

CONSTRUCTION MANAGEMENT BREADTH

Florida codes for maximum U-values and Solar Heat Gain Characteristics of different types of glass are located in Table 13-601.1 of the Florida Building Code:

Table 13-601.1

Type	U-factor	SHGC
Single pane clear	1.3	0.75
single pane tint	1.3	0.64
double pane clear	0.87	0.66
double pane tint	0.87	0.55

Architects specific data on window selection for The Waverly was unavailable. Florida code data was used as an assumed base case condition. Double pane glass was assumed used as a typical building standard. From a responsible engineering perspective double pane glass for this application is mandatory. However, glass that exceeds Florida Building Code may substantially reduce the annual mechanical system costs. Many aspects of window technology can be analyzed:

Tinted glass has the potential to absorb a substantial amount of the sun's energy in comparison to clear. A colorant is added to the glass during the production run. This keeps much of the light from entering the zone. These windows reduce solar heat gain and should reduce the loads on the HVAC system.

Reflective glass absorbs and reflects more light than tinted glass. A metallic coating is added to the outside of the glass at the last stages of production. Reflective glass is preferred in situations where a solar heat gain reduction is needed. The outer coating also creates an interesting addition to the architecture of the building. This system should reduce annual costs to the HVAC system.

Low-e glass is coated with a thin, transparent layer of silver or tin oxide. This allows visible light to pass through, but reflects infrared heat radiation back into the room creating an effect similar to the "greenhouse effect" typically associated with global warming. This reduces the heat loss through the windows in the winter. Low-e glass has a tendency to create a greater cooling load during summer conditions on account of the infrared radiation that reflects back into the room. While this is an amazing energy saving technology, low-e glass would not be useful in Orlando's hot and humid climate.

Triple glazing is a technique of adding yet another layer of glass to the double glazing scheme. This creates a scenario involving two air spaces to be filled with either air or low conductivity gas. This layer of protection decreases the U-value of the glass allowing less heat transfer.

The most common considerations in specifying glass are the U-value and the Solar Heat Gain Coefficient (SHGC). U-value determines the heat loss or heat gain due to temperature differences on either side of the window. The SHGC is a measurement determining the amount of heat transferred through direct, reflected, and diffused radiation. The following table indicates typical design and specifications for window systems based on HAP inputs.

	Outer Glazing	Glazing #2	Glazing #3	U-value	SHGC
Base Case	1/8" clear	1/8" clear	not used	0.87	0.811
Blu-Grn tint	1/4" B/G tint	1/8" clear	not used	0.565	0.6
Reflective	1/4" B/G reflective	1/8" clear	not used	0.565	0.401
Triple Pane	1/4" B/G reflective	1/8" clear	1/8" clear	0.381	0.39

ADVANTAGES AND DISADVANTAGES

Base Case Window system:

Advantages:

- Lowest price available satisfying Florida Building code
- All visible light enters room, for maximum daylight penetration

Disadvantages:

- High interior heat gain during cooling season
- High interior heat loss during heating season
- High radiation heat gain during cooling season

Tinted Glass:

Advantages:

- Lower price than reflective and triple pane glass
- absorbs many wavelengths of sunlight creating lower radiation heat gains
- Provides privacy to residents
- Decreases harsh interior lighting during peak sunlight hours

Disadvantages:

- Higher cost than traditional glass systems
- Lower radiation heat gain during heating seasons
- Less daylight penetration for residents

Reflective Glass:

Advantages:

- Lower price than triple pane glass

- Reflects and absorbs many wavelengths of sunlight creating lower radiation heat gains
- Provides privacy to residents
- Decreases harsh interior lighting during peak sunlight hours
- Adds to Architectural Appeal

Disadvantages:

- Higher cost than traditional glass systems and tinted glass
- Lower radiation heat gain during heating seasons
- Less daylight penetration for residents

Triple Pane Reflective Glass:

Advantages:

- Creates low heat loss/gain per square foot with low U-value
- Reflects many wavelengths of sunlight creating lower radiation heat gains
- Provides privacy to residents
- Decreases harsh interior lighting during peak sunlight hours
- Adds to Architectural Appeal

Disadvantages:

- Higher cost than double pane glass systems
- Heavier weight than double pane glass

Carrier's Hourly Analysis Program was used to study the potential energy savings associated with these different glazing technologies. The base case was first studied with Florida's code values for double glazing entered for all window data in The Waverly. This model was then simulated to find annual costs.

Next, the same building set-up was modified so that the exterior glazings were tinted with a Blue-Green Reflective film. This decreased the U-value of the window, and decreased the SHGC substantially.

Finally, triple pane glass was considered for the building. Although triple pane glass is rarely used due to cost, the benefits can sometimes be worthwhile. Again, the U-value and SHGC were decreased during this simulation.

Results of these analyses are summarized in the following table:

	Cooling Load (MBTU)	Heating Load	Total Load	Annual Cost(\$)
Base Case	24,490.00	1,288	25,778.00	57,363
Blu-Grn tint	21,654	1,257	22,911.00	51,554
Blu-Grn Reflective	17,864	1,262	19,126.00	47,261
Triple Pane	18,561.00	1,257	19,818.00	46,645

First Cost Analysis:

First cost must go into account when selecting which glass system is most applicable for The Waverly on Lake Eola. While it would be nice to always use the most efficient glass available, budget is a crucial element to the construction process. The Waverly utilizes an aluminum floor to ceiling storefront curtain wall system for most of the exterior walls. RSMMeans provides annual national and state averages for costs of different building components. The curtain wall section provides costs per square foot including aluminum framing components. Labor costs per square foot are also available.

In Technical Assignment 2, I calculated the total glazing area of The Waverly. I found that the building had 75,648 square feet of window area. This was used for the following cost analysis. The cost works program by RSMMeans was used to attain the following cost data for each window system:

	Per S.F.			Total Cost		
	Materials	Installation	Total	Mat.	Inst.	Total
Base Case	12.2	7.05	19.25	922906	533318	1456224
Blu-Grn tint	15	7.05	22.05	1134720	533318	1668038
Blu-Grn Reflective	17.45	6.2	23.65	1320058	469018	1789075
Triple Pane						2184336

Prices for triple pane windows were not available, however, a multiplication factor of 1.5 times the base case would be safe. This estimate is based on the added costs associated with the extra pane of glass, extra framing needed, and excess weight problems associated with installation. This factor is most likely low, however, it will be used to provide theoretical proof that the triple pane glass is not worthwhile.

A simple payback method was used to analyze the cost effectiveness of more efficient window technologies on The Waverly on Lake Eola. The calculations for this payback analysis are summarized in the following spreadsheet.

	HVAC Annual Coast	First Cost	Savings	First Cost	Payback
Base Case	57,363	1,456,224	0	0	0
Blu-Grn tint	51,554	1,668,038	5,809	211,814	36.46314
Blu-Grn Reflective	47,261	1,789,075	10,102	332,851	32.94904
Triple Pane	46,645	2184336	10,718	728,112	67.93357

This analysis first shows that the triple pane glass would not be worthwhile for The Waverly. Buildings are not built with a 67 year payback in mind, and this is not worthwhile considering the annual savings are not substantial when compared with the savings experienced with 2 pane blue-green reflective glazing.

Although the reflective window system has a higher first cost than the tinted window system, it is apparent that the added savings realized by the decrease in HVAC load are substantial enough to make the reflective tint a better investment. The tinted windows have a payback period greater than 36 years, as opposed to the 33 year payback of the reflective window system.

With a 33 year payback period it is hard to suggest a reflective system over the windows recommended in the Florida Building Code. Typically a payback period of more than 20 years is not recommended in the building industry. However, as energy prices continue to realize, as many experts assume they will, this payback period will see a decrease. The architectural benefits of the reflective windows, along with the increased privacy the tenants of The Waverly will see, display why the Owner chose to put up the extra investment in the reflective window system.