Information on Glass Products

This service bulletin should be used as a guide to evaluate glass products for potential replacement. Subject matter addressed includes:

- Glass Distortion
- Airspace Condensation
- Indoor Condensation - Sweating on the #4 Room Side Pane Surface
- Indoor Condensation - Condensation Rings on the #4 Room Side Pane Surface
- Outdoor Condensation
- Glass Breakage

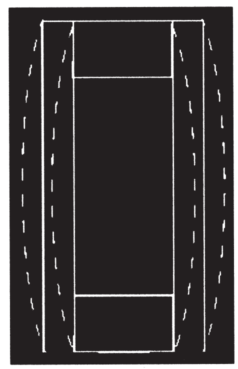
Glass Distortion

Glass distortion can be related to a number of factors and is mostly caused by environmental conditions and glass fabrication processes. Glass distortion is very subjective and the degree of perceptive distortion is influenced by the viewing angle, distance away from the window, objects being viewed, sky conditions and glass thickness. Since it is very difficult to assess the degree of distortion or bow in insulating glass products, glass units having distortion or bow in the glass should not be judged for their worthiness by an aesthetic evaluation.

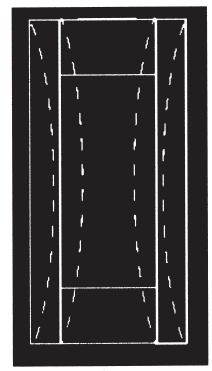
Glass should not be replaced for complaints or concerns of distortion in tempered or heat-strengthened glass products. Distortion in tempered or heat-strengthened glass products is created by the process of tempering. Glass is heated to approximately 1200ºF and quickly cooled. This process, although making the glass significantly stronger, produces undulations in the glass called roll ripple, bow and warp. Although controlled to minimum levels, this distortion is very subjective and is more apparent when viewed at critical angles from the exterior.

Glass should not be replaced for concerns or complaints of positive glass units. Distortion caused by a positive glass bow (glass panes bowed-out Fig. IG01-1) is caused by the airspace pressure being higher than the airspace fabrication pressure. This is normally seen on warm summer days, in periods of low barometric pressure, or when the insulating glass units are shipped to higher altitudes.

Glass should not be replaced for concerns or complaints of negative or concave glass units. Distortion caused by a negative glass bow (glass panes bowed-in Fig. IG01-2) is caused by the airspace pressure being lower than the atmospheric pressure. This is normally seen on cold winter days. The degree of this distortion is influenced by the glass thickness, airspace gap, IG unit size and geometry, temperature, barometric pressure, window installation altitude being lower than IG unit fabrication altitude, argon leakage and IG unit fabrication tolerances.



Positive Glass Bow
Fig. IG01-1



Negative Glass Bow
Fig. IG01-2

Airspace Condensation

Glass units should be replaced when condensation is evident in the airspace. Insulating glass units experiencing condensation in the airspace are usually due to a failure of the insulating glass seal. This is first evident in the wintertime when the outdoor temperatures are low causing a lower airspace temperature and the potential for condensation to form. Airspace condensation can also be caused by a small crack in the glass that is sometimes not immediately evident. To be assured that the condensation is in the airspace, the outdoor and indoor glass surfaces should be cleaned to make certain the condensation is in the airspace and not on the outdoor or indoor glass surfaces.

Glass Sweating or Indoor Condensation on the Room Side Glass Surface

Glass units having indoor condensation or sweating caused by high room side humidity conditions should not be replaced. This phenomenon is usually seen in the winter at the bottom edge of the glass, around the glass periphery, or sometimes on the complete indoor glass surface. It is caused by high room side humidity conditions when the indoor glass temperature is below the dew point of the room side air.

Condensation Rings on the Indoor Glass Surface

Glass units having indoor center condensation rings should be evaluated. When insulating glass unit panes are touching in the center, wintertime indoor condensation rings can be seen in the center of the glass. These rings may be circular or elliptical depending on the window shape (square, rectangular, circle top etc.). The cause for having the condensation rings is that when the glass lites touch in the glass center, there is a reduced insulating value, and the indoor glass temperatures are closer to the outdoor glass temperatures. This increases the potential for condensation rings on the room side pane and becomes evident when the room side glass temperature falls below the dew point temperature of the room side air.

It is suggested that the window or glass manufacturer be contacted to confirm that the glass is indeed touching in the center. Condensation at the center of the unit can also occur if the room side humidity levels are high. In addition, the use of bars or grilles in between the glass panes can result in the bars touching the glass and creating a cold surface, resulting in the formation of condensation where these bars are located in the IG unit (see TSB #IG08 “Use of Internal Grilles” for details). If the glass is touching in the center, venting of the unit or replacement of the glass may be required.

Outdoor Condensation

Glass units should not be replaced for complaints or concerns when outdoor condensation occurs. Condensation on the outdoor glass surface of an insulating unit is not an indication that the glass or insulating unit is defective. Under the right set of atmospheric conditions it is possible to get condensation on the outdoor surface of an insulating glass unit. Specifically, these conditions are as follows:

- Glass temperature is below the dew point temperature
- Clear night sky
- Still air
- High relative humidity
- Coated glass products (i.e. LoĒ™/LoĒ²® glass), argon filled insulating glass products

Exposed to the above conditions, the outdoor glass surface can radiate heat away to the night sky, and with good insulating glass products the outdoor glass temperature can fall below the dew point of the ambient air. When this occurs, moisture from the air can condense on the outdoor glass surface. Similarities of this condensation on glass products can be drawn to moisture or dew on lawns or on automobiles when exposed to the above mentioned natural occurring phenomena.

Glass Breakage

Glass breakage can occur from impact, thermal stress, bending (racking of the sash) or from excessive pressure differences between the airspace and the outside air. Glass is a brittle material and will fracture when subjected to a critical tensile stress level. Scratches, chips or digs in the glass surface caused by windblown debris or cleaning can produce stress concentrators that reduce glass strength. If these surface defects are severe enough, they can produce eventual glass breakage.

A typical impact breakage pattern is shown in Fig. IG01-3. Due to the small particle size when glass fractures from impact, at times the glass may evacuate the opening and this type of fracture pattern may not be immediately evident.

A typical breakage pattern from thermal stress is shown in Fig. IG01-4 and is caused by the glass not being able to sustain the thermal conditions experienced at the site. Although this cause of breakage is not very prevalent, at times this type of breakage may be seen. Conditions that can produce thermal breakage of glass panes can be related to a combination of the following: outdoor overhangs, indoor shading (blinds, draperies, etc.), size of window, and flaws at the glass edge. With the addition of LoĒ™ coatings and argon filling, the insulating value of the insulating glass product has been significantly improved, raising the central glass temperature on the room side pane, while the glass edges remain cold. This temperature gradient produces thermal stress in the room side glass pane, and if there are any significant edge flaws from handling, thermal breakage could take place initiating at the flaw. Some insulating glass products that Cardinal produces will have the indoor glass pane heat strengthened to virtually eliminate the potential of thermal breakage of this glass pane.

A typical breakage pattern for bending is shown in Fig. IG01-5 and is usually caused by a racking of the sash i.e. in a casement unit when one of the locks is engaged and the homeowner tries to open the window.

A typical breakage pattern from excessive pressure differences between the airspace and outside air is shown in Fig. IG01-6. This type of breakage is not very prevalent and is due to the glass not being able to meet the bending stresses induced by the deflection of the glass panes. Specific causes of breakage are due to extreme pressure differences between the airspace and outside air and can be from severely negative (bowed-in) or severely positive (bowed-out) glass units. Breakage from bowed-out glass panes is extremely rare and can be caused by shipment of the IG units to altitudes in excess of 6,000 ft. to 12,000 ft. (depending on unit geometry).

A typical breakage pattern for tempered glass is shown in Fig. IG01-7. All glass products have some level of inclusions i.e. seeds, bubbles, and stones which are an unavoidable part of the glass forming process. These inclusions are controlled to minimum levels and usually are not visible to the naked eye. One type of a very rare inclusion is called a nickel sulfide stone. This particular type of stone may undergo a phase transformation (shrink) in tempered glass due to the re-heat/quench operation. Over a period of time, these particles will tend to revert back to their original state (expand). This phase transformation can cause tempered glass to fracture spontaneously, but this is a rare occurrence. Annealed and heat-strengthened glass will not have fractures from inclusions i.e. nickel sulfide stones. Tempered glass is classified as a safety glazing material because when it fractures, it breaks into small relatively harmless fragments with no jagged edges or shards.

Breakage From Positive or Bowed-Out Glass Lites (Fig. IG01-1)

Positive units can be caused by warm temperatures, low barometric pressures, altitude changes from the IG unit fabrication point, and IG unit fabrication tolerances. If glass fractures occur from a positive airspace, it is usually only one of the glass panes and since the deflection is positive, the glass particles will usually evacuate the opening. Glass fractures from airspace pressures being higher than the airspace fabrication pressure are almost unheard of except on rare occasions above 6,000 ft. with certain glass sizes. Installation or shipping glass units to elevations higher than 6,000 ft. could produce the same effect on all glass sizes. When insulating glass units are shipped through or installed in extremely high elevations, installation of capillary tubes should be considered to reduce positive unit bow and the potential of glass breakage.

Breakage From Negative or Bowed-In Glass Lites (Fig. IG01-2)

Negative units can be caused by cold outdoor temperatures, high barometric temperatures, narrow glass sizes, large insulating glass airspace, argon gas loss, altitude changes from the IG unit fabrication point, and IG unit fabrication tolerances. This breakage type is more prevalent with wide airspace units. If glass fractures occur from a negative airspace, it is usually only one of the glass panes and since the glass panes are deflected toward the airspace during breakage, the glass particles almost always remain in the opening. It is not unusual for the glass fracture to sound like a loud bang. This loud noise is associated with the glass stress being relieved when fracture occurs and should not be construed as a dangerous situation.

Naturally, any glass that has fractured in the field should be replaced. Although most tempered glass breakage is caused by damage to the glass such as lawn mower debris, stones, carpenters tools etc., in general, tempered glass breakage is very rare because of its exceptional strength and impact resistance.

Impact Break Pattern

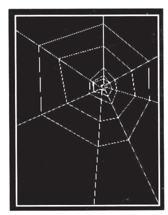


Fig. IG01-3

Thermal Stress Break Pattern

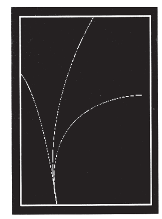


Fig. IG01-4

Bending Break Pattern

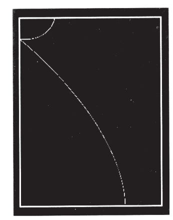


Fig. IG01-5

Pressure Difference Break Pattern

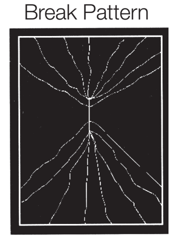


Fig. IG01-6

Tempered Break Pattern

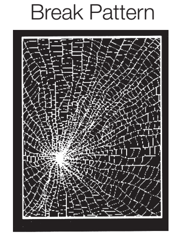


Fig. IG01-7

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