CLEARING UP CLARITY ISSUES

By Barry Barbas, President of Glass Restoration Inc.

This is intended to be a Technical Manuscript for Builders, Architects, Window Manufacturers, and Glass Companies. It is intended to be used as educational material, and can and should be shared with the End Users of glass products provided by or specified by the afore mentioned group.

GLASS: CLEARLY UNCLEAR

Modern glass used in all segments of society is generally at its highest quality point in history. Yet misconceptions, misunderstandings, and over expectations are common. This has resulted in much frustration on the part of all parties involved in the industry. Many of these frustrations have resulted in money, invested or lost, to solve, not problems, but rather, conditions that are common to glass. It is the attempt of the author to layout which conditions are inherent to glass and why, and separate them from actual flaws in glass that could be considered “Quality Issues”. Much study and time spent working in the industry has been put into this information. Where information has been gathered from outside sources for professional guidance, the sources will be noted for further reference by the reader if they chose to do so.

GLASS CLARITY

We like to think that glass is absolutely clear. A brand new piece of glass should be perfect, right? Actually, the glass that we have in our home or our automobile is not as crystal clear as we thought. Lens and precision optic makers have long known of the challenges of finding the highest quality piece to make their optics from. Due to limitations resulting from gravity, of all things, this has not been possible here on earth. This has led to experiments by the US Government and NASA to make a better glass in outer space. Zero Gravity has resulted in remarkable findings and improvements to that experimental glass. Glass and ceramics expert Delbert Day, who has been experimenting with glass melts on space shuttles over the past twenty years. Day is the Curators' Professor Emeritus of Ceramic Engineering at the University of Missouri-Rolla. He expected to end up with a purer glass. That's because on Earth, the melts--the molten liquid from which glass is formed--must be held in some kind of container. That's a problem. "At high temperatures," says Day, "these glass melts are very corrosive toward any known container." As the melt attacks and dissolves the crucible, the melt--and thus the glass--becomes contaminated. In Microgravity or zero gravity, you don’t need a container to hold the molten glass. All that is required is a system to hold the glass into an area of “No Contact” with external surfaces. They achieved this by using sound waves as an acoustic levitator to keep the molten glass where they wanted it to be.

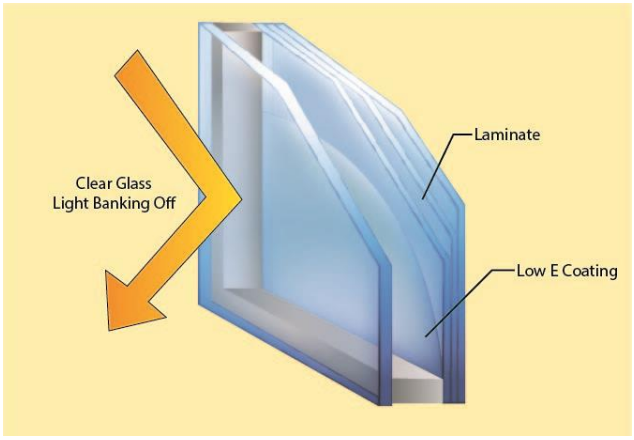
The results: To his surprise, the glass was of even higher quality than theory had predicted. But it wasn’t just the lack of impurities that made it a superior glass. What was learned is that, in outer space, glass does not crystallize the same way it does on Earth, leaving it much clearer than what we are accustomed to seeing. Also intriguing to space researchers is fluoride glass. A blend of zirconium, barium, lanthanum, sodium and aluminum, this type of glass (also known as "ZBLAN") is a hundred times more transparent than silica-based

glass. We can conclude from this research the silica based glass that we use is significantly less clear than the clear we thought we were seeing.

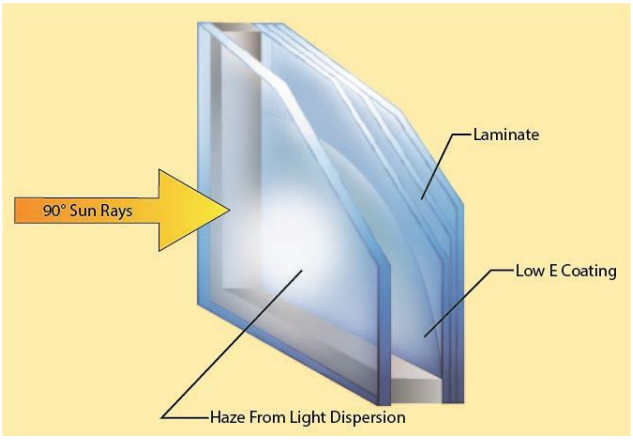
GLASS CLARITY PROBLEMS AT HOME ON EARTH

It has been noted by many Homeowners, that there is a problem with the clarity of their glass at certain times of day. This is most notable when the sun is low on the horizon and at a perpendicular angle to the glass. Builders have struggled to solve this issue by replacing glass at significant expense in some cases, only to still have the problem. So, the question arises, Is this a defect or a condition? As it turns out, light is scattered when passing through glass products. This scattering light produces haze, a milky or smoky condition. It can look like a very fine film of dust or coating on the glass that cannot be removed (See Cardinal Glass Technical Service Bulletin # CG07-09/13). Compared with clear or uncoated glass, coated glass products have a higher haze level. In addition, each product introduced to the glass, such as laminates, Low E coatings and additional glass panes adds to and intensifies the resulting haze. Haze is not considered a defect in glass. It is a condition of the combined layers of glass and other products used in the window or door glass. ASTM –D1003 has outlined a Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics, which includes glass. In that document, glass and glass treatments such as Low E and PVB or SGP Laminates are given a specific haze/visible light rating. You have to add all the factors together to get the percentage of haze that is inherent to the glass being used. The more products used to meet Energy Code and Impact Resistant Building Codes, the more resultant haze there will be.

Another condition that should not be overlooked is contaminates in the air at glass manufacturing facilities. Although much money is invested to purify the air, glass manufacturing plants and Insulated Glass assembly plants are not Class 1 Clean Rooms, but manufacturing facilities where product is coming in and out at a constant rate. Dust does land on glass, and is more noticeable in direct sunlight. Typical air has 35,000,000 particles per cubic meter, so it is inevitable that some dust will fall on and within insulated glass units.



Goal and Theory behind Low E Glass illustrated



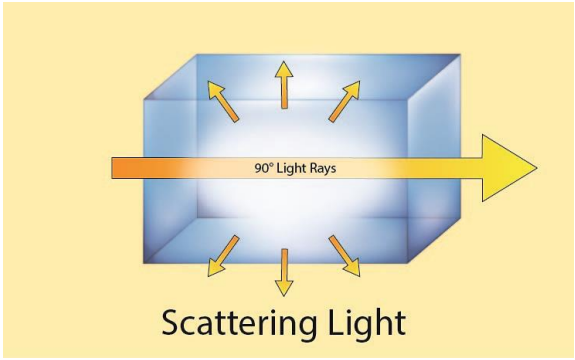
Haze From Dispersed Light Within The Glass

Low E Coatings are described by manufacturers as “Virtually Clear”. Why? Under most viewing conditions the coating is invisible. Under close inspection, and under certain lighting conditions, Low E coatings can be seen, and even cause adverse visibility affects.

Consider This:

The world's foremost lens makers, Ziess and Canon use the absolute best glass available. They have had to install elaborate protectors called Lens Hoods to keep light from striking the glass in their lenses. Why? Even with their Extra Low Dispersion coatings, light still disperses through the glass, and can and does ruin the optical quality and the image. Photographers avoid shooting into the sun due to this annoying problem. The windows on our homes and buildings do not have diaphragms to stop down the light, or hoods to shadow the glass to avoid the haze from direct lighting into the glass.

Light passing through glass



Light dispersing or scattering in lateral directions within the glass creating a glowing effect on the surface of the glass called Haze. One test that has been conclusive was shining a laser beam of light directly through a piece of high quality glass in a dark room. Light was scattered in all directions from glass molecules that crystallized in an unfavorable and unavoidable pattern.

Lens with Lens Hood shown. This somewhat effective concept would not work for most architectural applications. Another helpful quality engineered into a lens is that it is a tube with a flat black paint or coloring made to absorb the scattering light, thus mitigating the reflection of light to scatter again. All internal non glass parts of a lens are colored flat black for this reason.

Although lens hoods look quite at home on your camera lens, an attractive solution to the haze condition has not been accomplished for all architectural applications.

THE GOOD NEWS

There is good news. Innovators in the glass field have not rested, and in the future some of the haze will likely be reduced, but not eliminated. This condition only occurs for short periods of time each day, when sunlight is at a near perpendicular angle to the glass, and will likely not occur during other seasons, when the sun strikes the glass from a different direction. Rest assured, if you have the type of haze that only shows up at a particular time of day, it is a condition rather than a flaw. Changing the glass to another piece will not mitigate the condition. For all the energy saving benefits that Low E glass provides, there is a little clarity to give up. But for energy savings, Low E is clearly better glass for that purpose. The Low E coating is most frequently applied to the inside surface of the outer most pane of glass. Some manufacturers are experimenting with the location of this Low E coating in an effort to reduce resultant haze issues. For more information, visit www.GlassRestorationInc.com.