

Triple-Pane Guidelines

The continued progression towards energy-efficient windows will increase the need for triple-pane insulating glass. A triple-pane unit is more complex than the standard double-pane unit because of the reaction that occurs with two sealed airspaces, as well as the complexity of analyzing the risk for thermal stress breakage with three glass panes. Interaction of triple-panes with two airspaces and potentially three LoE™ coatings becomes a complex equation. Triple glazing has some challenging issues compared to double glazing when selecting the glass construction. The following factors need to be considered.

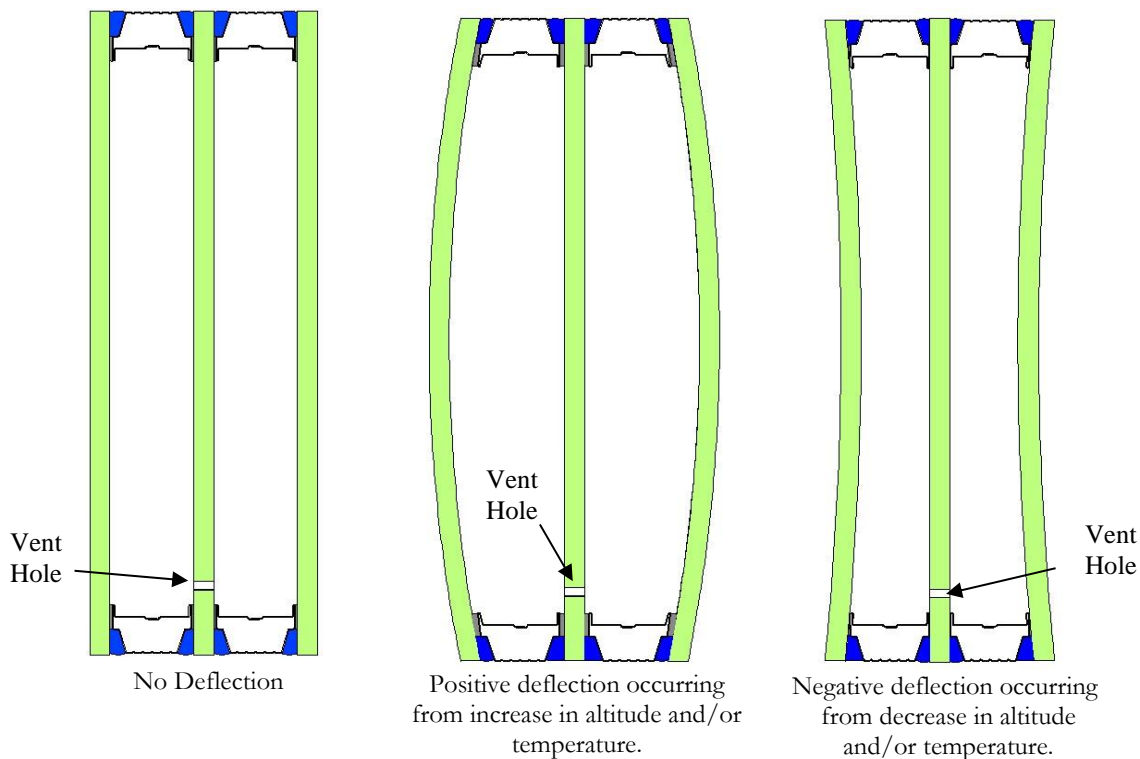
Airspace Dimension/Overall IG Thickness

The change in airspace pressure from temperature and/or altitude changes will

cause the outdoor and indoor glass lites in an insulating glass unit to deflect. The two major concerns from such deflection, and in particular triple-panes, are the stress on the insulating glass sealants and on the glass lites. Stresses that occur from temperature and altitude changes can be larger than those that occur in a standard double-pane unit. Effects of temperature and/or altitude changes on the edge seal and glass stress of a triple-pane unit with two 13.0mm airspaces will be similar to a double-pane unit with a 26.0mm airspace (airspaces are additive).

Equalization Hole in Center Lite

In some triple-pane units, Cardinal utilizes a small hole in the corner of the center pane to allow equalization of the pressure of the two airspaces. With a hole in the center lite, there will be minimal deflection on the center lite. Additionally, the use of the vent hole will be beneficial in high altitude applications because only one capillary tube will be required which will increase the longevity of the triple-pane.



Edge Load

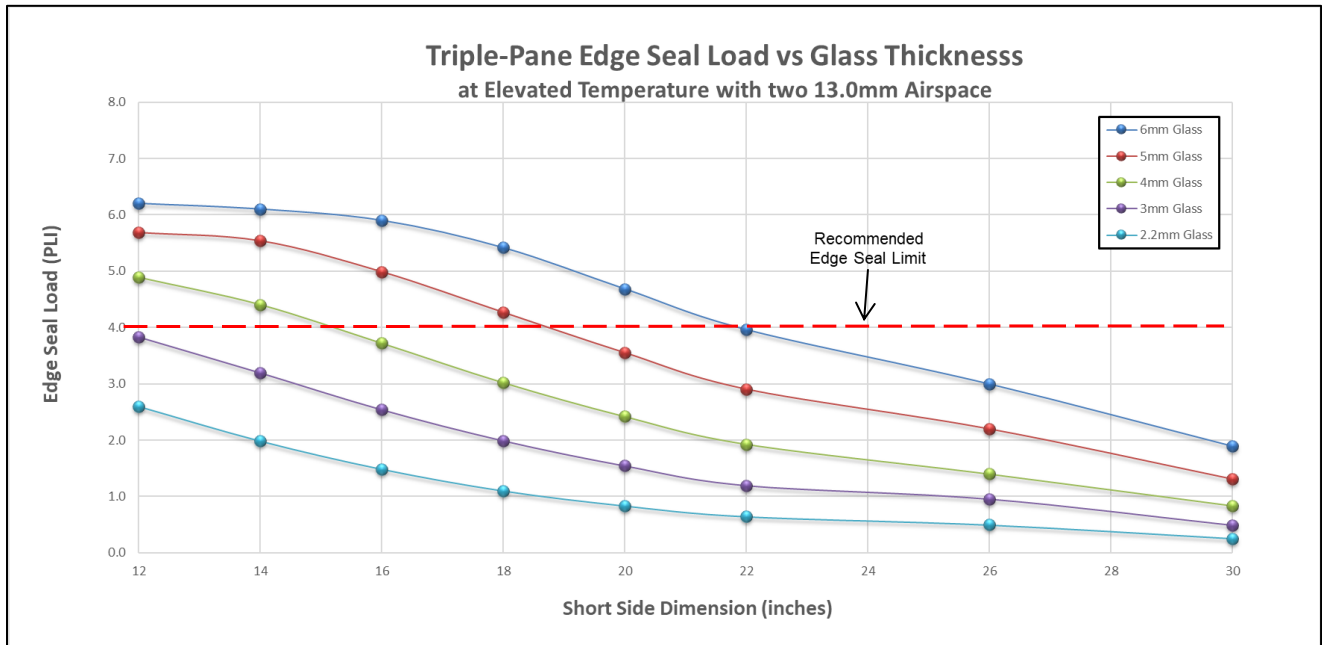
Factors that determine the amount of load applied to the glass lites and the insulating glass edge seal include:

- Glass thickness
- Size of the insulating glass unit
- Airspace dimension
- Temperature
- Altitude
- Windload

The graph below shows the resulting edge seal load on a triple-pane unit constructed with two 13.0mm airspaces at an elevated

airspace temperature, with various glass thicknesses.

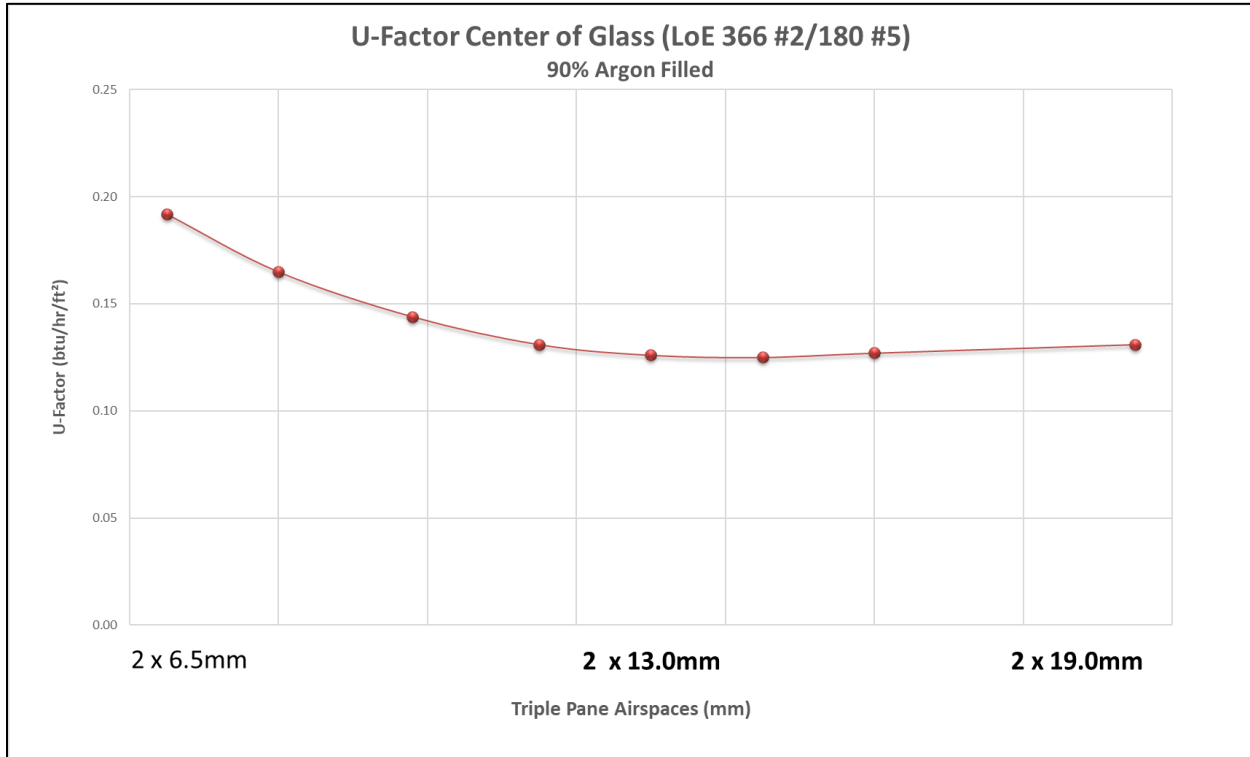
As illustrated in the graph, the edge seal load increases as the glass thickness increases. The load on the IG edge seals becomes significant on triple-pane units, especially when the short side dimension is less than 20 inches. A triple-pane unit constructed with three lites of 6mm glass will have edge seal loads more than three times higher than a triple-pane constructed with 2.2mm glass. For this reason Cardinal does not recommend the use of wide airspaces for triple-pane units, especially triple-panes utilizing thick glass.



Performance

As shown in the graph below, the optimum U-Factor occurs in airspaces between 9.8mm and 13.0mm. Using airspaces greater than

13.0mm increases the edge seal loads and does not improve the performance of the IG unit.



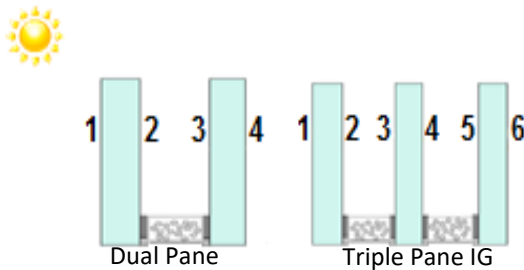
Triple-Pane Airspace Limitations

To minimize the edge seal loads and glass stress of a triple-pane IG unit, Cardinal recommends airspaces no larger than 13.0mm being used. As the glass thickness increases, the airspace should be reduced to help reduce stress on the sealants and glass lites.

These recommendations do not include effects from altitude changes. Recommendations are based on Cardinal's XL Edge® and Endur IG™ spacer systems.

Triple-Pane LoE Coating Placement

The use of two or three LoE coatings in a triple-pane will provide the optimum U-Factor performance. To achieve the optimum U-Factor, one LoE coating is required in each airspace of the triple-pane. To reduce the risk for thermal stress breakage, Cardinal recommends the coatings be positioned on the #2 and #5 surfaces versus #2 and #4 or #3 and #5.



In triple-pane constructions where LoE -i89® (#6) is used, LoE-180® is recommend for the center pane; see Cardinal's TSB IG07 Heat Treatment recommendations. The location of the coatings in a triple-pane has minimal effect on performance.

- The U-Factor is the same for a triple-pane with the LoE coating on #2 and #5, #2 and #4; or #3 and #5.
- Visible light transmittance, UV transmittance, and winter indoor glass temperatures are not affected by LoE coating placement.
- The Solar Heat Gain Coefficient (SHGC) will be slightly higher for a triple-pane with the coatings on #2 & #5, versus #2 and #4. The typical change in SHGC from surfaces #2 and #5 versus #2 and #4 result in only a .01 to .02 increase

Windload

The additional lite in a triple-pane will increase the windload resistance compared to a double-pane insulating glass unit. Per ASTM E1300, triple-pane units utilizing the same glass thickness as a double-pane unit will increase its windload resistance by 35%.

Safety Glass

To meet ANSI and CPSC requirements, all three lites of the triple-glazing are required to have safety glass, including the middle lite of the triple-glazing. Each safety lite will be identified by a required safety logo.

Altitude Limits

The allowable limits for shipping and installation for triple-panes without capillary tubes will in most cases be less than that of a double-pane. See Cardinal's Altitude tables for ship through and installation limits.

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