range of materials.

DOWSIL™ 895 Structural Glazing Sealant has been granted a European Technical Assessment based on independent testing in accordance with the current European structural glazing guideline ETAG 002. The product has been granted a CE label based on this approval.

# **DOWSIL™ product offering (continued)**

## **Weatherproofing sealants**

Dow offers a full line of high performance sealants for weatherproofing applications. Following is a brief description of DOWSIL™ Weatherproofing Sealants. These sealants are designed and intended to weatherseal building joints and should never be used as structural glazing or insulating glass adhesives. For more information on the proper use of silicone sealants in weatherproofing applications, please refer to the *Dow building envelope weatherproofing technical manual (EMEA)* which is available at [dow.com/construction](http://dow.com/construction).

### **DOWSIL™ 790 Silicone Building Sealant**

DOWSIL™ 790 Silicone Building Sealant is a one component, ultra-low modulus, neutral-cure silicone sealant. It offers outstanding unprimed adhesion to masonry and is well-suited for weathersealing of sensitive substrates such as natural stone. When used in accordance with Dow application and testing recommendations, the sealant forms a durable, flexible, watertight bond with many common building materials, including combinations of stone, concrete and masonry.

### **DOWSIL™ 791 Silicone Weatherproofing Sealant**

DOWSIL™ 791 Silicone Weatherproofing Sealant is a one component, low modulus, neutral-curing silicone sealant with a faster skinning time for general weathersealing applications.

## **Cleaners and primers**

Dow offers a line of cleaners and primers that are developed specifically for use with DOWSIL™ sealants. Most of our primers contain a UV tracer for increased safety and easier quality control. The UV tracer can be made visible using a UV lamp so that any surface areas which have not been properly primed can be immediately identified. In some instances, a specific cleaner or primer will be required for the silicone sealant to achieve optimal adhesion to a specific substrate.

### **DOWSIL™ R-40 Universal Cleaner**

DOWSIL™ R-40 Universal Cleaner is a specially formulated solvent blend designed to clean glass and metal profiles used in structural glazing applications.

### **DOWSIL™ R41 Cleaner Plus**

DOWSIL™ R41 Cleaner Plus is a specially formulated cleaning solvent which contains a special DOWSIL™ catalyst substance designed to clean and pre-treat a large variety of substrates for the bonding with DOWSIL™ sealants.



### **DOWSIL™ 3522 Cleaning Solvent Concentrated**

DOWSIL™ 3522 Cleaning Solvent Concentrated is a cleaner designed for the purging of two-component meter mix equipment used in structural glazing and IG production. The product does not contain halogenated solvent and has been specifically developed to digest cured silicone sealant present in equipment hoses and mixers.

### **DOWSIL™ 3535 Catalyst Cleaner**

DOWSIL™ 3535 Catalyst Cleaner is a solvent free, non-reactive, non-corrosive cleaner for two-component pump dispensing equipment. It enables a fast and easy switch of catalyst colors during production.

### **DOWSIL™ 1200 OS Primer, UV Traceable**

DOWSIL™ 1200 OS Primer, UV Traceable is a one-part chemical treatment primer designed for use with DOWSIL™ sealants in a variety of applications.

### **DOWSIL™ 1203 3in1 Primer**

DOWSIL™ 1203 3in1 Primer is used to improve adhesion and accelerate adhesion build-up of silicone sealants to various substrates. Additionally it cleans substrate surfaces, enabling the same material to be used for cleaning and priming. In case of very dirty surfaces additional cleaning with a cleaning solvent such as DOWSIL™ R-40 Universal Cleaner is necessary. DOWSIL™ 1203 3in1 Primer contains a UV tracer to visually control the quality of surface pre-treatment using a UV lamp.

### **DOWSIL™ Primer-C OS**

DOWSIL™ Primer-C OS is a one-part chemical treatment primer designed for painted and plastic surfaces to promote sealant adhesion development.

### **DOWSIL™ Construction Primer P**

DOWSIL™ Construction Primer P is a one-part film forming primer designed for use on porous substrates in weathersealing applications.

## Dow customer support

Dow offers a broad range of products and services to assist manufacturers in the production of insulating glass. Dow can assist the IG manufacturer in the design of the secondary seal joint dimensioning. Dow technical specialists can assist in the design, evaluation and component selection of the insulating glass system, considering the special requirements related to gas permeability. Dow can assist the IG manufacturer in the development of a comprehensive quality control program that can help to ensure proper sealant application and quality control. A further description of these customer support elements is provided in the following sections of this *Dow insulating glass technical manual*.

### Dow project support

Every structural glazing project using DOWSIL™ Structural Glazing Sealants must be reviewed and approved by Dow. Please refer to the *Dow silicone structural glazing technical manual (EMEA)* for a description of the guidelines that must be followed. In support of our structural glazing products, Dow will review insulating glass joint dimensioning to ensure compliance with European and industry standards. Dow will provide a recommendation letter supporting the use of DOWSIL™ Insulating Glass Sealants for a specific project. Approval is based on production in compliance with the guidelines provided by Dow in this manual.

The silicone secondary sealant of the IG unit is only one element of the final system — all components of the IG units must be considered to determine its overall performance. Many elements including the spacer type, butyl primary seal type and application, glass type, material performance, product application and workmanship will affect the overall performance of the IG unit. It is the responsibility of the IG producer to select the appropriate materials and construction of their manufactured IG units. The IG producer is ultimately responsible for the overall performance of the IG units produced.

### Design review for structural glazing project

All structural glazing projects must be reviewed and approved by Dow on project by project basis. Guidelines for the appropriate design of structural glazing are described in the *Dow silicone structural glazing technical manual (EMEA)*. For structural glazing projects that use insulating glass, the silicone secondary seal on the IG unit must be an approved silicone sealant. When DOWSIL™ Insulating Glass Sealants are selected for this application, Dow offers to review IG joint dimensions to ensure compliance with Dow and relevant industry standards. Please submit project information or the “Project Checklist” by the procedures described in the *Dow silicone structural glazing technical manual (EMEA)*. Please include information such as glass dimensions, sealant joint dimensions, total dynamic loads and a cross-section detail of the IG unit edge design.

### Testing for structural glazing project

For all structural glazing projects, the materials which contact the DOWSIL™ Structural Silicone Sealant must be tested for adhesion and compatibility by Dow. Guidelines for material selection and testing are described in the *Dow silicone structural glazing technical manual (EMEA)*. When DOWSIL™ Insulating Glass Sealants are used, Dow recommends that any material which has not been previously tested and approved by Dow for adhesion and compatibility should be tested by Dow prior to use.

## **IG production support**

Dow professionals offer their experience and expertise to any insulating glass manufacturer who selects DOWSIL™ Insulating Glass Sealants for their IG production. Dow technical specialists are available to review the IG production elements including material selection, production procedures, workmanship, quality control procedures and documentation.

Dow can also provide recommendations to IG producers who would like to receive a CE Mark or to comply with any other regional norms. Dow can assist in particular with achieving compliance according to gas-filled IG Sealant standard EN 1279 part 3. Many Dow customers have successfully passed EN 1279 part 3 gas loss requirements using DOWSIL™ Insulating Glass Sealants. We can help you achieve similar results. These issues are discussed further in subsequent sections of this *Dow insulating glass technical manual*.

# Design and material considerations

Many elements will help to determine the successful performance of an IG unit. In this section, we will discuss types of insulating glass, IG joint dimension and the components of an IG unit and how these components affect the overall performance of an IG unit. We will also consider how these elements relate to satisfying European standards. It is the responsibility of the insulating glass supplier to consult with the façade contractor or the curtainwaller to determine the parameters needed to design the silicone secondary seal joint. Dow will be then be able to calculate the joint bite based on the parameters provided via COOL or the calculation checklist which can be found in the Dow Calculation Checklist booklet available from your Dow Technical Specialist.

## Insulating glass components

An IG unit, whether used in a structural glazing system or in a mechanically captured or frame mounted glazing system, is intended to offer the building occupant an aesthetically pleasing, thermally efficient façade element which requires minimal maintenance during the expected life of the unit. Typical IG units are comprised of two (or occasionally three) panes of glass with a cavity between the panes. The panes of glass are sealed around the perimeter with a spacer and sealant system which ensures that the units are hermetically sealed and sufficiently stable to withstand thermal and windload stresses on the unit. For a typical “dual-sealed IG unit”, a polyisobutylene (PIB) or “butyl” primary seal between the metal spacer and glass provides low vapor permeability and a silicone secondary seal provides structural integrity for the panes of glass.

For insulating performance, the space between the panes of glass is filled with dry air or more commonly filled with an inert gas which provides

enhanced thermal insulating performance. To maintain the long term insulating performance of the unit, the glazed perimeter of the IG unit must have low vapor permeability to resist an ingress of moisture which can cause fogging of the IG unit. To absorb incidental moisture that may enter the void, a desiccant is commonly used in the spacer element. All of these elements must work synergistically to provide the expected performance of the IG unit. Below is a diagram showing a typical IG unit and the common elements of the design.

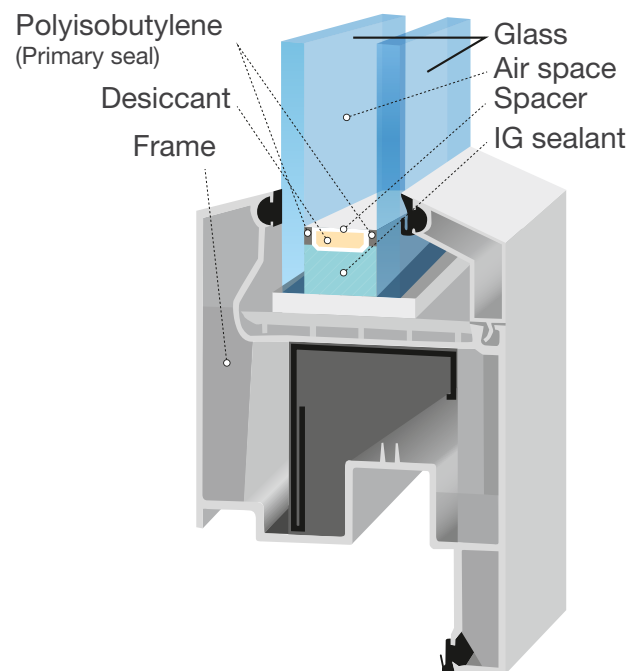
## Types of insulating glass

Depending on the specific assembly and mounting support of the façade, insulating glass can be classified into three different types. The three types of insulating glass are described in the following section.

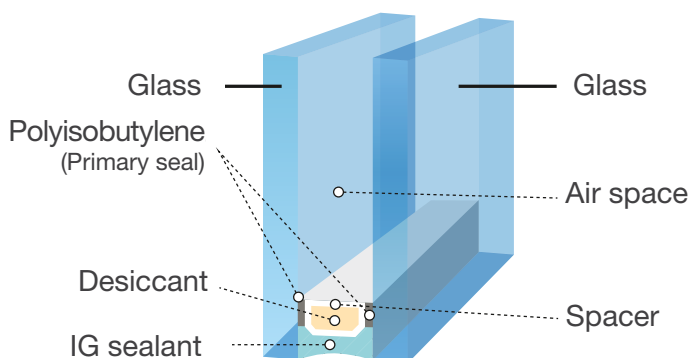
### Frame mounted insulating glass

Frame mounted insulating glass is secured on all four sides by a frame that completely covers the edge seal. The insulating glass may be placed inside a fixed frame or the insulating glass could be set on the frame then secured continuously by a pressure bar. Typical applications include curtainwall facades or windows constructed of wood, plastic or aluminium. In these designs, there is no restriction on the type of spacer bar system or sealant type used. Silicone insulating

### Frame mounted insulating glass unit



### Typical dual sealed insulating glass unit



glass sealants which are recommended for non-structural and structural applications can be used effectively in these designs.

### Insulating glass with uncovered edge seal

For insulating glass with an uncovered edge seal, there are additional demands on the primary and secondary seals of the IG unit. Ultra-violet (UV) rays from the sun travel readily through glass and can damage the edge seal of the IG unit. The sealants selected for insulating glass with uncovered edge seals must be tested in accordance with EN 1279 requirements. Only silicone sealants are stable after long term exposure to UV light. Current European structural glazing standards such as ETAG 002 (Guidelines for European Technical assessment for Structural Glazing Systems (SSGS) Part 1) accept only silicone sealants for structural glazing applications. Organic sealant such as polysulphide and polyurethane do not provide long term resistance to UV light and are not recommended for this application.

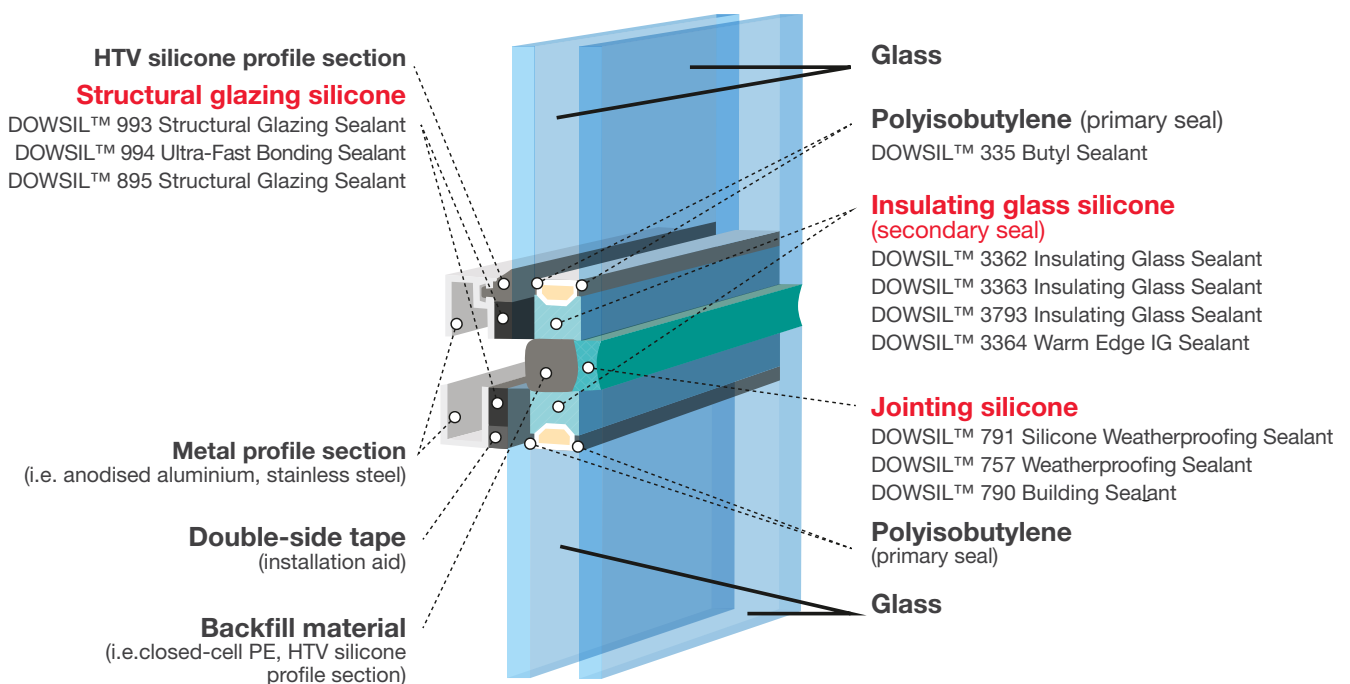
Typical examples of insulating glass with uncovered edge seal include:

- Silicone structural glazing where the IG unit is structurally glazed on the inner pane of glass.

In these designs, the IG secondary seal is structurally attaching the outer pane of glass. A design is considered “structurally glazed” if 1, 2, 3 or 4 edges of the glass are supported by structural silicone sealant and there is no mechanical attachment of the glass along the edge. A silicone insulating glass sealant approved for structural glazing projects must be used. Organic sealants are not permitted in these applications according to European standards.

- Silicone structural glazing where the insulating glass is produced as a “stepped glass” and the structural silicone is applied to the inner surface of the outer pane of glass. In this design, the secondary seal of the IG unit is typically not acting structurally. Nevertheless, due to the high UV exposure of the edge seal of the IG unit, only UV-stable silicone insulating glass sealants are recommended for this application. Please see the figure below.
- Structural glass systems which are point supported or bolted to the structure. Structural glass systems often have the appearance of a structurally glazed facade. These systems are not structural glazing unless the glass fixation is done only on the interior pane of glass. The insulating glass edge is typically uncovered in these designs.

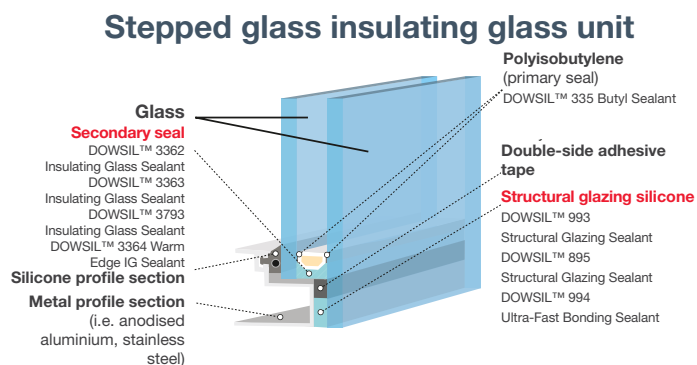
Standard SG detail with IG unit



# Design and material considerations (continued)

## Insulating glass with mechanically retained edge seal

Many proprietary systems have been introduced where the inner pane of an IG unit is mechanically retained to the structure. These designs commonly use a metallic U-profile channel applied into the silicone secondary seal of the IG units. The IG unit is attached to the structure of the building by mechanical retention along the cavity of the U-profile channel. Some designs have a continuous U-profile channel and some are positioned periodically along the perimeter of the glass. Some designs use a combination spacer and U-profile in one extrusion. These designs are considered as structural glazing since the outer pane of glass is structurally attached to the profile and not the inner pane of glass.



Since these designs are proprietary to the system designer, Dow reviews and approves these designs on a system by system basis. Although the designs may appear similar, variations will determine whether Dow considers the design a “structural glazing” or an “insulating glass” application.

All mechanically retained IG systems must be reviewed and approved by Dow Technical Specialists. Upon completion of this review, Dow will determine whether a design is considered “insulating glass with mechanical retention” or “structural glazing to a U-profile channel”.

## Insulating glass joint dimensioning

Proper dimensioning of the secondary seal of an IG unit is critical to the ultimate performance of the unit. Many factors affect the performance including wind, climatic and impact loads. Dow offers to review the joint dimensioning of an IG secondary seal and will make recommendations based on the following guidelines. Ultimately the IG manufacturer is responsible for the joint dimensioning and performance of their IG units.

## Insulating glass joint dimensioning guidelines

Following are guidelines that apply for the use of DOWSIL™ Insulating Glass Silicone Sealants.

- A minimum joint depth of 6 mm is required if the edge seal of the IG unit provides any structural function such as for structural glazing.
- When used for structural function, the IG secondary seal shall be as determined by the IG sealant depth calculation for total dynamic load (wind load, climatic load, impact load)
- When used for structural function and the IG unit is subjected to permanent shear or tension load, the IG secondary seal shall be as determined by the IG sealant depth calculation for continuous load.
- The above guidelines are minimum requirements and exclude any application tolerances.

## Insulating glass terminology

### Sealant depth

The sealant depth is the minimum dimension from the spacer to the outer edge of the silicone secondary seal. This dimension may also be referred to as the “bite” or “height” of the insulating glass sealant.

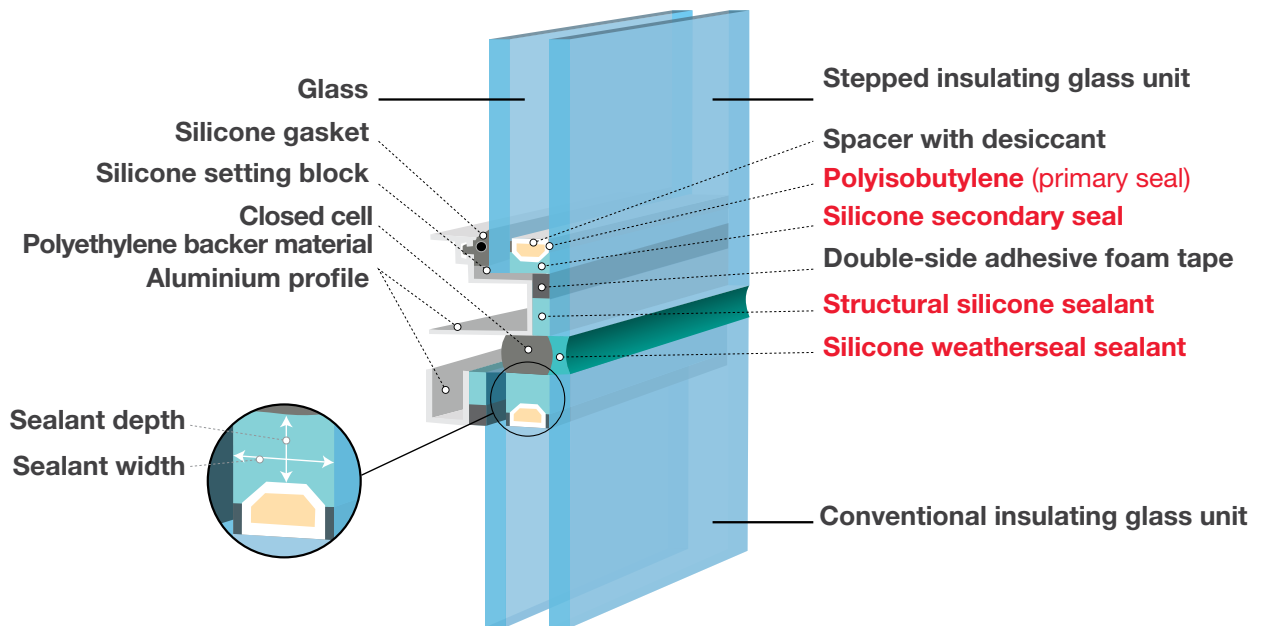
### Sealant width

The sealant width is the dimension between the panes of glass. The sealant width may also be referred to as the “cavity” or “air space” of the IG unit.

### IG sealant depth calculation for total dynamic load (wind load, climatic load, impact load)

The sealant depth requirement is based on the total dynamic loads applied to the IG unit. The loads may be from the wind, climate or impact. Higher wind loads and larger dimensions of the glass require greater sealant depth. Climatic loads are determined by the change in temperature and pressure on the IG unit. Climatic loads on the secondary seal are greater for smaller glass dimensions in most situations. Dow considers the effect of climatic loads during the joint dimensioning of an IG unit. Additional loads such as impact loads or point loads can also be considered in the determination of total dynamic load.

## Structural glazing in an insulating glass unit assembly



### IG sealant depth calculation for total dynamic load

$$\text{Minimum sealant depth (m)} = \frac{\text{Glass short span dim. (m)} \times \text{Total dynamic load (Pa)} \times 0.5}{140,000 \text{ Pa}}$$

- Glass short span dimension (SSD) is the shorter of the two dimensions of the rectangular glass panel; for example, on a 1.5 m by 2.5 m glass panel, the SSD is 1.5 m
- Total dynamic load is the difference between the pressure in the cavity of the IG unit and the sum of wind load and atmospheric pressure. The pressure in the cavity is affected by temperature, elevation and atmospheric pressure during production of the IG unit. Impact loads such as line loads or snow loads can be included in the total dynamic load. The stiffness of the glass panes will affect the total dynamic load.
- The maximum wind load in pascal is based on a return period of 10 years according to EUROCODES and local regulations; this value is provided by the design professional to Dow.  
1 Pa = 1 N/m<sup>2</sup>
- 140,000 Pa (0.14 MPa) is the Maximum Allowable Design Stress for both DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3793 Insulating Glass Sealant, DOWSIL™ 3364 Warm Edge IG Sealant.
- 210,000 Pa (0.21 MPa) is the Maximum Allowed Design Stress for DOWSIL™ 3363 Insulating Glass Sealant (high strength insulating glass sealant).
- Maximum allowable design stress is based on the Ru,5 value with a safety factor of 6. The Ru,5 value is the probability at 75% that 95% of the population will have a breaking strength above this value.

### IG sealant depth calculation for continuous load

The IG secondary seal is subject to continuous load if the outer pane of glass is not supported by horizontal framing members or setting blocks, or is being used in roof glazing or positive sloped glazing. The deadload weight of the glass

must be considered in the joint dimensioning of the IG unit. Thicker glass panes will require greater sealant depth of the IG joint. Additional loads such as snow loads will also affect the continuous load on an IG unit and should be considered.

# Design and material considerations (continued)

## IG sealant depth calculation for continuous load

$$\text{Min. sealant depth (m)} = \frac{2,500 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times \text{Glass thickness (m)} \times \text{Glass dim. (m}^2\text{)}}{2 \times [\text{Height (m)} + \text{Width (m)}] \times \text{Allowable design stress for cont. load}}$$

- 2,500 kg/m<sup>3</sup> is the specific mass of float glass corresponding to approximately 25,000 N/m<sup>3</sup> of specific weight
- 9.81 m/s<sup>2</sup> is a factor for gravity
- Glass Thickness and Glass Dimension are determined only for the outer pane of insulating glass unit
- The Allowable Design Stress for Continuous Load for DOWSIL™ 3364 Warm Edge IG Sealant is 9,500 Pa; DOWSIL™ 3362 Insulating Glass Sealant and DOWSIL™ 3793 Insulating Glass Sealant is 7,000 Pa; DOWSIL™ 3363 Insulating Glass Sealant is 11,000 Pa

## Material component considerations for insulating glass production

For the successful performance of IG units, it is important that the proper materials are selected. There are many different types of glass, glass coatings, spacer materials, desiccants, primary seals, etc. to choose from. These products must be tested and found to be compatible with each other. There are special considerations when using specific components of an IG unit. The following discussion is intended to help the manufacturer of IG units to properly select and handle the components of an IG unit. It is ultimately the decision of the IG producer to select the materials for their own IG units.

### Glass coatings

Due to the continual advancement in glass coating technology, a wide range of possibilities are available to the glass processor. All glass coatings should exhibit sufficient resistance to chemicals, maintain adhesion to glass and remain integral. In addition, the DOWSIL™ Insulating Glass Sealant should be tested for long term adhesion to the specific glass coating. Coatings which do not meet these requirements should be removed from the glass surfaces to be bonded.

### Coating types

#### *Glass enamel*

Glass enamel is a ceramic glass coating that is applied by various means, i.e. spray, roller, screen print, transfer print or dip coating. The inorganic coating is fused to the glass surface by firing the

glass at a high temperature (> 550°C). For successful performance, the enamel must demonstrate scratch resistance, chemical resistance, smooth surface roughness and a thermal coefficient of expansion similar to glass. In most cases, DOWSIL™ Insulating Glass Sealants demonstrate excellent adhesion to glass enamel coatings, often requiring a primer.

#### *Metal and metal oxide coating*

Metal or metal oxide coatings are either pyrolytically or magnetronically applied to the glass surface. In the pyrolytic method, molten metal or metal oxide is applied at high temperature to the glass by either dipping or spraying. Magnetron sputtering allows various metal and metal oxide coatings to be applied in thin layers on the glass substrate. This permits a broad range of light reflection, light transmission, infrared reflection and color of the glass surface. Magnetron sputtering also allows for a combination of heat and sun protective coatings to be applied one on top of the other.

Hard coatings are usually composed of nickel and chrome elements which are especially suited as sun protective coatings. Sun protective coatings can be applied either pyrolytically or magnetronically.

Soft coatings usually contain silver which has high reflective properties and is especially effective in protection against heat radiation. As a rule, coatings that provide heat reflective properties are magnetronically applied, so that the silver coating which is soft and susceptible to corrosion may be embedded between metal oxide layers such as tin or bismuth oxide.



Depending on the coating type, the coating may have to be removed from the surface area to be sealed. Each individual coating type should be tested by Dow. Normally, insulating glass sealants can be applied over all pyrolytic coatings and most hard magnetronic coatings without the need for primer, while heat reflective coatings that contain a soft silver layer must be completely removed.

### *Polymer coatings*

Various polymer coatings are available for use as spandrel glass coatings. These coatings may be single or multiple components. Polymer coatings which are based on organic polymers such as polyurethane, acrylic, polyester or epoxy are not generally acceptable for structural glazing applications. Inorganic silicone based polymer spandrel coatings are available and may be suitable for structural glazing applications. The coating manufacturer must verify that their polymer coating is durable and has long term adhesion to glass. Specific polymer coatings must be tested for compatibility and long term adhesion with the DOWSIL™ Insulating Glass Sealant.

### **Glass coating removal**

DOWSIL™ Insulating Glass Sealants should only be applied to coatings which exhibit sufficient resistance to chemicals, long term adhesion to glass, durability and integral performance. If a glass coating does not demonstrate these features or is incompatible with the insulating glass sealant, the glass coating must be removed. It is the responsibility of the glass supplier to determine whether edge deletion of the glass coating is required; please follow recommendations from the glass supplier. Also if the DOWSIL™ Insulating Glass Sealant does not adequately adhere to the glass coating, the coating must be completely removed from the glass surfaces to be bonded. Coating removal should be complete leaving no residue on the glass surface. Should coating residue remain on the glass surface, appropriate tests on representative samples should be performed to ensure that the residue does not adversely affect adhesion of the DOWSIL™ Insulating Glass Sealant. Following are the known practices used to remove glass coatings.

### *Mechanical stripping*

This is the most common method to remove a glass coating. Special grinding tools are used to remove glass coating only on the surfaces to be bonded. Grinding may be done manually or integrated into the production line. The quality of the coating removal is dependent upon the nature of the coating, the quality and condition of the grinding machine, as well as the production variables such as feed rate, grinder speed and grinding pressure. Wet grinding may also be effective to remove a glass coating. For some coating types, it is not possible to achieve a completely residue free coating removal by means of mechanical stripping. Accordingly, testing of sealant adhesion to glass surfaces treated by this method is especially important to ensure proper adhesion.

### *Chemical removal*

This method uses acid in an appropriate concentration to remove a soft coating from glass. This technique is effective in removing a coating completely from glass. Due to the inherent dangers of handling such substances, this technique is rarely used today.

### *Thermal removal*

This method uses a heat-gun to chemically destroy the glass coating. Once the coating is oxidized, it can be easily wiped from the glass. Due to the inability to control the heat-gun, this method is rarely used today.

### **Spacer system components**

For successful performance of an IG unit, the spacer system components serve several functions. The spacer profile maintains the cavity dimension and encloses the cavity of the IG unit. The spacer also supports the desiccant which keeps the cavity free of moisture. A primary seal provides a vapor barrier for the cavity of the IG unit. A wide range of spacer system components are available for IG production. There are advantages and disadvantages to all of these materials. Following is a discussion of the different spacer system components available.

# Design and material considerations (continued)

## Spacer profile types

### *Aluminium profiles*

Aluminium profiles may be either mill finished or anodized in a variety of colors. Aluminium spacers are very common due to their low cost, ease of handling and bending.

### *Zinc or galvanized steel profiles*

Zinc or galvanized steel profiles are low cost and easy to handle. Steel has a lower coefficient of thermal expansion and heat transmission than aluminium which often improves the durability and performance of an IG unit.

### *Stainless steel profiles*

Stainless steel profiles are generally higher in cost and more difficult to handle. Handling depends on the dimension of the profile. Stainless steel is very durable and has a lower heat transmission coefficient than aluminium to provide a durable, high performance IG unit. Stainless steel profiles are available in silver or black.

### *Organic spacer profile*

This spacer type is a composite of organic polymer and a metallic foil to provide a vapor barrier. Some organic spacer profiles use glass fiber impregnation in the organic polymer to provide stiffening.

### *Rubber profile with self adhesive surface*

This spacer type is composed of a silicone foam core with a two-sided adhesive, a metallic foil and pre-applied butyl seal to provide a vapor barrier. This profile provides good thermal insulating properties.

### *Thermoplastic spacer*

Thermoplastic spacer is applied directly on the glass surface on the automated production line. This material is a one-component hot melt sealant that acts as a spacer, vapor barrier and desiccant in one. This material provides very good thermal insulating properties.

## Desiccant

A desiccant is a molecular sieve which is inserted into the spacer profile during IG production. This molecular sieve acts to absorb incidental moisture in the cavity of the IG unit. Proper

storage and handling of the desiccant is critical for the performance of the IG unit. Different grades of desiccant need to be used for dry air and gas-filled IG units.

## Primary seal

The primary seal in an IG unit provides the vapor and gas barrier between the metallic or organic spacer profile and glass.

Polyisobutylene (or PIB) is the common material used as a primary seal in an IG unit. The PIB must be continuous during application and be fully compatible with the adjacent materials including the secondary seal of the IG unit. For successful performance, the PIB must be stable and durable in the climatic environment in which the IG unit will be exposed.

## Gas-filled insulating glass units

Due to global demands to lower the levels of carbon dioxide (CO<sub>2</sub>) emissions and the fact that domestic emission accounts for 25% of the total CO<sub>2</sub> emissions, modern building construction must provide more thermally efficient window and façade systems. Until recently, windows have been one of the primary sources of thermal loss in building construction. Due to the development of new low emissivity (low-E) coated glass, gas-filled IG units and warm edge technologies, windows can now be thermally efficient as well as providing aesthetic appeal to the building construction.

Thermal transfer by conduction and convection in an IG unit can be decreased by substituting air with a gas having lower thermal conductivity (argon, krypton or xenon). Transfer by radiation can be decreased using low emissivity (low-E) glass and the thermal conductivity at the edge can be reduced through warm edge technology. The table below reports the thermal transmittance of a single glass pane and IG units (U<sub>g</sub>) with and without low-E coating and gas-filling.

## Silicone sealant use in gas-filled insulating glass units

While the key performance advantage of organic based sealants (polysulphide, polyurethane) for high thermal efficient IG units is their low gas permeability, (which allows them higher workmanship tolerance) their relatively weaker

Number of panes	Type	U <sub>g</sub> -value (EN 52619) W/(m <sup>2</sup> K)
Single pane	Monolithic float glass, 4 mm	5.2
Double pane	Float glass (2 x 4 mm glass, 16 mm spacer, air filled)	2.8
	Float glass (2 x 4 mm glass, 16 mm spacer, low-E coat (1x), air filled)	1.8
	Float glass (2 x 4 mm glass, 16 mm spacer, low-E coat (1x), argon filled)	1.3
	Float glass (2 x 4 mm glass, 1 x 16 mm inter-pane space), low-E coat (1x), Krypton-filled	1.0
Triple pane	Float glass (3 x 4 mm glass, 1 x 16 mm spacer), low E coating gas-filled	0.4

adhesion to glass after exposure to sunlight prohibits their use in structural glazing, roof glazing or any other application that requires high durability, UV exposure and/or extreme weathering resistance.

Silicone sealants, on the other hand, excel in their adhesion durability to glass after sunlight exposure, making them the material of choice for structural and commercial glazing as well as demanding roof glazing applications. With over 50 years of global experience with silicone insulating glass sealants, the excellent performance and service-life of silicone dual-sealed IG units have been demonstrated.

Past years developments have demonstrated that argon-filled, silicone dual-sealed IG units can be manufactured, which reliably pass EN 1279 part 3 requirements. Numerous commercial systems using gas and silicone have been successfully introduced to the market. Consequently, silicone dual-sealed IG units can today be produced that not only excel in their durability and longevity, but also reliably meet the stringent requirements for gas retention, and therefore provide optimum service-life and insulation value.

Due to the high gas permeability of silicone sealants, special considerations must be taken in the design and manufacture of silicone sealed IG units. The key point is to focus on the gas leakage through the IG unit as a whole, not necessarily through individual components. Indeed, a properly applied polyisobutylene primary seal is

so impermeable to inert gases that it alone acts as the main barrier to gas leakage while the secondary seal acts to secure the two glass panes and protect the primary seal from harsh environmental conditions and premature degradation. The next table summarizes overall argon gas permeability of dual seal sealant types.

### Design considerations

Design is a primary element affecting whether an IG unit will pass gas loss requirements. The loss of gas can be reduced by increasing the resistance to gas leakage. Gas leakage can be slowed by decreasing the area available for gas transmission and increasing the path length required for gas transmission.

Bent spacer-frame corners, gas-filling techniques integrated into the IG assembling process (rather than filling via holes drilled into the spacer), improved semi-automatic PIB application equipment and in-line (heated) PIB primary seal presses have all substantially contributed to the reduction of gas loss and helped to improve the quality and service-life of IG units.

It has been demonstrated that IG edge-seal systems which have the ability to accommodate some movement within the spacer itself, place less stress on the primary seal and thus ensure low gas loss rates under accelerated and actual service-life conditions.

Examples of such spacers include thermoplastic spacers or rubber profile spacers.

## Design and material considerations (continued)

Sealant type	Argon permeability [cm <sup>2</sup> /(s cmHg)]	
	Single seal	Dual seal
Polyisobutylene (PIB)	5 x 10 <sup>-11</sup>	n/a
Polysulphide	1.5 x 10 <sup>-10</sup>	6.82 x 10 <sup>-11</sup>
Polyurethane (polybutadien)	8.0 x 10 <sup>-10</sup>	8.00 x 10 <sup>-11</sup>
Polyurethane (polyether)	2.8 x 10 <sup>-9</sup>	8.24 x 10 <sup>-11</sup>
Silicone	3.7 x 10 <sup>-8</sup>	8.33 x 10 <sup>-11</sup>

Insulating glass edge-seal systems that minimize differential thermal movement or minimize primary seal movement, especially within the sensitive corner region, tend to perform significantly better in terms of gas loss rates than systems with high thermal movement. For example, IG units of different designs, but based on stainless steel spacers, have better gas loss rates than IG units using aluminium spacers. In the case of rigid spacers, the degree to which the primary seal is strained during periods of positive pressure differential and the time during which extension in the primary seal occurs are determined by the modulus and elastic recovery of the secondary seal. A secondary seal which has high modulus and high elastic recovery will reduce the strain on the primary seal. In practice, positive pressure differentials occur at low atmospheric pressures or at high temperature, whereby temperature is responsible for most pressure differentials. Therefore, the tensile stress behavior (Young's modulus) of secondary sealants at elevated temperatures must be considered as well as elastic recovery properties of the sealant. DOWSIL™ 3363 Insulating Glass Sealant (high strength capability) has been specifically developed to provide the high modulus and elastic recovery requirements of this application.

### Workmanship considerations

Workmanship plays an important role in determining the success of gas filling, much as it does in ensuring success of manufacturing a standard air-filled IG unit. Following are some practices which will assist in the qualification and production of IG units which pass gas-filling requirements:

- Glass panes and spacers must be properly cleaned to ensure that the primary and secondary sealants achieve satisfactory adhesion.
- Spacers must be properly aligned. Failure to do so will result in less than desired secondary seal depths. PIB primary seal stressing and failure can occur if insufficient secondary seal is present to maintain structural integrity of the IG unit. Bent corners are recommended to maintain a solid, uniform spacer function.
- Corner keys and any probe holes located in the spacer should be injected with PIB to eliminate voids or openings of any kind through which gas could migrate. Any voids or openings will act as a channel through which the gas will migrate with minimal resistance.

- The PIB primary seal cannot contain voids or skips. Any voids or skips will act as an open door for gas migration. The PIB primary seal must be applied in a uniform and continuous depth and thickness along the entire perimeter of the IG unit. The PIB must be homogeneous and fully wet both the glass and spacer during IG production.
- The secondary seal must also be free of voids or skips. Any inconsistencies may allow undue stressing or failure of the PIB seal, the primary barrier to gas leakage. Two-part sealants must be properly mixed and used at the proper mix ratio. Please refer to the Product Quality section of this manual for proper guidelines.

Dow can assist the IG manufacturer to optimize their design and production processes to meet current European gas loss testing requirements. For more information, please contact your Dow Technical Specialist.

### **Insulating glass with warm edge**

In thermally high performing facades, the edge seal of the glass is typically the weak point where heat loss can still be observed. This heat loss can be minimized by using a thermally optimized spacer system. Stainless steel spacer bars perform better than aluminium spacers, but recent development efforts by insulating glass component manufacturers have led to even more thermally efficient spacers with a thermal conductivity (lambda value ) as low as 0.14W/mK. Optimization is achieved by a careful spacer bar material

choice and cross section design. This low thermal conductivity in turn decreases the Psi value\* and U-value for the IGU in windows and façades.

Examples of thermally improved spacer materials are silicone foam rubber or foiled plastics. Similarly, to further optimize the edge of the IGU, it is crucial to also reduce the heat loss through the silicone secondary sealant. The generally accepted thermal conductivity of a conventional silicone sealant used in thermal modeling for assessment of the thermal performance is 0.35W/mK (according to EN ISO 10456). The use of DOWSIL™ 3364 Warm Edge IG Sealant, with a unique thermal conductivity of 0.19W/mK, can lead to a further reduction of the heat flow through the edge of the IGU and consequently, a reduction of the heat losses through a façade. Depending on the system type and dimensions, improvements up to 5% in U-value for the curtain wall can be obtained without design, change compared to a conventional silicone for secondary sealing of IGU.

For insulating glass units already produced using a high performing warm edge spacer, DOWSIL™ 3364 Warm Edge IG Sealant can positively impact the overall performance even further (please also refer to the Dow/SWISSPACER Study, available on request).

\*Psi value: linear heat transmission at the edge of the glass [W/mK] according to EN ISO 10077-2:2012-06

For more information or assistance in developing a more thermally efficient insulating glass unit, please contact your Dow Technical Specialist.

# Product quality

Dow performs extensive quality assurance testing in our manufacturing facilities in accordance with ISO 9001 standards. This section of the manual is intended to provide sealant users with procedures and recommendations for the proper storage, handling, use and quality control of DOWSIL™ Insulating Glass Silicone Sealants. As a sealant user, you must read, understand and closely follow the procedures and recommendations set forth in this section of the manual. Factory production control procedures for insulating glass production are also described in various industry standards such as EN 1279 part 6. If you have questions regarding any of the following procedures or recommendations, contact your local Dow Technical Specialist prior to using the DOWSIL™ sealant.

## General considerations

### Material storage and handling

DOWSIL™ sealants must be stored at the recommended temperature and environment. Excessive temperatures or moisture may cause a sealant to be damaged. Sealant cure, adhesion and physical properties could be harmed if the sealant is not handled and stored properly. The sealant user must understand and follow recommendation on the proper use of dispensing equipment for two-component silicone sealants.

### Shelf life

DOWSIL™ sealants must be used within their stated shelf life. Sealant that is used beyond its stated shelf life may not cure properly to its full physical properties and must not be used.

### Joint preparation and sealant application

Specific procedures and recommendations on joint preparation and sealant application are made later in this section. These procedures and recommendations will help to ensure proper sealant adhesion, cure and joint fill. Ignoring or skipping a step in the process could have an adverse effect on the performance of the insulating glass sealant. These procedures should be understood and completely followed by the sealant user.

### Quality control

Dow provides recommendations and procedures that must be completely understood and followed by the sealant user. These procedures are proven to be effective and reliable. In the Documentation

section of this manual, Dow provides quality control logs which can be used by the sealant user. Dow will assist you in the development of a comprehensive quality control program. Dow will also audit a production facility and make recommendations for improvement if necessary.

### One-component butyl sealants

DOWSIL™ 335 Butyl Sealant is ready to use when stored between +10°C to +30°C. If stored at lower or higher temperatures, volume output is impacted and there is a high risk of condensation when stored at lower temperatures, although DOWSIL™ 335 Butyl Sealant is resistant against frost. DOWSIL™ 335 Butyl Sealant has a shelf life of 36 months from date of production provided it is properly stored in its original packaging.

## One-component silicone sealants

### Storage temperature and conditions

DOWSIL™ Insulating Glass Silicone Sealants must be stored at a temperature below 30°C. An expiry date is clearly marked on the product packaging. Sealant should only be used if it is within the expiry date shown on the package. The sealant should be kept in its original unopened package until the sealant is to be used. Sealant should be stored indoors in a dry environment.

### Skin-over time/elastomeric test

A skin-over time and elastomeric test should be performed once per day and on each new lot of sealant to be used. The purpose of this test is to ensure that the sealant cures fully and has typical elastomeric properties. Any variation such as excessively long skin-over time may indicate that the sealant is out of shelf life or has been stored at excessively high temperature. Skin-over time will vary with temperature and humidity. Higher temperature and higher humidity will cause the sealant to skin-over and cure faster. Skin-over times may differ from the data recorded in the relevant technical data sheets.

The following procedure must be performed before any material is used in production. Production quality control procedures, such as adhesion tests, are described later in this section.

1. Spread a 2 mm thick layer of sealant on a polyethylene sheet.
2. Every few minutes, touch the sealant film lightly with your finger.

3. When the sealant no longer adheres to your finger, the skin-over time has been reached. If the skin-over time is greater than 2 hours, do not use this material and contact your Dow Technical Specialist.
4. Allow the sealant to cure for 48 hours. After 48 hours, remove the sealant from the polyethylene sheet. Stretch the sealant slowly to determine whether it has cured to normal elastomeric properties. A control sample of “good sealant” can be used for comparison. If the sealant has not cured properly, do not use the material and contact your Dow Technical Specialist.
5. Record results in your Quality Control log. A sample log is available in the Documentation section of this manual. The completed log should be retained and be available for review by Dow upon request.

## Two-component silicone sealants

### Storage temperature and conditions

DOWSIL™ Insulating Glass Silicone Sealants must be stored at temperatures below 30°C. An expiry date is clearly marked on the product packaging for the curing agent and base. Sealant should only be used if it is within the expiry date shown on the package. The sealant should be kept in its original unopened package until the sealant is to be used. Sealant should be stored indoors in a dry environment. Containers of curing agent and base are not lot-matched. For practical purposes it is best to use the oldest container of material first.

### Two-component dispensing equipment guidelines

DOWSIL™ Insulating Glass Silicone Sealants are high performance materials, which are certified and approved by official authorities and test institutes for use as an insulating glass sealant in structural glazing applications. Properly applied, they provide excellent long-term adhesion and durability, which is necessary for IG applications.

DOWSIL™ Insulating Glass Silicone Sealants require correct pumping and mixing by the sealant user to achieve their intended performance. State of the art technology for the application of

two-component sealants uses a sophisticated pumping, metering and mixing machine with either a dynamic or static mixer. There are several different suppliers for such equipment. The dispensing machines available in the market are all different in design, so therefore Dow strongly recommends that the sealant user follow the guidelines provided by the equipment supplier regarding the proper use and maintenance of the dispensing equipment. In addition to the guidelines from the equipment supplier, Dow recommends that the sealant user understands and complies with the following best practices:

### Maintain proper production facility temperature

Ambient temperature in the production facility must be between 10°C and 40°C. For best performance, maintain a temperature of between 18°C to 30°C. At colder temperatures, between 10°C and 18°C, cure rate and adhesion development will be slower. In higher temperatures, between 30°C and 40°C, working time will be shorter.

### Provide proper sealant storage conditions

Sealant containers must be stored below the sealant's recommended storage temperature of 30°C. Sealant can be used at temperatures of up to 40°C. If a sealant container is kept in a production facility at a temperature of greater than 30°C for one week, replace the material. Containers should be stored in their original unopened containers.

### Avoid excessively high humidity

In higher relative humidity, the sealant will cure faster and have a shorter working time. Excessively high humidity (> 80%) could cause moisture on the substrate surface and adversely affect sealant adhesion. To minimize the damage of moisture on the individual sealant components, pails and drums must be kept airtight during storage and after being placed on the dispensing equipment. When using a pressure pot, the air inside the drum or pail must be filtered and dried (silica gel filters are recommended).

## Product quality (continued)

### Curing agent must be homogeneous

Prior to placing material on the dispensing equipment, the curing agent should be visually inspected and agitated in the pail to ensure homogeneity. Do not incorporate excessive air during mixing of the curing agent. Low viscosity curing agent (HV) is more likely to show separation and should be mixed prior to use. High viscosity curing agent (HV/GER) does not generally require mixing but it should be checked in all cases before use. It is recommended to mix the curing agent one to three days before the pail needs to be changed to allow the curing agent to de-air.

### Properly maintain sealant dispensing equipment

It is essential that the sealant user establish a quality program that will ensure that the sealant dispensing equipment is functioning properly. Because there are many different manufacturers of dispensing equipment, maintenance requirements will differ. Requirements common to all equipment manufacturers include:

- Sealant must be dispensed free from exposure to air. DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3363 Insulating Glass Sealant and DOWSIL™ 3364 Warm Edge IG Sealant must be processed in a closed system free from exposure to air. Air introduced during the change of sealant containers must be completely bled out or flushed out of the system prior to use.
- Regularly inspect and maintain components of dispensing equipment. Air can be incorporated into the sealant if the pump is defective or gaskets have hardened or are damaged allowing air ingress into the system. When using high pressure pumping equipment with a follower plate system, regularly check the follower plate to ensure that it is moving smoothly and will not be blocked by a damaged drum or pail or by a damaged or brittle gasket. Proper maintenance and cleaning of the mixer helps to ensure properly mixed sealant. Filters should be regularly inspected and replaced as necessary.
- Ensure that there is no contamination of sealant components. Sealant must not come in contact with machinery oils from the equipment. Pumps must be checked for tightness and oil should not be used on the follower plates.

When using a solvent such as DOWSIL™ 3522 Cleaning Solvent Concentrated for cleaning of the mixing line, the sealant lines must be completely closed against the solvent lines to avoid contamination of the sealant with solvent. All gaskets must be compatible with the cleaning solvent.

Regularly maintain gaskets. Some gaskets, especially those in direct contact to the sealant components, could become brittle or will show a volume increase after prolonged exposure. Deteriorated gaskets must be immediately replaced. Please request from your equipment supplier gaskets and other components, which are compatible and recommended for use with DOWSIL™ Insulating Glass Silicone Sealants. The equipment supplier should also provide a schedule for regular replacement of gaskets. Please contact your Dow Technical Specialist if you need specific recommendations.

### Additional requirements for DOWSIL™ 3364 Warm Edge Sealant

DOWSIL™ 3364 Warm Edge Sealant can be used on the same dispensing equipment as all standard two-part silicone sealants such as as piston pump technology. One additional process requirement is to maintain a maximum material pressure of 250 bars. The characteristic conductivity performance of DOWSIL™ 3364 Sealant can be adversely affected by higher material pressure due to the material specific formulation. Exceeding the maximum pressure by pump processing will increase the thermal conductivity of DOWSIL™ 3364 Sealant up to the level of a standard sealant such as DOWSIL™ 3362 Sealant.

### Surface preparation and sealant application

Insulating glass production requires a diligent and thorough procedure to ensure that glass and accessory materials are properly cleaned prior to sealant application. The following procedures should be followed for IG production.

1. **Inspect** glass, spacer profiles, U-profile inserts, etc. prior to use. The materials used in production must be representative of the materials that were tested and approved by Dow. The substrates should be in good condition and not damaged by outdoor weathering.
2. **Clean** glass and accessory substrates including spacers, U-profile extrusions, etc. During automated IG production, glass is cleaned through an automated washing process. The IG manufacturer must ensure that joint surfaces be clean, dry, dust free and frost free. Moisture or contaminants on the surface may have an adverse effect on sealant adhesion to a substrate.
3. **Prime** joint surfaces to receive sealant if required by Dow.



4. **Place** the spacer system and glass. Care must be taken to not contaminate cleaned surface during any phase of production. If contamination occurs, surfaces must be recleaned.
5. **Apply** sealant into the IG joint cavity. If applied through an automated process, ensure that the joint is completely filled with sealant. If applied manually, push the bead of sealant into the joint in a continuous manner to avoid air entrapment.
6. **Tool** the sealant joint surface with a tooling device such as a spatula. Many insulating glass dispensing guns use self-tooling nozzles. Ensure that the tooling device provides a completely filled joint without air entrapment.
7. **Inspect** the finished insulating glass units. Determine whether the entire joints have been properly filled and tooled. The sealant must be continuous and free of voids or gaps. Inspect whether the sealant is curing properly. Ensure that all of the recommended quality control tests are being performed.

### Substrate cleaning procedure

The key to acceptable sealant adhesion is a clean surface. For most IG production, glass is cleaned through an automated washing process. If glass or accessory materials are to be cleaned manually, please use the following recommended procedures:

#### Non-porous substrates

Non-porous substrates such as glass and metallic profiles must be cleaned with a solvent prior to application of sealant.

Dow recommends the “two-cloth cleaning method” be used to clean non-porous materials. The “two-cloth cleaning method” is described later in this section. DOWSIL™ R-40 Universal Cleaner and DOWSIL™ R41 Cleaner Plus are recommended for solvent cleaning of non-porous substrates. Alternate solvents or cleaning agents will be considered. Please contact your Dow Technical Specialist for more information.

#### Solvent consideration

The solvents named in this section are recommended based upon our experience with these products. You should always check with the supplier of the substrate to ensure that the cleaning procedures and solvents are compatible with each substrate.

### Masking

If aesthetics are important, surface adjacent to the IG joint can be protected by masking. Prior to sealant installation, a masking tape can be applied to the surface adjacent to the joint. Test the tape prior to use to ensure that it can be easily removed and does not damage the substrate. During application of the tape, do not apply the tape to joint surfaces since residual adhesive from tape may harm sealant adhesion. Immediately after the sealant has been applied and tooled, remove the tape.

### Two-cloth cleaning method

The “two-cloth cleaning method” is a proven technique to clean non-porous surfaces. The use of one cloth to clean a substrate is not a recommended procedure and is not as effective as two cloths. Clean, soft, absorbent, lint-free cloths must be used. This method consists of cleaning the substrate with a solvent saturated cloth followed by a drying wipe with a separate clean cloth. Following is the procedure described in greater detail:

1. Thoroughly clean all surfaces of loose debris.
2. Pour a small quantity of cleaning solvent into a working container. A clear plastic, solvent-resistant, squeeze bottle works best for this purpose. Do not apply solvent directly from the original container.
3. Wipe the joint surfaces with sufficient force to remove dirt and contaminants.
4. Immediately wipe dry the solvent wet surface of the substrate with a separate clean, dry cloth. The second cloth must wipe the substrate before the solvent has evaporated.
5. Visually inspect the second cloth to determine if contaminants were effectively removed. If the second cloth remains dirty, repeat the “two-cloth cleaning method” until the second cloth remains clean. For each subsequent cleaning, rotate each cloth to a clean portion of the cloth. Do not clean with the dirty portion of the cloth. For best results, replace used and dirty cloths frequently.

### Substrate priming procedure

For most IG production, priming is not required. In some instances, special coated glass types or spacer profiles may require priming. In these non-standard applications, please use the following procedure for primer application:

## Product quality (continued)

Before using, verify that the DOWSIL™ 1200 OS Primer, UV Traceable and DOWSIL™ 1203 3in1 Primer are within their stated shelf lives. The primer should be stored below 25°C in its original unopened container. The primer should be clear and water-like in appearance. If the primer is milky white in appearance, do not use the primer.

1. Joint surface must first be clean and dry. The step of priming should begin within four (4) hours after the cleaning step. If there is a greater time delay, joint surfaces must be recleaned prior to priming.
2. Pour a small amount of primer into a clean, dry container. Do not pour more than a 10 minute supply of primer into the working container. Replace and tighten the cap on the container immediately after dispensing the primer. Excessive exposure of the primer to atmospheric moisture will cause it to deteriorate and turn milky white in the container.
3. Pour a small amount of primer from the working container onto a clean, dry, lint-free cloth and gently wipe a thin film on all joint surfaces requiring primer. Apply only enough primer to wet the surface. **Overpriming can cause adhesion loss between the sealant and the substrate.** If too much primer is applied, a powdery white film will form on the substrate. Overpriming is not an acceptable practice and should be stopped immediately. Overprimed surfaces must be recleaned (DOWSIL™ R-40 Universal Cleaner) and primed in a proper manner.
4. Allow the primer to dry until all of the solvent evaporates. This typically takes from 5 to 30 minutes depending on temperature and humidity.
5. Inspect the surface for dryness and for the appearance of overpriming. A primed non-porous surface will have a slight haze. Primed surfaces must be sealed within the next four (4) hours. Any surfaces primed and not sealed within four hours must be recleaned and reprimed before applying sealant.

In case DOWSIL™ 1203 3in1 Primer is used, please refer to the Technical Data Sheet for detailed application procedure.

## Sealant application and quality control procedures

### Sealant application procedure

Sealant should only be applied in IG joints which have been cleaned and primed by the recommended procedures. Sealant must be applied to clean, dry, dirt-free and frost-free surfaces. Sealant adhesion may be harmed by an improperly cleaned or primed joint surface. Sealant must also completely fill the IG joint. The performance of the IG unit is dependent on having sufficient sealant depth or bite. An underfilled secondary seal in an IG unit may jeopardize the performance of the IG unit.

The following procedures describe the proper procedures to apply sealant:

1. Apply sealant in a continuous operation using an application gun or dispensing equipment. A positive pressure, adequate to fill the entire joint, should be used. By “pushing the bead” of sealant into the joint in a continuous manner, air entrapment can be avoided. If applied through an automated process, ensure that the IG joint is completely and continuously filled.
2. Tool the sealant with light pressure before a skin forms on the sealant. This is typically within 5 to 15 minutes. Most automated operations use a self tooling nozzle. Ensure that this tooling nozzle provides adequate pressure to complete fill of the IG joint.
3. Avoid the use of wet tooling aids such as soaps or solvents during tooling. Dry tooling is recommended. Do not scoop sealant since this does not effectively push sealant into the joint causing the sealant to fully wet out the sides of the joint.
4. If the surface adjacent to the IG joint has been masked, remove the masking at this time.

### Sealant cure requirements

Silicone sealants require exposure to atmospheric moisture to cure. In a closed container or concealed joint that is not exposed to atmospheric moisture, sealant cure will be slow to nonexistent. Sealant adhesion will only occur if the sealant is allowed to cure to its full physical properties. Please ensure that the tooled sealant joint is fully exposed to the environment.

## Factory glazing cure requirements

Dow only supports the production of insulating glass with DOWSIL™ Insulating Glass Silicone Sealants in a factory environment. Production of insulating glass at the construction site is not supported by Dow.

DOWSIL™ one-component insulating glass sealants typically require 7 to 21 days to cure in a production facility environment. Cure rate depends on the sealant used, sealant joint depth, temperature and humidity. IG units which use one-component insulating glass sealants should not be shipped to the job site until the sealant has fully cured and it can be demonstrated through quality control testing that the sealant has achieved full adhesion (100% cohesive failure).

DOWSIL™ two-component insulating glass sealants cure in deep section within 3 to 4 hours depending on temperature and humidity. The sealant generally achieves full adhesion (100% cohesive failure) in 1 to 3 days depending on the glass type. IG units should not be shipped to the job site until the sealant has fully cured and it can be demonstrated through quality control tests that the sealant has achieved full adhesion (100% cohesive failure). Verification of sealant cure and adhesion is done through the use of “peel adhesion” and/or “H-piece” testing. These procedures are described in greater detail later in the next section.

### Storage/transportation of IG units under cold conditions/temperatures:

Right after production, packing (e.g. wrapping by plastic foil etc.) of IG units shall not be done/started before such IG units undertake a minimum curing time of

- 48 hours when storage/transport temperature is at 15°C or higher
- 3 days when storage/transport temperature can drop to 10°C
- 5 days when storage/transport temperature can drop below 10°C

The temperature mentioned above reflects the lowest temperature peaks that may occur during

the storage/transport period (including day/night deviations). These are general recommendations. Please contact your local Dow Technical Specialist for further information concerning specific production and packaging conditions.

## Quality control test procedures

### General considerations

Quality Control is an important element of successful IG production. This section of the manual should be fully understood and continually reviewed by the sealant user. The procedures and recommendations made in this section are the foundation of a comprehensive quality control program. In the Documentation section of this manual, Dow provides quality control logs which you can use for the development of a comprehensive quality control program by the sealant user. Dow will assist you in the development of a comprehensive quality control program specifically for your organization. Dow will also audit a production facility and make recommendations for improvement if necessary.

### Sealant production quality control

During production, periodic quality control should be performed on DOWSIL™ Insulating Glass Silicone Sealants produced through two-component dispensing equipment. These test procedures help to ensure the sealant is being properly mixed at the correct ratio. These tests and their recommended frequency are described in the next section.

#### Glass test

The glass test is a procedure used to evaluate the mix quality of DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3363 Insulating Glass Sealant and DOWSIL™ 3364 Warm Edge IG Sealant. This test is performed each time a pump starts-up and after either the curing agent or base containers are changed. The purpose of this test is to determine whether the two-component dispensing equipment is adequately mixing the sealant base and curing agent.

Sealant production QC test	Frequency of test		
	After each pump start-up	After each container change	Diagnostic investigation
Glass test	Required <sup>1</sup>	Required <sup>1</sup>	Required
Butterfly test	Required <sup>1</sup>	Required <sup>1</sup>	Required
Snap Time test	Required	Required	Required
Mixing Ratio test	Not Required	Not Required	Required

<sup>1</sup> Either the glass test or butterfly test must be performed at the scheduled frequency. It is not required that both tests be performed.

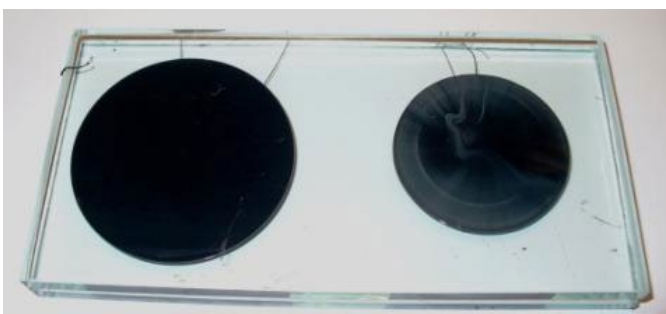
## Product quality (continued)

For standard DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3363 Insulating Glass Sealant and DOWSIL™ 3364 Warm Edge IG Sealant, the sealant base is white and the curing agent is black. When properly mixed, the finished sealant is uniform black, with no grey or white streaks. Improper mix can be the result of a damaged check valve, a clogged hose, a clogged mixer, etc. Regular equipment maintenance will help to ensure proper sealant mixing. Please consult with your dispensing equipment manufacturer for maintenance guidelines.

If grey, white or custom colored DOWSIL™ 3362 Insulating Glass Sealant and DOWSIL™ 3363 Insulating Glass Sealant are being used, please contact your Dow Technical Specialist for recommendations.

To perform the glass test method, apply a bead of sealant to a clean, clear glass sample which is approximately 10 cm x 10 cm. Place another clean, clear glass sample on top of the silicone, pressing the two pieces of glass together. Please refer to the diagram below. The resulting sandwiched sealant should then be visually inspected for grey or white streaks. The sealant should appear completely uniform and black. If results are negative, perform the test again after additional material is processed through the machine. If the results are negative again, equipment maintenance may be required. If additional assistance is required, please contact your Dow Technical Specialist.

### Glass test



Proper mixing

Insufficient mixing

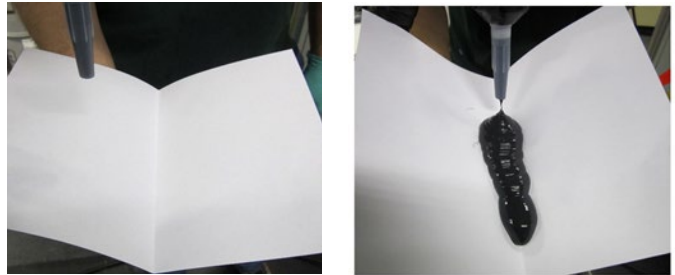
### Butterfly test

The butterfly test is a procedure that is similar to the glass test. This test is performed at each pump start-up and after either the curing agent or base containers are changed. The purpose of this test is to determine whether the two-component dispensing equipment is adequately mixing the sealant base and curing agent.

Following is the procedure for performing a butterfly test:

1. Fold a sheet of stiff, white A4 paper in half.
2. Apply a bead of sealant to the fold in the paper.
3. Press the sheet of paper together compressing the sealant into a thin film.
4. Pull the paper apart and visually inspect the sealant for indications of poor mix.

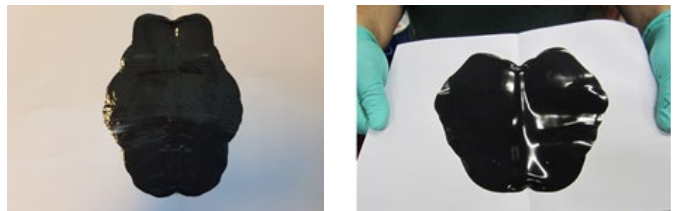
### Butterfly test



Apply sealant to folded paper



Press together



Insufficient mixing

Proper mixing

### Snap time test

Once proper mixing of the sealant is established by the glass test and/or butterfly test, a snap time test must be performed. This test is performed each time a pump starts-up and after either the curing agent or base containers are changed. The snap time test helps to determine if the mix ratio is correct and whether the sealant is curing properly. Mixed sealant will handle like a one-component sealant until the chemical reaction between the base material and curing agent begins to occur. The sealant will in a matter of minutes begin to “snap” and begin to show elastomeric or rubber properties.

Following is a procedure for the snap time test:

1. Fill a small container with mixed DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3363 Insulating Glass Sealant or DOWSIL™ 3364 Warm Edge IG Sealant.
2. Place a small stick or spatula into the sealant. Record the time.
3. Every few minutes, pull the stick out of the sealant. Do not stir or agitate the sealant. As the sealant becomes more cured, the sealant will become stringy. Once the sealant tears cohesively and snaps back once it is pulled, this is the “snap time”. Record this time.

### Snap time test



The snap time test will vary depending on temperature and humidity. Higher temperatures and higher humidity will cause the sealant to snap faster. Colder temperatures and lower humidity conditions will slow the snap time. Snap time will also vary from tester to tester depending on how the results are interpreted. Also, there will be variation from lot to lot of material and as the sealant ages. Highly unusual snap time values could be an indication of a problem with the pump. The most important determination from snap time is that the sealant does cure. If the sealant does not cure, then further investigation is required.

Please be aware that snap time values reported in the technical data sheets need to be considered as indicative information. Snap time measurement is quite dependent of many factors such as temperature, humidity, mixing ratio and the tester itself. As an example, snap time will generally be higher in cold countries (Russia, Baltic countries

etc..) than in warm countries (Spain, Italy etc...). Customer will need to establish its own baseline depending on local conditions when setting up the material in production.

### Mixing ratio test

The mixing ratio test is not a test that is required by Dow as a daily test. This test is useful to determine whether the sealant is mixing at the recommended ratio of 10 to 1 by weight. Most two-component silicone dispensing machines provide a set of valves which allow the mixing ratio to be checked. Following is a procedure to perform the mixing ratio test:

1. Hold a disposable cup underneath each valve outlet on the pump. Open the valve for 10 seconds or at least 3 strokes of both the base and curing agent pumps. Pressure valves needs to be adjusted in such a way that they equalize the pressure on both components.
2. Weigh the two cups, minus the weight of the cup itself. The weight ratio between the two components should be between 9 to 1 and 11 to 1.

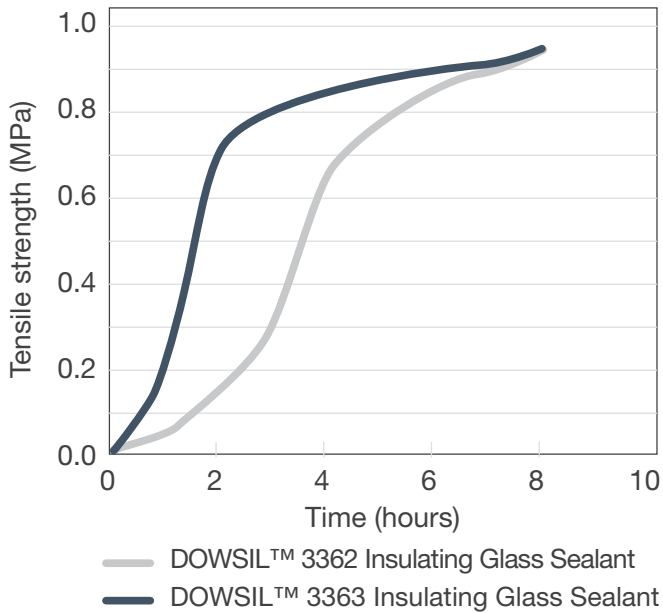
The mixing ratio test is a useful test if there are concerns with the mix of the sealant or the snap time. This test method is a very good diagnostic test and along with the glass test or butterfly test and the snap test, should be useful in the investigation of equipment problems. Dow Technical Specialists are available to assist you if there is a concern with mixing or cure with DOWSIL™ Insulating Glass Sealants.

### Adhesion and cure quality control tests

The following adhesion and cure quality tests should be used to provide consistent and reliable sealant quality during IG production. Each test is valuable in its own way and must be considered as part of your comprehensive quality control program. Peel adhesion testing is recommended as the daily test to verify sealant adhesion. H-piece testing is recommended as a test to verify proper cured sealant properties. Butterfly adhesion test is an alternate adhesion test of an actual IG production unit.

# Product quality (continued)

## Adhesion build-up (mixing ratio 10:1)



Dow requires the adhesion and cure quality control tests be performed by the sealant user at the frequency recommended in the table below.

### Peel adhesion test

The peel adhesion test is the most effective daily test to verify sealant adhesion to a substrate. This simple screening test should be used as the daily test to verify adhesion of sealant to a substrate. This test should be performed on all substrates to which the sealant is expected to have adhesion at the following intervals:

- After each pump start-up or after extended breaks
- After a change of the curing agent or base container
- For each new lot of substrate

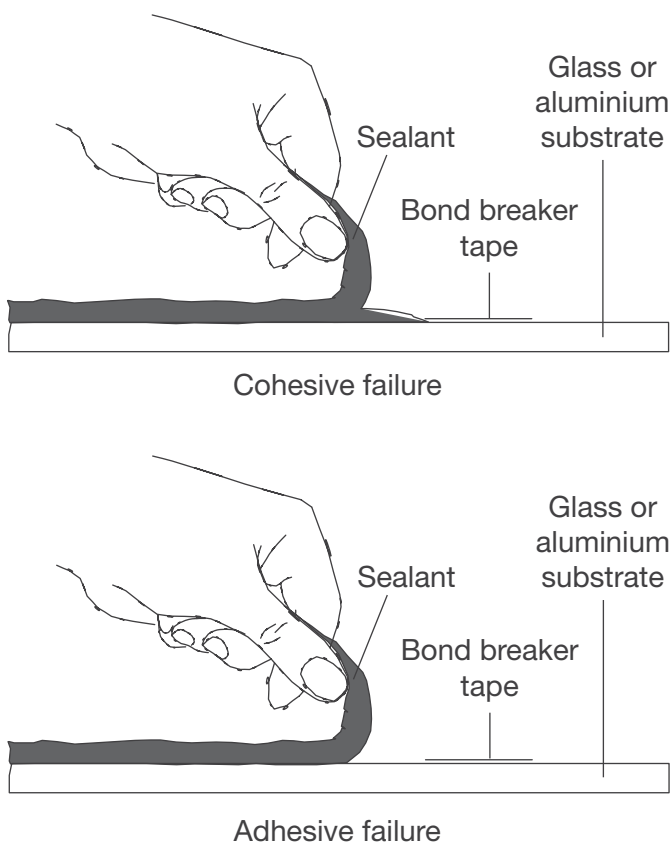
Following is a description of the peel adhesion test:

1. Clean and prime the representative sample substrate.
2. Place a piece of polyethylene sheet or bond breaker tape across the flat surface.
3. Apply a bead of sealant and tool it to form a strip approximately 20 cm long, 1.5 cm wide and 6 mm thick. At least 4 cm of the sealant should be applied over the polyethylene sheet or bond breaker tape.
4. It is best to imbed a wire mesh halfway within the body of the sealant. For best results, solvent clean and prime the screen to ensure good adhesion to the wire mesh. If wire mesh is not available, reliable results can still be achieved.
5. After sealant cure, grasp the 4 cm tab of sealant which overlays the polyethylene sheet. Pull the sealant at a 180° angle. Peel back only 1 to 2 cm of sealant leaving the remainder in place for additional testing.
6. If the sealant tears within itself and remains fully bonded to the substrate, this is called “cohesive failure”. 100% cohesive failure is desirable since this indicates that the strength of adhesion is greater than the strength of cohesion.
7. If the sealant releases from the substrate, the sample indicates 100% adhesive failure (or 0% cohesive failure). Since sealant adhesion develops over time, repeat the test after an additional 24 hours of cure. Continue until 100% cohesive failure is achieved. If adhesion does not develop as expected, contact your local Dow Technical Specialist.

Sealant adhesion and cure QC test	Frequency of test		
	After each pump start-up	After each container change	After each substrate change
Peel adhesion test	Required	Required	Required
H-piece test	Alternate to peel adhesion test	Alternate to peel adhesion test	Alternate to peel adhesion test
Butterfly adhesion test	Alternate to H-piece test	Alternate to H-piece test	Alternate to H-piece test
Deglaze test	Not generally required*	Not generally required*	Not generally required*

\* Deglaze testing is a valuable test that should be included in every comprehensive quality control program. Deglaze testing may be required for specific projects or if special warranties are requested.

## Peel adhesion test



**Important:** Insulating Glass Units should only be shipped to the job site once full adhesion has been verified by successful peel adhesion tests (100% cohesive failure).

### *H-piece test*

The H-piece test is the primary test used to evaluate sealant cure properties. This test should be performed once for every combination of base and curing agent. If a container is changed, an H-piece test should be used to confirm that the sealant cure properties are acceptable. In some instances, Dow may not require H-piece testing as a part of a comprehensive quality control program if other procedures such as peel adhesion and butterfly adhesion testing are performed at an appropriate frequency and if local standards and regulations do not require H-piece testing. The H-piece test can be used as a daily adhesion quality control test but because the peel test is less complicated to perform, the peel test is the recommended daily adhesion quality control test.

Every time a container is changed, two H-piece test samples should be produced. Samples should be made using actual representative production samples. The glass substrates should be cleaned and primed in the same manner as production units are prepared. The test samples should be stored in the same temperature and humidity environment as the actual production units.

The first H-piece sample should be tested when production units are to be shipped to the job site. The peel adhesion tests are a qualitative test to verify full adhesion (100% cohesive failure). H-Piece tests are a quantitative test: if properly cured, the sealant should have a minimum strength of 0.70 MPa with 100% cohesive failure. If results are not meeting expectations, shipping should not be allowed and the second H-piece used for additional testing.

Full adhesion typically occurs after 1 to 3 days of cure for DOWSIL™ two-component insulating glass silicone sealants, and 7 to 21 days for DOWSIL™ one-component insulating glass silicone sealants, depending on joint sealant depth, temperature and humidity.

Following are some additional recommendations for peel adhesion testing:

- Run on production samples from the exact same lot of substrate or profile.
- The substrate should be cleaned exactly the way the production units are cleaned.
- The peel adhesion samples must be cured in the same temperature and humidity that the production units are stored.
- Samples should be tested periodically, for example 1, 2, 3 days cure for DOWSIL™ 3362 Insulating Glass Sealant, DOWSIL™ 3363 Insulating Glass Sealant and DOWSIL™ 3364 Warm Edge IG Sealant. Testing can conclude once the peel adhesion test shows full adhesion or 100% cohesive failure. For Dow one-component insulating glass sealants, peel adhesion tests should be performed at 7 day intervals.
- Once samples achieve full adhesion, samples can be immersed in room temperature water for one day to seven days and tested again for cohesive failure. Local authorities may require that this additional procedure be taken.

## Product quality (continued)

Test samples can be prepared using a wooden block which has been cut to allow a cavity to be filled with sealant in the dimension shown. The wooden block should be pre-treated with a soap solution or paraffin wax to provide a bond-broken surface for the sealant. Alternatively, a polyethylene bond breaker tape can be applied to the wooden surfaces to contact the sealant. A polyethylene U-channel specifically designed for this test method can also be used.

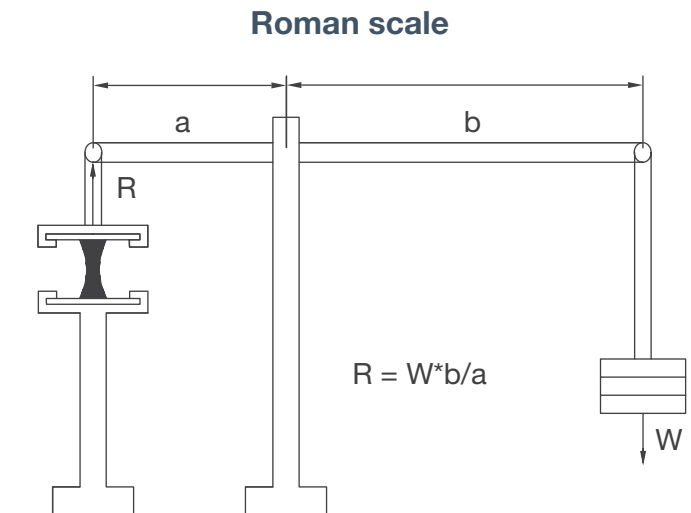
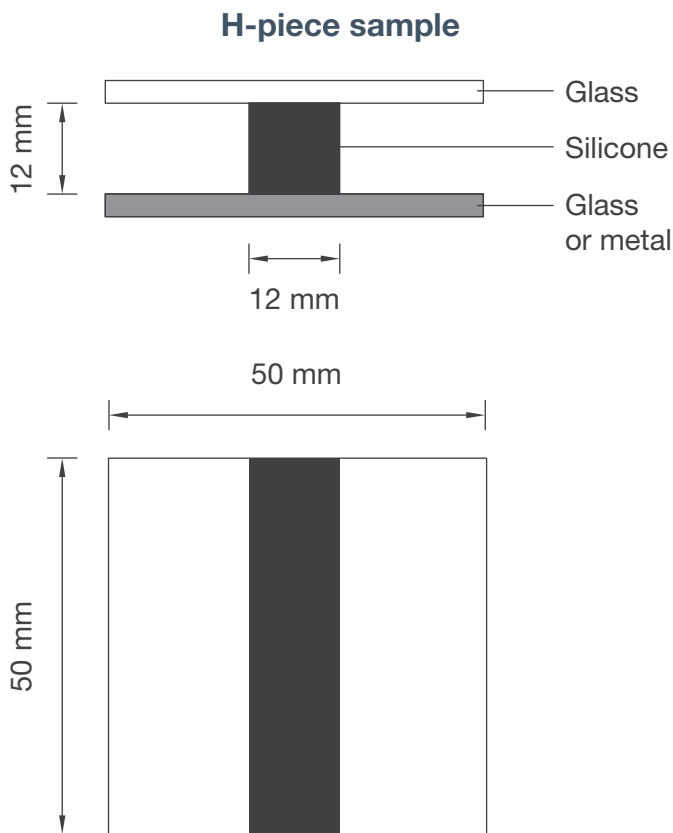
Two H-piece samples should be produced for every combination of curing agent and base used in production. Test samples should be stored in the same conditions as the actual production units. One sample should be tested at the same time that production units are to be shipped to the job site. Separately, peel adhesion testing should verify full adhesion (100% cohesive failure) at the same time.

H-piece samples can be tested with either a tensiometer or through the use of a “Roman Scale”. A Roman Scale as represented below will allow the silicone user to test sealant cure and

adhesion with a low cost piece of equipment.

The weight applied to the silicone joint is equal to the weight ( $W$ ) on the Roman Scale plate times the ratio of  $b/a$ . The H-piece sample should be tested to rupture. The tensile strength at rupture should be a minimum of 0.70 MPa. This value corresponds to strength of  $12 * 50 * 0.7 = 420$  N applied to the test piece. This strength corresponds to a load of 42 kg. If the Roman Scale is designed to have a  $b/a$  ratio of 10, a weight of 4.2 kg should be applied to the plate ( $W$ ). The load should be applied for a maximum of 10 seconds with no adhesive or cohesive failure of the H-piece. If no rupture occurs, incrementally add 0.5 kg to the scale until the H-piece ruptures. Record the load at rupture and percent cohesive failure observed on the test sample.

In absence of local standards, H-piece testing should meet a minimum strength of 0.70 MPa with 100% cohesive failure to actual production substrates. Results of H-piece testing should be recorded in a quality control log. A sample Quality



Control Log is included in the Documentation section of this manual.

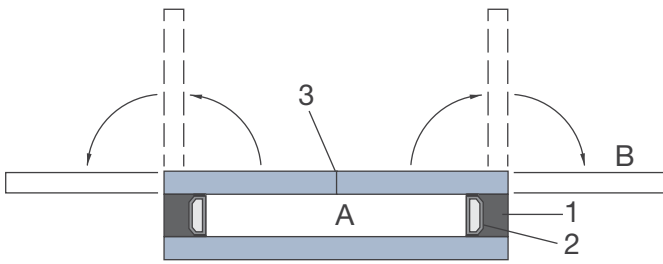
### *Butterfly adhesion test*

The butterfly adhesion test is an alternate procedure to evaluate adhesion of the sealant to glass. This test can be performed as an alternative or in addition to the H-piece test. This test may be performed on a test mock up sample or directly on an actual IG production unit — always use representative samples of all substrates.

To perform this test, score then break the glass at the midpoint of the pane. Bend the two halves outward at a 180° angle. Inspect the adhesion of



## Butterfly adhesion test



the secondary seal. There should be no greater than 5% adhesive failure on the glass surfaces.

1. DOWSIL™ Insulating Glass Silicone Sealants
2. Spacer system
3. Glass scored then broken at midpoint

If an actual production unit is used in this test, note the quality of the sealant application. Note whether the sealant fill is complete and free of voids or bubbles. Observe the quality and continuity of the PIB application. This procedure provides an opportunity to evaluate the overall quality of the IG unit application.

### *Deglaze test (only for Quality Bond warranty)*

Deglazing is a method of quality inspection used to confirm sealant adhesion, joint fill and quality in actual IG production units. Deglazing includes complete detachment of both glasses.

Once the glass is removed, the silicone sealant is inspected for cure, mix, uniformity of fill, lack of bubbles or air entrapment and most importantly, to verify sealant adhesion.

Deglazing is very useful to production personnel as a form of feedback on their performance. Production personnel should be present during the inspection.

Included in the Documentation section of this manual is a deglaze inspection form. During inspection, the following elements should be evaluated:

- Measured dimension of the Insulated Silicone joint sealant. The minimum depth of silicone sealant as determined in the project review must be satisfied. An underfilled joint may affect the performance of the IG unit.
- Adhesion of the insulated sealant to the glass. Sealant must achieve full adhesion (100%

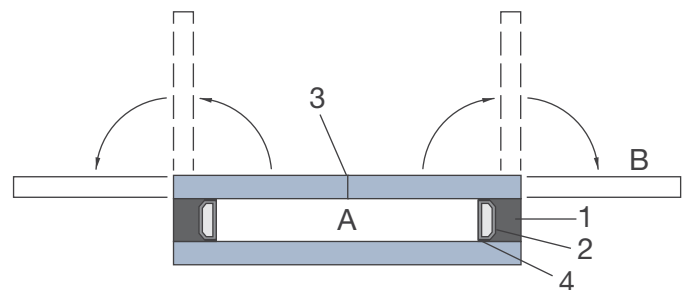
cohesive failure) to all substrates.

- Sealant uniformity of cure and sealant mix.
- Lack of air entrapment and bubbles in the sealant.
- Any deficiencies observed should be reported in the IG Quality Control Log.

Dow does not require this test method as a standard quality control procedure. Nevertheless it is a good practice that should be incorporated in a comprehensive quality control program.

For special warranties and certain projects, Dow may require this procedure in the quality control program.

Deglazing should be performed as a regular quality control procedure in a production operation. This test can be performed randomly



on any production sample.

This test should be performed as described:

Prepare a small sample of IG unit +/- 200 mm x 200 mm, spacer and butyl only on 2 sides.

1. DOWSIL™ Insulating Glass Silicone Sealants
2. Spacer system
3. Glass scored then broken at midpoint
4. PIB

It is best to cut the glass at the midpoint and pull the glass from A to B.

A check of all points mentioned as described

## Product quality (continued)

earlier in this manual, can be performed on the remaining sealant and butyl.

Following is a recommended frequency for deglaze testing to be performed on a project:

1. First deglaze – 1 unit out of first 10 units manufactured (1/10)
2. Second deglaze – 1 unit out of next 40 units manufactured (2/50)
3. Third deglaze – 1 unit out of next 50 units manufactured (3/100)
4. Through remainder of project, 1 unit of every 100 units manufactured

For further assistance, please contact your Dow Technical Specialist.

### Documentation

The sealant user is responsible for developing proper quality control documentation for their project. Dow provides in the following pages, sample quality control logs that can be used on their own or as a model for a customized quality control manual.

A comprehensive quality control manual for production of IG units for a structural glazing project should include the following:

- Insulating glass joint dimension details that were reviewed and approved by Dow
- IG joint dimensioning approval letter(s) from Dow
- Project substrate and materials descriptions and specifications
- Adhesion and compatibility approval letter(s) from Dow
- In-house IG production and quality control procedures
- Completed sealant production quality control logs with glass test, butterfly test, snap time test and mix ratio test results
- Completed sealant adhesion and cure quality

control logs with peel adhesion test, H-piece test and butterfly adhesion test results

- Traceability documentation which allows each IG unit to be precisely correlated to a specific date, time and location of production. All production units must be numbered so that they can be specifically linked to the quality control logs. The position of each IG unit on the building should be marked on the elevation drawing so that it can be easily identified if required. This traceability documentation is critical in the event that a problem needs to be investigated on a project.

Dow will assist you in the development of a comprehensive quality control program. During a Production and Quality Control Audit, your comprehensive quality control program will be evaluated.

### Production and quality control audit

Dow will audit the IG production and quality control operations of any user of DOWSIL™ Insulating Glass Sealants. During this audit, the sealant user's production operations, quality control procedures and documentation will be evaluated. Below are some of the important elements that Dow will be evaluating during an audit:

### Production facility operations and safety

- Clean production facility
- Production facility temperature and humidity
- Proper sealant storage and handling
- Properly operating and well maintained sealant dispensing equipment
- Proper substrate handling
- Compliance with recommended sealant application procedures from Dow: two-cloth cleaning method, priming, sealant application, tooling, etc.
- Storage and handling of production units
- Compliance with reasonable safety procedures

including safe handling of flammable materials and use of personal protective equipment

personnel and implement a comprehensive quality control program

### Quality control

- Compliance with Dow sealant production quality control procedures: glass test or butterfly test, snap time test, mix ratio test
- Properly completed sealant production quality control log
- Compliance with adhesion and cure quality control procedures from Dow: peel adhesion test, H-piece test, butterfly adhesion test
- Properly completed adhesion and cure quality control log
- Traceability documentation in accordance with Dow recommendations
- Commitment by management to train

## Dow Quality Bond™ — Bringing quality to incredible heights

The Dow Quality Bond™ program lifts silicone sealing and bonding to the highest level by implementing standards of best practice in quality control, quality assurance and production application with specialist silicone applicators.



Insulating glass manufacturers are invited to apply for membership of Dow Quality Bond™. For further details on this program and how to apply, please visit [qualitybond.com](http://qualitybond.com).

# Sealant cure quality control log

Company name and location:

Project name and location:

Dispensing pump type and location:

Date	Time	Temp. & humidity	C/A lot number	Base lot number	Glass test	Snap time test	Mix ratio test	Tester

**Sealant adhesion quality control log  
(Peel adhesion test)**

Company name and location:								
Project name and location:								
Dispensing pump type and location:								
Cleaning solvent:				Primer				
Substrates:				Primer lot number:				
Date	Time	Temp. & humidity	C/A lot number	Base lot number	Peel adhesion test (% Cohesive failure)			Tester
					Day 1	Day 2	Day 3	

**Sealant cure quality control log  
(H-piece test, butterfly adhesion test and elastomeric test)**

Company name and location:									
Project name and location:									
Dispensing pump type and location:									
Cleaning solvent:					Primer:				
Substrates:					Primer lot number:				
Date	Time	Temp. & humidity	C/A lot number	Base lot number	H-piece test		Butterfly adhesion test	Elasto-meric test	Tester
					MPa	%CF			

## Sealant cure quality control log (Deglaze test)

Company name and location:			Project name and location:		
Dispensing pump type and location:			Frame description:		
Cleaning solvent:	Primer:		Primer lot number:		
Glass description:			Sealant application date:		
Date	Time	Temp. & humidity	C/A lot number	Base lot number	Measured IG depth
Joint fill	Sealant mix	Air entrapment or bubbles	Sealant adhesion to glass	Sealant cure uniformity	Other observations

## For more information

Learn more about Dow's full range of High Performance Building solutions by visiting us online at [dow.com/construction](http://dow.com/construction).

Dow has sales offices, manufacturing sites and science and technology laboratories around the globe.

Find local contact information at [dow.com/contactus](http://dow.com/contactus).



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