

Outline


- Introduction
 - Presentation Overview
 - Project Overview
 - Theme
 - Goals
- Building envelope analysis
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 - Analysis
 - Curtain Wall Prefabrication
 - Recommendations / Conclusions
- Infection control analysis
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 - Site Overview
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 - Acknowledgments / Questions

The Wilmer Eye Institute

Outpatient Surgery and Lab Building

An entity of: Johns Hopkins Hospital

Maintaining a Safe and Functional Building Environment





Tyler M. Smith
Construction Management
Thesis Advisor: Dr. John Messner

Baltimore, Maryland

Quick Building Stats

- The Wilmer Eye Institute Outpatient Surgery and Laboratory Building
- Baltimore, MD
- \$65M Construction, \$92M Total Project Cost
- Design-Bid-Build with GMP Contract
- 202,000 SF
- 7 storeys including basement
 - Outpatient Surgical Center (first floor)
 - Offices and Lobby (second floor)
 - Open Research Laboratories (third thru sixth floor)

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Tyler M. Smith

5th Year Architectural Engineer

Construction Management Option


Starting career with RDH Building Sciences, Inc. in Portland, Oregon



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Presentation Overview

- Project Overview
- Building Envelope Investigation
- Infection Control Analysis
- Ultraviolet Germicidal Irradiation (UVGI)
 - Mechanical and Electrical Breadth Studies
- Conclusions
- Q & A

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Project Overview

- General Building Statistics →
- Key Players
 - Owner:
 - Johns Hopkins Hospital
 - Primary architect:
 - Wilmot Sanz
 - General Contractor:
 - The Whiting-Turner Contracting Company

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Project Overview

- Duration
 - Groundbreaking – April, 30, 2007
 - Planned completion Summer '09
 - ~30 month duration
- Structure
 - Cast-in-place concrete
 - Mildly reinforced two-way plates

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Theme

- Maintaining a safe and functional building environment
 - Building Envelope
 - Crucial to indoor environment integrity
 - Infection control
 - Extremely important in medical construction
 - Patient health and sensitive laboratory experiments
 - UVGI System
 - Improves indoor air quality

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Goals

- Learn!
 - Prepare for career

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Building Envelope Analysis

- Introduction
 - Exterior enclosures
 - Critical role in regulating the indoor environment
 - Failures can be detrimental and costly
- Technical goals
 - Thermal bridging
 - Issues and prevention
 - Curtain-wall prefabrication
 - Feasibility and practicality

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Building Envelope Analysis

- Primary exterior wall systems
 - Cavity Wall
 - standard 4" brick facade
 - 2" air space
 - 2" polystyrene insulation
 - Air and vapor barrier
 - 8" CMU back up
 - Curtain Wall
 - Double pane 1/2" glazing
 - Tubular aluminum framing

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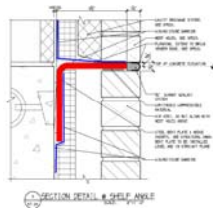
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Building Envelope Analysis

- Thermal bridging
 - Heat is lost through wall elements of high heat flow conductance
 - Steel brick shelves transfer heat from floor slab outdoors
 - Issues
 - "Cold-spots"
 - Condensation

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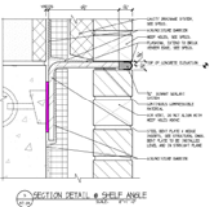
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Building Envelope Analysis


- Prevention
 - Insert thermal "break"
 - Utilize thermally insulating material in connection

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SECTION DETAIL - SELF ANGLE



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Building Envelope Analysis

- Curtain Wall Prefabrication
 - Large curtain walls in NE corner of building
 - Full height of building
 - > 3000 SF
 - 5'-6" units assembled offsite, delivered, and lifted into place by crane
 - Contacted Service Glass (CW Installers)
 - Have resources, but...

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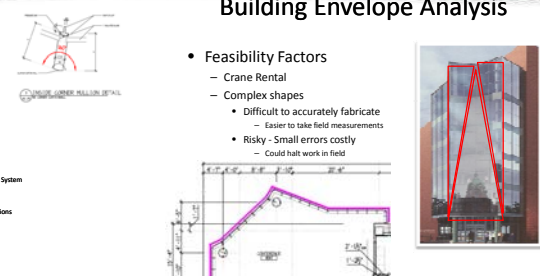

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Building Envelope Analysis

- Feasibility Factors
 - Crane Rental
 - Complex shapes
 - Difficult to accurately fabricate
 - Easier to take field measurements
 - Risky - Small errors costly
 - Could halt work in field

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Building Envelope Analysis

- Recommended Actions
 - Thermal Bridging
 - Insertion of plastic medium in brick shelf connection
 - Curtain Wall
 - Stick build as planned
- Conclusions
 - Envelope design & construction critical to indoor environment
 - Monitor process thru entire project
 - Unitization of CW not ideal in this case

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Infection Control Analysis

- Introduction
 - Hospital construction projects affect the safety of many people
 - Important to minimize impact negative impacts of construction on existing facilities

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Infection Control Analysis

- Building Site Overview
 - Adjacent facilities
 - Cancer Research Building I
 - General Outpatient Center
 - Weinberg Building
 - Sidney Kimmel Comprehensive Cancer Center
 - Many occupants
 - Mostly 24 hour operation


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Infection Control Analysis




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- **ICRA Guidelines**
 - Precautions to be taken based on project criteria
 - AIA Program intended to reduce risks of medical construction projects
 - Copy of guidelines in appendix of report
- **Wilmer Building**
 - New major construction project
 - Classified as "Type D" project
 - Proximity to sensitive facilities
 - Classified as highest patient risk group

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- **Wilmer Building**
 - Precautions outlined in Division 1 of Specifications
 - Contractors must adhere
 - Primary precautions:
 - Dust and debris control
 - Daily site cleaning
 - HEPA filter vacuums
 - Construction vestibule/anteroom


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Infection Control Analysis

- **Conclusions**
 - Project poses a significant risk to adjacent sensitive medical facilities
 - ICRA guidelines must be closely followed

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Ultraviolet Germicidal Irradiation (UVGI)

- **Introduction**
 - Micro-organisms can grow anywhere air comes into contact with moisture
 - Water constantly condensing on cooling coils
 - Good medium for growth of microbial spores that can cause respiratory infections
 - Coils can be treated with UV light

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Ultraviolet Germicidal Irradiation (UVGI)





- **Benefits of UV in air-handling units**
 - Helps minimize infectious agents in airstream
 - Prevents coil fouling—saves energy
 - Fouled coils decrease coil heat transfer rate and air constriction increases pressure on fans
 - System stays clean
 - No need for maintenance (cleaning)
 - Operates at design conditions for life of equipment
 - Likely extends operational life of equipment



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Ultraviolet Germicidal Irradiation (UVGI)

- **Cost-Benefit Analysis**
 - Costs
 - First cost of installation
 - Operating cost of UV lamps
 - Annual replacement of lamps
 - Savings
 - Fan energy savings
 - Cooling energy savings
 - Maintenance savings

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Ultraviolet Germicidal Irradiation (UVGI)

- Cost-Benefit Analysis
 - Followed method outlined by Dr. Kowalski, P.E.
 - 2006 report demonstrates cost justification of UV
 - Assumed coils become fouled
 - Calculate costs of additional energy required
 - Compare annual savings to initial cost for payback period
 - Started by assuming a 20% operational deficiency per example

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Ultraviolet Germicidal Irradiation (UVGI)


Mechanical and Electrical Breadth Calculations

- Cooling energy savings
 - 20% Fouling

Desig.	Space	Airflow (cfm)	Cooling Load, clean (Btu/h)	Capacity loss due to fouling (btu/h)	Cooling Savings (kW)	Cooling Energy Savings (\$)
AHU-1	Laboratory	44,000	2,600,000	520,000	37.17	\$37,088
AHU-2	Laboratory	44,000	2,600,000	520,000	37.17	\$37,088
AHU-3	Laboratory	44,000	2,600,000	520,000	37.17	\$37,088
AHU-4	Laboratory	44,000	2,600,000	520,000	37.17	\$37,088
AHU-5	Clinical	44,000	3,027,000	605,400	43.28	\$43,179
AHU-6	Redundant	44,000	3,027,000	605,400	43.28	\$43,179
AHU-7	Office	50,000	3,526,000	705,200	50.41	\$50,298
			19,980,000	3,996,000	286	\$285,010

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Ultraviolet Germicidal Irradiation (UVGI)

Mechanical and Electrical Breadth Calculations

- Fan energy savings
 - 20% Fouling

Desig.	Space	Airflow (cfm)	Coiling Coil Pressure Drop, clean (in.w.g.)	Pressure increase due to fouling (in.w.g.)	Fan Energy Savings (kW)	Fan Energy Savings (\$)
AHU-1	Laboratory	44,000	0.82	0.164	1.49	\$1,483
AHU-2	Laboratory	44,000	0.82	0.164	1.49	\$1,483
AHU-3	Laboratory	44,000	0.82	0.164	1.49	\$1,483
AHU-4	Laboratory	44,000	0.82	0.164	1.49	\$1,483
AHU-5	Clinical	44,000	0.97	0.194	1.76	\$1,754
AHU-6	Redundant	44,000	0.97	0.194	1.76	\$1,754
AHU-7	Office	50,000	1.53	0.306	3.15	\$3,143
					13	\$12,581

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Ultraviolet Germicidal Irradiation (UVGI)

Mechanical and Electrical Breadth Calculations

- UV Costs
 - Contacted an undisclosed manufacturer for costs
 - Each AHU requires 18 Philips PL-L60WTUV lamps
 - 60 nominal watts, 18 UV Watts, high output and wind chill corrected for this application
 - End-user list price of \$8250 per unit
 - 64 man-hour installation
 - Project requires 156 Lamps; replacement cost is \$30 per lamp
 - Assumptions
 - Maintenance (cleaning) cost of \$1000/year before UV (per Kowalski example)
 - \$0.1139 average retail electricity cost in MD at end of 2007 (per U.S. DOE statistics)
 - Assumed a rate of \$35/hr for installation workers
- Ran through with these numbers...

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Ultraviolet Germicidal Irradiation (UVGI)

Mechanical and Electrical Breadth Calculations

- Cost-Benefit Analysis
 - Payback Periods

% Fouling	Initial Cost	Annual Savings	Payback Period (years)
20%	\$63,770	\$293,268	0.22
10%	\$63,770	\$144,473	0.44
5%	\$63,770	\$70,075	0.91
2%	\$63,770	\$25,436	2.51

- Payback periods seem short
- Kowalski example paid off in just a few years

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Ultraviolet Germicidal Irradiation (UVGI)

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Ultraviolet Germicidal Irradiation (UVGI)

CLINICAL AIR HANDLING UNIT PLAN

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Ultraviolet Germicidal Irradiation (UVGI)

- Recommendations
 - Implement UVGI system in all AHU's
- Conclusions
 - UVGI is a good tool in protecting IAQ
 - Systems tend to pay off in energy savings relatively quickly


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Conclusion

- Capstone Project Summary
 - Building envelope critical to maintaining indoor environment
 - Must be acknowledged throughout the entire project
 - Prefabrication of the curtain wall unfeasible
 - Need for a crane
 - Complexity of the wall

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Conclusion

- Capstone Project Summary
 - Infection control precautions must be taken due to the building's close proximity to other sensitive medical facilities.
 - UVGI system will effectively prevent microbial growth and will likely pay itself off in a few years through savings in energy costs.

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Conclusion

- Goal Achievement
 - Learned a great deal
 - Building envelope
 - UVGI
 - Deadlines
 - Progress reporting
 - Good practice with industry correspondence
 - Unique opportunity to collaborate with professionals and gain real world knowledge

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Questions??

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Ultraviolet Germicidal Irradiation (UVGI)

- UV Costs
 - Manufacturer costs
 - Each AHU requires 18 Philips PL-L60W TUV lamps
 - 60 nominal watts, 18 UV Watts, high output and wide chit corrected for this application
 - Ballasts are Advance PureVOLT UV lamp ballasts
 - End-user list price of \$8250 per unit
 - Installation requires about 4 hours per unit, figure 8 hours for the first unit. This installation should take 2 installers a total of 4 days, less the electrical connections.
 - Project requires 156 Lamps; replacement cost is \$30 per lamp.
 - Replacement intervals at 1 year allow for 15% depreciation in output. 2 year replacement must allow for 25% depreciation in output.

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Ultraviolet Germicidal Irradiation (UVGI)

- UV Costs
 - Assumptions
 - Maintenance (cleaning) cost of \$1000/year before UV (per Kowalski example)
 - \$0.1139 average retail electricity cost in MD at end of 2007 (per U.S. DOE statistics)
 - Assumed cooling coil COP of 4.1 - typical for chilled water system (from Kowalski report)
 - Assumed a rate of \$35/hr for installation workers

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Ultraviolet Germicidal Irradiation (UVGI)

- Cost-Benefit Analysis
 - UV Data

Desig.	UV wattage (W)	UV Lamp Fixture First Cost (\$)	UV Lamp Installation Cost (\$)	UV Lamp Replacement Bulb Cost (\$)	UV Operating Cost (\$)	
AHU-1	1080	\$8,250	\$560	\$540	\$1,078	
AHU-2	1080	\$8,250	\$280	\$540	\$1,078	
AHU-3	1080	\$8,250	\$280	\$540	\$1,078	
AHU-4	1080	\$8,250	\$280	\$540	\$1,078	
AHU-5	1080	\$8,250	\$280	\$540	\$1,078	
AHU-6	1080	\$8,250	\$280	\$540	\$1,078	
AHU-7	1080	\$8,250	\$280	\$540	\$1,078	
		7,560	\$57,750	\$2,240	\$3,780	\$7,543

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Ultraviolet Germicidal Irradiation (UVGI)

- Cost-Benefit Analysis
 - Payback Period
 - 20% Fouling

	Total Initial Cost (\$)	Total Annual Savings (\$)	Payback Period (yrs)
9350	\$37,953	0.24835	
9070	\$37,953	0.23898	
9070	\$37,953	0.23898	
9070	\$44,316	0.20467	
9070	\$44,316	0.20467	
9070	\$52,823	0.1717	
	\$63,770	\$293,268	0.217

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180° Disinfection Method is Less Effective for Air Disinfection, Equal Effect on Coil

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Superior 360° Lamp Placement = Maximum Disinfection of Air on the Fly, Equal Coil Disinfection

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