III. Process Recommendations

A. Inspection of Incoming Material

Quality Assurance

1. Glass

a. Check incoming glass and record on form #QARF01 to determine if it is dry with no evidence of surface contamination. If there is an indication of either, check to see if the glass is stained or has surface damage. Glass that is wet but not stained should be used as soon as possible before surface corrosion takes place.

b. Check the glass container for evidence of impact or breakage. If breakage is present, a claim should be filed against the carrier.

c. Check to assure that the product delivered matches what was ordered. Items to check: Type, thickness, lite count, container count, tin orientation and score side orientation.

If discrepancies are found, notify your supervisor immediately.

d. After the glass has been accepted, strict precautions should be taken to prevent degradation of the glass surfaces and edges. The product should be stored in a dry and well ventilated warehouse.

2. Spacer Material

The spacer material supplier should provide written documentation that the material conforms to the agreed upon material specifications. Each coil should be inspected for the following and the results recorded on form #QARF02:

a. Dimension - slit width should conform to the specified width given for each nominal air space dimension within a tolerance of +.000", -.005". Thickness should conform to .0105" for tin-plated steel and to .0100" for stainless steel.

b. Cleanliness - check cleanliness by wiping surface with a clean cotton cloth dampened with MEK. Cloth must have no deposit of oil or other foreign material present.

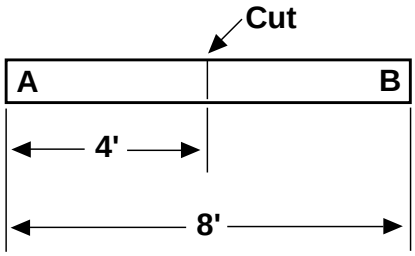
** Note: Methyl Ethyl Ketone (MEK) is toxic and flammable. Consult manufacturer or supplier for safe handling recommendations and compliance with environmental requirements and regulations.*

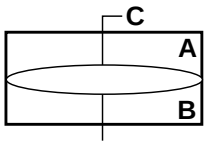
c. Surface Condition - visually inspect coil surface for evidence of oil, dirt, rust, or other deposits.

d. Edge Condition - visually inspect coil to ensure that edges are not damaged.

e. Camber - Before threading a new roll of material into the feeder press, it should be inspected for camber as outlined below:

- Unroll and cut off an eight-foot length of material strip.
- Lay the strip on a clean flat surface and cut in half.
- Rotate end "A" to match up with end "B" while keeping both faces up as shown





below.

- Measure the camber at the center of the strips as shown at "C".
- Total camber should not exceed 1/8" (1/16" per side).
- Material with total camber exceeding 1/8" should be rejected.

3. Desiccated Matrix

The desiccated matrix readily adsorbs moisture. The drum cover should not be removed until it is ready to be used.

3. Desiccated Matrix (cont.)

The following checks and procedures should be recorded on form #QARF03 and retained as part of your ongoing quality control process:

a. Inspect drums for dents and other damage upon receipt of each shipment. Damaged drums should be reported to the freight carrier for a possible claim.

b. Wipe any dirt or dust from the drum lids prior to removing them.

c. Inspect the moisture indicator card affixed to the drum lid prior to placing the drum under the drum unloader. The color of the moisture indicator should be light blue.

4. Sealants

Before product use, each drum should be inspected and checked for shelf life. The lot numbers should be recorded on form #QARF04 and maintained in a daily log book by the person responsible for the quality control function.

Sealant manufacturers conduct lot acceptancy requirement testing on each lot prior to shipping. The sealant supplier should provide information on the material property being tested, a description of each test performed, and the test methods or test standards used.

Certification - The insulating glass manufacturer may require the sealant supplier to certify that each lot meets lot acceptancy test requirements and the material specifications.

5. Closure Connector

Inspect all incoming shipments of screws and/or pop-rivets to insure that they are what was ordered. Confirm that they are of the proper type, size, and material. Check for cleanliness. They should not have oil, dirt or debris on their surfaces. Also, record the supplier, quantity received, and date received on form #QARF06. Boxes should be kept closed during storage to keep the parts clean.

6. Muntin Bars and Clips

a. Inspect incoming muntin bars to verify that they are made of the specified materials and that they are the proper size, type, and color as ordered. Also, check for cleanliness and for damage. All information should be recorded on form #QARF07 and maintained in a daily log. Boxes should be kept closed during storage to keep the bars clean.

b. Muntin bar clips should be checked for proper type, size, fit, and cleanliness. There should be no indication of discoloration or contamination on the surface of the parts. All information should be recorded on form #QARF07 and maintained in a daily log. Injection molded parts should also be checked for blistering and unusual surface texture, indicating improper mold temperatures, which could cause brittleness. Brittle parts could break during installation into either the muntin bar or spacer.

It should be noted that nylon materials absorb moisture which can be released inside the airspace of an IG unit under certain conditions. Therefore, the parts should be stored and covered in a clean, dry storage area until they are used. The boxes should be kept closed so airborne dust, debris, and solvent vapors and oils that are sometimes present in a factory environment, cannot deposit on the clips.

c. In selecting muntin bar systems and fabrication techniques for your IG products, you should be aware of the following potential IG unit fogging sources:

Muntin Bars

Solvent cleaning of muntin bars.

Touch-up paints on muntin bars.

Lubricants / cutting and notching.

Contamination during storage.

Lubricants / roll-forming.
Improper paints and coatings.
Improper paint application.

Clips

Improper plastic formulation.
Lubricants and release agents.
Moisture absorbed by plastic.
Plasticizers in the polymer.
Contamination during storage.

III. Process Recommendations

B. Inspection and Testing During Manufacture

Quality Assurance

1. Glass

Movement from storage: Strict precautions should be taken to prevent edge damage and surface contamination of the glass in its movement from inventory or cutting to the glass washer location. Special care should be exercised as the glass is placed on carts and the carts themselves should be in good condition with adequate cushion for the edges of the glass.

The following glass characteristics should be inspected and judged according to the acceptance criteria given in the appropriate specification or approved test method.

a. Washer - Load End:

- **Correct Glass Type** - The glass should be examined to determine if its type matches the order. Its type should match the order for thickness, coated or uncoated, annealed vs. tempered or heat strengthened, and color. If any discrepancies are found, the line supervisor should be notified immediately.
- **Size** - Using a calibrated tape measure, the glass should be checked for size, usually to the nearest 1/32". For glass whose thickness is equal to or thinner than 3.5 mm the size specification is +/- 1/32" and +/- 1/16" for glass thicker than 3.5 mm.
- **Edges** - The edges of every lite should be examined for chips, bevel, flares, corners on or off. Acceptable limits for PPG glass are given in the PPG document titled "Glazing Select Quality Glass Specification (Abridged)".
- **Coating Orientation** - A continuity tester is used to determine the location of the coated surface of the glass. When the tester is placed on the coating, the circuit is closed and a voltage is shown or an indicator light will come on depending on the type of tester used.
- **Bow Orientation** - Thermally strengthened glass should be oriented such that the convex side is placed up. This is determined by sighting along an edge for flatness. If there is a deviation from flatness, the convex surface is the surface that the bow is toward.
- **Score Orientation** - The score orientation as delivered by the primary glass manufacturer should be noted. Generally primary glass manufacturers score glass on the atmosphere side of float glass. For some dark gray glasses atmosphere side orientation should be toward the outdoors to avoid checkerboard appearance on buildings.

b. Washer:

The washer's single function is to clean and dry the glass so that acceptable IG units can be fabricated. Washing usually consists of a pre-wash, detergent wash, final rinse, and air blow-off operations. Washer operation and maintenance should be in accordance with the manufacturer's operations manual. Schedules for items such as tank changes and filter replacements along with routine maintenance should be posted in the area, completed, and signed off as part of standard operating practice.

A quick way to see if the rinse water needs to be de-mineralized is to take a 50 cc water sample at the outlet of the treatment unit. Add 3 drops of silver nitrate. If whitish clouds appear, the de-mineralization is inadequate. The water is satisfactory if the water remains clear. Another way to measure the level of de-mineralization is with an ohm meter. The proper reading on an ohm meter for adequate de-mineralization is 100,000 ohms.

Water temperature plays an important role in good glass cleaning. **It is recommended that water temperature in the detergent wash section be in the 140°F range, +/- 5°F.**

Air blow-off should be such that the glass leaving the washer is dry, both on the surfaces and edges. There should be no evidence of moisture or water marking after the moisture has dried. The operators manual should be consulted for adjustments and maintenance schedules. It is a good practice to push index cards through the air knife slits. This will help to remove debris from the slits. Do not use metal banding as this will enlarge or make the slits irregular.

c. Washer - Unloading and Assembly

Upon exiting the washer, the glass should be examined for the following characteristics and judged in accordance with the appropriate glass specification. See the attached "Glazing Select Quality Glass Specification (Abridged)".

- **Visual Defects -** Glass should be examined for both included defects such as bubbles and stones as well as surface damage such as rubs and scratches before assembly. Lighting for transmittance inspection consists of fluorescent tubes mounted under the washer run-out / IG assembly conveyors. Lighting for reflectance inspection consists of over conveyor fluorescent tubes (approx. 8' - 12' overhead). Additionally, inspection capabilities are improved if all background (flooring, conveyor framing, etc.) is painted black and remains uncluttered. Glass with defects that exceed the allowable limit of the specification should be discarded.
- **Coating Defects** - Coated glasses should be examined for coating defects, and may be judged in viewing transmission and/or reflection. The detection of a defect in itself does not determine its disposition. Its size and intensity as compared to the limits allowed in the appropriate specification should be used to determine if it is acceptable or rejectable.
- **Cleanliness -** Using the same lighting as described above, those glass surfaces that will be to the inside of the finished unit should be free of any perceptible oil, dirt, lint, moisture, or other forms of surface contamination. Extra precautions should be taken to prevent silicone-based lubricants or lotions from coming in contact with the glass so as not to affect sealant adhesion.
- **Edges -** Just as the lites were examined at the feed end of the washer for chips and corner damage, glass exiting the washer should be visually examined for any evidence of edge or corner degradation. Normal causes for such defects which were not detected at the load end are improper handling and loading of the line. Proper spacing should be maintained or glass impact and consequent defects will result.

2. Spacer

The following characteristics should be routinely checked on spacers during the manufacturing of the spacer frames (Also see section IV in the Recommended Techniques Manual).

a. Dimension

Spacer lengths should be checked after roll forming to confirm that spacers meet the specifications for width (W), height (H), and lip (L). See Section II in this manual for spacer material dimensional specifications. Overall spacer

width should be within +/- .005" of the nominal dimension.

Splay, the spread or turning in of the channel legs, should not exceed +/-.005" total.

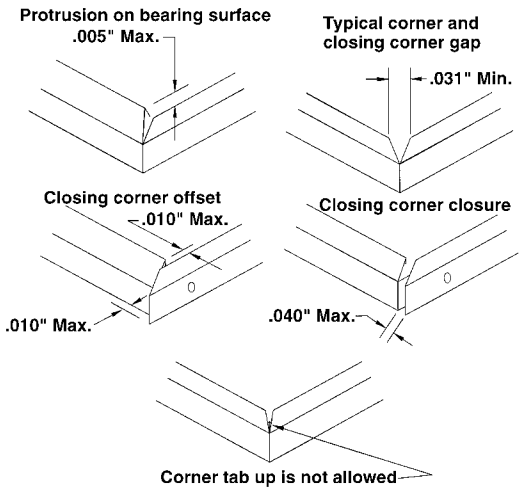
The swage, or downsizing of the spacer end tab so it will fit properly into the other end of the folded spacer, should be checked. The swaged portion of the spacer should be about .030 to .035 less than the width of the unswaged portion of the spacer. If the swage is not properly done, high points on the spacer may result, which could lead to improper sealing of the IG unit or glass damage. Also, if the tab fits too tightly into the trailing end of the spacer, excess force will be required to insert the tab during spacer folding. This often leads to hand and finger indentations into the sealant, which may result in inadequate wetout of sealant. This forms an improperly sealed unit.

Also check to ensure that twisting of spacer lengths does not occur after roll forming which could cause objectionable frame deformation. Maximum twist should not exceed 15° per 3 foot length; 90° twist in 18 feet.

After the spacers are folded into frames, the overall size (width and height) of the frames should be checked and should be within +/- .032" of the specified nominal dimension. If these dimensions are not correct, the sightline of the finished unit will not be correct, plus there may not be adequate space behind the spacer for the required secondary sealant in the case of dual seal units, or the spacer could even extend beyond the edges of the IG unit.

b. Cleanliness

Use the same procedure described in Section III, part A, "Inspection of Incoming Material" to ensure that stamping and roll forming operations have not deposited dirt, oil, or grease onto the surface of the spacer that is detrimental to the bonding of the sealants or desiccated matrix to the spacer.



c. Spacer Frame Corners

Inspect corners of assembled spacer frames for flare, for gaps in the corner folds, gap at the closing joint, or out-of-plane bearing surfaces. Also check to see that the corner tab has folded in toward the airspace instead of out toward the glass. Record on form #QARF08 or #QARF09. See the spacer frame corner details above:

The corners should also be inspected for evidence of overbending or back bending of the corners, which can occur during folding of the spacer frames. Eliminating both of these will help to insure better sealing of the IG corners, and reduce the possibility of glass damage.

d. Closing Joint and Fastener

The closing joint and fastener must be thoroughly sealed. This may be the most critical step in making high quality IG units. After the IG unit is assembled and the closing joint fastener is installed, the fastener should be inspected to insure that it is straight and fully seated against the spacer. Also, the closing corner should be inspected for proper mending of the corner sealant. Then, patching sealant must be applied over the screw head to fully encapsulate the fas-

tener head and to bond with the surrounding sealant and the spacer surface. After patching, no exposed spacer should be visible. If improper sealing is found at the closing joint and/or fastener, the unit should be either repaired or discarded and your methods and procedures should be reviewed to determine the cause of the deficiency.

e. Printing

Check alignment plus legibility and correctness of pertinent information printed on the spacer by the ink-jet printer, if applicable.

3. Desiccated Matrix

The following checks should be conducted at the beginning of each shift:

a. Freshness

Prior to each shift, the freshness of the material on the pump should be tested using the microwave test procedure or a temperature rise test as recommended by the desiccated matrix manufacturer.

b. Exposure

As a rule of thumb, the desiccated spacer frames should not be allowed to hang exposed to the environment for more than four hours. Allowable exposure time will change depending on temperature, relative humidity, and bead height. Specific recommendations should be as directed by your matrix supplier.

Also, the spacer frame conveyors should not transport the frames above the glass washers, as this would allow moisture from the washers to be absorbed by the desiccant matrix, reducing its drying capacity.

After the units are assembled and have cooled sufficiently to avoid collapse after sealing, the closure joint connector should be installed as soon as possible to eliminate further reduction of the matrix drying capacity.

c. Adhesion

The adhesion of the matrix should be checked and recorded on form #QARF08 or #QARF09 at the beginning of each day/shift or whenever a different coil of steel is used, following the test method below.

Maximum adhesion of the hot melt matrix is obtained by applying the product at the proper application temperature to clean, dry spacer. The minimum application temperature at the head for the hot melt matrix is 240°F. The proper application temperature should be checked by evaluating the adhesion of the matrix to spacer on a daily basis. The spacer material must be free of oils, moisture, rust, and dirt.

An alternative to the hot melt matrix material is ambient temperature applied desiccated matrix that is applied at 150°F to 190°F and will not slump at temperatures up to 185°F. This material achieves a tack free room temperature cure within about 40 minutes after application. As with hot melt, to achieve good adhesion to the spacer, the spacer material must be free of oils, moisture, rust, and dirt.

d. Test Method for Adhesion of Desiccated Matrix to Spacer Frames

Materials:

- Desiccated matrix material
- Roll formed spacer
- Small screwdriver

Procedure:

- Apply sample of matrix to spacer frame at thickness used in production.
- If perimeter insulating glass sealant is hot melt, apply perimeter sealant at production thickness as well.
- Allow spacer to cool to ambient temperature.

- Take small screwdriver and try to pry and peel matrix from spacer.

Results:

Adhesion is acceptable when the matrix breaks when pried and peeled.

Action Required:

Acceptable adhesion requires no corrective action, proceed with production. Unacceptable adhesion requires the following actions:

- Check spacer for contamination by dirt, moisture, corrosion, or oils. If contaminants are present, take necessary actions to remove contaminants.
- Check spacer temperature to ensure it has reached plant temperature.
- Check for the proper amount of matrix being applied. Make necessary adjustments to equipment if proper amounts are not being applied.
- Check that the matrix is being applied at the proper temperature.
- Repeat test.

e. Quantity Requirements

At the beginning of each run, it should be verified that the proper quantity of matrix is being used. Use either of the following methods: 1. Weigh a 12" length of spacer with matrix inside and compare to a 12" length of the same size spacer without matrix. 2. Or measure the bead height of the matrix in the spacer, using a micrometer or a measuring gauge, to ensure that it is at the proper height to provide your required drying capacity. Also inspect the bead to ensure that it spans the entire width of the spacer. Contact your desiccant matrix supplier for matrix mileage and drying capacity tables. **Each licensee bears the responsibility for deciding the amount of matrix that should be applied per lineal foot of spacer.** Remember, different matrix types provide different drying capacities. The recommended minimum is the equivalent drying power of two long sides of a standard box spacer filled with molecular sieve beads. Your matrix supplier can help you determine this quantity.

The amount of desiccant needed during the life of the unit depends on such factors as:

- Desired unit life.

  The longer the desired life of the unit, the greater the quantity of desiccant needed to maintain a dry atmosphere inside the unit.

- Sealant type and quantity.

  Moisture vapor and various gases permeate through different sealants at different rates. If the IG sealant allows moisture vapor to pass through it at a relatively rapid rate, then more desiccant will be required to keep the unit dry inside.

- Workmanship.

  Voids, skips and gaps in the sealant increase the amount of moisture that permeates the airspace.

- The glazing system.

  This affects the durability of the insulating glass sealant. A poorly designed glazing system may cause the IG unit to sit in water and reduce the life of the unit.

Given the very wide range of variables that can impact IG unit quality, a licensee following conscientious quality control practices can achieve consistent CBA test results while operating within the application amounts specified by the desiccant manufacturer. However, because of differences in your operation, we recommend testing of your specific products to determine a minimum matrix level.

4. Sealants

a. Thermoplastic materials (non-curing) polyisobutylenes and hot melt butyls.

- Polyisobutylene (PIB) manufacturers should provide a recommended operating temperature range at the extruder head and a butyl application rate or volume to meet the insulating glass manufacturer's primary sealant bead dimensions and tolerances (i.e., width and thickness).
- Hot melt butyl sealant manufacturers should provide recommended operating temperatures and allowable temperature ranges for the hot melt extruder system at these typical locations in the extruder system:

  Nozzle

  Pump

  Regulator

  Follower Plate

  Hose

b. Thermosetting materials (chemically curing) - polysulfides, polyurethanes, silicones, and DSE sealants.

- One-part chemically curing sealants - Start-up procedures consist of assuring that the pumping system has no cured sealant within the system. These sealants begin curing on contact with moisture in the air. At the conclusion of the shift or at breaks, the dispensing gun should be covered so the sealant is not exposed to air.
- Two-part materials - a base and an accelerator mixed in a specific ratio. At the end of the day, the hose from the static mixer to the dispensing gun should be left full of base component. At the start of work, the curing agent line should be opened and material pumped through the line until material exiting the dispensing gun is no longer the color of the base, but is a consistent blend color of the base and the curing material. The butterfly test is used to ensure that the sealant is consistent and thoroughly mixed.

c. Sealant Butterfly Test

(Note: There is a different butterfly test for finished IG units.)

Procedure:

- Dispense a bead of sealant onto a piece of paper or napkin.
- Fold the paper or napkin in half, smearing the sealant bead to a thin film.
- Pull the paper or napkin apart and visually inspect the sealant smear formed.
- If the sealant smear contains streaks or inconsistent coloring, more sealant must be pumped through the lines to improve

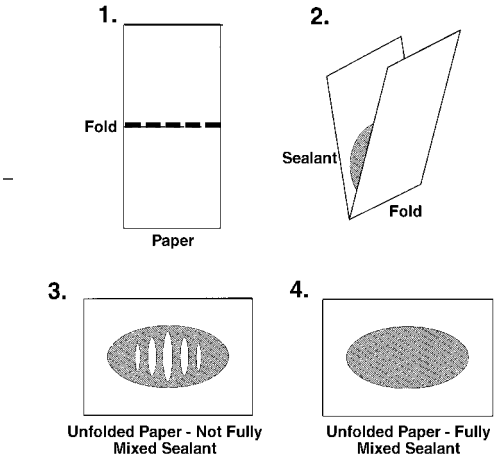


Figure 1

the mixing quality. If the sealant smear is of a consistent color, the sealant is properly mixed and ready for use.

d. If gray streaking continues to occur, the static mixers should be checked for possible clogged or plugged conditions.

Record results on form #QARF05. (See Figure 1.)

e. In-House Testing Prior to Production

- One-part chemically curing sealant - Prior to beginning the day's production, a skin-over or tack-free time test should be completed. The test checks sealant working time. Any great variation (extremely short or excessively long times) in the sealant skin-over or tack-free time may indicate an out-of-shelf-life sealant. This test is performed as follows:
  - Tool a bead of sealant into a thin film.
  - Every few minutes, touch the sealant film lightly with your finger.
  - When the sealant does not adhere to your finger, the sealant is said to have skinned over or tacked.
- Two-part chemically curing sealants - Once full mix of the two-part sealant (as confirmed by the butterfly test) is achieved, a snap-time test should be performed. This test assists in determining the sealant working time and deep-section cure time. It is also a guide in determining whether the mix ratio is correct. The snap-time test is performed as follows:
  - Fill a cup or container with mixed sealant.
  - Place a stick or pencil in the sealant.

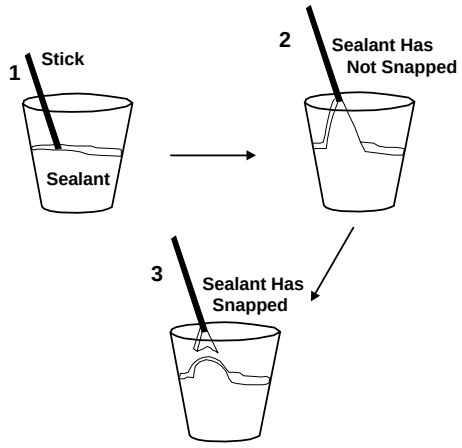


Figure 2

  - Every five to ten minutes, pull on the stick or pencil.
  - If the sealant does not tear within itself (cohesively) when the stick or pencil is pulled out, the sealant has not snapped. The time at which the sealant tears within itself (cohesively) when the stick or pencil is pulled out is termed the "snap time". Record results on form #QARF05. (See Figure 2.)

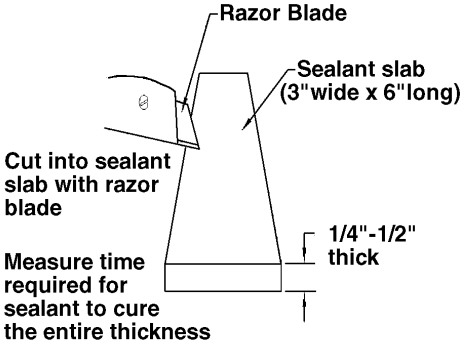
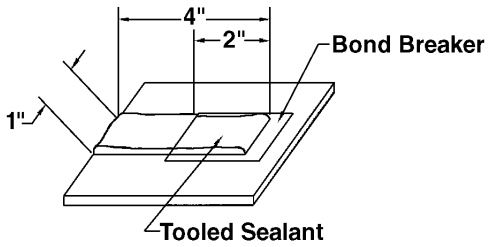


Figure 3

- Two-part chemically curing sealants- Curing rate can also be confirmed by the deep section cure test. Mixed sealant is formed into a slab 3" wide x 6" long by 1/4" or 1/2" thick. Every 1/2 hour, razor into the sealant bead (See Figure 3).

When the complete depth of sealant has cured, the sealant has attained deep section cure. Consult the sealant supplier for acceptable cure rates vs. thickness of the slab. Record results on form #QARF05.

- Adhesion to glass and spacer - One and two-part chemically curing sealants. A tab adhesion test should be performed on a regular basis to ensure adhesion to glass, coated glasses, and metal spacers. Perform the adhesion test as follows and record the results on form #QARF05:
  - Clean a production-grade sample of glass or spacer in a manner similar to the production cleaning process.
  - Apply and tool a bead of sealant onto the glass or spacer.
  - After a specified sealant cure condition



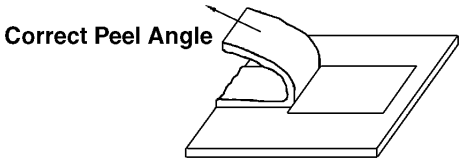


Figure 4

and time, pull at the sealant bead with your finger.

  - If the sealant fails cohesively within itself, the sealant is considered to have acceptable adhesion. If the sealant fails adhesively at the bond line, the sealant does not have acceptable adhesion. Contact the sealant supplier for assistance in determining the cause of poor sealant adhesion. (See Figure 4.)
- Slump Tests - Slump can be defined as the sealant slumping (sagging or flowing) out of the insulating glass unit joint after it has been tooled or wet packed. Sealant manufacturers typically test each sealant lot for slump in accordance with ASTM D2202 - Test Method for Slump of Caulking Compounds and Sealants prior to shipping to ensure it flows less than 0.1 inch. The insulating glass unit manufacturer should visually check each sealant lot for excessive slump or use SIGMA Test Method - Slump of Sealants - A.3.B Channel Method and record the results on form #QARF05.

Packaging and Hold Times - Sealant manufacturers will supply recommended cure times prior to moving and shipping IG units. These recommendations should be met by the IG manufacturer between assembly/sealing and moving IG units.

When packaged in the early stages of cure, units should be placed in cases, racks, or pallets with adequate bottom supports to prevent glass slippage during sealant cure.

The sealant manufacturer should supply recommendations for correct bond breakers for bottom supports to prevent sealants from sticking to the IG unit bottom supports.

Packing cases must be open enough to allow good ventilation to allow the sealant to cure during handling and shipping.

5. Completed IG Units

Once per shift, it is good practice to inspect approximately 25 IG units as they come off the

Suggested Glass Offset and Sealant Dimensions

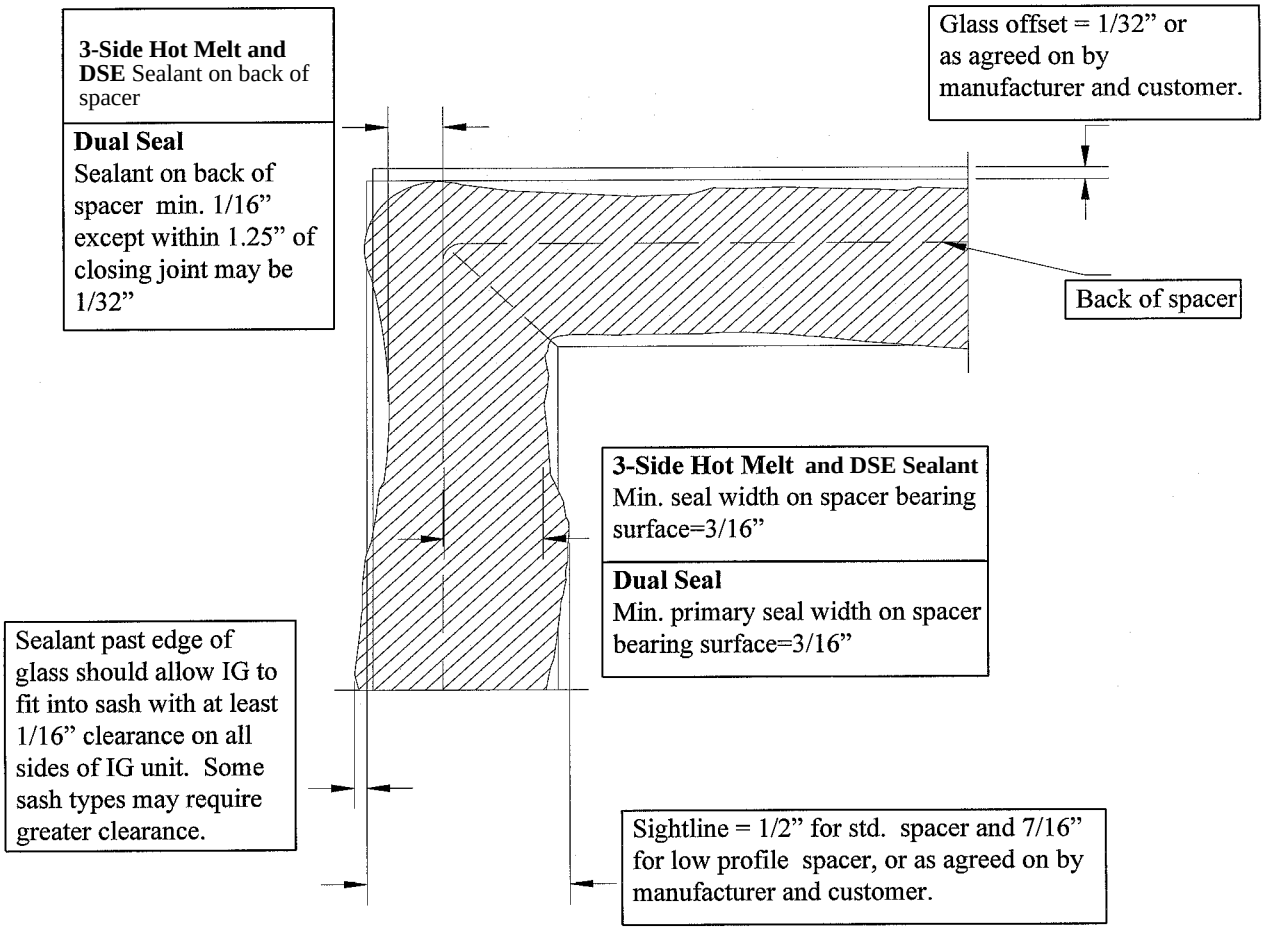


Figure 5

line and record the results of the inspection on form #QARF10. Each IG unit should be inspected for the following (see Figure 5):

a. Glass Alignment and Overall Size

Alignment of the two component pieces of glass in the IG unit may be critical to the ability of the IG unit to fit into a sash or frame.

As a minimum, the following is suggested: One short edge and one long edge should be aligned within 1/32". Mismatch on the sides opposite the aligned edges may be permitted to a maximum of 1/8". For residential applications IG unit manufacturers may elect to use a different glass alignment tolerance to fit their own or their customer's particular needs.

Overall IG unit size may vary from the exact ordered size by the following amount:

- With no laminated glass -1/16", +1/8".
- With laminated glass -1/16", +3/16".

As with the alignment specification, IG unit manufacturers may elect to use a different glass size tolerance to fit their own or their customer's particular needs.

Many residential applications will require tighter size specifications than those shown above.

a. Overall Unit Thickness

Overall unit thickness is critical not only to the appearance of the finished product, but to the proper function of the IG unit following glazing into a frame or sash.

Large variations from nominal thickness may indicate that your process is not properly adjusted and may not be adequately squeezing out the primary sealant.

Some sash and glazing systems can accommodate greater edge and corner thickness tolerances than others. However, large variations in center of glass thickness compared to edge thickness can create objectionable visual distortion in the IG unit.

Acceptable unit thickness tolerances should be determined based on your own specific requirements and those of your customer. As a general rule however, we suggest that at the time of manufacture, overall unit thickness at the corners, edges, and center of the IG shall be nominal +/- 1/32".

b. No Exposed Spacer

During fabrication of the Intercept™ spacer, the equipment automatically undersizes it to the proper dimension so that when it is placed into the IG unit, it will be inset from the edge of the glass the correct amount. This will allow the proper space behind the spacer for sealant, and creates the correct sightline in the finished IG unit. Care must be taken when placing the spacer onto the glass to insure that the proper inset is maintained.

After application of the sealant, around the entire perimeter of the IG unit the spacer shall be completely covered with sealant with no voids or gaps. This will reduce exposure of the spacer to corrosive brick wash solutions or environmental contaminants which may enter the sash. On dual seal units, the minimum sealant thickness shall be 1/16" except within 1.25" of the closing corner where the minimum thickness may be 1/32". On single seal and DSE units, the minimum sealant thickness shall be .035". The spacer must not extend beyond the edges of the glass anywhere.

After the units are complete, if any voids are found in the sealant, they must be filled so that no spacer material is exposed.

A good tool for applying wet sealants when filling voids in dual seal units is a plastic spatula

such as used for spackling holes in drywall. These can be obtained from most hardware stores. These work just as well as a metal spatula, and have the added advantage that they are not as likely to scratch or damage the glass edges of the IG unit.

The proper method is to gather a portion of wet sealant on the end of the spatula and with the width of the spatula parallel to the edge of the glass, force sealant into the void so that the sealant is pushed against the spacer. The goal is to completely fill the void so there are no gaps between the sealant and the glass or spacer. Voids and gaps in the sealant will be sites where moisture may collect resulting in spacer corrosion.

c. Sealant Squeeze-out

The allowable squeeze-out of sealant past the edge of the IG unit is completely dependent upon the application, the bottom line being that the IG unit must fit into the sash. Some sash configurations allow only 1/16" between the edges of the glass and the sash. In these cases, if 1/16" of sealant protruded out past the glass on opposite sides of the unit, it would be very difficult to insert the IG unit into the sash, plus thermal expansion and contraction of the frame could cause pressure on the edge seal of the IG unit.

Therefore it is recommended that IG manufacturers evaluate their own requirements to determine the allowable sealant squeeze-out past the IG edges. However, in many applications 1/16" is acceptable.

d. Sealant Width

On dual seal systems, after roll pressing, a continuous 3/16" width adhered bead of primary sealant must be present between the glass and spacer bearing surfaces around the entire perimeter of the unit. On single seal systems, after roll pressing, the single sealant must form a continuous 3/16" width adhered bead between the glass and spacer bearing surfaces around the entire perimeter of the unit, plus it must cover the back of the spacer.

e. Sightline

Each unit should be checked to determine if any portion of the spacer or sealant intrudes into the airspace beyond the allowable standards. When measured from the outermost edge of the IG, this distance shall be not greater than 1/2" for standard spacers and 7/16" for low profile spacers.

f. Matrix Bead Fill

At this time another quick visual check should be made of the matrix bead to see if it looks correct. The bead should fill the spacer from edge to edge, and the top surface should be smooth with no skips and no globs.

g. Glass & Coating

Visually inspect each IG unit to determine if each lite of glass is of the proper type and if coating is on the proper surface.

If the glass manufacturer requires coating deletion, the coated lite should be inspected around the perimeter to see if the coating has been properly deleted as specified. Incomplete coating deletion could result in either premature coating or edge seal failure or both.

Each IG unit should be inspected for coating and glass surface defects, airspace contamination, smears, and sealant spots on the glass.

h. Glass Shell Chips

The shell chip acceptance criteria should be decided by agreement between the glass manufacturer and the IG unit manufacturer. As a general rule, one shell chip per unit may be acceptable if it is on the non-airspace surfaces of the glass, is not greater than 1/4" across, and is not within 2" of any corner. Keep in mind that any type of glass edge damage greatly reduces its

strength and makes it much more susceptible to thermal stress and bending type breakage.

If a shell chip is found on the airspace side of the glass at the edge, and the shell is still in place, the IG seal may have been breached by the chip. This sometimes occurs during handling when the edge bumps against a support or other object. If this type of chip is found, the IG unit should be set aside to determine whether it is repairable or should be discarded.

i. Glass Cracks/Scratches

As a minimum, do a 5-second scan of the IG unit held at arms length to look for glass cracks and scratches.

j. IG Unit Squareness

The IG unit may be evaluated for squareness by using a true 90° cutter's square with a free leg long enough to span any dimension being checked. Position the square at a corner, using the long dimension as a base, and checking the short dimension against the free leg in order to determine the deviation of that edge in inches either way from 90°. The other 3 corners of the unit may be checked in the same manner.

Where the two glass edges are not aligned, the edge protruding out the farthest is considered for the placement of the square and for the measurement at any point.

k. Ink Jet Printing

Look inside the unit to see that all pertinent ink jet printing is properly aligned, is in place and contains the proper information.

l. Muntins

If muntin bars are inside the IG unit, visually inspect the intersections and ends for debris, and check to see that all muntin bar clips are completely snapped into place in the spacer channel. Also, check to see that the muntin bars are not scratched or have rub marks or contamination on their surfaces. Since muntin bars are a highly visible part of the IG unit and are often viewed at very close range by the homeowner, even very minor defects may be cause for rejection. Therefore, very high standards of inspection should be set for your muntin bar operations.

m. Gas Fill Plug Seal

Following gas fill, check the closing joint and fastener to insure that they are sealed properly, with no voids or bubbles. To insure that there are no massive gas leaks at this location, you may use a gas leak detector, such as models 21-050 and 21-250 produced by the GOW-MAC Instrument Co. (Ph. 610/954-9000).

n. Gas Fill Port Seal Integrity Test

Failure of this test will indicate a massive leak at the gas fill port. This is not a test for sealant permeability.

Procedure:

Lay the IG unit horizontally on a flat surface, such as a cutting table. Either stack 5 to 10 units high, or if testing a single unit, place a 10# weight in the center of the unit, to create a slight internal pressure. If there is a leak, this will force argon out the leak.

Using the Gow-Mac gas leak detector, "sniff" the area around the gas fill port, and the corner of the IG unit adjacent to the gas fill port. If there is a leak, within 1 to 2 seconds, the needle on the leak detector will swing to the right or left depending on the gas type being detected.

Result:

If a leak is detected, the gas fill port and/or closure joint are inadequately sealed.

Action Required:

The defective unit should either be repaired or discarded.

o. IG Unit Seal Adhesion Test (butterfly)

The adhesion of the IG unit sealant should be tested and verified at least twice per shift. Failure of this test may indicate one or more of the following:

- Contaminants on the glass and/or spacer.
- Incomplete washing or rinsing of the glass.
- Defective sealant materials.
- Proper seal line temperature not reached.

Procedure:

Select an IG unit from today's production, that has cooled approximately 4 hours. Wear proper safety equipment. With a glass cutter, score a large X on the unit. Along each side of the unit score parallel to the spacer 2" from it. Score these 2" strips into 7" widths. Break the glass at all score lines and remove the triangular pieces. Rotate each 2" x 7" piece of glass approximately 30 degrees, while watching for loss of sealant adhesion to either the glass or spacer.

Result:

The sealant may stretch or tear, or the spacer may bend. However, after rotating the glass, there should be evidence of sealant adhered to both the glass and spacer. Close inspection in good lighting may be necessary to see a very thin skim coat of sealant on the glass and spacer.

Action Required:

If the sealant does pull away from the glass or spacer at any point, the production line should be stopped and the cause found and corrected. All glass produced since the last successful test should be set aside until its disposition is determined.

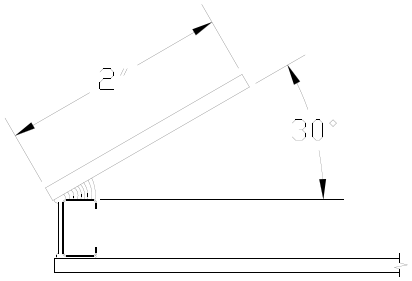


Figure 6

p. IG Unit Water Immersion Test

Two fairly simple methods of checking the seal integrity of an IG unit are a water dip test and a water immersion test.

The dip test involves dipping each edge of an IG unit into a container containing at least 1" of water. If the unit fogs or if water appears inside the unit, the unit has failed.

A slightly more elaborate test is the water immersion test, which involves completely submerging an IG unit into a bath of 120° F water, placing weights on the unit to hold it down, and watching for bubbles and/or fog and water inside the unit. In this method, to avoid breakage or popping of the seals due to increased internal pressure, the unit should not be left in the heated water more than a few minutes.

These two methods will both expose relatively large leaks in the IG edge seal. However, these tests are not capable of determining leaks due to permeation of gases or moisture vapor through sealants.

If a completed IG unit does not pass all of the above inspections and tests, it must be either disposed of or repaired.

Once the production line is properly set up and

all workers are aware of good quality practices and the requirements for proper IG unit construction, rarely should defects be found in a particular set of 25 units that are inspected. Occasionally there may be one defective unit in a particular set. If two or more are found, production should be shut down and the problem corrected.