Objectives

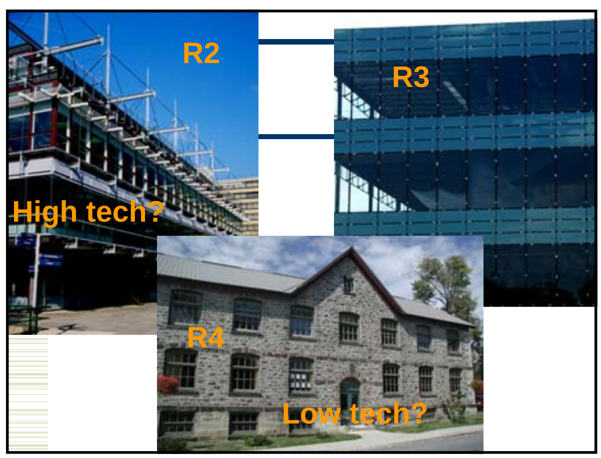
- This talk aims to
  - Develop awareness of curtainwall performance
  - appreciate impact of performance on bldg
  - differentiate between window features
  - understand variables in selection

Windows & Curtainwalls

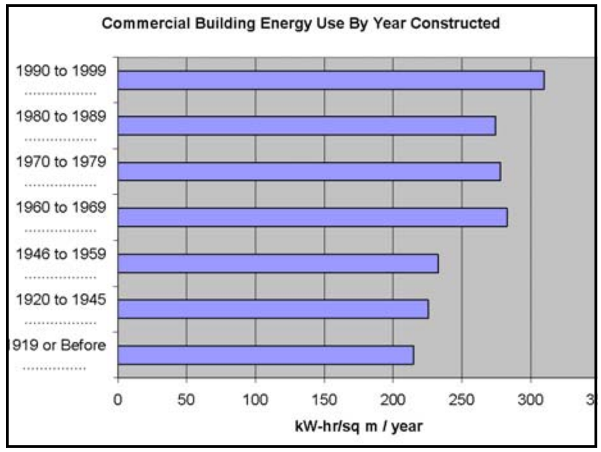
- A major element in modern architecture
- Must apply the usual building enclosure design principles
  - Support, Control, Finish, Distribute
- Must also consider
  - Control of solar radiation and light
  - Allowance for ventilation

Curtainwalls

- Functions: Same as wall – *plus* transparent and allow ventilation
  - not easy= hence expensive + compromise
- Structure - transfer loads
- Rain control
- Heat control
- Airflow control – tight / ventilation
- Solar control – gain / reject

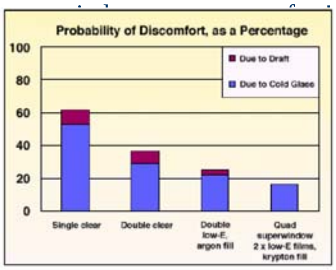


- Getting good



Comfort

- V



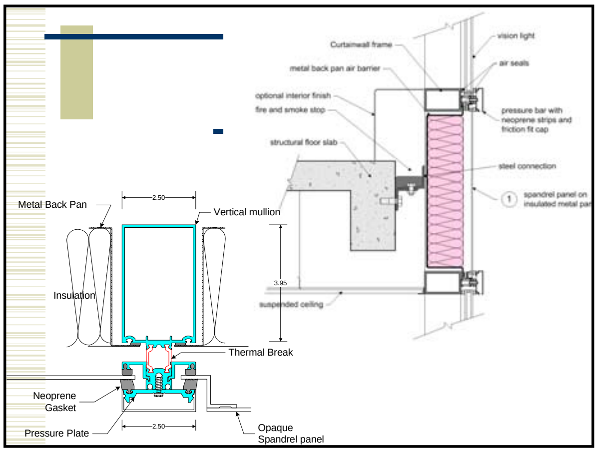
Source: Lawrence Berkeley National Laboratory (Lyons and Arasteh).

Why Good Curtainwalls?

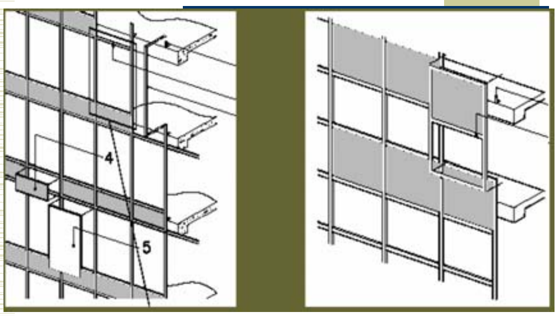
- Major impact on
  - energy performance, e.g. HVAC equip
  - condensation resistance
  - comfort (warm, no drafts
  - view and light
  - rain penetration resistance
  - sound control (air and mass)

Curtainwalls

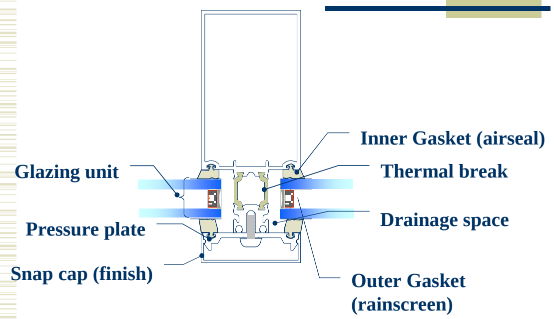
- Similar principles as windows
- Increased lateral structural loads
- Larger units means more movement
- Different joints



Types

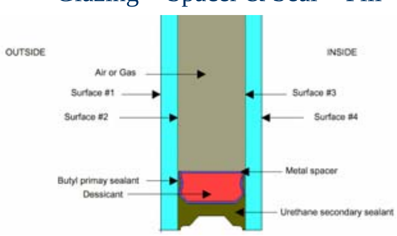


Anatomy of a Curtain Wall (Typical Mullion)



Anatomy of an IGU

- IGU = Insulated Glazing Unit
  = Glazing + Spacer & Seal + Fill



Functions

Performance Metrics

Performance Metrics

- Heat Flow (R,U)
- Condensation resistance (CRI)
- Solar Heat Gain Coefficient (SHGC)
- Visual Transmittance (VT)
- Air Leakage (AL)
- Water penetration

Controlling Heat

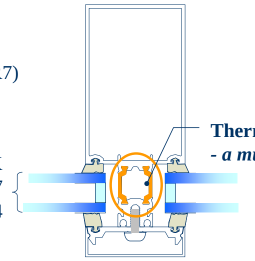
- Windows and curtainwalls usually have the lowest thermal performance of all parts of the enclosure
- Must control heat for
  - Comfort
  - Energy
  - Health
  - Durability

} ***Prevent Condensation*** (Health, Durability)

Controlling Heat

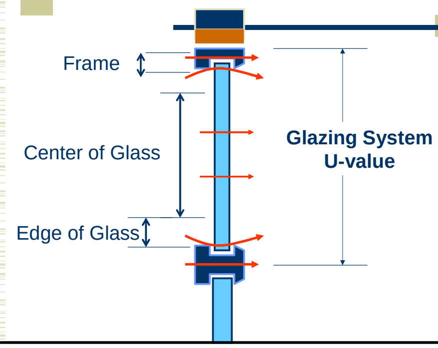
Available:
•krypton gas fill
•quad glazing (to R7)
• super spacers

U= 1.3 - 2.7 W/mK
RSI = 0.37 - 0.77
R=2.1 - 4.4



Thermal break *- a must*

Heat Flow



IGU

- Simple tabulated values
- Center of glass quoted
- Edges matter!

Low-e Coatings

- Low-e coatings reduce the amount of heat transferred by radiation

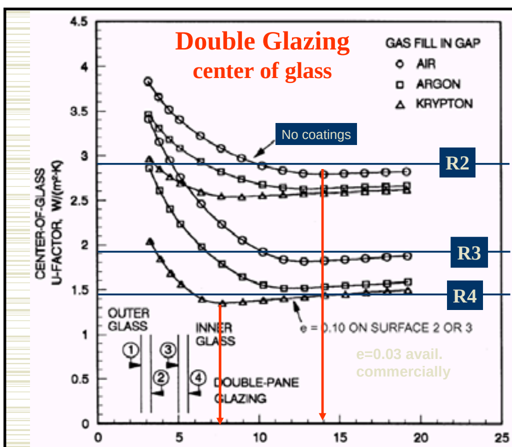
Coating	Emissivity	Radiation Reduction
Uncoated Glass	0.84	-
Low-e 0.2	0.20	75%
Low-e 0.1	0.10	90%
Low-e 0.04	0.04	95%

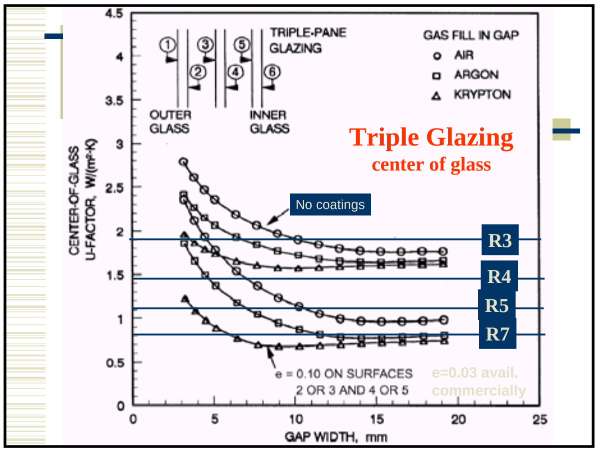
Common (Low-e 0.2, Low-e 0.1)

Gas Fills

- Gas fills reduce the amount of heat transferred by conduction and convection through the space in the glazing unit

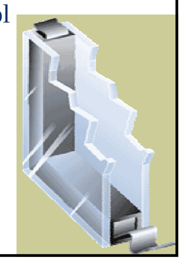
Fill	Conductivity (W/mK)	Reduction in Conductive Transfer
Air	0.0241	-
Argon	0.0162	33%
Krypton	0.0086	64%
Xenon	0.0051	79%

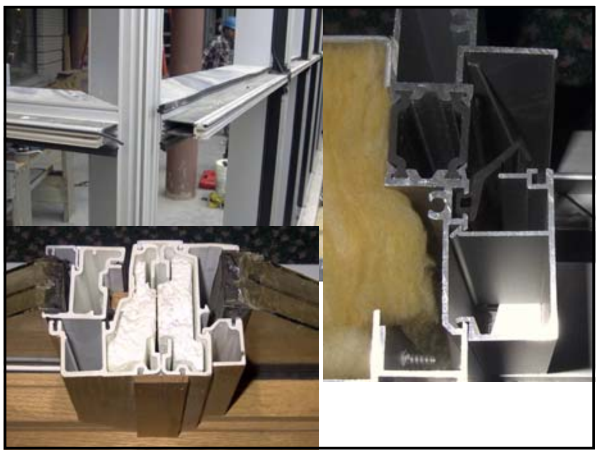


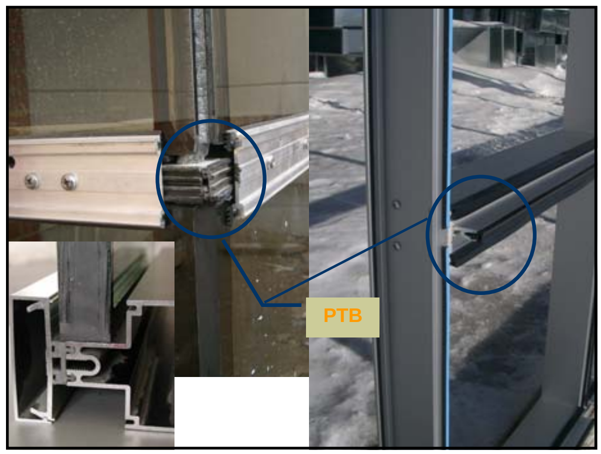


Warm-edge / super spacers

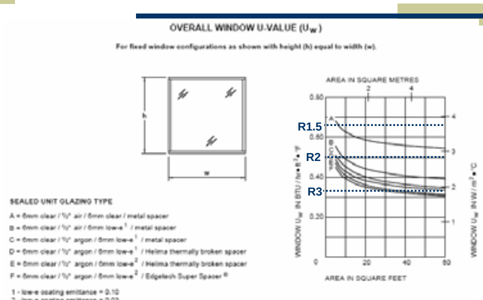
- Heat flow through spacers is important
- Critical for condensation control
- Super spaces
  - Plastic/foam edges seals
  - stainless steel, very thin
  - Dramatically reduce cool glazing edges





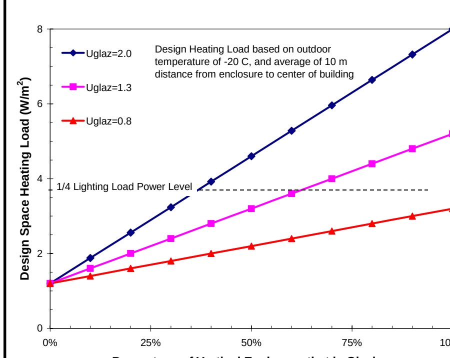


Mullions = heat loss



Kawneer isoport 518

Controlling Heat



Better enclosures allow one to avoid need for perimeter heating

Controlling Sun

- Balance between
  - Controlling solar heat gain (SHGC)
  - Controlling light transmission (VT)

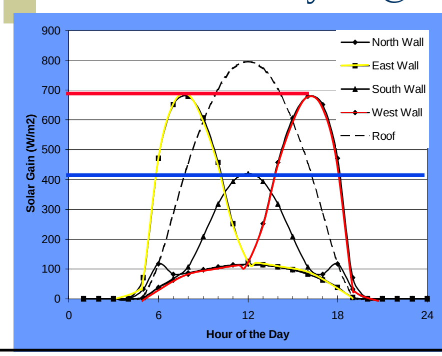
Solar Heat Gain Coefficient

- SHGC = Solar Heat Gain Coefficient
  = Fraction of solar radiation that passes
- Typical clear, dbl-glazed window SGHC = 0.72
- Higher SHGC?
  - Maybe small residential buildings in heating climate
- Low SHGC?
  - Commercial buildings
  - Buildings with large glazing ratios (large window/wall)
  - Buildings in cooling or mixed climate

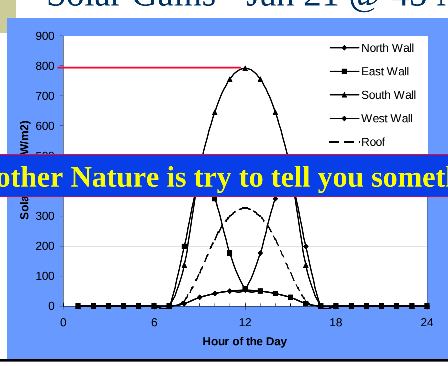
Visible Transmittance

- VT = Visible Transmittance
  = Fraction of visible light that passes
- Typical clear, dbl-glazed window VT = 0.75-0.80
- Windows with VT > 0.50+ are perceived to be clear
- Tinting changes the color of light that passes
- low-e coating does not change color
- Spectrally selective has lower SHGC with good VT

Solar Gains - July 21 @45 N



Solar Gains - Jan 21 @ 45 N

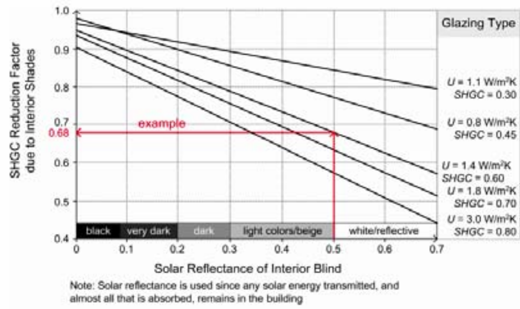


Mother Nature is try to tell you something

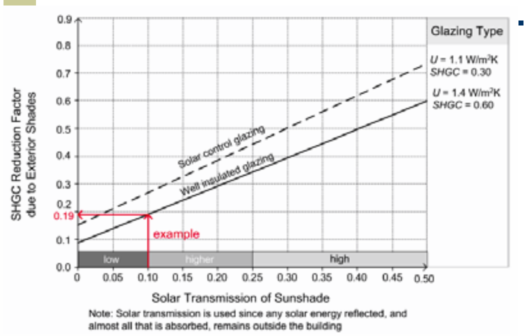
Shades & high performance

- High performance glazing reduces efficacy of interior shades
- Increases performance of exterior shading

Interior Shade

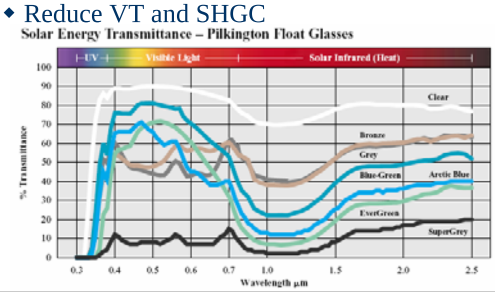


Exterior Shade



Body tints

- Reduce VT and SHGC



Spectrally Selective *Magic*

- Reduced SHGC with a high VT
- Allows daylighting and view with low solar heat gain
- Tend to have good U-values
- Great choice for west/east view windows
- All directions in large commercial buildings

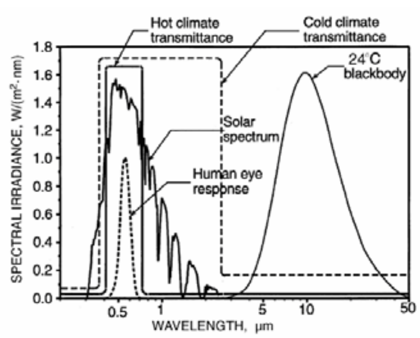
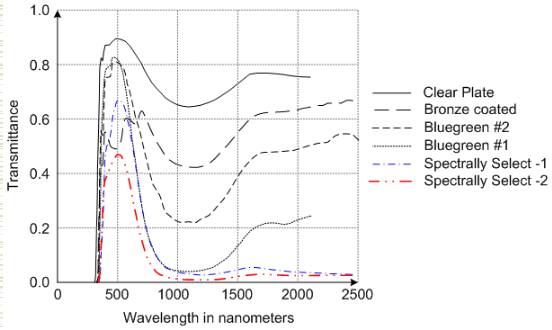


Fig. 24 Demonstration of Two Spectrally Selective Glazing Concepts, Showing Ideal Spectral Transmittances for Glazings Intended for Hot and Cold Climates



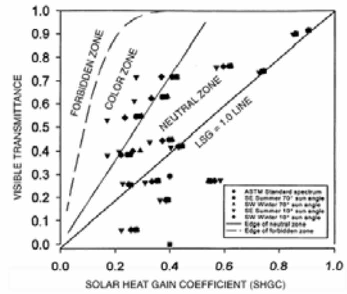


Fig. 35 Visible Transmittance Versus SHGC at Various Spectral Selectivities (McCluney 1996)

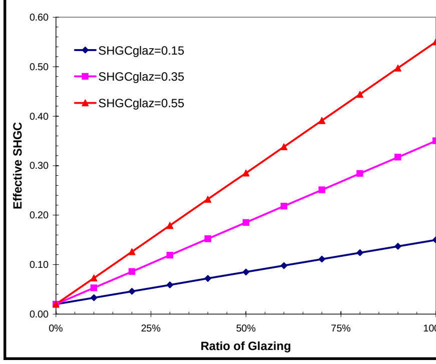
Balancing SHGC & VT

Glazing	VT	SHGC	LSG
Reflective blue-green	0.33	0.38	0.87
Film on clear glass	0.19	0.22	0.86
Green tinted, medium	0.75	0.69	1.09
Green low-e	0.71	0.49	1.45
Sun-control low-e + green	0.36	0.23	1.56
Super low-e + clear	0.71	0.40	1.77
Super low-e + green	0.60	0.30	2.00

Spectral Selectivity of Several Glazings

LSG = Light to Solar Gain ratio = Tv/SHGC

Controlling Solar Radiation



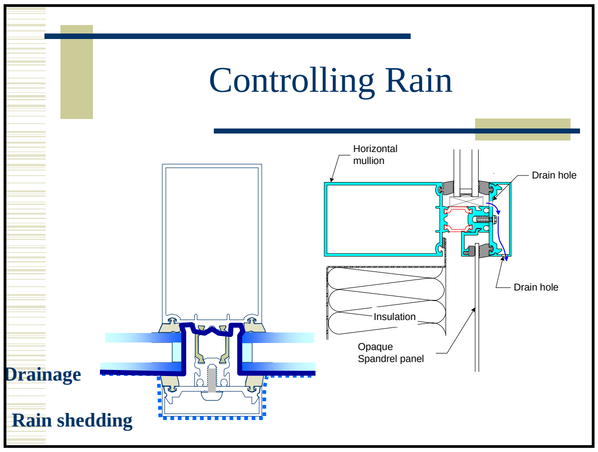
Low SHGC and Reduced Glazing Ratio to reduce cooling load

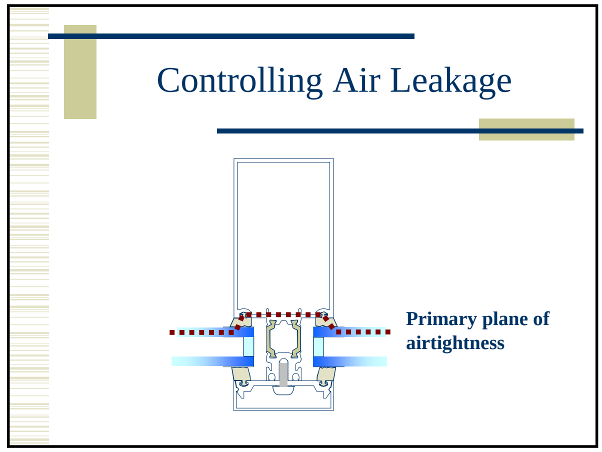
Controlling Rain Penetration

- IGU is a perfect barrier
  - Concentrates water
- What about the interfaces between
  - IGU & Frame
  - Frame and Other claddings
  - Curtainwall and parapets and grade

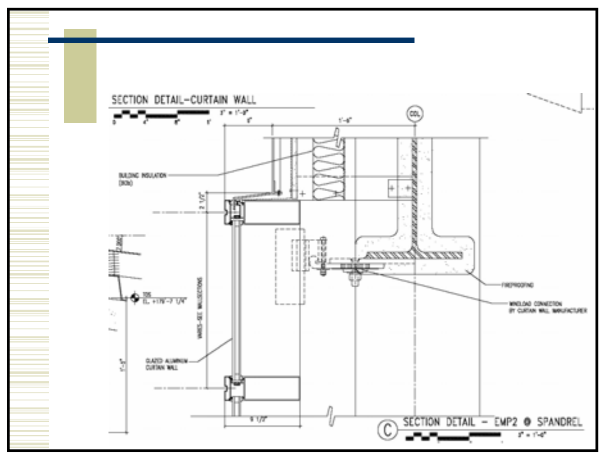
Controlling Rain Penetration

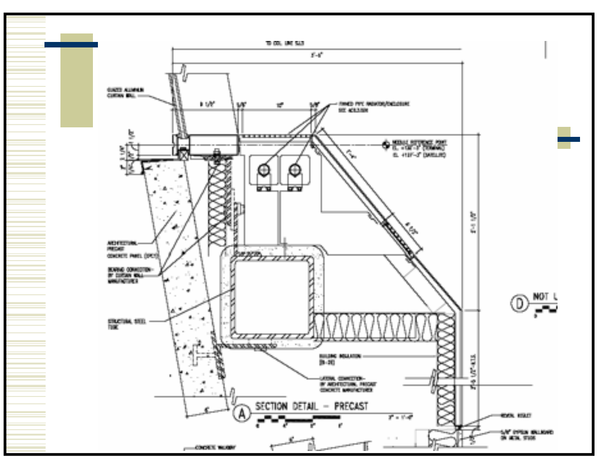
- Curtain leak internally (esp. at corners)
- they leak at the interface with the wall
- Therefore
  - Design and install using the ***drained approach***

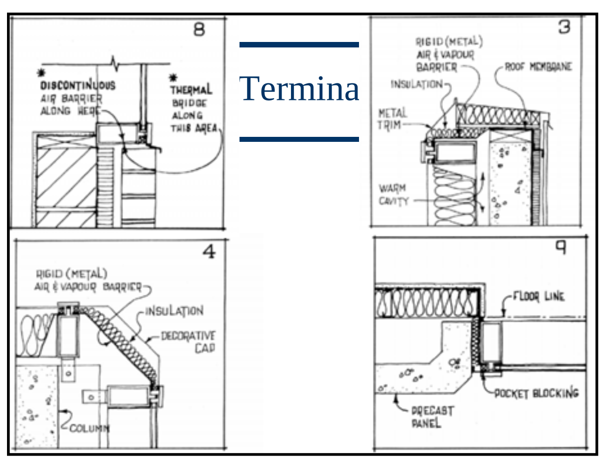

Controlling Rain
Horizontal mullion
Drain hole
Drain hole
Insulation
Opaque Spandrel panel
Drainage
Rain shedding


Controlling Air Leakage
Primary plane of airtightness

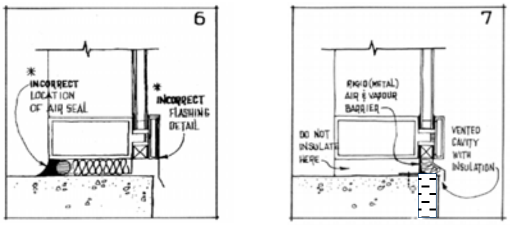

Air Flow Control


SECTION DETAIL–CURTAIN WALL
SECTION DETAIL – EMP2 @ SPANDREL


SECTION DETAIL – PRECAST


Termina
8
* DISCONTINUOUS AIR BARRIER ALONG HERE
* THERMAL BRIDGE ALONG THIS AREA
3
RIGID (METAL) AIR & VAPOUR BARRIER
ROOF MEMBRANE
INSULATION
METAL TRIM
WARM CAVITY
4
RIGID (METAL) AIR & VAPOUR BARRIER
INSULATION
DECORATIVE CAP
COLUMN
9
FLOOR LINE
POCKET BLOCKING
PRECAST PANEL

Grade termination



Movements

Performance Metrics

- Heat Flow (R,U)
- Condensation resistance (CRI)
- Solar Heat Gain Coefficient (SHGC)
- Visual Transmittance (VT)
- Air Leakage (AL)
- Water penetration

Conclusions

- Understand importance of windows to building performance
- Balance U, SHGC, and VT
- Design and build
  - draining frames, drained connections
  - air barrier continuity with walls
- Curtainwalls - use less glass of better quality

Websites

- University of Waterloo

  Building **E**ngineering **G**roup
  - www.civil.uwaterloo.ca/beg
- Balanced Solutions
  - www.balancedsolutions.com

University of Waterloo

Balanced Solutions