HOW WINDOWS AND DOORS CAN IMPROVE ENERGY EFFICIENCY

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I. INTRODUCTION

HOW WINDOWS AND DOORS CAN IMPROVE ENERGY EFFICIENCY

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II. CLIMATE CHANGE

THE FACTS:

- **For over the past 200 years, the burning of fossil fuels, such as coal and oil, and deforestation has caused the concentrations of heat-trapping "greenhouse gases" to increase significantly in our atmosphere. These gases prevent heat from escaping to space, somewhat like the glass panels of a greenhouse.**
- **If greenhouse gases continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 3.2 to 7.2ºF above 1990 levels by the end of this century. Scientists are certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of greenhouse gases will change the planet's climate.**
- **Climate change affects people, plants, and animals. Scientists are working to better understand future climate change and how the effects will vary by region and over time.**
- ***http://www.epa.gov/climatechange/basicinfo.html***

HOW CAN WINDOWS AND DOORS MAKE A DIFFERENCE?

- **The quantity and quality of light around us determine how well we function. Light affects our health, safety, comfort, and productivity. In your home, you can save energy while still maintaining good light quantity and quality.**
- **Many existing buildings have single glazed, wood or metal frame windows, that don't close or operate properly. These windows are not energy efficient or economic. They allow heating and cooling cost dollars to literally fly out the window.**

- **The largest areas of heat gain and loss in a home are through the windows and doors. In warm climates like Arizona, Nevada and Southern California, summertime heat gain is the main concern. Windows with double glazing and spectrally selective coatings can help reduce that heat gain.**
- **High-performance windows and doors not only provide reduced annual heating and cooling bills; they reduce the peak heating and cooling loads as well.**
- **There are several energy efficiency aspects to windows including the frame, insulated glass material, insulated glass spacers, and the installation.**
- **Using high performance low E glass and thermally broken window frames the efficiency of windows and doors can be greatly improved.**
- **By using tight fitting EPDM based seals and precision fabrication, air infiltration can be reduced to increase energy performance.**
- **Energy Star qualified windows and doors can help homeowners meet higher energy standards.**
- **Meeting the higher energy standards that are being set also means fewer emissions from our buildings which are a large contributing factor to greenhouse gasses.**

III. USGBC AND ENERGY STAR

UNITED STATES GREEN BUILDING COUNCIL (USGBC)

- **The U.S. Green Building Council (USGBC) is a non-profit organization founded in 1993 which is committed to expanding sustainable building practices. Today, there are 15,000 plus members that include building owners and end-users, real estate developers, facility managers, architects, designers, engineers, general contractors, subcontractors, product and building system manufacturers, government agencies, and nonprofits.**

- **LEED (Leadership in Energy and Environmental Design) is a voluntary, consensus-based national rating system for developing high-performance, sustainable buildings. Developed by USGBC, LEED addresses all building types and emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, materials and resources selection, and indoor environmental quality. LEED is a practical rating tool for green building design and construction that provides immediate and measurable results for building owners and occupants.**

- **Using Energy Efficient Windows and Doors are an important part of the LEED certification process.**
- ***All information from www.usgbc.org***

ENERGY STAR

- **ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping to save money and protect the environment through energy efficient products and practices.**

- **ENERGY STAR labeled windows meet a stringent energy efficiency specification set by the Department of Energy and have been tested and certified by the National Fenestration Rating Council (NFRC). NFRC is an independent, third-party certification agency that assigns specific energy efficiency measures such as U-factor and Solar Heat Gain Coefficient to the complete window system, not simply the glass. ENERGY STAR qualified windows may have two or more panes of glass, warm-edge spacers between the window panes, improved framing materials, and Low-E coating(s) which are microscopically thin coatings that helps keep heat inside during the winter and outside during the summer.**

- **Windows and Doors that have the ENERGY STAR label meet the government's energy efficiency guidelines and help to reduce carbon emissions.**

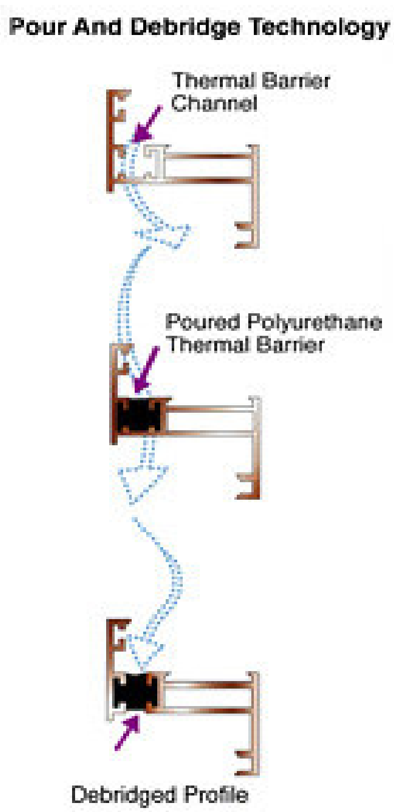
IV. THERMAL BREAK PROCESS

- **Thermally broken windows improve energy efficiency by controlling the forms of heat transfer.**
  - **Heat or thermal heat energy can be transferred through a material in three manners.**
    - ***Conduction* is simply the process where heat is transferred through materials touching one another.**
    - ***Convection* is where gases or liquids circulate to transfer thermal energy.**
    - ***Radiation* transfers heat energy at a distance through high frequency waves such as visible light, ultraviolet or microwaves.**

- **The window frame and sash frames are insulated against heat and cold conduction. This is done by separating the outside metal parts from the inside with a material such as polyurethane, greatly reducing the amount of heat or cold transferred through the frames. This feature is known as a thermal break or thermal barrier**.
- **A thermal break or thermal barrier is a non-metallic resin or plastic material installed in the metallic window frame that physically separates the interior part of the window from the exterior part. Hence, the pathway for heat energy to be transferred or conducted through the window frame is thermally broken.**
- **There are two ways to thermally break an aluminum window.**
  - **Fill and De-bridge process in which resin is injected into extruded aluminum parts machined to form a thermal break**
  - **Strut and Spacer system where aluminum frame profiles are separated with polyamide spacers.**

- **<u>Pour and Debridge Process (Cut and Fill)</u>**
  - **Aluminum profile is extruded with a thermal barrier channel, this is designed in such a way as to limit the mass of metal on the externally exposed surface**
  - **Specially formulated two component liquid polyurethane is poured into the thermal barrier channel.**
  - **The two components consist of a reactive resin and a polymeric isocyanate. Combined in the prescribed ratio, they react rapidly to become a very strong insulating polymer.**
  - **After the mixture is fully reacted and becomes a solid, the web connecting the channel is then removed by the debridging machine, thus creating a thermal barrier.**
  - **When the pour and debridge process is completed and the window is assembled there is no aluminum contact throughout.**
  - **This process does weaken the structural integrity of the extrusion.**
  - **One way to enhance the structural strength of the extrusion is by Skip debridging. This leaves a small aluminum bridge remaining across the thermal cavity. This enhances structural integrity but does sacrifice some thermal performance. Typically a one inch aluminum bridge remains every foot along the extrusion.**

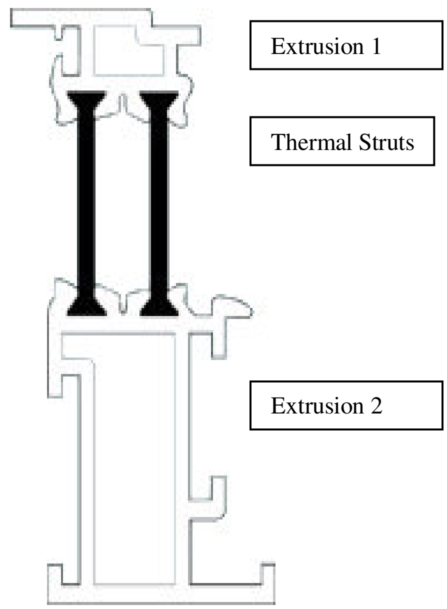
- **Pour and Debridge Process**



- **Thermal Strut Thermal Barrier**
  - Compared to the pour and debridge process, the Thermal Strut process is a totally different approach.
  - Rather than a singular aluminum extrusion which is cut apart after the thermal break is inserted in the channel, Thermal Strut takes two separate extrusions and joins them through the use of pre-manufactured plastic.
  - Both the inside and outside aluminum profiles are extruded independently with a cavity that will ultimately receive the strut.
  - Knurling wheels ride in the cavities for the entire length of the profiles, imprinting ridges into both legs of the cavity.
  - The Thermal strut process allows window manufacturers to offer two-color aluminum products because the inside and outside aluminum profile surfaces are independently extruded and finished.
  - Thermal Strut offers strength, resistance to heat transfer and unexcelled flexibility.
  - The key to the thermal struts effectiveness is its unique composition of glass-reinforced nylon 6/6. The process orients the glass fibers in three directions, countering stress in these dimensions for maximum structural integrity.

- The material is extruded into a shape that effectively and economically joins two separate aluminum extrusions (the inner and outer profiles of the window, door, or curtain wall)

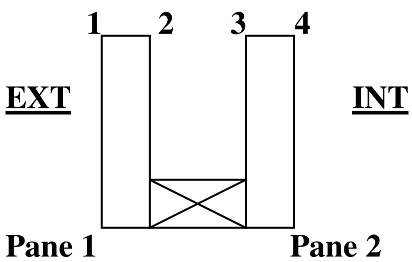
- **Thermal Strut Process**



V. DOUBLE GLAZING with ARGON GAS

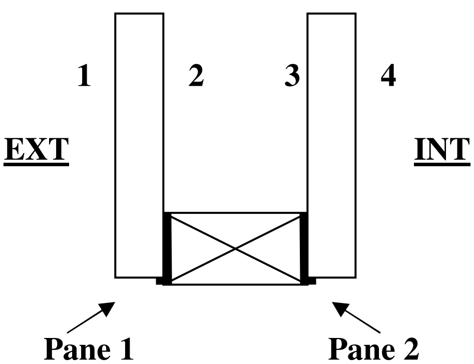
- **Insulated glass units consist of two or more panes of glass separated along the edges by a spacer system and elsewhere by an airspace usually between 1/2 and 1 inch.**
  - **The unit is sealed along the perimeter to prevent the movement of air in or out of the space between the glasses. This sealed airspace acts as a great insulator and dramatically improves the thermal performance of the window.**
  - **The greater the insulated glass unit overall thickness the greater the insulating effect and the greater the price of the window.**
  - **An insulated glass unit thickness of about 7/8 inches appears to be the optimum from a cost/benefit standpoint for most applications.**
- **The air space between the glass panes in an insulated glass unit is usually filled with desiccant dried air. Inert gases can be substituted for air in this sealed space as an energy efficiency option.**
- **Inert gases are much denser than air and therefore slow the heat transfer process by reducing the amount of convection that takes place.**
  - **Argon is the most common form of gas used in this application.**
  - **Others such as Krypton and Xenon are more expensive and only used in special large curtain or window wall applications.**
- **An often-overlooked energy efficiency item with insulated glass systems is the type of spacer used between the glass panes along the edges.**

- Older technology uses aluminum box sections, but these conduct heat readily between the glass and the spacer. They can create unnecessary thermal stresses on and premature failures of the hermetic seal. Another drawback to these spacers is that they are a common cause of interior glass condensation in extremely cold weather.



The spacer butts against the glass allowing for heat transfer and also moisture failure.

- State-of-the-art window designs use "warm-edge" spacers. These systems do not have direct metal to glass contact but separate the window glass from the spacer structure with some less heat conductive material like butyl sealant or plastics.



The spacer does not butt against the glass directly but is buffered by a sealant or plastic.
This is also known as a double seal.
This reduces the energy transfer through the spacers.

VI. GLASS OPTIONS

- **Low-emissivity (Low-E)** coatings are microscopically thin, virtually invisible, metal or metallic oxide layers deposited on the glass surface primarily to reduce the U-factor by suppressing radiative heat flow.
- The principal mechanism of heat transfer in insulated glass is thermal radiation from warm surfaces to cooler surfaces. Coating a glass surface with a low-emittance material reflects a significant amount of this radiant heat, thus lowering the total heat flow through the window.
- **Low-E glass coating improves energy efficiency by controlling the *radiation* aspect of thermal energy transfer.**
- Low-E coatings are transparent to visible light, and opaque to infrared radiation.
- Specially designed coatings, often based on metallic oxides, are applied to one or more surfaces of insulated glass.
- These coatings reflect radiant infrared energy, thus tending to keep radiant heat on the same side of the glass from which it originated. This often results in more efficient windows because: radiant heat originating from indoors is reflected back inside, thus keeping heat inside in the winter, and infrared radiation from the sun is reflected away, keeping it cooler inside in the summer.
- **Low-E glass blocks the higher angle summer sun rays from passing through and heating a building's interior, while in winter it allows the lower angle rays of the winter sun to pass through and provide supplemental heating to the building's interior.**
- **Several versions are now available of varying effectiveness and at various price levels.**

  - **Two types of Low-E glass coatings**
    - Hard Coat
      - Hard coat Low-E glass is manufactured by pouring a thin layer of molten tin onto a sheet of glass while the glass is still slightly molten.
      - The tin actually becomes "welded" to the glass. This process makes it difficult or "hard" to scratch or remove the tin.
      - Often this glass has a blue tint to it.
    - Soft Coat.
      - Soft coat Low-E glass, involves the application of silver, zinc or tin to glass in a vacuum.
      - The glass enters a vacuum chamber filled with an inert gas which is electrically charged.
      - The electricity combined with the vacuum allows molecules of metal to sputter onto the glass. The coating is fairly delicate or "soft."
      - Furthermore, if silver is used (and it often is) this coating can oxidize if exposed to normal air. For this reason, soft coat Low-E glass must be used in an insulated glass assembly.

- Sealing the soft coating in between two pieces of glass protects the soft coating from outside air and sources of abrasion.
- The space between the two pieces of glass is often filled with argon gas. The argon gas inhibits oxidation of the metallic coating. It also acts as an additional insulator.
- The soft coat process has the ability to reflect more heat back to the source.
- Higher R value, which means it is a better insulator.

GLASS R VALUES (Cardinal Corp. values)

Type of Glass	R Value
Single Pane regular glass	0.85
Clear Insulated Glass 7/8 inch overall thickness	2.08
Hard Coat Low-E insulated glass	2.45
Hard Coat Low-E insulated glass with argon	2.75
Soft Coat Low-E insulated Glass	3.50
Soft Coat Low-E insulated glass with argon	4.35

- **Soft coat performs better than hard coat low-E's but cost more.**
- **Low-E glass of any variety is worth the extra cost.**
- **In the case of budget limitations low-E glass should be used on at least the southern and western exposures of buildings.**

- **Low-E Glass performance is measured by the following factors:**
  - **Visible Light Transmittance –** The amount of light coming through the window or door.
  - **UV –** The amount of Ultra Violet rays coming through the window or door.
  - **Solar Heat Gain Coefficient (SHGC) –** The amount of solar radiation that enters a building as heat. The lower the number, the better the glazing is at preventing solar gain.
  - **Fading Transmission –** The portion of energy transmitted in a spectral region from 300 to 700 nanometers. This region includes all of the ultraviolet energy and most of the visible spectrum, and will give the best representation of relative fading rates. The lower the number, the better the glass is for reducing fading potential of carpets and interior furnishings.
  - **U-Factor –** This represents the heat flow rate through a window expressed in BTU/hr/ft2/ºF, using winter weather conditions of 0ºF outside and 70ºF inside. The smaller the number, the better the window system is at reducing heat loss.
  - **R-Value -** Measure of resistance to heat loss. The higher the R-value of a material, the better its insulating qualities.

- **Example Chart from Cardinal Glass Corporation, one of the numerous manufacturers of Low-E glass.**

GLASS PERFORMANCE
** All information from www.cardinalcorp.com

PRODUCT	VISIBLE LIGHT TRANSMITTANCE %	SOLAR HEAT GAIN COEFFICIENT (SHGC)	WINTER U-FACTOR (AIR/ARGON)	UV	FADING TRASMISSION
Single-Pane, Clear	90%	.86	1.04/---	.71	.84
Double-Pane, Clear	81%	.76	.48/---	.56	.74
Ordinary Low-E	75%	.72	.35/.31	.44	.63
LoE-366	66%	.27	.29/.24	.05	.43
Single-pane, Tinted	68%	.73	1.04/---	.38	.58
Double-pane, Tinted	61%	.63	.48/--	.32	.52
Double-pane, Tint & Low-E	57%	.57	.35/.31	.21	.45
LoE-240	40%	.25	.30/.26	.16	.35

VII. SIZING AND FRAME OPTIONS

- **The size and frames of windows also affect the energy efficiency.**
- **Oversized windows with thicker frames will allow a lot more energy transfer than smaller windows and doors.**

VIII. CONCLUSION

- **Energy efficient windows are truly a tenant and owner appreciated upgrade to any commercial or residential structure.**
- **They add value to the property and reduce energy operating costs for years to come.**
- **If selected and installed properly, "green" windows provide ongoing year round energy savings that offset the extra upfront costs.**

- **Energy efficient windows for new construction or replacement purposes make good environmental and economic sense.**
- **The Government is offering tax rebates for using energy star labeled windows for 2009 and 2010.**
  http://www.energystar.gov/index.cfm?c=products.pr_tax_credits

IX. HERITAGE ADVANTAGE

- **Energy Star product manufacturer partner**
- **Qualified Energy Star products**
- **Manufacturing Thermally Broken windows and doors since 2001.**
- **Use the Thermal Strut process for our thermally broken products**
- **Double Sealed Steel Spacers**
  - **Steel spacers offer a similar expansion coefficient as the glass.**
  - **Barrier between the glass and spacer so no conductivity.**
- **Cardinal Lo-E366 glass**
- **Automated window and door manufacturing process.**

X. SOURCES

- **www.doe.gov**
- **www.epa.gov**
- **www.energystar.gov**
- **www.usgbc.org**
- **www.cardinalcorp.com**
- **www.askthebuilder.com**