## Analysis IV – Heat Transmission Study of the Curtainwall

***Executive Summary***

Trivial issues, such as curtainwall composition, can have an enormous impact on energy costs for a building. Since the majority of the building is enclosed by the curtainwall, its glazing unit's insulating properties are an extremely important tool in preventing energy loss.

With this in mind, this analysis will be composed of two main studies: a *HAP* analysis to study the effects of the curtainwall glazing on mechanical loads and a thermal gradient to study the heat transmission properties of the curtainwall. In the end, a mechanical energy cost impact will be constructed for the separate systems. Changes to parts of the system will be made based on cost and performance of glass types.

The goal of this research is:

- ✓ To perform a thermal gradient and HAP analysis in the comparison the original glazing in the teak and mahogany curtainwall to a Viracon Low-E alternate glazing.
  - o Make recommendations on which glazing is appropriate to the owner based on cost and heat transfer performance, along with an energy analysis.

Mercersburg Academy will have to consider both the initial costs along with the energy impacts when deciding whether or not to switch systems.

***Overview***

With 91% of the 16,864 square feet of curtainwall on the Center for the Arts composed of glazing units, the potential for heat loss is quite significant. Having the best performing glass insulation-wise is of utmost importance. Below is a figure explaining the three most vital energy properties of glazing units:

**Low-E Performance Properties**
* Taken from PPG Website

| | | |
|---|---|---|
| Keeps you warmer in the winter | U-Value |  |
| Keeps you cooler in the summer | Solar Heat Gain Coefficient |  |
| Reduces UV energy and allows visible light | Transmittance |  |

The current curtainwall arrangements glazing units have the following insulation values:

**Default Glazing Properties**

| Glass Type | % of Typical CW | Visible Transmittance | Solar Transmittance | Winter U-Value | Shading Coefficient |
|---|---|---|---|---|---|
| Annealed | 5% | 0.73 | 0.37 | 0.299 | 0.45 |
| Tempered | 28% | 0.73 | 0.37 | 0.299 | 0.45 |
| Fritted | 58% | 0.46 | 0.23 | 0.29 | 0.31 |

This analysis will evaluate the insulation properties, listed above, of the curtainwall system arrangements using the following criteria: HAP analysis, thermal gradient, and energy impact. Since the annealed and tempered units are negligible and serve an architectural purpose, only the fritted units will be changed. The end product will consist of a comparison between the current system and the new Viracon system.

***Viracon Low-E Glazing***

This mechanical analysis will only analyze one separate alternative fritted glazing unit. Upon researching the current curtainwall glass in the Center for the Arts, it was discovered that the insulation properties of the glazing units were already very good (U-Value = 0.29). It was difficult to find glazing units with a lower U-Value than 0.29. The best possible unit found was the following Low-E Viracon glass:

| Product | Transmittance | | | Reflectance | | | U-Value | | Shading Coefficient | Relative Heat Gain | SHGC | LSG | European U-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Visible | Solar | U-V | Vis-Out | Vis-In | Solar | Winter | Summer | | | | | |
| Solarscreen Low-E (VE) Insulating Glass With Argon Gas | | | | | | | | | | | | | |
| VE 1-2M | 70% | 33% | 10% | 11% | 12% | 31% | 0.25 | 0.21 | 0.43 | 89 | 0.37 | 1.9 | 1.2 |

***Thermal Gradient***

Thermal gradients focus solely on the insulation properties of the wall section being analyzed. They show what rate the temperature increases going from the outside to inside of the wall section. In this study, the current glazing units in the teak and mahogany curtainwall will be compared to the Viracon Low-E glass units. The wooden curtainwall frames will stay unchanged in the study. The following table summarizes the heat transmission performances of the two glazing units:

**Temperature Increase Through Glazing**

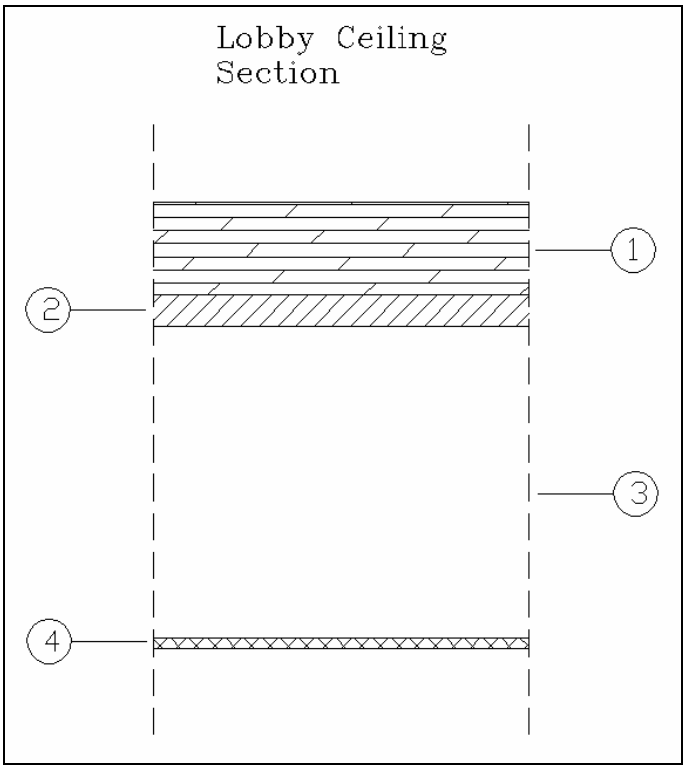
| Surface | Current T&M Glazing | Viracon Low-E Glazing |
|---|---|---|
| Outside | 10 | 10 |
| Outer Film | 18.8 | 19.0 |
| Glazing | 34.8 | 34.2 |
| Inside | 70.0 | 70.0 |
| | | |
| Increase in Temperature Across Glazing | 16.0 | 15.2 |

Since the thermal gradient analysis is primarily focusing on the properties of the glazing units, the most important increase in temperature, across the glazing unit, is listed in the table above. Both glass units have a similar increase in temperature, approximately 16°F, across their respective glazing.

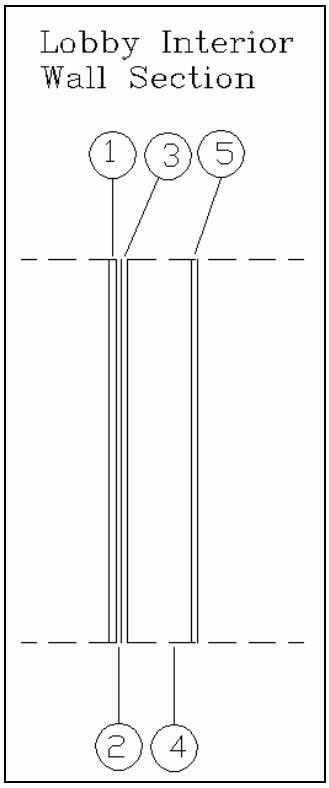
***HAP Mechanical Load Simulation***

This analysis focuses in on cutting energy costs by attaining the top performing system. It continues with the *HAP* (Hourly Analysis Program) analysis to study the effects of the curtainwall glazing on the mechanical loads. This computer program easily allows separate studies to be run based on changes to the curtainwall glazing units.

Below are the two sections of the lobby shell that will remain constant across the studies:

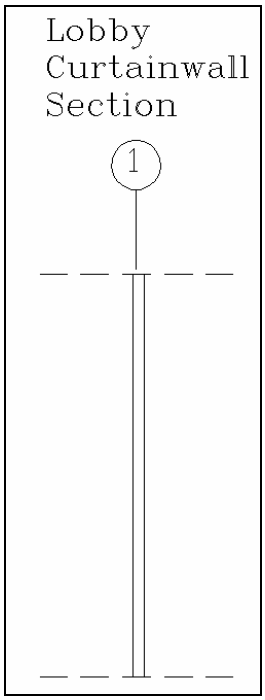



1. 9” built-up roofing
2. 3” metal decking
3. 2.5’ air space
4. 1” ceiling panels




1. 5/8 “ gypsum wall board
2. vapor barrier
3. 5/8 “ gypsum wall board
4. 6” rigid insulation
5. 1/2 “ gypsum sheathing (metal studs)

While the interior wall and roof sections remain constant over the studies, the curtainwall composition will change from the default glazing to the Viracon Low-E glazing units for comparison between the systems. Below are the sections of both curtainwall arrangements:




1. CW glass unit
    a. Default MACA glazing
    b. New Viracon Low-E glazing

The following table summarizes the results of the two analyses, showing the effects of the glazing type on the lobby's required mechanical load and the cost of the entire curtainwall:

**Summary of HAP Analyses**

| Glazing Unit | Cost of Curtainwall | Sum of Peak CFM | Total Coil Load |
|---|---|---|---|
| Default | $ 1,294,563 | 515 | 10.9 MBH |
| Viracon Low-E | $ 1,359,291 | 485 | 10.3 MBH |

It can be seen that switching to the Viracon Low-E glazing units results in a 6 % savings in required mechanical load on the lobby area. On the other hand, this also corresponds to a cost increase of approximately $65,000.

***Energy Analysis***

While the HAP analysis provided some insightful feedback on the effects of different curtainwall glazing on the required mechanical loads in the lobby, it is important to take the research a step farther by looking into the energy impacts. To put the two studies in a context most understandable to owners, an energy cost impact will be compiled. This estimate is based on the energy consumed by the supply and return fans at MACA. It shows the amount of money saved or lost annually, on mechanical energy costs, when switching systems. Complete energy calculations can be found in Appendix E. Below is a summary table of the energy findings:

**Comparison of T&M CW Glass Units**

| System | KWh | Annual Energy Cost |
|---|---|---|
| Default Glazing | 2637180 | $ 131,859 |
| Viracon Low-E Glazing | 2478949 | $ 123,947 |
| | | |
| **Viracon SAVINGS** | | $ 7,912 |

Solely considering the energy impacts, switching to the Viracon Low-E glazing units would save 6 %, almost $8,000, in annual electrical costs when compared to the original glazing units.

***Conclusion***

Through the thermal gradient, HAP analysis and energy study, the performance characteristics of the default and Viracon Low-E glazing units can be compared. While the thermal gradient did not produce any breakthroughs, the HAP and energy analyses provided significant feedback. Below is a comparison table for the two glazing units:

**Comparison of Glazing Units**

| Glazing Unit | Cost of Curtainwall | Annual Energy Costs |
|---|---|---|
| Default | $ 1,294,563 | $ 131,859 |
| Viracon Low-E | $ 1,359,291 | $ 123,947 |
| | | |
| Switch to Viracon Difference | $64,728 | $7,912 |
| | | |
| Payback | | 8.2 Years |

The table above shows the impacts of switching to the Low-E Viracon glazing units. Although the initial costs of switching the glazing units is nearly $65,000, the annual mechanical energy savings allows for a payback period of just over 8 years. When dealing with glazing units, anytime that there can be a substantial savings on the energy side, coupled with a payback of less than 10 years, the switch should be made. It is recommended that the original glass units in the teak and mahogany design be substituted with the Viracon Low-E glass units.

The owner, Mercersburg Academy, can review the comparison chart above to decide if switching glazing units meets their overall campus vision.

Project-wide effects of switching the glazing units:

- ✓ The original glazing units were a Viracon brand, so the switch to the Viracon Low-E glazing units will have no effect on the installation times and overall schedule.
- ✓ On the same lines as above, the new Viracon Low-E glazing units can be installed by the same subcontractors as the default glazing units.