GLASS PROCESSING RECOMMENDATIONS FOR IGU FABRICATION

GLASS STORAGE

a) Glass should be stored indoors and conditioned to room temperature before IGU fabrication begins. This avoids a heat sink and can help control and prevent condensation from forming on the lites, either before or after IG fabrication starts.
b) Store uncut glass away from sources of airborne contaminants to avoid the potential risks associated with glass bonding surface defects.
c) The more storage-sensitive vapor deposition low-e glass coatings have shelf lives ranging from 3 to 6 months, so control inventories and rotate stock.
d) Avoid prewashing glass until immediately prior to IGU fabrication begins.

GLASS HANDLING

a) For best practices regarding both safety and material handling needs, handle single lites.
b) Wear soft cotton or other effective gloves to prevent fingerprints/oil/other contaminants that can add to washing requirements; handle the edges with insides of gloved fingers through all manual processing.
c) Vapor deposition low-e glass needs to be conveyed coating side up to avoid coating damage

GLASS CUTTING

a) General: Vapor deposition low-e coated glass also needs to be cut with the coated side up to the cutter wheel. Automated cutters reduce the performance risks associated with variable cut quality, and are preferred.
b) Use of Approved Cutting Fluids:

- Best Practice dictates using only approved cutting fluids from either the water-soluble or full-flash families of cutting lubricants. These by experience will either evaporate and/or fully wash away once the cut glass has been racked and staged, and the washing process is complete. A simple visual test is used to determine that the cutting fluid can be fully removed. This test can be provided by Tremco Technical Services to add candidate cutting fluids to those we have had experience with. Those already approved are listed as follows:
    - Approved Cutting Fluids:
        - Billco Manufacturing’s Glass Cutting Fluid
        - Bohle America’s Glass Supplies Acecut 5503 & Acecut
        - Edgeworks’ CoolCut Glass Cutting Oil
        - Petro Canada Cutsol Fluid
        - Perfect Score Technologies’ HP-5503
        - Sunnyside Specs Paint Thinner.

c) Cut Quality: Once the lites have been cut, glass edge cut quality is to be monitored as a critical element of IGU durability; contact both your glass provider and your glass cutting equipment manufacturer for best practices on cutting wheel selection by wheel diameter, glass thickness and coating types in use. Guard against cutting defects, which can include:

- Rough cuts
- Shark’s teeth or serration hackle deeper than 25% of thickness
- Flare or wings

RECOMMENDATIONS REGARDING ADHESIVE COMPATIBILITYAND EDGE DELETION OF COATED GLASS

a) General: Many coatings are used within the protected surfaces inside the IGU cavity. It is recommended that vapor deposition low-e coatings be edge deleted, as best practices should consider the latent risks associated with unplanned ingress of water into the glazing cavities, along with potentially acidic solutions. Deletion of low-e coatings is generally not due to chemical incompatibility, as adhesion is generally very good to our spacer's adhesive. It is mainly undertaken to control this risk of interlayer coating corrosion. This is the key driver in our recommendation to delete soft-coat low-e coatings. While ultimately it is the decision of the IG fabricator to delete soft-coat low-e coating, primary advisory input should be also sought from the providers of the coated glass and applied spacers and sealants used.

b) Methods: Methods to remove coatings include the typical wheel grinding, but other techniques such as electrical discharge have been used. Edge depth of deletion should be fully inside the sealant perimeter and the transition line within the perimeter of the spacer. Validate effectiveness using an ohmmeter to verify that no conductivity remains.

c) Recommendations to Edge Delete based on classification of coating:

- All soft-coat Low-E coatings are edge deleted
- All Pyrolytic Low-E coatings do not need edge deletion

GLASS WASHING

a) General:

- See Glass Handling above for pointers on handling.
- Water Quality Requirements: Water quality inputs to the system are relatively broad, except in the final rinse section where mineral salts deposited on the glass in rinsing or drying can reduce adhesion. Best practice for a clear final rinse is via a non-recirculating system, if only for surety of low mineralization of dissolved solids; final rinse hardness should be <50 ppm as best practice, with progressive potential interference with sealant adhesion up to <200 ppm. Treatment systems to reduce rinse water mineralization through DI or RO systems (de-ionization or reverse osmosis) are recommended if hardness exceeds 200 ppm. Water softeners are generally to be avoided, as these systems exchange, rather than remove mineralization.Generally feed glass lites 'coating-up' at shallow angles to the washer's air knives, in order to maximize air-curtain water removal and drying potential.

b) Washing:

- Maintain wash water temperature in the range of 120 to 140 °F (48 to 60 °C) per glass manufacturer.
- Detergent use should be minimized, as the limited benefits diminish and instead create a risk of IG failure if completeness-of-rinse is compromised in any fashion. A quick check is to see minimal foam in the wash tank and no foam in the primary/first rinse tank.
- All spray nozzles in all washer sections are to be free-flowing at > 1 gpm to completely cleanse the glass and rinse the brushes.

c) Drying:

- No water droplets on the bondline surfaces should be present upon washer exit.
- The air drying section needs to be supplied through clean blower filters to minimize contamination and maximize airflow.

TYPICAL PROBLEMS ENCOUNTERED WITH GLASS WASHING PROCESSES

TO BE USED AS A CHECKLIST TO CONTROL AGAINST

a) Washing:

- Conveyor speed through system is either too fast or too slow: Too fast curtails drying, and too slow can interfere with timing of the flow switch logic. Consult the manufacturer for optimal speeds.
- Too much detergent: Heavy froth in wash tank leads to frothy rinse tanks and incomplete final rinsing.
- Temperature is too low, allowing for incomplete removal of protective additives and dirt.

b) Rinsing:

- No provision for, or incorrect plumbing routing in the system designed to provide a clear final rinse; this directly leads to hard water or detergent residue interfering with adhesion.
- Clear final rinse shut off or set to low-flow to avoid droplets, leading to hard water or detergent residue interfering with adhesion; this can also occur if the DI/RO supply water is exhausted.
- Clear final rinse flow timer by-passed or malfunctioning, leading to hard water or detergent residue interfering with adhesion.

TESTS & QC TO HELP ASSESS GLASS CLEANLINESS

a) Level #1: **Monitor systems** for wash temp at 130 °F (54 °C) inspect that the rinse section has no froth and that final rinse's water hardness is preferably <50 ppm and never >200 ppm.

- Take corrective actions to maintain these requirements.

b) Level #2: **Visually examine** washed glass with backlighting to detect defects in glass, reveal debris, fingerprints or cup marks (vacuum cup handling devices can leave plasticizer residues, so cover these with breathable spun polyester hairnets if applied to interior IG surfaces after washing).

c) Level #3: **The Fog Test** is used to further reveal surface contamination that is difficult to see

- Hold candidate glass over the steam usually present at the washer entry, and resultant condensation will reveal where the normal surface energy of clean glass may have been altered via patterns seen when exposed to the condensation forming on the glass.
- Alternatively, a washed lite can be chilled in a refrigerator/freezer, and upon cooling and later removal to the open environment will produce the same effect of condensation to reveal brush marks, fingerprints, streaks or smudges, etc.
- Clean glass should be viewed in this test as having a very uniform and very fine-grained condensation pattern, like a frosty mug.

d) Level #4: **The Slosh Test** is used destructively/investigatively to reveal detergent contamination left on the glass after exiting the washer.

- Pierce a sealed IGU, introduce a small volume of clean tap, bottled or DI water, and cover the pierced hole with your finger.
- Twirl/rotate the IGU for a few times every few minutes over a 10 minute period to rinse and re-rinse the cavity's two glass surfaces, potentially re-dissolving any thin detergent residue into this clean water.
- Pour this rinse-water solution into a small clear jar previously rinsed with the same clean water source.
- Cap and shake the water sample to observe for any variation/frothing as compared to a control where bubbles fall after being shaken and quickly coalesce and flatten. Bubbles remaining from the primary sample indicate detergent contamination.

e) Level #5: **Measuring Contact Angle** is an analytical technique that utilizes the principle that a known liquid in contact with a solid interface (in this case water-to-clean glass) should always produce the same appearance of beading or angle-of-contact that a droplet of the liquid makes to that surface. For water to soda-lime glass this is ~29°, but if the glass surface was contaminated with a wax for instance, the water would bead up higher, and the droplet's angle-of-contact would be much higher due to the change in glass surface energy. This technique is very technical, but a keen observation of very pronounced water beading in excess of what all have come to casually view as normal can reveal that more investigation with dyne pens that measure surface energy (or other analytical technique) is warranted.

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