
KGB
Maser
Management. Engineering. Consulting.
The Millennium Science Complex
University Park, PA
Penn State
Integrated Project Delivery /
Building Information Modeling
Senior Capstone Thesis

KGB Maser
Management. Engineering. Consulting.

Project Team Members

Jason Brognano
Lighting/Electrical Designer

Michael Gilroy
Mechanical Designer

David Maser
Construction Manager

Stephen Kijak
Structural Designer

Project Overview

Location, Size, and Use

- Science Research complex
- 275,600 sq. ft.
- Three above grade floors, penthouse, mezzanine, and basement

Time and Cost

- Design-Bid-Build Delivery
- June 2008 — July 2011 Construction
- $230,000,000 budgeted overall cost
- $175,000,000 building cost

Sustainability Features

- LEED Gold Certification
- Green roofs on both wings
- Low VOC materials on interior
- Daylight integration in perimeter spaces
- CO_2 occupancy density sensors

KGB Maser
Management Engineering Consulting

Construction

CONSTRUCTION PHASE	DURATION (DAYS)	START	FINISH
Notice to Proceed	1	8-12-08	8-12-08
Foundation	270	2-16-09	2-26-10
Superstructure	274	7-7-09	7-23-10
Enclosure	303	11-9-09	1-5-11
Building Systems & Finishes	345	12-14-09	4-8-11
Construction Duration	758	8-12-08	7-7-11
Substantial Completion	1	7-7-11	7-7-11

Project Overview

Lighting and Power

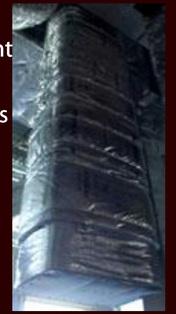
- All lighting on 480Y/277V supply
- Receptacle and small loads on 208Y/120V
- Lutron Ecosystem in public perimeter spaces
- Occupancy and daylight sensor control
- Lighting control panels for exterior spaces
- Campus tied, 12.47kV supply voltage
- Dual 5000A main-tie-main switchgear
- Rigid conduit and aluminum cladding in electrical rooms to mitigate EMF interference

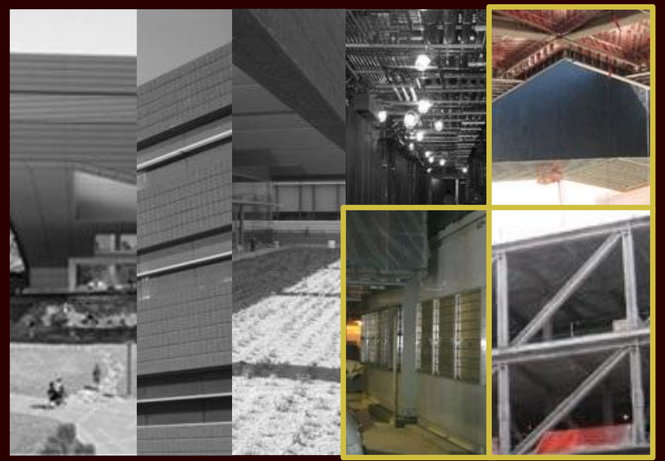
KGB Maser
Management Engineering Consulting

Project Overview

Mechanical

- VAV Reheat Air Distribution
  - (5) 50,000 CFM AHUs deliver 100% OA to General Lab Areas
  - (3) 40,000 CFM AHUs serve Office & Common Areas
  - Animal Care, Quiet Lab, and Clean Room AHUs
- High pressure steam from PSU central plant
  - Reduced to medium and low pressure for use
- PSU campus chilled water used for cooling coils AHUs
- Dedicated exhaust system for fume hoods, biosafety cabinets
- CO_2 Sensors throughout to maintain air quality
- 4th floor penthouse and basement mechanical rooms





Structural

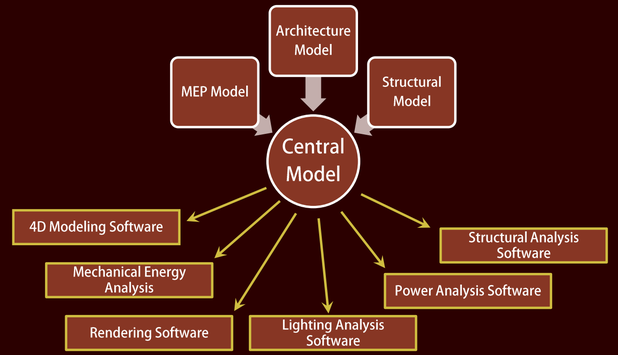
- Steel Structure
  - LWT Concrete on 3inch Metal Deck
  - Wide Flange Beams and Girders, 21 and 24 inches deep
  - 22ft. X 22ft. Bays
- 154ft. Cantilever at the North-West corner of the Building
  - 4 Main Supporting Trusses
  - Web Members Oriented for Axial Compression
  - Moment Connected Members for Stiffness
  - Controlled by Deflection - 2 inch Allowance
- Lateral System
  - Shear Walls, Braced Frames, Moment Frames
  - 90% of Lateral Forces Received by Shear Walls
  - Seismic Forces Control
- Foundation
  - Micropiles Beneath Pile Caps
  - Grid of Foundation Beams

KGB Maser
Management Engineering Consulting

IPD/BIM Goals

- Update option-specific designs within the appropriate **BIM models**
- Perform analyses using the **central model** as a base
- Document **model sharing processes** to achieve design goals
- Work collaboratively to asses repercussions of design changes on **all disciplines**

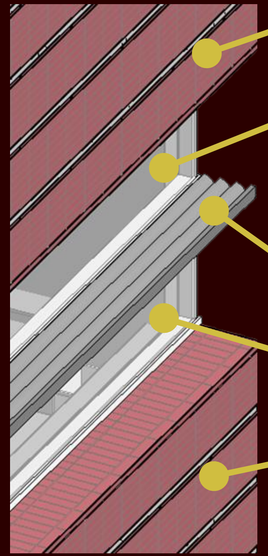
KGB Maser Goals of Analysis



Engineering Goals

- Decrease energy consumption by **10%**
- **Reduce size** and **cost** of structural system
- Modify façade to accommodate **multiple disciplines:** daylight delivery, structural efficiency, mechanical system sizing, and constructability

KGB Maser
Management Engineering Consulting



Precast Panel providing approx. 28in. overhang

Upper Glazing: 40% Frit

Continuous Louvered Overhang

Lower Glazing

Precast Panel

Existing vs. Proposed Facade

Key Design Issues

How does overhang depth affect **mechanical load?**

How does overhang depth affect **daylight delivery?**

Is it possible to **reduce the weight** of panels?

Can all options come to a conclusion that is **beneficial** and **cost effective?**

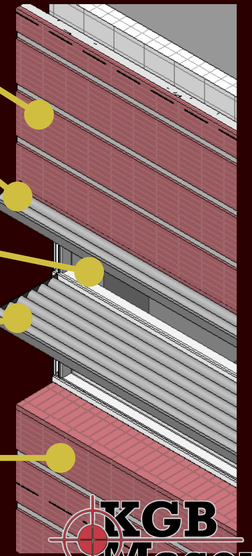
Revised brick attachment to concrete panel

Small louver to allow for additional overhang

Glazing change to balance mechanical and lighting implications

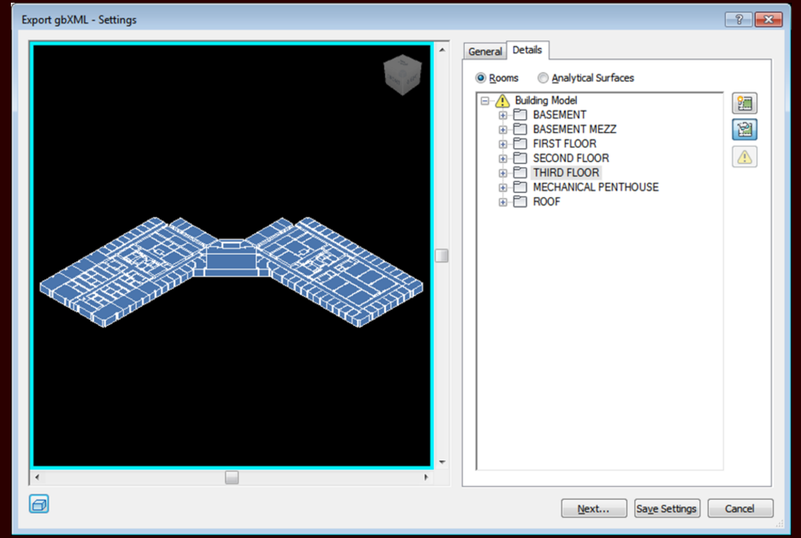
Larger louvered overhang at mid-point of window

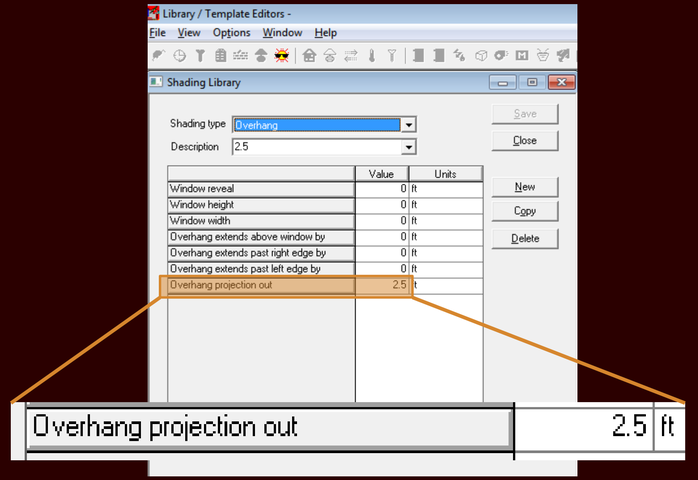
Thinner façade panel to decrease weight and cost

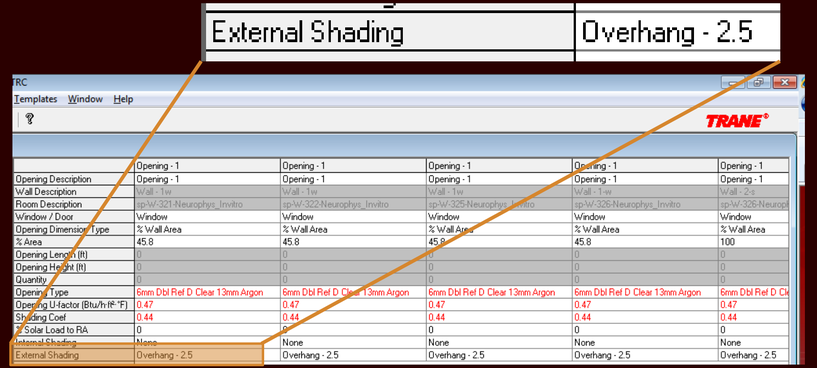


KGB Maser Management Engineering Consulting

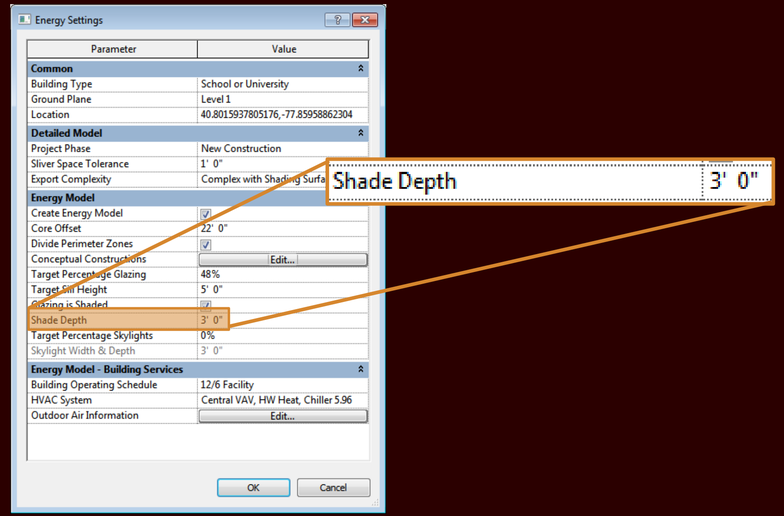
Overhang Investigation: Trane TRACE

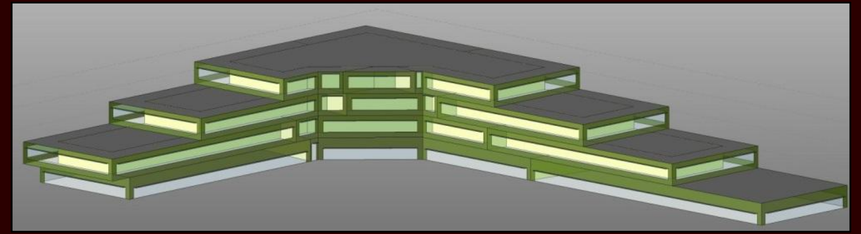


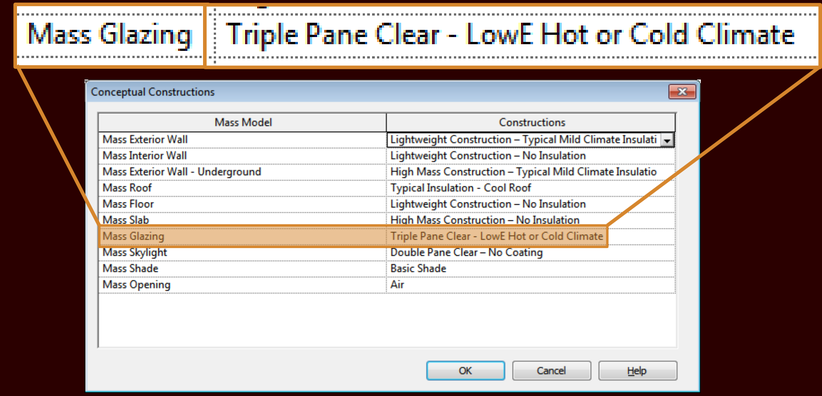




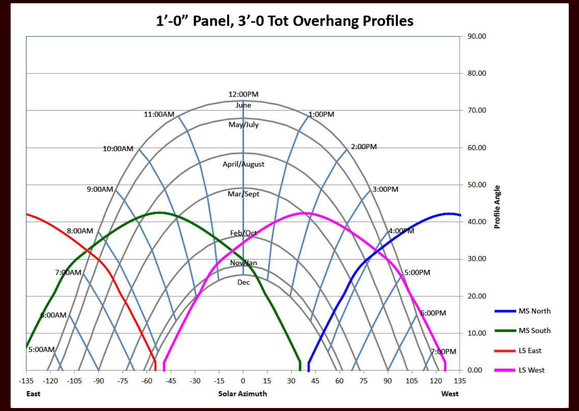
Overhang Investigation: Project Vasari

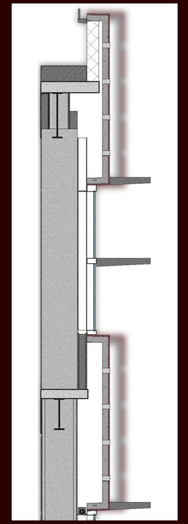


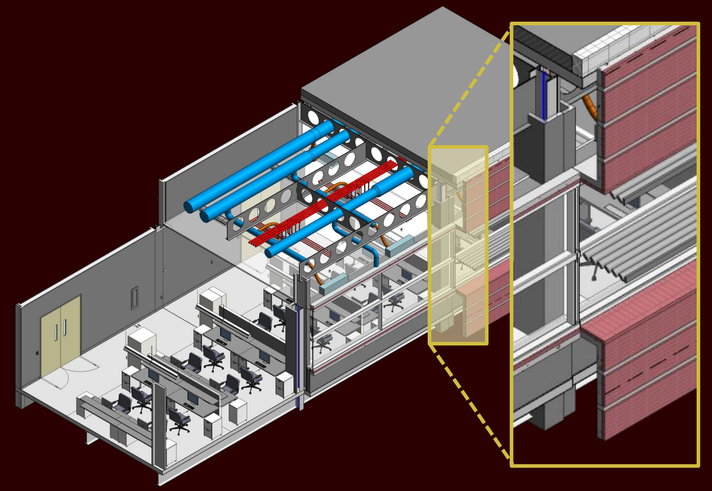


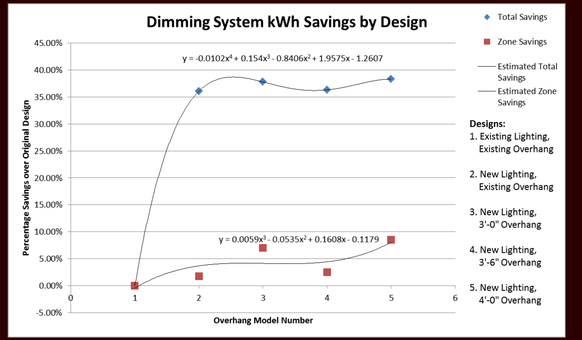


Overhang Investigation: Daysim









KGB Maser
Management Engineering Consulting

Overhang Investigation: Operating Cost Findings

At 3'-0″ the zone savings density is as follows:

Existing System 0.5905 kWh/SF applied to 14115 SF of perimeter area

3'-0″ Overhang 0.5494 kWh/SF applied to 14115 SF of perimeter area

Total operating cost savings at $0.08/kWh is $46.48 for the third floor perimeter spaces

Existing System 8335.34 kWh energy usage

3'-0″ Overhang 7754.36 kWh energy usage

Net Difference 580.98 kWh energy usage

Applied building wide, the overhang saves mechanical operating costs by $23,088

Overhang and Glazing Analysis: Summary of Effect on HVAC Operating Cost

	Existing Glazing			Proposed Glazing			
Overhang Depth	2.5	3	3.5	0	2.5	3	3.5
TRACE Results	$1,501,728	$1,494,852	$1,490,400	$1,512,576	$1,481,418	$1,478,640	$1,478,268
Decrease	-	0.45%	0.75%	-0.7%	1.35%	1.53%	1.56%
Vasari Results	$953,470	$952,430	$951,956	$888,241	$884,272	$883,823	$883,286
Decrease	-	0.11%	0.16%	6.84%	7.26%	7.30%	7.36%

Energy Savings (kWh)

Design Overhang	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	% Savings
Actual Grand	135.01	112.46	118.70	107.26	123.12	117.71	117.71	123.17	113.72	127.98	128.93	125.25	1451.08	0.00%
New Grand	100.58	78.23	73.52	61.91	70.60	63.21	63.13	69.44	70.10	83.76	93.91	99.26	927.72	36.07%
3' Grand	97.35	75.36	70.71	60.18	68.73	62.67	62.82	67.96	67.78	81.56	91.47	96.10	902.75	37.79%
3.5' Grand	100.16	77.80	73.03	61.65	70.54	63.10	63.02	69.23	69.73	83.36	93.51	98.95	924.12	36.32%
4' Grand	96.29	74.55	70.08	59.68	68.31	62.60	62.78	67.51	67.09	80.87	90.47	95.06	895.33	38.30%
Actual Zone	49.61	38.20	37.02	33.01	37.73	36.03	36.03	37.78	35.75	42.59	47.24	47.28	478.33	0.00%
New Zone	60.40	43.29	35.08	26.96	30.42	24.77	24.69	29.25	33.41	43.58	55.47	62.57	469.95	1.75%
3' Zone	57.17	40.42	32.27	25.24	28.55	24.23	24.38	27.77	31.09	41.38	53.04	59.41	444.99	6.97%
3.5' Zone	59.97	42.86	34.59	26.70	30.35	24.66	24.58	29.05	33.04	43.17	55.07	62.26	466.36	2.50%
4' Zone	56.11	39.61	31.64	24.74	28.12	24.16	24.34	27.32	30.40	40.68	52.03	58.36	437.57	8.52%

Orientation Change Summary

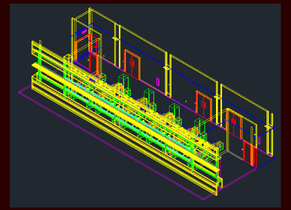
Design Overhang	MS South kWh from Table X	Mat. Science North		Life Science East		Life Science West	
		Total kWh	% of MS South	Total kWh	% of MS South	Total kWh	% of MS South
Actual Grand Total	1451.08	1446.46	99.68%	1457.40	100.44%	1447.28	99.74%
Actual Zone Total	478.33	473.70	99.03%	484.65	101.32%	474.53	99.21%

KGB Maser Management Engineering Consulting

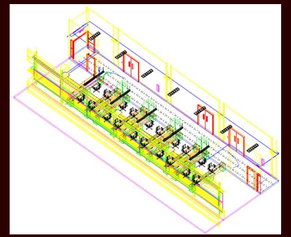
Impact on Lighting Design

StudentExport.rvt

Export parameter change to "ACIS Solids"

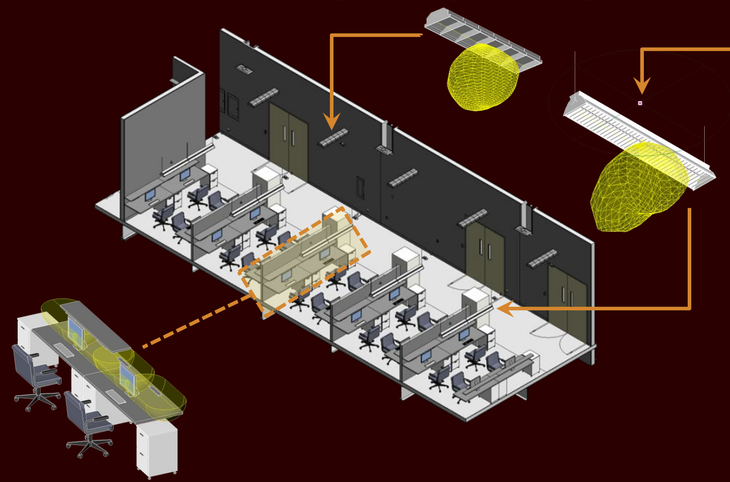


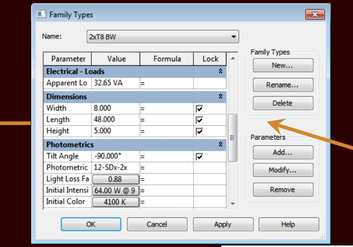
StudentExport.dwg

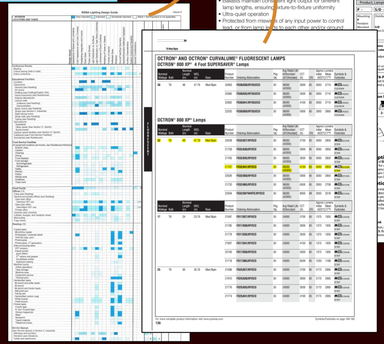


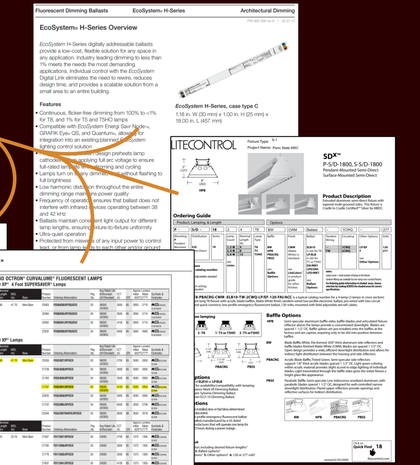
StudentExport.AGI

Import to AGI32 where material properties are assigned





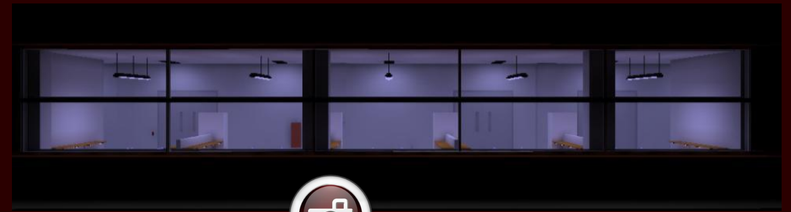


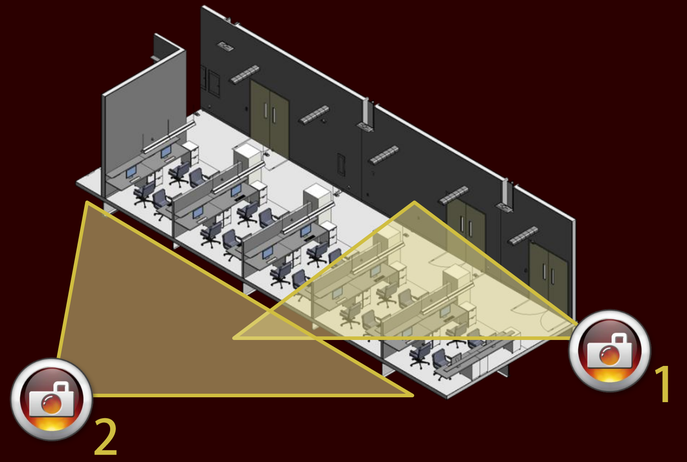


KGB Maser
Management Engineering Consulting

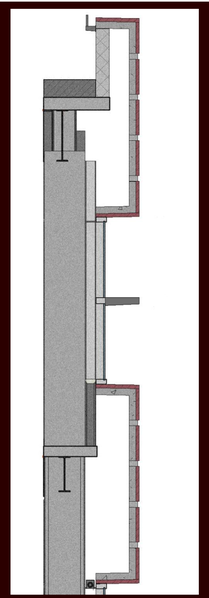
Impact on Lighting Design

Study Area Illuminance Summary						
Space	Illuminance (fc)			Max./Min.	Coeff. Of Variation	Uniformity Gradient
	Min.	Avg.	Max.			
Study Area Only	9.0	36.5	106.0*	11.73	0.47	2.47
Corridor Only	4.5	9.36	10.8	2.40	0.15	1.31
Student Area Combined	15.0	34.3	55.0	3.67	0.27	1.42
Corridor Combined	7.3	20.0	25.3	3.47	0.23	1.38





KGB Maser
Management Engineering Consulting



Panel Depth Assessment

Existing Conditions

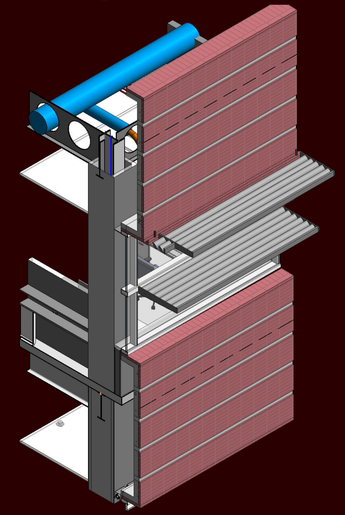
- 27.6″ Deep
- 6″ Thick Concrete at Face
- 2″ Facebrick
- Largest Panel 21ft. Wide by 11ft. Tall

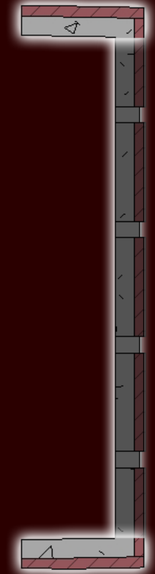
Gravity Controlled Design

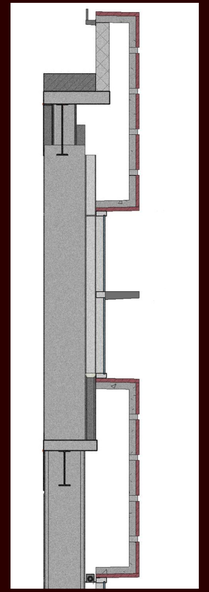
- Prone Position Causes Greatest Stress
- 2 Bearing Connections at Either End
- 2 Lateral Connections at Either End

	Cracking Stress		
(factored)	477.2971	psi	

Self Weight Check Prone			
Weight/in.	8.53125	lb./in.	(factored)
Inertia of Strip	76.765625	in.4	
Moment	16695.94	lb.in.	
Stress	462.17134	psi.	OK







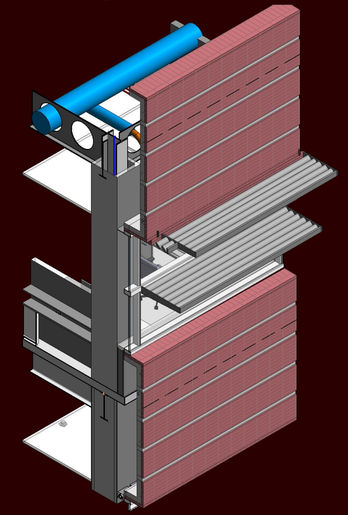
Panel Depth Assessment

Existing Conditions
- 27.6″ Deep
- 6″ Thick Concrete at Face
- 2″ Facebrick
- Largest Panel 21ft. Wide by 11ft. Tall

Gravity Controlled Design
- Prone Position Causes Greatest Stress
- 2 Bearing Connections at Either End
- 2 Lateral Connections at Either End

	Cracking Stress	
(factored)	477.2971	psi

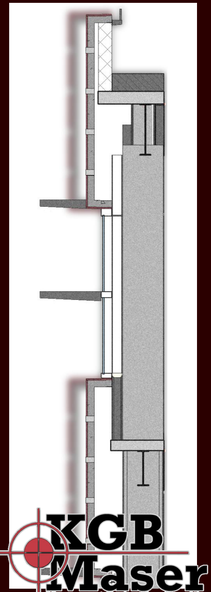
Self Weight Check Prone			
Weight/in.	8.53125	lb./in.	(factored)
Inertia of Strip	76.765625	in.4	
Moment	16695.94	lb.in.	
Stress	462.17134	psi.	OK



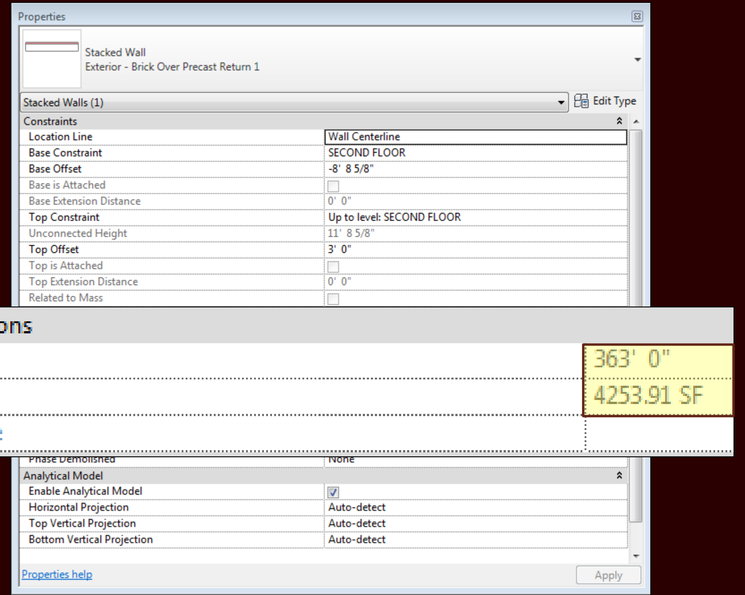
Redesign
- 15.75″ Deep
- 5″ Thick Concrete at Face
- 1/2″ Facebrick
- Largest Panel 21ft. Wide by 11ft. Tall

Wind Controlled Design
- Prone Position Causes Greatest Stress
- 2 Corbel Connections at Either End
- 2 Lateral Connections at Either End

Required Steel		
Vu.max=	189	k.
As.req=	0.44	in.2
μe=	3.4	
As.req=	0.32	in.2
As.min=	0.77	in.2
As=	0.77	in.2
Ah=	0.30	in.2
Ldh=	8.91	in.



KGB Maser
Management Engineering Consulting



Cost Assessment

Existing Pre-Cast							
Total (SF)	Material	Labor	Equipment	Total	Cost	Time	O & P
72319.11	27.3	1.74	1.63	30.67	$2,218,027	$2,816,894	$3,295,766
			TOTAL COST =	$3,295,766.47			

Redesign Pre-Cast							
Total (SF)	Material	Labor	Equipment	Total	Cost	Time	O & P
72319.11	25.03	1.74	1.63	28.4	$2,053,862	$2,608,405	$3,051,834
			TOTAL COST =	$3,051,834.62			

Cost Savings = $240,000

KGB Maser Management Engineering Consulting

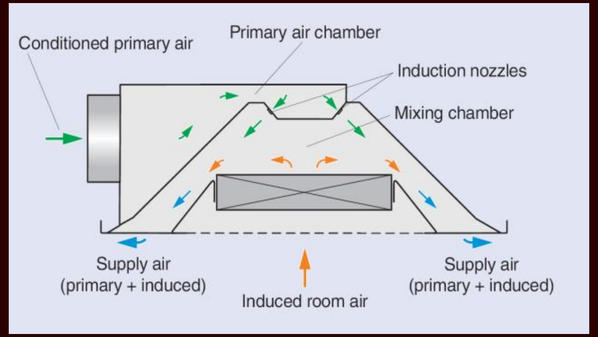
Existing vs. Proposed Distribution

Existing VAV Distribution System

Energy efficient design that can be **easily controlled** to space airflow needs

Familiar system for designers and contractors

Less pumping energy required



Proposed Active Chilled Beam Distribution System

Takes advantage of the higher **specific heat capacity of water**

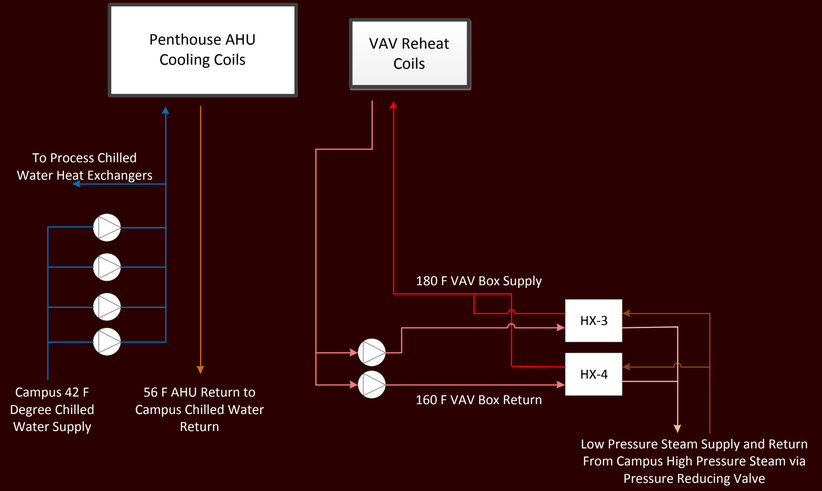
More concern for handling **latent** loads

Higher **initial cost**

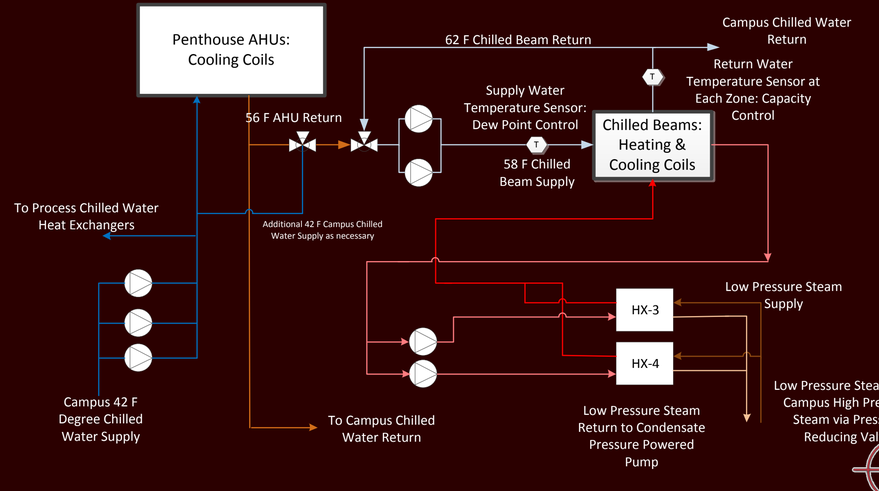
Fan energy saved, pumping energy increased

Existing vs. Proposed Distribution

Existing VAV Water Flow Diagram

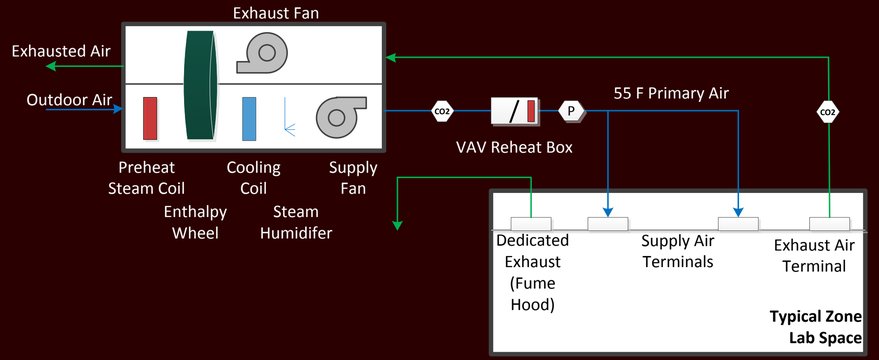


Proposed Chilled Beam Water Flow Diagram

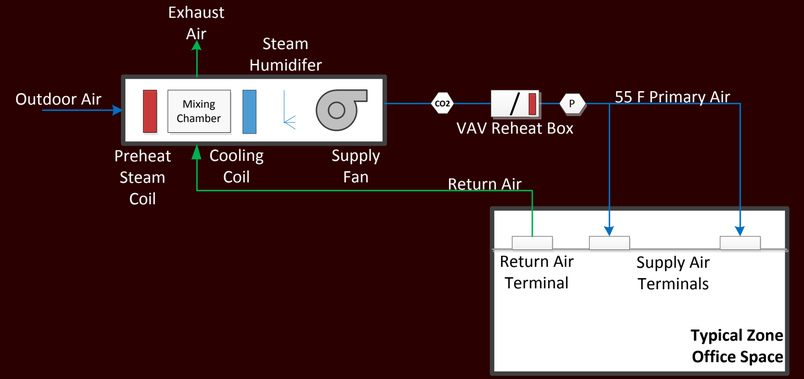


Existing vs. Proposed Distribution

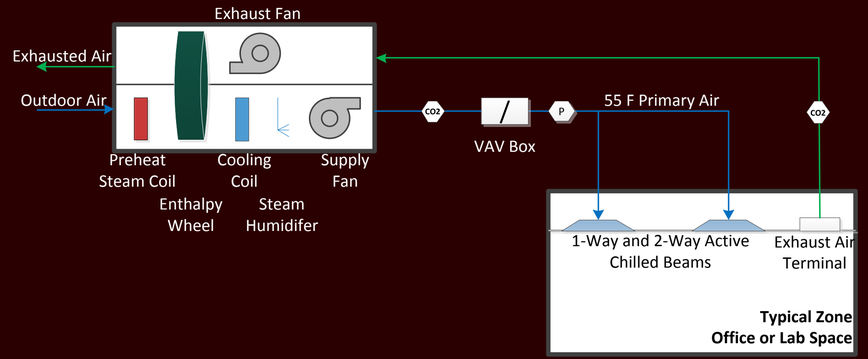
Existing Lab VAV Air Flow Diagram



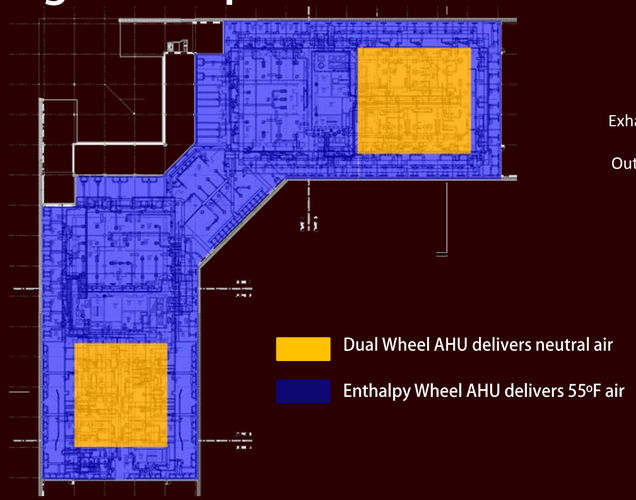
Existing Office VAV Air Flow Diagram



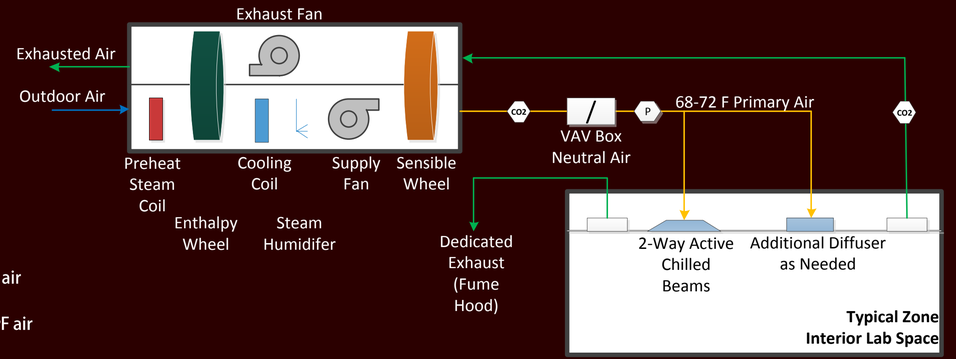
Perimeter Zone Chilled Beam Air Flow Diagram



Existing vs. Proposed Distribution

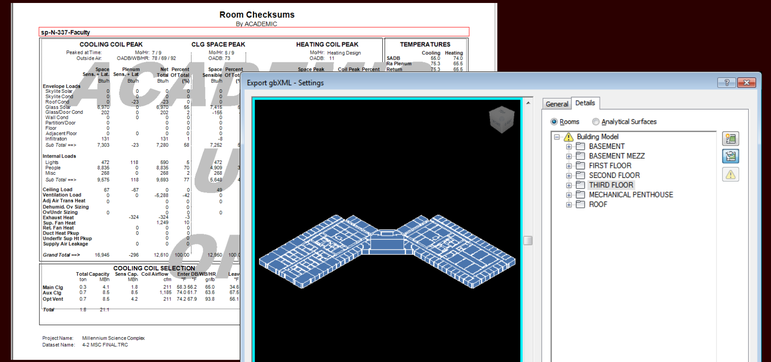


Interior Lab Chilled Beam Air Flow Diagram



Active Chilled Beam Design Process

1. Obtain room loads from Trane TRACE updated model



2. Compare ventilation needs: ASHRAE 62.1, Latent, Air Changes

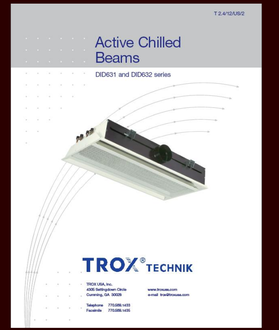
$$Office: 0.06 * SF + 5 * People$$

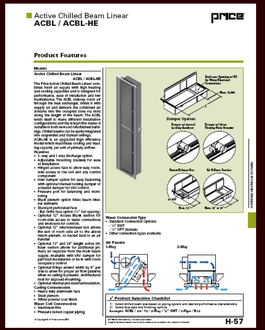
$$Labs: 0.18 * SF + 10 * People$$

$$Q_{Latent\,CFM} = \frac{q_{latent}}{(0.68\ x\ (W_{room} - W_{Primary}))}$$

6 Air Change Minimum for Lab Spaces

3. Select Chilled Beam Manufacturer





KGB Maser Management Engineering Consulting

Active Chilled Beam Design Process

4. Reference RCP & Manufacturer Selection Spacing Program

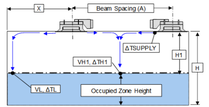
DID 632 Two Way Active Chilled Beam Selection Program

Input DID	4 pipe coil		2 pipe coil		Project	Room-No.	Comment
	cooling	heating	cooling	heating			
Vwater DID	1.25 GPM	1.35 GPM	1.00 GPM	0.90 GPM			
Unit length	4.0 ft						
Nozzle-type	U						
Vair-primary DID	140.0 CFM						
Connection-diameter / primary air	6 in						

Input Temperatures	cooling		heating		Input Room Dimensions	
Tair-primary	55.0 °F		55.0 °F		Room Height (H)	11.0 ft
Troom / rel. Humidity	75.0 °F	53.0 %	70.0 °F	50.0 %	X	12.0 ft
					Y	10.0 ft
Twater-flow	58.0 °F		95.0 °F		Occupied Zone Height	6.0 ft

TROX® TECHNIK
The art of handling air

Results	4 pipe coil		2 pipe coil	
	cooling	heating	cooling	heating
ΔTwater	-4.9 °F	5.9 °F	-6.7 °F	14.8 °F
Twater-return	62.9 °F	89.1 °F	64.7 °F	80.2 °F
ΔT room - water flow	-17.0 °F	25.0 °F	-17.0 °F	25.0 °F
ΔT Room water average	-14.5 °F	22.0 °F	-13.7 °F	17.6 °F
Qwater DID	-3085 BTUH	3694 BTUH	-3332 BTUH	3705 BTUH
Qair DID	-3048 BTUH	-2297 BTUH	-3048 BTUH	-2297 BTUH
Q DID	-5133 BTUH	1398 BTUH	-5380 BTUH	1408 BTUH
ΔP water	1.7 ft WG	2.0 ft WG	4.8 ft WG	1.4 ft WG
ΔP air	0.68 inch WG			
NC (incl. 10 dB room absorbtion)	30			

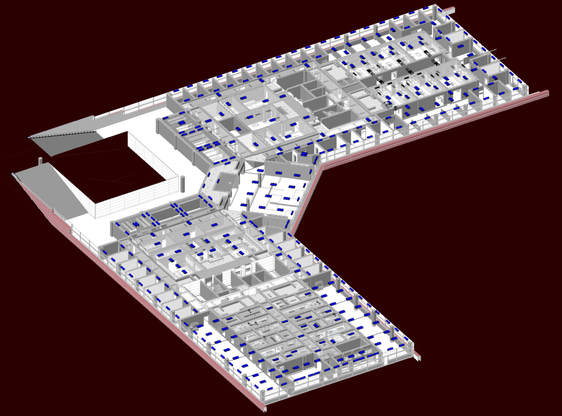


NOTE: This calculation program is only applicable to DID632 beams manufactured by TROX USA.

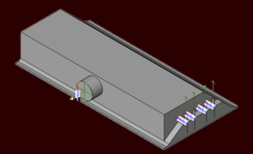
Terminal Velocities and Temperatures					Support Values		TROX USA, Inc
vL2 (measured 2" from wall)	91 FPM	64 FPM	91 FPM	64 FPM			4305 Settingdown Circle
vL6 (measured 6" from wall)	56 FPM	39 FPM	54 FPM	38 FPM	N-nozzles total	90	Cumming, GA 30028
vH1	53 FPM		53 FPM		Aeff	0.046295 ft²	Phone: (770) 569-1433
ΔTL	-1.7 °F	0.1 °F	-1.6 °F	0.1 °F	veff	3024 FPM	Fax: (770) 569-1435
ΔTH1	-0.8 °F		-0.7 °F		H1	5.0 ft	www.TROXUSA.com
ΔTsupply	-15.8 °F	2.8 °F	-15.1 °F	2.8 °F	L	15.0 ft	Version 1.8
Connection-diameter / primary air	DID632-HC		DID632-US		room air dew point-cooling	56.7 °F	1/21/2011

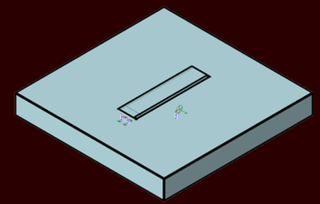
Text in red represents a value that is not generally recommended (see user notes for details).

5. Use RCP to place beams in space in Revit MEP model



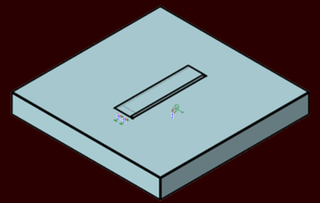
6. Adjust Chilled Beam Families in Revit

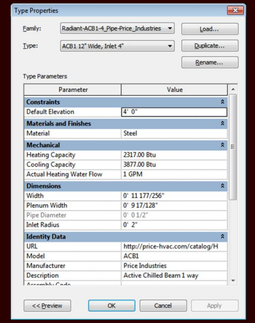




KGB Maser
Management Engineering Consulting

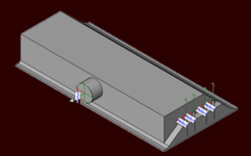
Active Chilled Beam Design Process

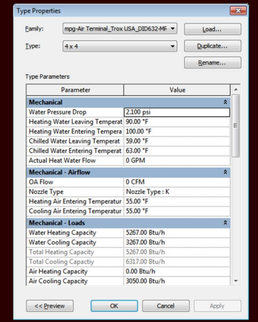




Summary of TROX Chilled Beam Adjustments		
Parameter	Downloaded Setting	Adjusted Setting
Flow Configuration	Calculated	Preset
Flow Direction	In	In
Family	Air Terminal	Mechanical Equipment
Location of Inlet	Side	Top (Cost Option)
Air Flow	Instance: Keeps CFM constant for the same family	Type: Allows different CFM for same family

6. Adjust Chilled Beam Families in Revit

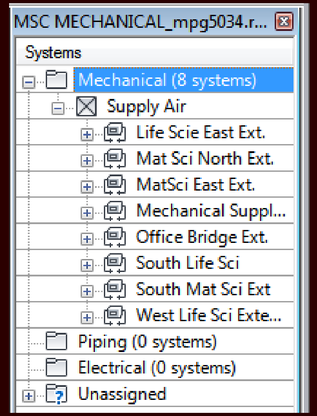




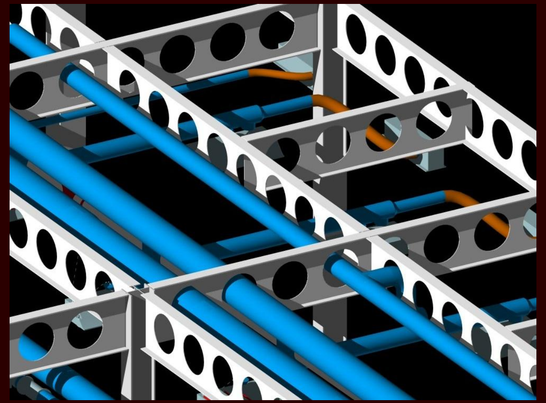
KGB Maser Management Engineering Consulting

Active Chilled Beam Design Process

7. Create Systems so Revit can calculate Duct, Pipe Sizes

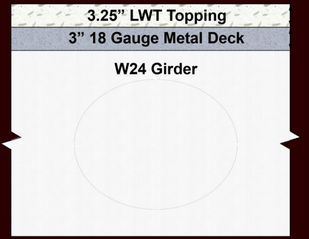


8. Place main duct runs in cellular openings

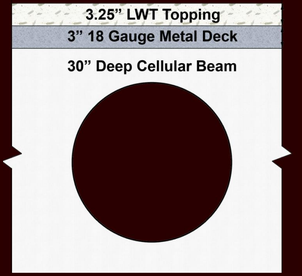


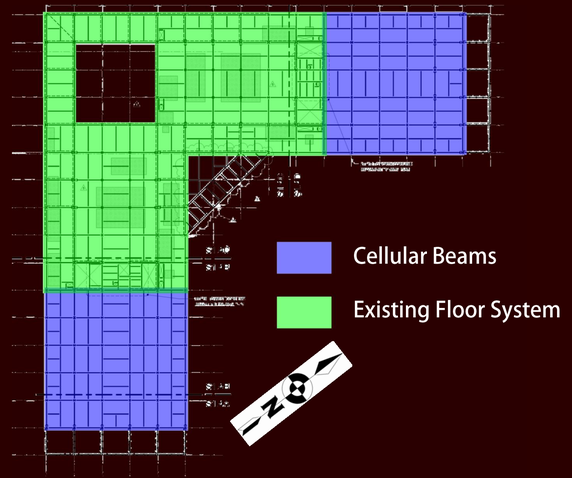
Structural Integration With Chilled Beams

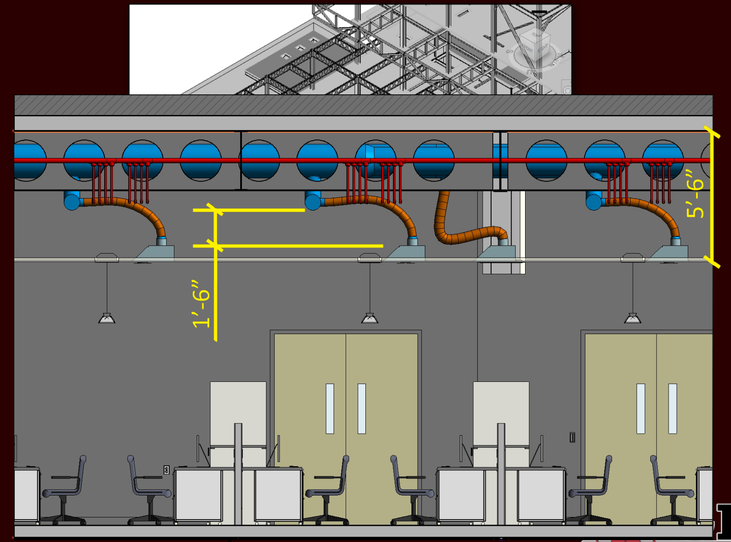
Existing Composite Floor System
- 22ft. X 22ft. Bays
- 21in. Deep Wide Flange Beams
- 24in. Deep Wide Flange Girders
- Floor Supports Green Roof
- NWT Concrete

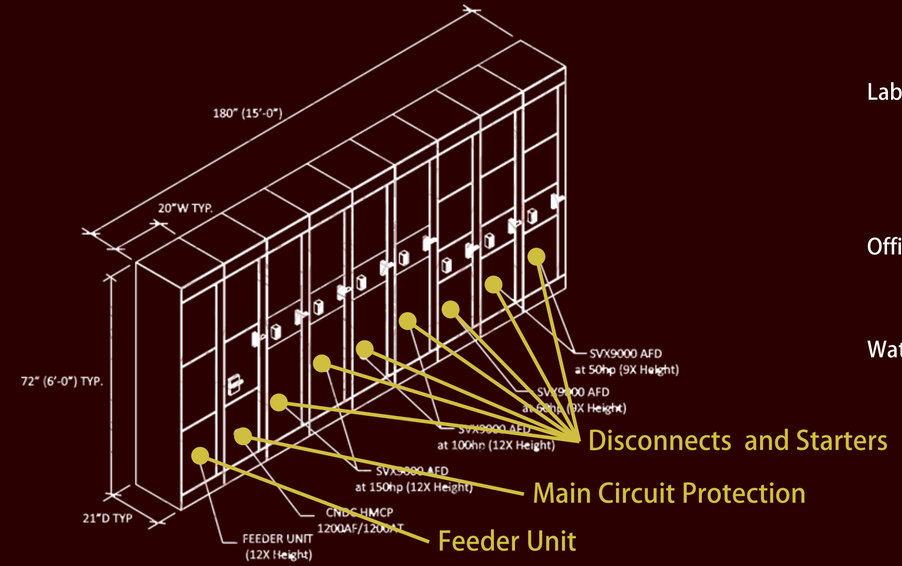


Redesign
- 30in. Deep Cellular Beams
- LB30X44 Beams
- LB30X57 Girders
- Lighter Bays









Chilled Beam Electrical Reaction

Lab Service:
- ACF-1
- ACF-2
- ACF-3
- ACF-4
- ACF-5

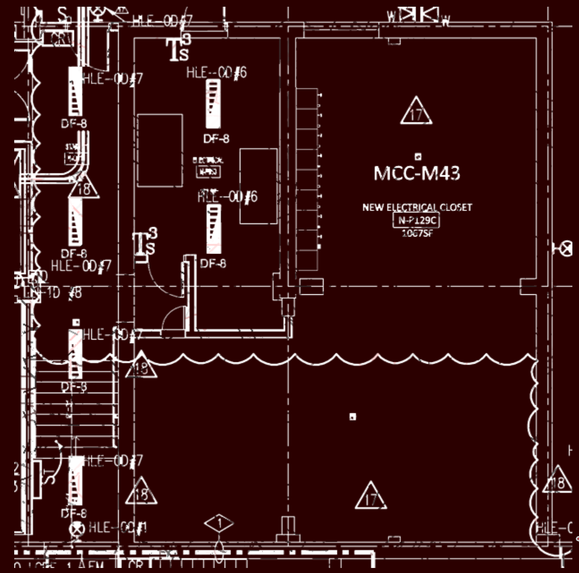
Office Service:
- ACF-6
- ACF-7
- ACF-8

Water Pumps:
- CWP-1
- CWP-2
- CWP-3 (standby)
- CWP-4 (low flow)
- HWP-5
- HWP-6

Labs/Offices:
- AHU-EXT-1
- AHU-EXT-2

Interior Spaces:
- AHU-INT-LS1
- AHU-INT-LS2
- AHU-INT-MS1
- AHU-INT-MS2

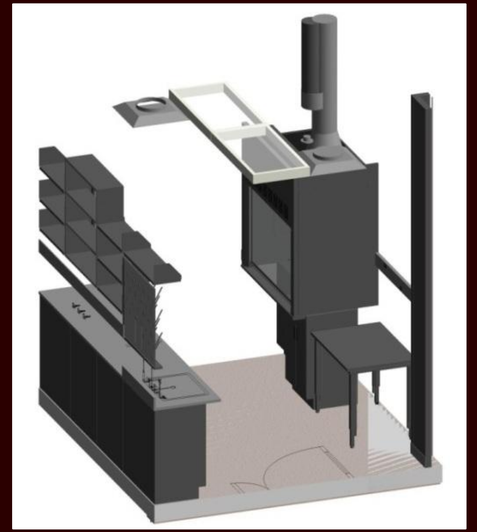
Consolidated to MCC:
- CWP-1
- CWP-2 (standby)
- CWP-3
- CWP-4 (standby)
- CWP-5 (low flow)
- HWP-5
- HWP-6 (standby)



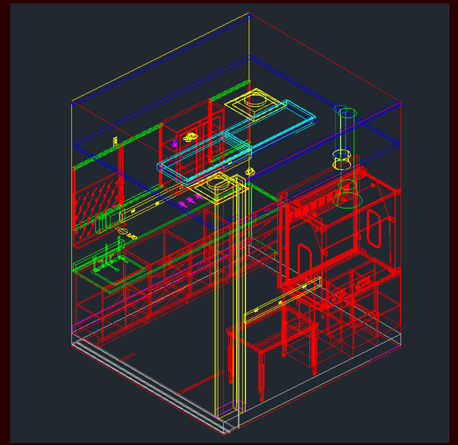
KGB Maser
Management Engineering Consulting

Fume Hood Face Velocity Testing: Software Process

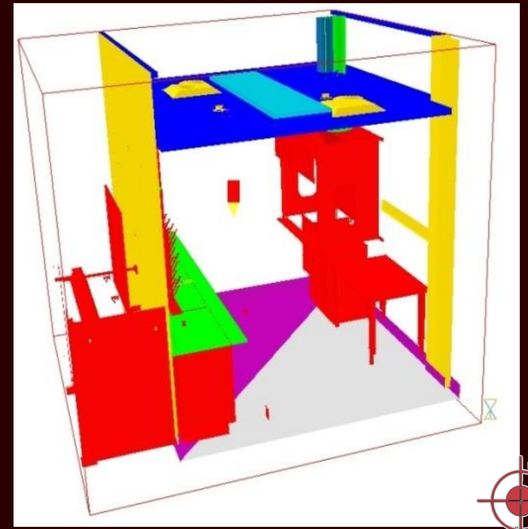
Section Box applied to W324A-Hot Room



DXF Export from Revit Architecture



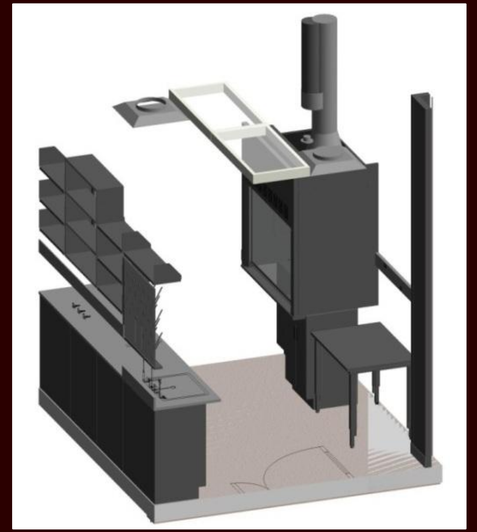
Attempted import as geometry into Phoenics 2009



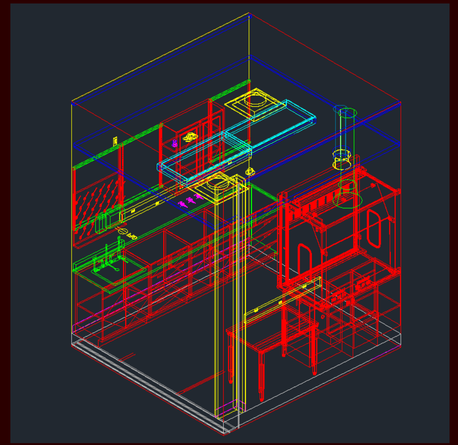
KGB Maser
Management Engineering Consulting

Fume Hood Face Velocity Testing: Software Process

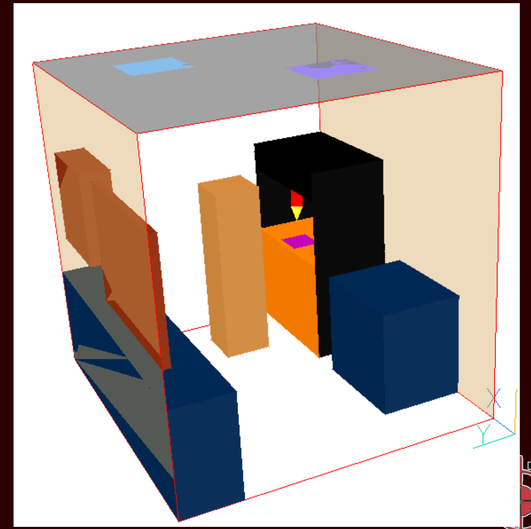
Section Box applied to W324A-Hot Room



DXF Export from Revit Architecture



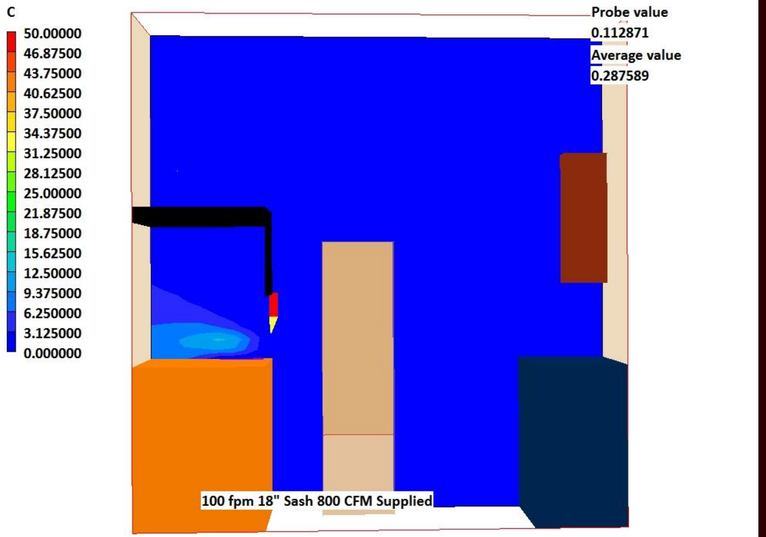
Final Model created with Phoenics elements



KGB Maser
Management Engineering Consulting

CFD Contaminant Test: 18″ Sash Position

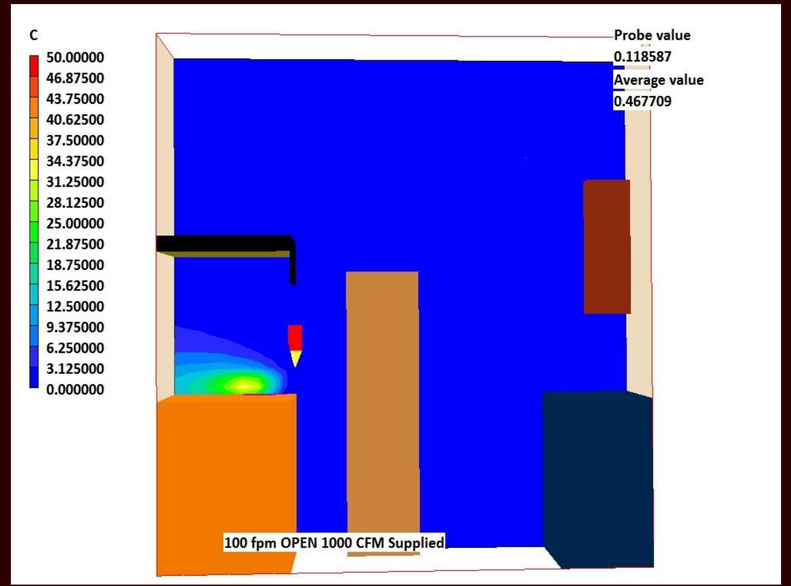
100 FPM



80 FPM

KGB Maser
Management Engineering Consulting

CFD Contaminant Test: 30″ Sash Position



100 FPM

80 FPM

KGB Maser
Management Engineering Consulting

Fume Hood Results

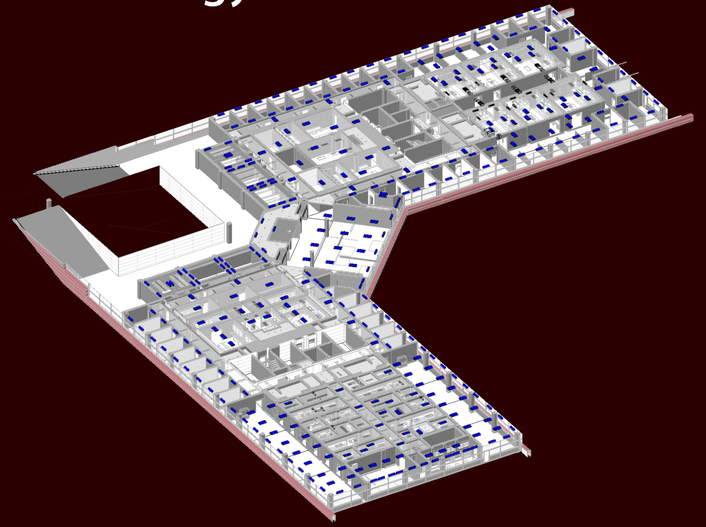
1. Face Velocity **achieved during 18″** simulations, **not 30″**
2. **14.2% more** contaminant present at face of fume hood in 80 fpm, 18″ sash
3. **18.0% more** contaminant present at face of fume hood in 80 fpm, 30″
4. All contaminant readings **less than 0.015% of source,** drop significantly at Human
5. **31.94%** energy savings from conditioning less air

Summary of Fume Hood Makeup Air Costs and Savings		
Metric	100 fpm VAV	80 fpm ACBs
Cooling/Dehumidification	$233,356	$122,597
Heating	$6,479	$13,447
Fan	$110,512	$81,042
Humidification	$17,610	$33,343
CAV Operation Costs	$367,958	$250,431
VAV Multiplier for Operation	0.32	0.32
Adjusted Operation Costs	$116,704	$79,428.
Percent Savings		31.94%

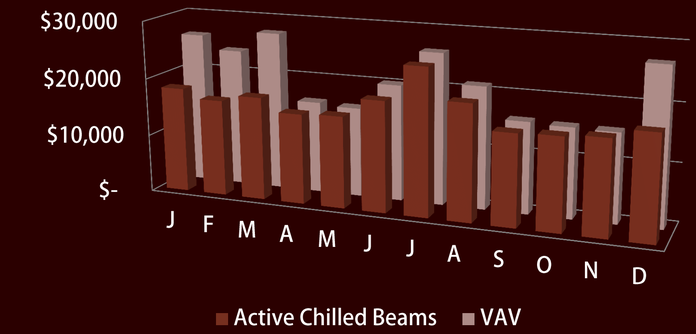
KGB Maser
Management Engineering Consulting

Energy Model Results

3rd Floor and Estimated Building Operating Costs			
		3rd Floor	Building
Existing VAV	Building Energy kBtu/yr	16,478,534	98,871,204
	Operating Costs	$250,288	$1,501,728
	Cost/SF	$5.84/ft^2	
Proposed ACB + Triple Pane Glazing	Building Energy kBtu/yr	13,912,786	83,476,716
	Operating Costs	$214,983	$1,289,898
	Cost/SF	$5.02/ft^2	
	Percent Savings	14.1%	



Monthly Operating Costs



KGB Maser
Management Engineering Consulting

Mechanical Equipment Schedule

Family and Type	Count	Total	COST
Radiant-ACB1-4: ACB1 12" Wide, Inlet 4"	1	1327.75	$1,327.75
Radiant-ACB1-4: ACB1 12" Wide, Inlet 4"	1	1327.75	$1,327.75

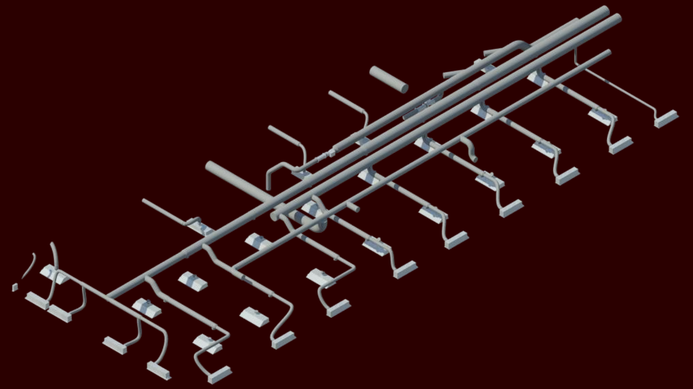
Duct Schedule

Size	Area	Length	Unitless Length	Cross Area	Volume Per FT	Weight
13"x13"	88 SF	20' - 4 1/4"	20.354167	0.022 SF	0.02	70.34
14"ø	4 SF	1' - 0"	1.000001	5.445938	0.03781901	6.54
16"x16"	110 SF	20' - 6 7/8"	20.572917	0.026 SF	0.03	106.65
18"x18"	123 SF	20' - 6 7/8"	20.572917	0.035 SF	0.03	106.65
20"x20"	67 SF	10' - 1 9/32"	10.10551	0.038 SF	0.04	69.85

Pipe Schedule

Family and Type	Size	Length	Unitless Length	Material	Labor	Equipmet	Total	COST
Pipe Types: Standard	1/2"ø	0' - 10 29/32"	0.909167	5.25	5.6	1.25	12.1	$11.00
Pipe Types: Standard	1/2"ø	0' - 7 31/32"	0.662917	5.25	5.6	1.25	12.1	$8.02
Pipe Types: Standard	1/2"ø	1' - 0 29/32"	1.075833	5.25	5.6	1.25	12.1	$13.02

Mechanical Redesign Cost Assessment



CHILLED BEAMS	DUCTWORK	PIPING	PUMPS	AHUs	TOTAL
$9,608,000	$2,966,400	$377,840	$165,484	$2,274,046	$21,035,567

Cost Increase = $1,847,567

KGB Maser
Management Engineering Consulting

Comparing Life Cycle Costs of Mechanical Systems

If inflation occurs and PSU remains a coal fired plant, the Active Chilled Beam system should be considered

If PSU changes to a Natural Gas plant, the Active Chilled Beam system should be considered

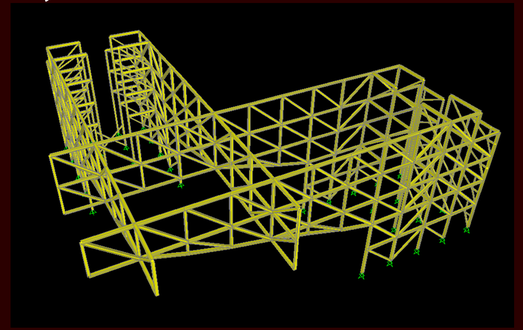
Coal Plant Findings			
	Real Rate	2% Inflation	5% Inflation
VAV	$54,813,916	$63,883,395	$63,856,220
ACB	$55,346,191	$62,693,273	$62,647,108
Percent Savings	-0.97%	1.86%	1.89%
NPV Differential	($532,275)	$1,190,122	$1,209,111

Natural Gas Plant			
	Real Rate	2% Inflation	5% Inflation
VAV	$64,693,985	$72,152,832	$72,110,021
ACB	$59,478,486	$69,307,263	$69,259,831
Percent Savings	8.06%	3.94%	3.95%
NPV Differential	$5,215,499	$2,845,568	$2,850,190

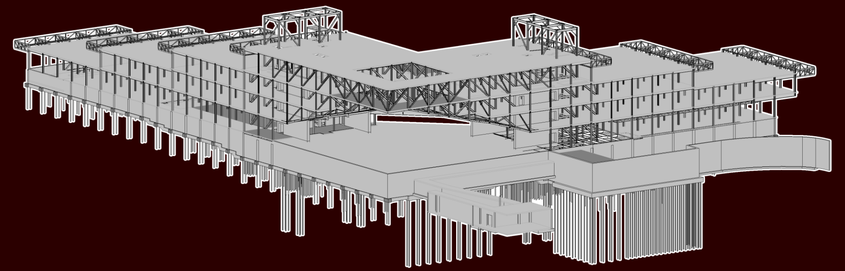
KGB Maser
Management Engineering Consulting

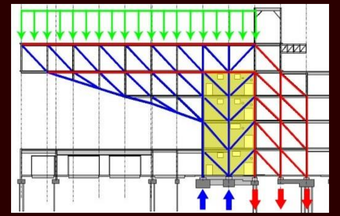
154ft. Overhang

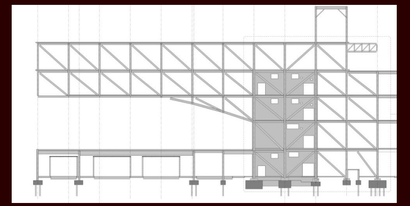
- 4 Main Trusses at Gridlines 2, 5, B, & E
- 11 Bays Lengthwise
- Moment Connections
- Members Oriented for Compression
- Sizes Ranging from W14X90 to W14X550
- Controlled by Deflection



Existing Cantilever







…3S

…Revit

…ntilever Model to Serve as Base

…iderations

…ation with Lighting and Mechanical

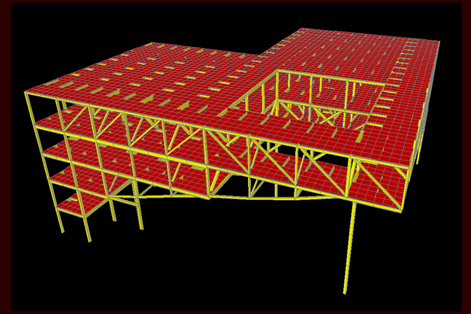
…ities to be Take… Redesigned

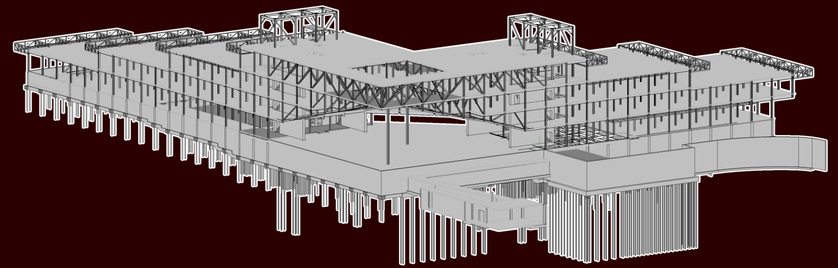
Truss Location

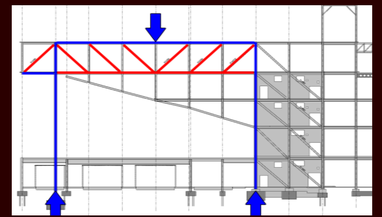
KGB Maser
Management Engineering Consulting

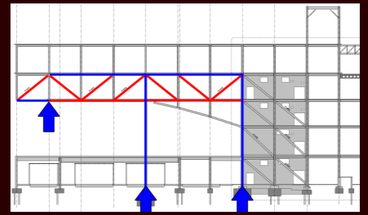
Redesign

154ft. Overhang
- 4 Main Trusses at Gridlines 2, 5, B, & E
- 9 Bays Lengthwise
- Pin Connections
- Members Oriented for Tension
- Sizes Ranging from W14X90 to W14X311
- Controlled by Strength







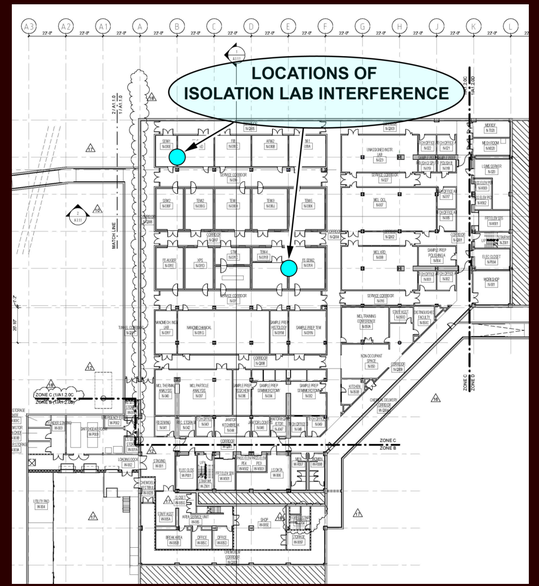


Actual BIM Process
- Build Complete Cantilever in SAP
- Analyze in SAP
- Redesign in SAP
- Replicate in Revit
- Use Existing Conditions Model and Modify

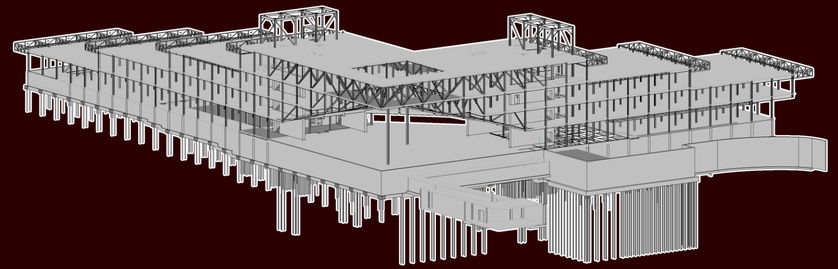
IPD Considerations
- Integration with Lighting and Mechanical
- Quantities to be Taken from Redesigned Model

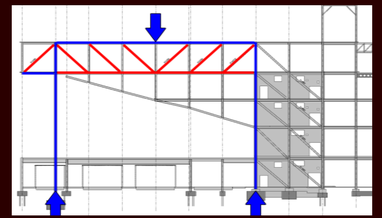
,

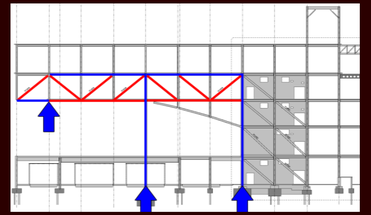
KGB Maser
Management Engineering Consulting

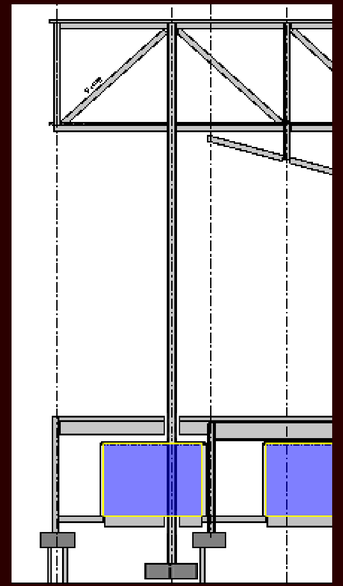


Redesign









Isolation Lab Interference

- Column **Penetrates** Through Slab
- Labs Limited to 130 micro inches/second
- Labs Sequestered from Foundation

Proposed Solution

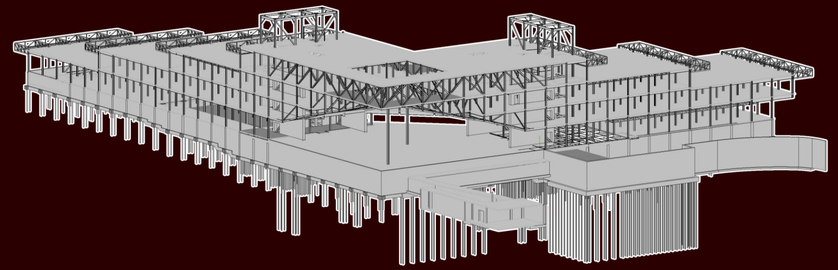
- Column Pile Caps 3ft. Beneath Bottom of Isolation Slabs
- Isolation Slabs **Poured Around** Columns
- **Compressive Material** to Fill Gap

KGB Maser
Management Engineering Consulting

Structural Redesign Cost Implications

Existing Entire Structure			
Framing Tons	Column Tons	Framing Cost	Column Cost
3058.7 Tons	953.84 Tons	$8,179,891.34	$2,386,659.20
	Total =	$10,566,550.54	

Existing 3rd Floor Structure			
Framing Tons	Column Tons	Framing Cost	Column Cost
595.72 Tons	231.47 Tons	$1,848,680.85	$434,508.19
	Total =	$2,283,189.04	

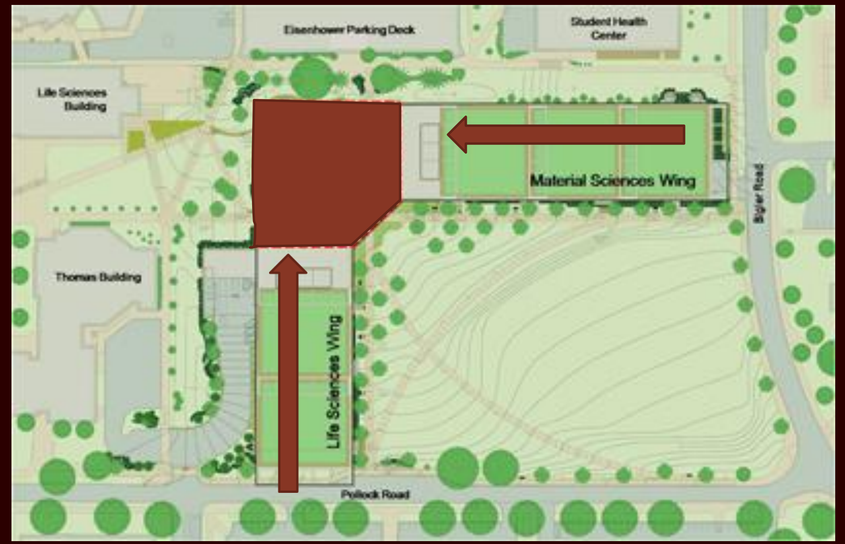


Cost Savings = $2,290,815

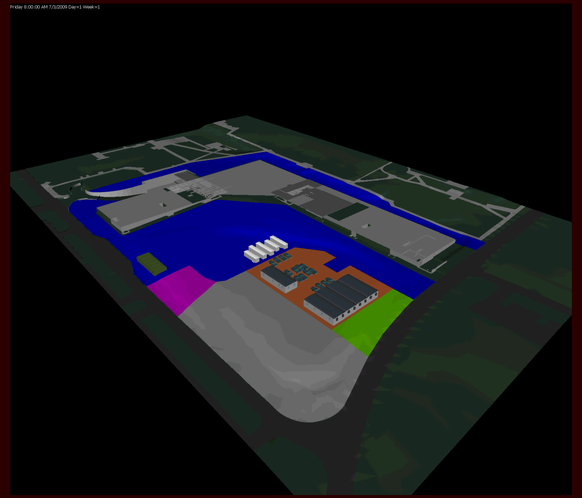
Redesign 3rd Floor Structure			
Framing Tons	Column Tons	Framing Cost	Column Cost
459.79 Tons	202.92 Tons	$1,310,896.61	$539,218.72
	Total =	$1,850,115.33	

Cost Implications to Entire Structure			
Savings/SF	Total SF	Total Savings	Total Cost
$8.3326/SF	274,922 SF	$2,290,815.05	**$8,275,735.48**

KGB Maser Management Engineering Consulting

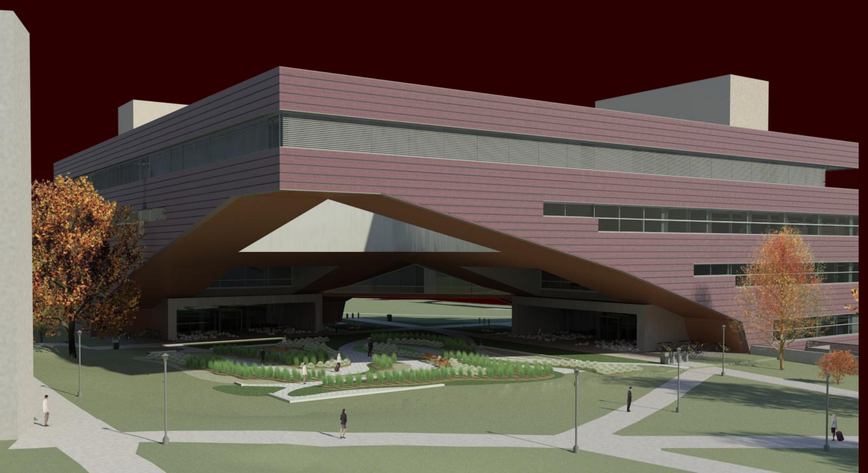


Steel Sequencing 4D Model



KGB Maser
Management Engineering Consulting

Existing Courtyard Design

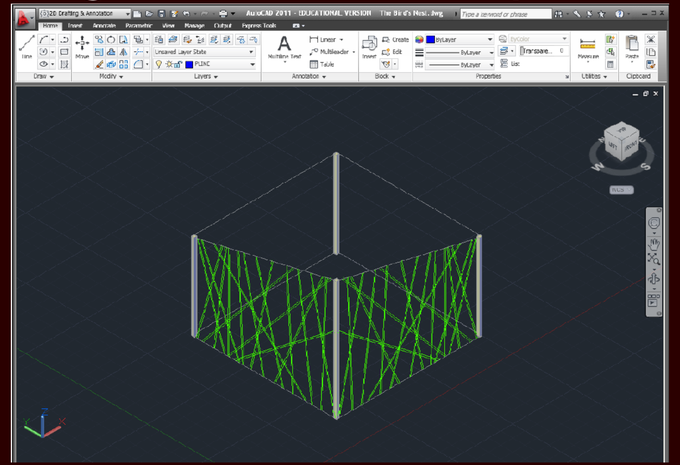


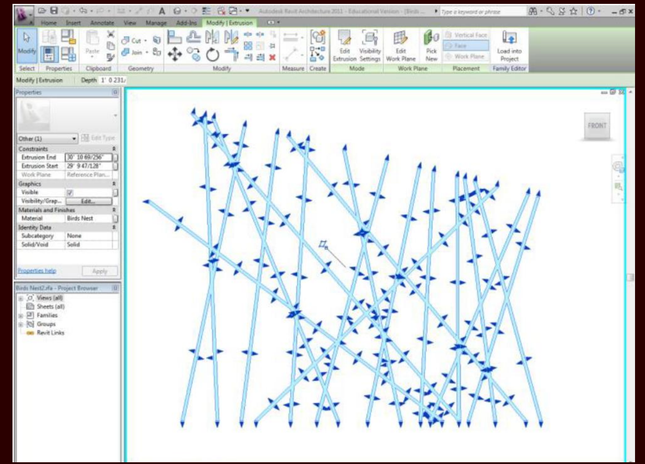
Type	Total	Unit	Cost Total	Cost Unit	Cost
RPC Shrub: Century 1'-10"	244	EA	22	EA	$5,368.00
RPC Shrub: Switchgrass (2) 4'-0"	327	EA	17.1	EA	$5,591.70
Basic Wall: Concrete Panel Wall	214.5	FT	11.45	LF	$2,456.03
Custom Park Bench 6'-0"	5	EA	526.5	EA	$2,632.50
Bicycle Racks	8	EA	649	EA	$5,192.00
Stamped Stone Path	4271.75	SF	17.05	SF	$72,833.34
Mulch	4624.63	SF	2.91	SY	$498.43
Bermuda Ornamental Grass	1298.57	SF	50	SY	$2,404.76
Ground Cover Grass	8487.97	SF	220	MSF	$ 1.867.35
Fern/Boulder Area					
Exposed Aggregate Concrete					
Decorative Pea Gravel					
Decorative Boulders					

Total Including O & P, Waste, Delivery, & Time Modifications = **$271,745.24**

KGB Maser
Management Engineering Consulting

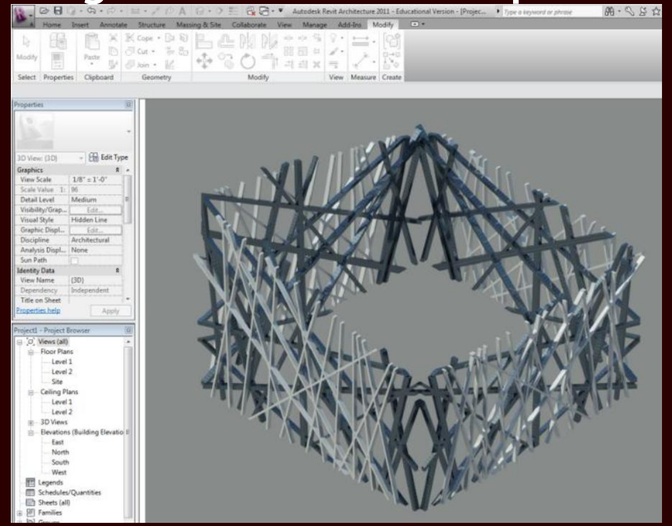
Cage Structure Development

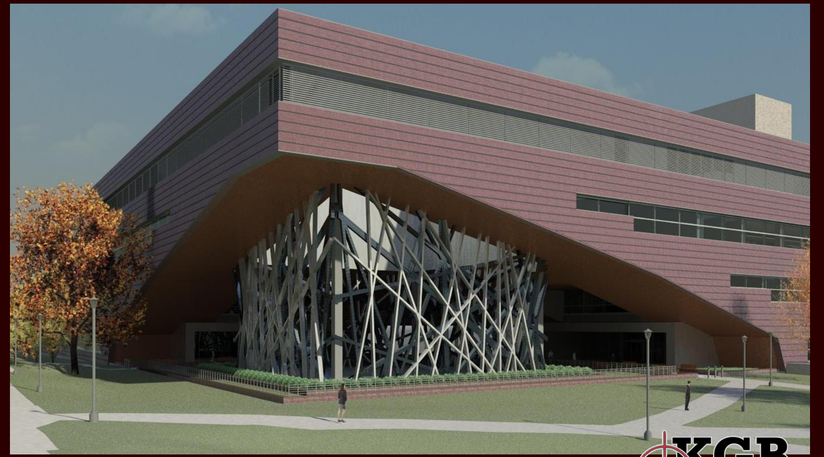




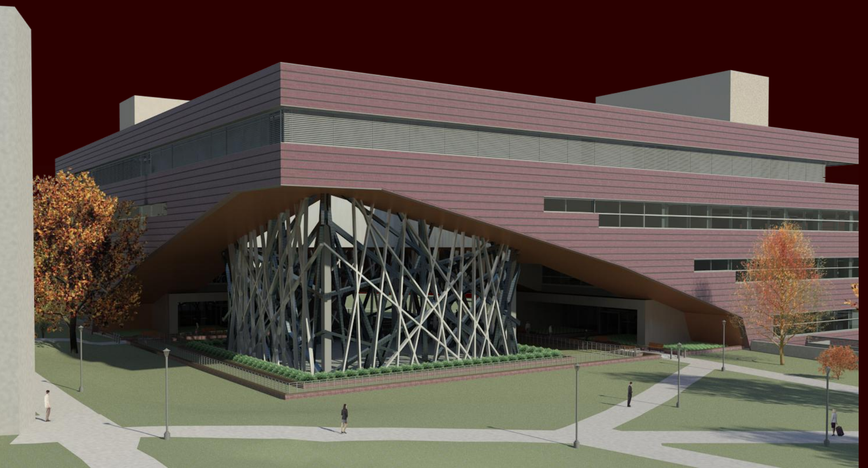
KGB Maser
Management Engineering Consulting

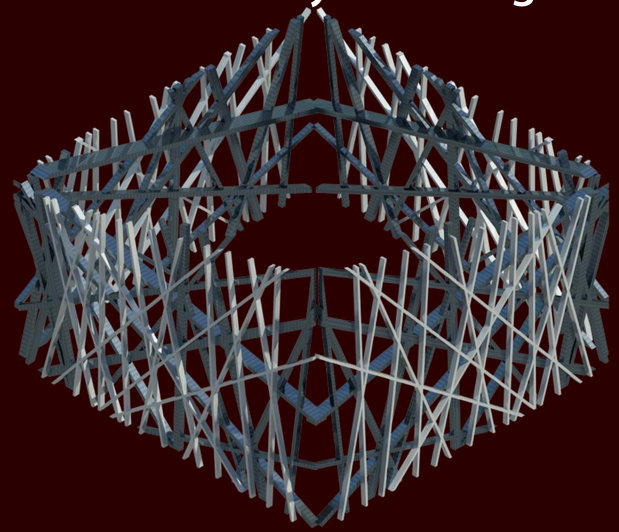
Cage Structure Development

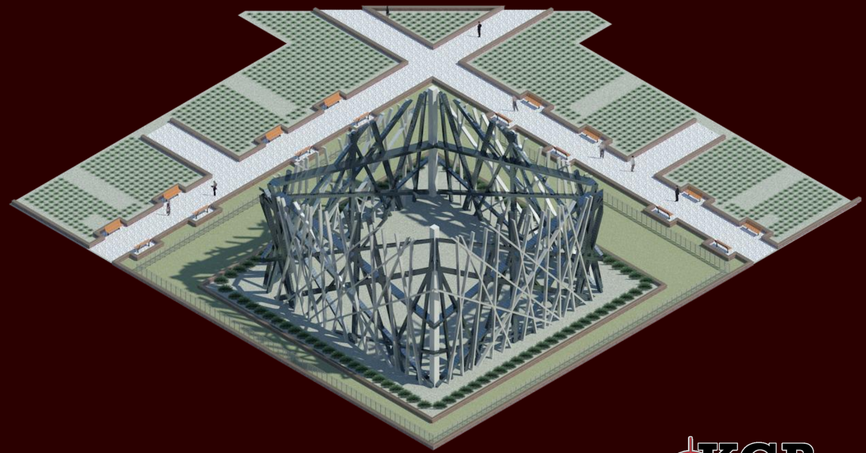




Final Courtyard Design

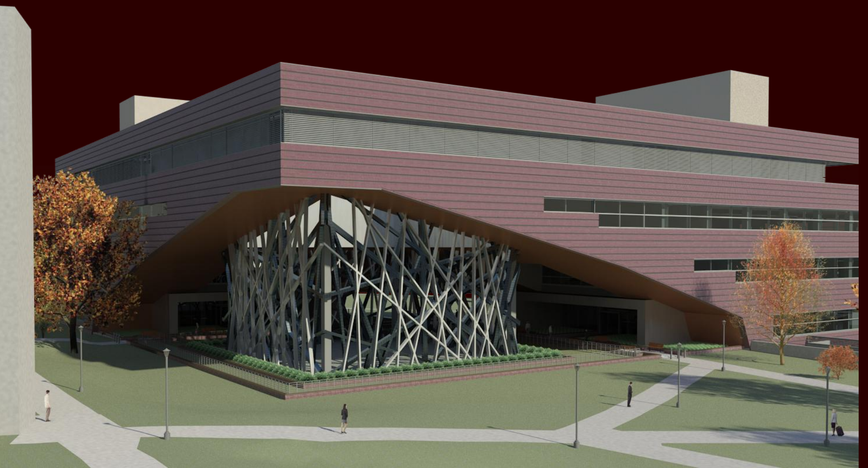






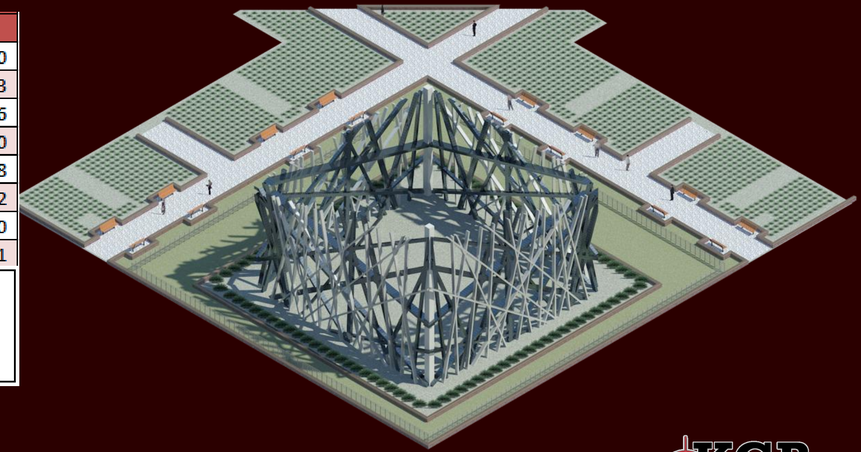
KGB Maser
Management Engineering Consulting

Final Courtyard Design



Type	Total	Unit	Total	Unit	Cost
RPC Shrub: Acacia 3'-6"	101	EA	63.8	EA	$ 6,443.80
RPC Shrub: Fountain Grass 1'-6"	733	EA	21.01	EA	$ 15,400.33
Basic Wall: Courtyard Path Wall	1617.89	LF	12.34	LF	$ 19,964.76
Park Bench 6'-0"	16	EA	448.5	EA	$ 7,176.00
Courtyard Railing	486.5	LF	22.92	LF	$ 11,150.58
Mulch	14492.05	SF	2.91	SY	$ 1,561.92
Cage Structure	1	EA	1	EA	$ 500,000.00
Courtyard Sod	9356.29	SF	265.95	MSF	$ 2,488.31

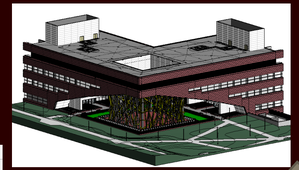
Total Including O & P, Delivery, Waste, & Time Modifications = **$866,984.16**



KGB Maser
Management Engineering Consulting

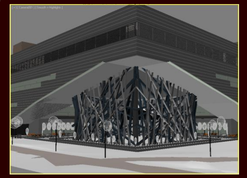
Final Courtyard Design

Lighting

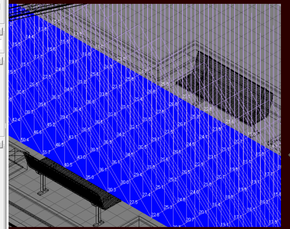


CantileverModel.rvt

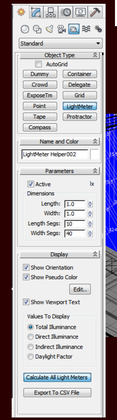
Export from Revit as
Cantilever.fbx;
Import to 3ds Max Design
with File Link Manager

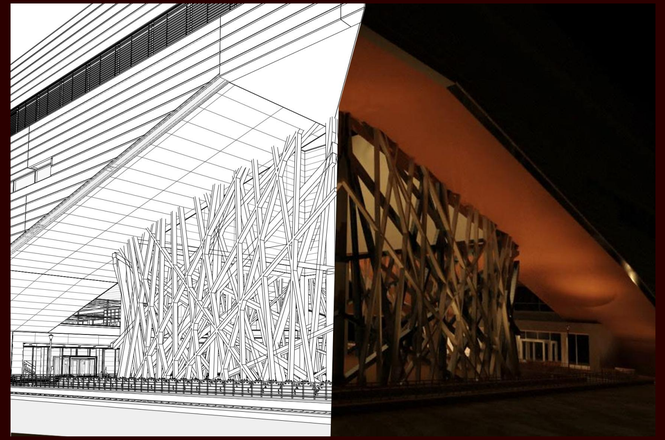


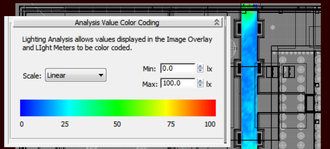
CantileverModel.max

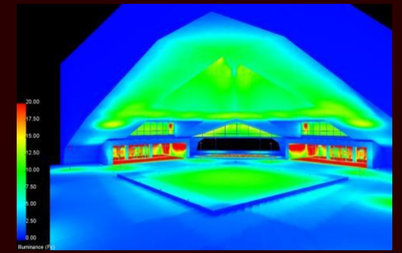


3ds Max Calc Points









Courtyard Illuminance Summary									
Calculation Grid	AGI Illuminance (fc)			3ds Illuminance (fc)			AGI Specific Values		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Max./Min.	Coeff. Of Variation	Uniformity Gradient
Paths	1.10	7.72	63.20	0.102	23.15	59.00	57.45	1.16	3.10
LS Interior Well	1.90	10.32	72.40	Not Measured			38.11	0.59	13.30
LS Exterior Well	1.80	9.33	39.10				21.72	0.41	7.48
MS Interior Well	1.90	9.91	47.60				25.05	0.49	15.03
MS Exterior Well	2.00	9.68	54.10				27.05	0.51	18.03

KGB Maser
Management Engineering Consulting

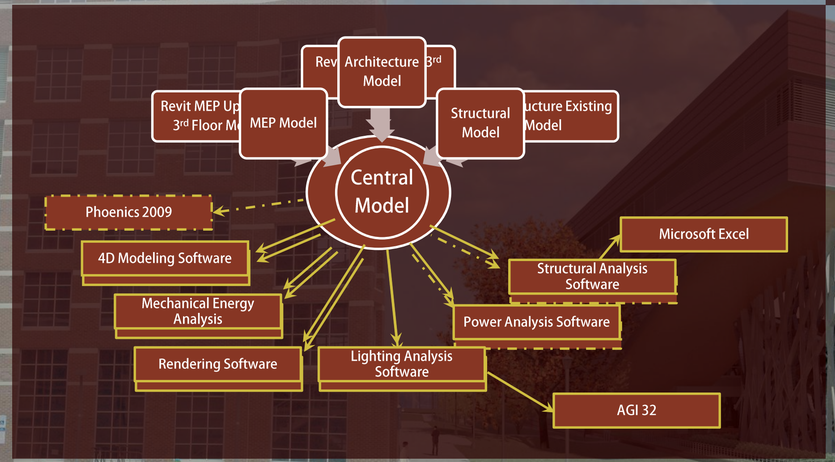
Summary of Cost Implications

SUMMARY OF SYSTEM FIRST COSTS				
	FAÇADE REDESIGN	STRUCTURAL REDESIGN	MECANICAL/ENERGY REDESIGN	COURTYARD REDESIGN
EXISTING COST	$3,295,766	$10,566,550	$19,188,000	$271,745
PROPOSED COST	$3,051,834	$8,275,735	$21,040,000	$604,910
SAVINGS/EXPENSE	$243,932	$2,290,815	$1,852,000	$333,165

TOTAL FIRST COST SAVINGS = $349,582

KGB Maser Management Engineering Consulting

KGB Maser Conclusions

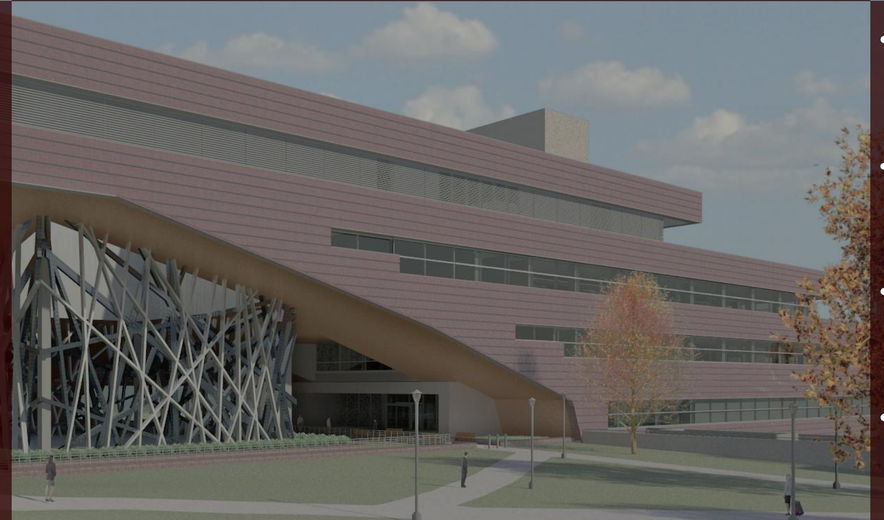


- Decreased energy consumption by 14.2%
- Reduced size and cost of structural system: $2,290,815
- Proposed façade provided marginal operating cost savings and lower initial cost in lighting and structural systems

KGB Maser
Management Engineering Consulting

IPD/BIM Lessons Learned

- Must work consistently in communicative environment
- Challenging to keep uniform group formatting standards
- Need to explain technical reasoning behind each decision to all disciplines



- Adequate time must be allotted for overcoming software design issues
- Not all information can be shared between modeling platforms; intermediate steps must be taken
- A higher level of coordination can be achieved during system designs
- Model sharing is a one way street outside of Revit platforms

KGB Maser
Management Engineering Consulting

Acknowledgements

The Thornton Tomasetti Foundation

The Leonhard Center Penn State

Faculty Advisors
Bob Holland
Andres Lepage
Richard Mistrick
Ted Dannerth
Kevin Parfitt
Jelena Srebric
John Messner
Moses Ling

Whiting Turner
Chris Dolan

Penn State OPP
Dick Harris

Corey Wilkinson

Paul Bowers

Thornton Tomasetti Engineers

Flack & Kurtz MEP Engineers

HOK
John Jackson

SKM Systems Analysis
Johnny Ma
Ruperto Sanchez

BR+A Consulting Engr.
Britt Ellis

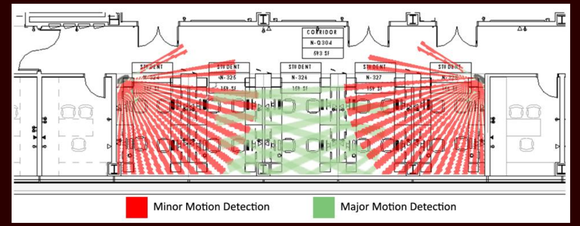
Penn State Students
Ryan Solnosky
Building Stimulus IPD/BIM Team
BIMception IPD/BIM Team
Michael Lucas
Patrick Morgan


Questions and Comments
Thank you for your time
KGB
Maser
Management Engineering Consulting

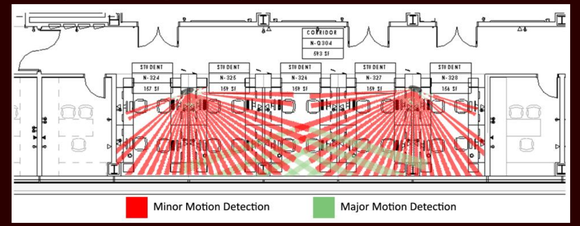
Lighting/Electrical Appendices

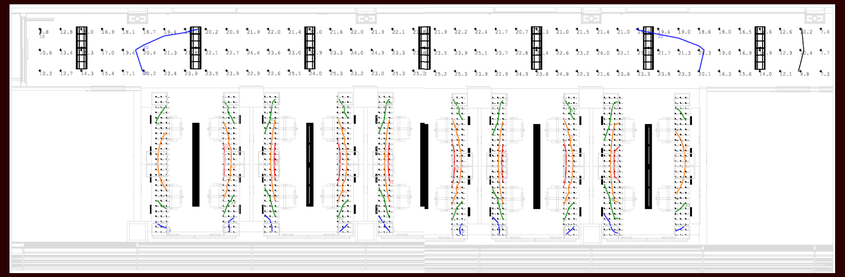
Space 1: Study Area

Study Occupancy Pendant Sensor Coverage



Study Occupancy Task Sensor Coverage



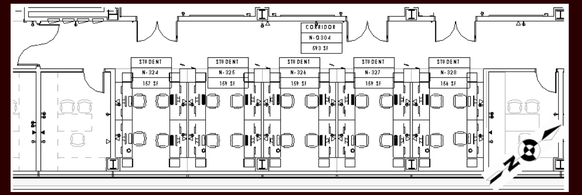


Illuminance Contours

- 10 fc
- 20 fc
- 30 fc
- 40 fc
- 50 fc

Space	Area (ft^2)	Allowable LPD (W/ft^2)	Allowable Power (W)	Total Power Used (W)	Actual LPD (W/ft^2)
Study Area	825.0	1.2	990.0	657.0	0.796
Corridor	657.9	0.5	329.0	224.0	0.681*

Study Area Floor Plan



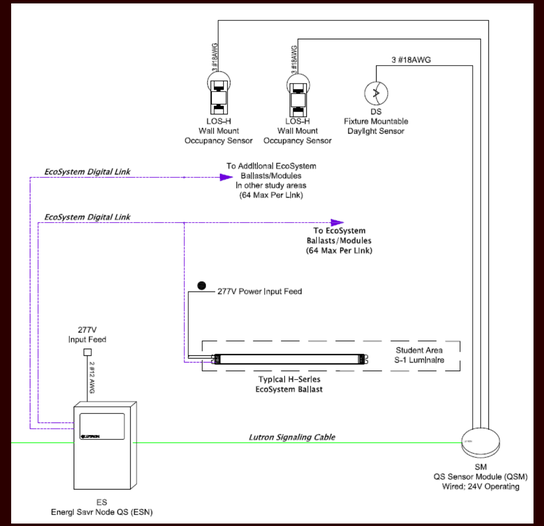
Study Area Luminaires

Lithonia Lighting ES8
ES8P-132-277-(BALLAST)-L841HT8
LiteControl SDx
P-S/D-1824T8-BW-CWM-(BALLAST)-277
Philips Alcko Aris
ARIS-11-40-120-PRL-DWC

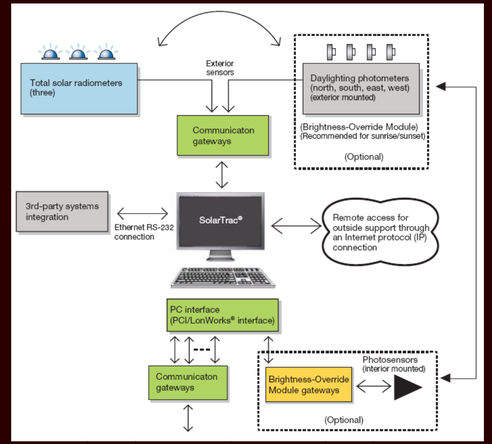
KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

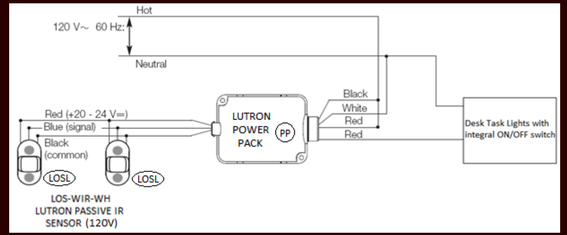
EcoSystem Wiring Diagram



Space 1: Study Area Shading Diagram



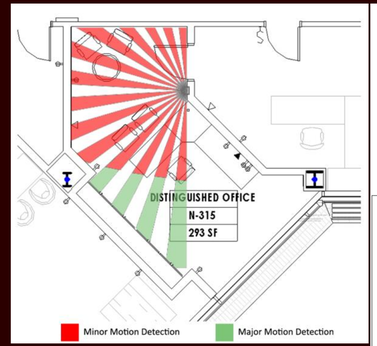
Task Occupancy Sensor Wiring Diagram

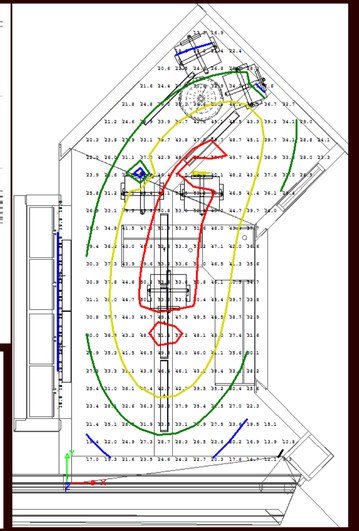


Lighting/Electrical Appendices

Space 2: Perimeter Office

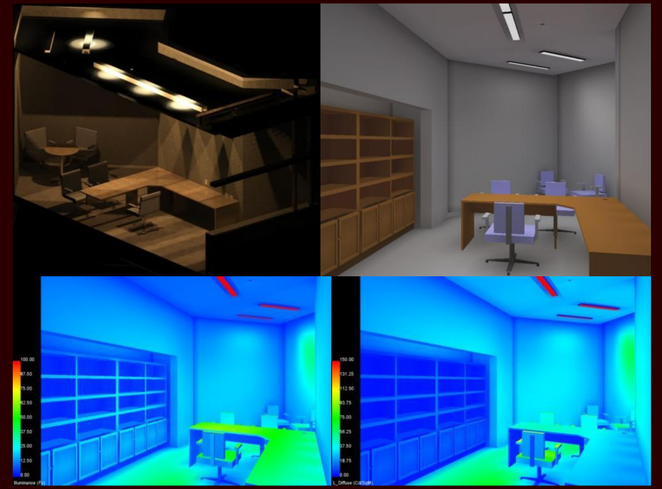
Office Coverage and Contours



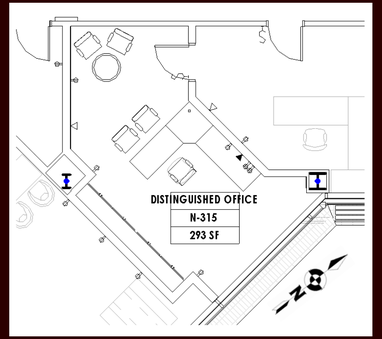


Illuminance Contours

- 10 fc
- 20 fc
- 30 fc
- 40 fc
- 50 fc



Office Floor Plan



Office Luminaires

LiteControl Mod-66
LG-D-66N-2-4-T8-FP-CWM-IND-ECO/ELB-277

LiteControl Mod-66 Chalkboard
W-ADW-66N-1080T8-6044-CWM- -ELB- -277

LiteControl Mod²
LG-WWD-44-1-8-T5HO-CWM-IND-LP/ELB-277

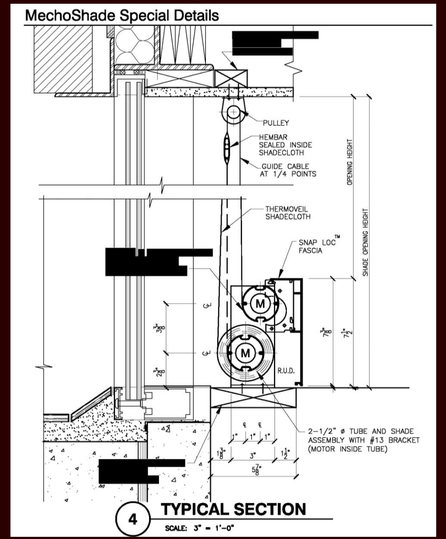
Lighting Type	Area (ft²)	Allowable LPD (W/ft²)	Allowable Power (W)	Total Power Used (W)	Actual LPD (W/ft²)
Office General	262.38	1.1	288.61	262.8	1.00
Decorative	262.38	1.0	262.38	132	0.50

Office Illuminance Summary						
Calculation Grid	Illuminance (fc)			Max./Min.	Coeff. Of Variation	Uniformity Gradient
	Min.	Avg.	Max.			
Horizontal Task	7.60	35.75	53.90	7.09	0.31	4.83
Vertical at Shelves	14.9	19.36	22.10	1.48	0.10	1.17

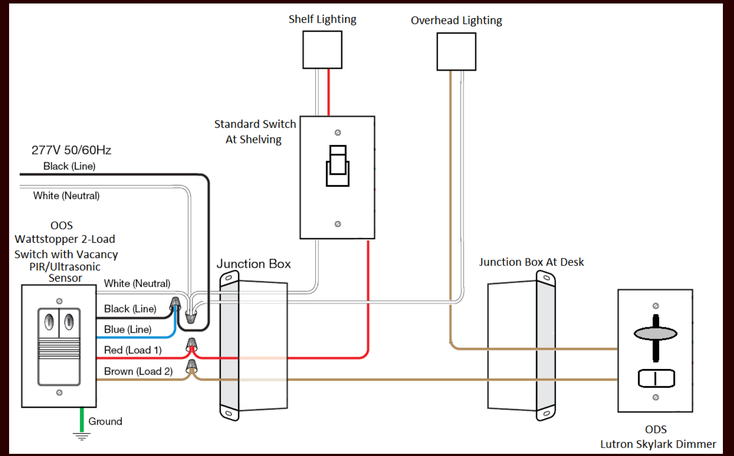
KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Shading Cut Sheet



Space 2: Office Wiring Diagram



Lighting/Electrical Appendices

Space 3: Cantilever Courtyard

Courtyard Luminaires

Deco Lighting D457 Wall Pack
- D457-250-M-MT-CG-BL

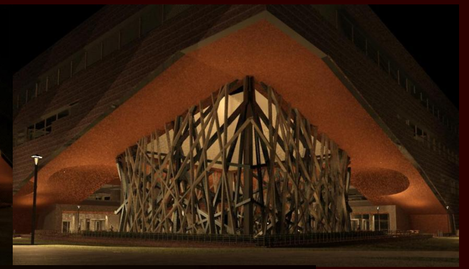
Philips Allscape SL-23
- SL-23-70MH-T6-277- MFLD-F-BK

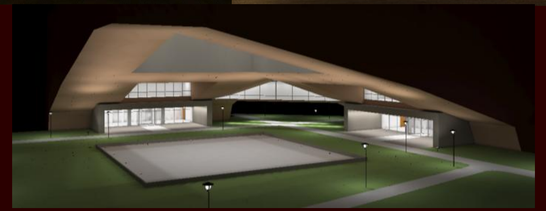
Kim Lighting ALF10 Series
- ALF11/70PMH/277/BL/HDS/FH/BL/SM18BL

Lightolier Calculite HID
- C6P30MHACLW/C6A39P30E2

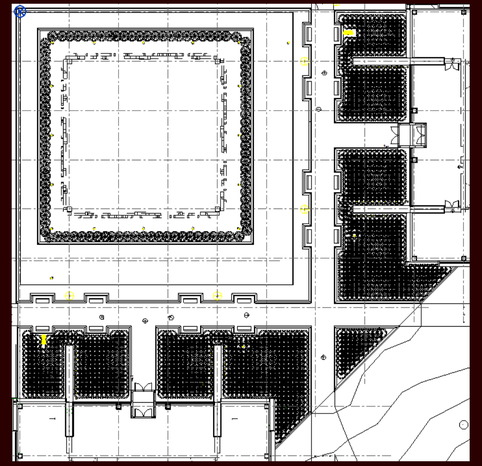
Louis Poulsen Kipp Post
- KIP/1/100W/MH/ED-17/medium/277V/BLK

Kurt Versen Square Aperature
- H8643-SY-LP
- H8460-SW-LP
- H8452-SY-LP





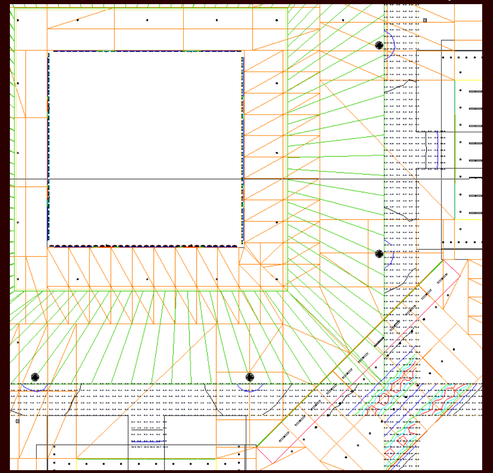
Courtyard Area Floor Plan

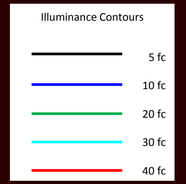


KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Space 3: Cantilever Courtyard Illuminance

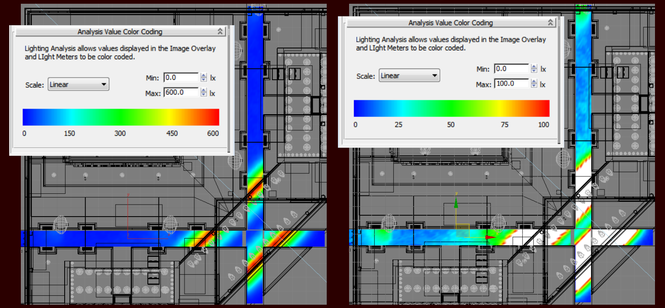




Area Location	Area (ft²)
Walkway	4703.50
Courtyard Grass	7962.42
Courtyard Planting	8877.38
Cantilever Soffit*	14691.73
Light Well Walls	9528.10
Entry Outer Planting	5526.18

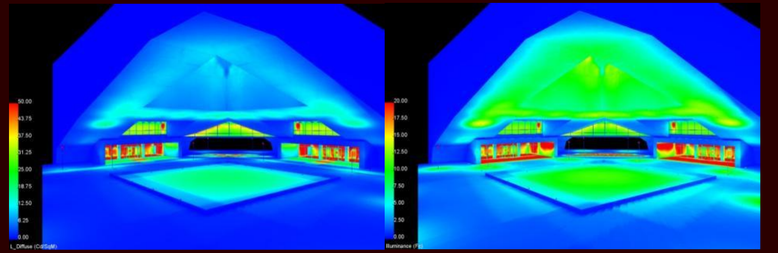
*Area of slope that will be floodlighted

Courtyard 3ds Outputs



Courtyard Illuminance Summary									
Calculation Grid	AGI Illuminance (fc)			3ds Illuminance (fc)			AGI Specific Values		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Max./Min.	Coeff. Of Variation	Uniformity Gradient
Paths	1.10	7.72	63.20	0.102	23.15	59.00	57.45	1.16	3.10
LS Interior Well	1.90	10.32	72.40	Not Measured			38.11	0.59	13.30
LS Exterior Well	1.80	9.33	39.10				21.72	0.41	7.48
MS Interior Well	1.90	9.91	47.60				25.05	0.49	15.03
MS Exterior Well	2.00	9.68	54.10				27.05	0.51	18.03

Courtyard AGI32 Outputs

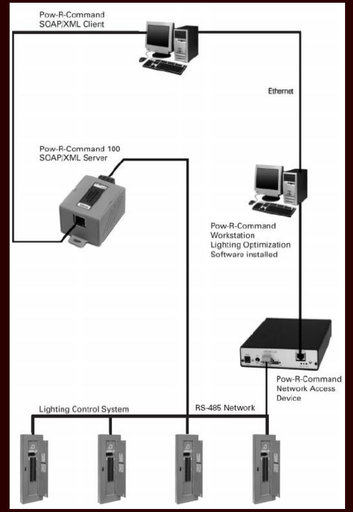


Lighting Type	Area (ft²)	Allowable LPD (W/ft²) or (W/Lf)	Allowable Power (W)**	Total Power Used (W)	Actual LPD (W/ft²)
Building Grounds*	See Area Summary Table Below	1.0 W/Lf	339.5	7191.00 (total redesign — all luminaires)	0.25 (All surfaces redesign is intended to illuminate)
Plaza Areas and Walkways (>10′ Wide)*	See Area Summary Table Below	0.2 W/sq.ft.	N/A		
Canopies and Overhangs*	See Area Summary Table Below	1.25 W/sq.ft	32599.35 to 38044.35		
Building Façades	See Area Summary Table Below	1.25 W/sq.ft.	11910.13 to 24219.83	2176.00 to 3791.00	0.16 to 0.23

*Areas are tradable by ASHRAE Standard 90.1, Table 9.4.5
**Allowable power varies depending upon the classification of the areas in the table below

KGB Maser
Management Engineering Consulting

Courtyard Wiring Diagram



Lighting/Electrical Appendices

Space 3: Courtyard Lighting Control

- Eaton Pow-R-Command lighting control panels with Pow-R-Command 1000 Lighting Optimization Software
- One central workstation and one lighting optimization workstation
- Line-voltage 277V equipment controlled by computer interface and control cabling
- Integrated daylight sensor for day/night automatic overrides
- Controls exterior courtyard space and light well floods

Lighting/Electrical Appendices

Electrical Panelboard Designs: HL-3D

Existing

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: HL-3D		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	200					
277/480, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225					
14,000MIN A.I.C. SYM			In MCC	.		Feed Through:	.	Ground Bus	X					
Neutral: 100%		Number of Poles:		42		TVSS:	.	Isolated Ground Bus						
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT	
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.	
1	*STUDENT LIGHTING*	20	0.83			1	2	1.70			20	*STAFF & FACULTY LTG*	2	
3	*ELECTROACTIVE POLY LTG*	20		1.60		3	4		1.90		20	*STUDENT LIGHTING*	4	
5	*ORGANIC ELEC & PHO LTG*	20			1.60	5	6			1.90	20	*STUDENT LIGHTING*	6	
7	*DRY LAB A&B, STAFF LTG*	20	1.41			7	8	2.20			20	*STAFF LIGHTING*	8	
9	*STAFF ADMIN, KITCHEN LTG*	20		1.23		9	10		1.32		20	*CONFERENCE ROOM LTG*	10	
11	*DRY LAB, MISC. COMP. LTG*	20			1.28	11	12			1.52	20	*CONFERENCE ROOM LTG*	12	
13	*CORRIDOR LIGHTING*	20	1.60			13	14				20	*SPARE*	14	
15	*CORRIDOR LIGHTING*	20		1.54		15	16				20	*SPARE*	16	
17	*CORRIDOR LIGHTING*	20			1.68	17	18				20	*SPARE*	18	
19	*SPARE*	20				19	20				20	*SPARE*	20	
21	*SPARE*	20				21	22				20	*SPARE*	22	
23	*SPARE*	20				23	24				20	*SPARE*	24	
25	*SPARE*	20				25	26				20	*SPARE*	26	
27	*SPARE*	20				27	28				20	*SPARE*	28	
29	*SPARE*	20				29	30				20	*SPARE*	30	
31	*SPARE*	20				31	32				20	*SPARE*	32	
33	*SPARE*	20				33	34				20	*SPARE*	34	
35	*SPARE*	20				35	36				20	*SPARE*	36	
37	*SPARE*	20				37	38				20	*SPARE*	38	
39	*SPARE*	20				39	40				20	*SPARE*	40	
41	*SPARE*	20				41	42				20	*SPARE*	42	
	Subtotals (kVA):		3.84	4.37	4.56			3.90	3.22	3.42		Subtotals (kVA)		
	Total Loads:		Phase A:		7.74 kVA			90.00 %				Demand Factor		
			Phase B:		7.59 kVA			20.98 kVA				Demand Load		
			Phase C:		7.98 kVA			26.22 kVA				Load x 1.25		
	Total Connected Load:				23.31 kVA			31.58 A				AMP		

Panelboard HL-3D Circuit Calculations

Circuit 2

Mark	Quantity	W/Luminaire	Total W	PF	Total VA
DC-1A	8	46.0	368.00	0.98	375.51
NF-1	23	65.0	1495.00	0.99	1510.10
O-1	4	65.7	262.80	0.99	265.45
OS-1	1	70.0	70.00	0.98	71.43
WW-1	1	62.0	62.00	0.98	63.27
Totals:			**2257.80**	**0.99**	**2285.76**

Circuit 4

Mark	Quantity	W/Luminaire	Total W	PF	Total VA
S-1	12	65.7	788.40	0.99	796.36
NF-1	9	65.0	585.00	0.99	590.91
Totals:			**1373.40**	**0.99**	**1387.27**

Circuit 13

Mark	Quantity	W/Luminaire	Total W	PF	Total VA
C-1	14	32.0	448.00	0.98	457.14
DF-8	5	65.0	325.00	0.99	328.28
Totals:			**773.00**	**0.98**	**785.43**

Panelboard					
Tag		HL-3D	HLE-3D	LR-3D1	LCP-1
Voltage System		480Y/277 V	480Y/277 V	208Y/120 V	480Y/277 V
Calculated Design Load (kW)		147.64	169.01	46.94	83.55
Calculated Power Factor		0.807	0.801	0.833	0.81
Calculated Design Load (kVA)		182.94	210.88	56.32	102.58
Calculated Design Load (A)		220.14	253.76	156.44*	123.44
Feeder					
Feeder Protection Size		125 A	150 A	110 A	70 A
Number of Sets		1	1	1	1
Wire Size					
	Phase	(3) 4/0	(3) 250 kcmil	(3) 3/0	(3) #1
	Neutral	(1) 4/0	(1) 250 kcmil	(2) 3/0	(1) #1
	Ground	#6	#6	#6	#8
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.3718	0.4598	0.3117	0.1901
	Total – All Phases	1.1154	1.3788	0.9351	0.5703
	Neutral	0.3718	0.4598	0.6234	0.1901
	Ground	0.0726	0.0726	0.0726	0.0437
	Total – All Wires	1.5598	1.911	1.6311	0.8041
Minimum Conduit Area (Sq. in.) (Above x 2.5)		4.0513	4.9293	4.1395	4.1395
Conduit Size (NEC Chapter 9, Table 4)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Conduit Size (NEC Table C.1)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Feeder Length		207 ft.	25 ft.	140 ft.	140 ft.
Final Voltage Drop (V)		4.80	0.60	1.70	1.70
Final Voltage Drop (%)		1.00%	0.12%	1.4%	1.4%
Feeder Re-sizing		Not Needed	Not Needed	Not Needed	Not Needed

Redesign

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: HL-3D		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	125					
277/480, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225					
14,000MIN A.I.C. SYM			In MCC	.		Feed Through:	.	Ground Bus	X					
Neutral: 100%		Number of Poles:		42		TVSS:	.	Isolated Ground Bus						
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT	
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.	
1	*STUDENT LIGHTING*	20	0.83			1	2	2.29			20	*STAFF & FACULTY LTG*	2	
3	*ELECTROACTIVE POLY LTG*	20		1.60		3	4		1.39		20	*STUDENT LIGHTING*	4	
5	*ORGANIC ELEC & PHO LTG*	20			1.60	5	6			1.90	20	*STUDENT LIGHTING*	6	
7	*DRY LAB A&B, STAFF LTG*	20	1.41			7	8	2.20			20	*STAFF LIGHTING*	8	
9	*STAFF ADMIN, KITCHEN LTG*	20		1.23		9	10		1.32		20	*CONFERENCE ROOM LTG*	10	
11	*DRY LAB, MISC. COMP. LTG*	20			1.28	11	12			1.52	20	*CONFERENCE ROOM LTG*	12	
13	*CORRIDOR LIGHTING*	20	0.79			13	14	3.50			20	*SPARE*	14	
15	*CORRIDOR LIGHTING*	20		1.54		15	16		3.50		20	*SPARE*	16	
17	*CORRIDOR LIGHTING*	20			1.68	17	18			3.50	20	*SPARE*	18	
19	*SPARE*	20	3.50			19	20	3.50			20	*SPARE*	20	
21	*SPARE*	20		3.50		21	22		3.50		20	*SPARE*	22	
23	*SPARE*	20			3.50	23	24			3.50	20	*SPARE*	24	
25	*SPARE*	20	3.50			25	26	3.50			20	*SPARE*	26	
27	*SPARE*	20		3.50		27	28		3.50		20	*SPARE*	28	
29	*SPARE*	20			3.50	29	30			3.50	20	*SPARE*	30	
31	*SPARE*	20	3.50			31	32	3.50			20	*SPARE*	32	
33	*SPARE*	20		3.50		33	34		3.50		20	*SPARE*	34	
35	*SPARE*	20			3.50	35	36			3.50	20	*SPARE*	36	
37	*SPARE*	20	3.50			37	38	3.50			20	*SPARE*	38	
39	*SPARE*	20		3.50		39	40		3.50		20	*SPARE*	40	
41	*SPARE*	20			3.50	41	42			3.50	20	*SPARE*	42	
	Subtotals (kVA):		17.03	18.37	18.56			21.99	20.21	20.92		Subtotals (kVA)		
	Total Loads:		Phase A:		39.02 kVA			65.78 %				Demand Factor (worksheet)		
			Phase B:		38.58 kVA			77.02 kVA				Demand Load		
			Phase C:		39.48 kVA			96.27 kVA				Load x 1.25		
	Total Connected Load:				117.08 kVA			115.93 A				AMP		

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: HLE-3D

Existing

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: HLE-3D		Mounting:	Surface:		X		Main Lugs Only:		.	Amp Main CB					100
277/480, 3 Phase, 4 Wire			Flush:		.		Shunt Trip Main:		.	Amp Bus					225
14,000MIN A.I.C. SYM			In MCC		.		Feed Through:		.	Ground Bus					X
Neutral: 100%		Number of Poles:			42		TVSS:		.	Isolated Ground Bus					.
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT		
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.		
1	*EXIT SIGN*	20	0.10			1	2	1.02				*STAIR N-1 LIGHTING*	2		
3	*TOILET & CORRIDOR LTG*	20		2.16		3	4		1.45			*STAIR N-1 LIGHTING*	4		
5	*OFFICE LIGHTING*	20			2.30	5	6					*SPARE*	6		
7	*SPARE*	20				7	8					*SPARE*	8		
9	*SPARE*	20				9	10					*SPARE*	10		
11	*SPARE*	20				11	12					*SPARE*	12		
13	*SPARE*	20				13	14					*SPARE*	14		
15	*SPARE*	20				15	16					*SPARE*	16		
17	*SPARE*	20				17	18					*SPARE*	18		
19	*SPARE*	20				19	20					*SPARE*	20		
21	*SPARE*	20				21	22					*SPARE*	22		
23	*SPARE*	20				23	24					*SPARE*	24		
25	*SPARE*	20				25	26					*SPARE*	26		
27	*SPARE*	20				27	28					*SPARE*	28		
29	*SPARE*	20				29	30					*SPARE*	30		
31	*SPARE*	20				31	32					*SPARE*	32		
33	*SPARE*	20				33	34					*SPARE*	34		
35	*SPARE*	20				35	36					*SPARE*	36		
37	*PENEL LE-3D VIA*	50	4.94			37	38					*SPARE*	38		
39	*XFMR 'TRE-LE-3D'*			3.80		39	40					*SPARE*	40		
41	*(50G)*	3P			3.80	41	42					*SPARE*	42		
	Subtotals (kVA):		5.04	5.96	6.10			1.02	1.45	0.00		Subtotals (kVA)			
	Total Loads:		Phase A:		6.06 kVA				60.00 %			Demand Factor			
			Phase B:		7.41 kVA				11.74 kVA			Demand Load			
			Phase C:		6.10 kVA				14.68 kVA			Load x 1.25			
	Total Connected Load:				19.6 kVA				17.68 A			AMP			

Panelboard HLE-3D Circuit Calculations

Circuit 3

Mark	Quantity	W/Luminaire	Total W	PF	Total VA
C-1	20	32.0	640.00	0.99	646.46
NF-4	2	65.0	130.00	0.98	132.65
SC-2	4	20.0	80.00	0.98	81.63
NF-5	3	65.0	195.00	0.99	196.97
		Totals:	**1045.00**	**0.99**	**1057.72**

Panelboard					
Tag		HL-3D	HLE-3D	LR-3D1	LCP-1
Voltage System		480Y/277 V	480Y/277 V	208Y/120 V	480Y/277 V
Calculated Design Load (kW)		147.64	169.01	46.94	83.55
Calculated Power Factor		0.807	0.801	0.833	0.81
Calculated Design Load (kVA)		182.94	210.88	56.32	102.58
Calculated Design Load (A)		220.14	253.76	156.44*	123.44
Feeder					
Feeder Protection Size		125 A	150 A	110 A	70 A
Number of Sets		1	1	1	1
Wire Size					
	Phase	(3) 4/0	(3) 250 kcmil	(3) 3/0	(3) #1
	Neutral	(1) 4/0	(1) 250 kcmil	(2) 3/0	(1) #1
	Ground	#6	#6	#6	#8
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.3718	0.4598	0.3117	0.1901
	Total – All Phases	1.1154	1.3788	0.9351	0.5703
	Neutral	0.3718	0.4598	0.6234	0.1901
	Ground	0.0726	0.0726	0.0726	0.0437
	Total – All Wires	1.5598	1.911	1.6311	0.8041
Minimum Conduit Area (Sq. in.) (Above x 2.5)		4.0513	4.9293	4.1395	4.1395
Conduit Size (NEC Chapter 9, Table 4)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Conduit Size (NEC Table C.1)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Feeder Length		207 ft.	25 ft.	140 ft.	140 ft.
Final Voltage Drop (V)		4.80	0.60	1.70	1.70
Final Voltage Drop (%)		1.00%	0.12%	1.4%	1.4%
Feeder Re-sizing		Not Needed	Not Needed	Not Needed	Not Needed

Redesign

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: HLE-3D		Mounting:	Surface:		X		Main Lugs Only:		.	Amp Main CB					150
277/480, 3 Phase, 4 Wire			Flush:		.		Shunt Trip Main:		.	Amp Bus					225
14,000MIN A.I.C. SYM			In MCC		.		Feed Through:		.	Ground Bus					X
Neutral: 100%		Number of Poles:			42		TVSS:		.	Isolated Ground Bus					.
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT		
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.		
1	*EXIT SIGN*	20	0.10			1	2	1.02				*STAIR N-1 LIGHTING*	2		
3	*TOILET & CORRIDOR LTG*	20		1.06		3	4		1.45			*STAIR N-1 LIGHTING*	4		
5	*OFFICE LIGHTING*	20			2.30	5	6			3.50		*SPARE*	6		
7	*SPARE*	20	3.50			7	8	3.50				*SPARE*	8		
9	*SPARE*	20		3.50		9	10		3.50			*SPARE*	10		
11	*SPARE*	20			3.50	11	12			3.50		*SPARE*	12		
13	*SPARE*	20	3.50			13	14	3.50				*SPARE*	14		
15	*SPARE*	20		3.50		15	16		3.50			*SPARE*	16		
17	*SPARE*	20			3.50	17	18			3.50		*SPARE*	18		
19	*SPARE*	20	3.50			19	20	3.50				*SPARE*	20		
21	*SPARE*	20		3.50		21	22		3.50			*SPARE*	22		
23	*SPARE*	20			3.50	23	24			3.50		*SPARE*	24		
25	*SPARE*	20	3.50			25	26	3.50				*SPARE*	26		
27	*SPARE*	20		3.50		27	28		3.50			*SPARE*	28		
29	*SPARE*	20			3.50	29	30			3.50		*SPARE*	30		
31	*SPARE*	20	3.50			31	32	3.50				*SPARE*	32		
33	*SPARE*	20		3.50		33	34		3.50			*SPARE*	34		
35	*SPARE*	20			3.50	35	36			3.50		*SPARE*	36		
37	*PENEL LE-3D VIA*	50	4.94			37	38	3.50				*SPARE*	38		
39	*XFMR 'TRE-LE-3D'*			3.80		39	40		3.50			*SPARE*	40		
41	*(50G)*	3P			3.80	41	42			3.50		*SPARE*	42		
	Subtotals (kVA):		22.54	22.36	23.60			22.02	22.45	24.50		Subtotals (kVA)			
	Total Loads:		Phase A:		44.56 kVA				61.27 %			Demand Factor (worksheet)			
			Phase B:		44.81 kVA				84.23 kVA			Demand Load			
			Phase C:		48.10 kVA				105.28 kVA			Load x 1.25			
	Total Connected Load:				137.5 kVA				126.79 A			AMP			

KGB Maser Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: LR-3D1

Existing

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: LR-3D1		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	225						
120/208, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225						
10,000MIN A.I.C. SYM			In MCC	.		Feed Through:	X	Ground Bus	X						
Neutral: 200%		Number of Poles:		42		TVSS:	.	Isolated Ground Bus	X						
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT		
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.		
1	*P.C. RECEPTACLE*	20	0.80			1	2	0.80			20	*P.C. RECEPTACLE*	2		
3	*RECEPTACLE*	20		1.08		3	4		0.80		20	*P.C. RECEPTACLE*	4		
5	*P.C. RECEPTACLE*	20			0.80	5	6			0.80	20	*P.C. RECEPTACLE*	6		
7	*RECEPTACLE*	20	1.08			7	8	0.80			20	*P.C. RECEPTACLE*	8		
9	*P.C. RECEPTACLE*	20		0.80		9	10		0.80		20	*P.C. RECEPTACLE*	10		
11	*RECEPTACLE*	20			0.54	11	12			0.80	20	*P.C. RECEPTACLE*	12		
13	*P.C. RECEPTACLE*	20	0.80			13	14	0.80			20	*P.C. RECEPTACLE*	14		
15	*SPARE*	20				15	16		0.80		20	*P.C. RECEPTACLE*	16		
17	*P.C. RECEPTACLE*	20			1.16	17	18			0.80	20	*P.C. RECEPTACLE*	18		
19	*RECEPTACLE*	20	1.08			19	20	0.80			20	*P.C. RECEPTACLE*	20		
21	*P.C. RECEPTACLE*	20		0.72		21	22		0.80		20	*CLEANING RECEPTACLE*	22		
23	*P.C. RECEPTACLE*	20			0.90	23	24			0.80	20	*CLEANING RECEPTACLE*	24		
25	*P.C. RECEPTACLE*	20	0.72			25	26	0.80			20	*CLEANING RECEPTACLE*	26		
27	*RECEPTACLE*	20		0.72		27	28		0.80		20	*CLEANING RECEPTACLE*	28		
29	*P.C. RECEPTACLE*	20			0.40	29	30				20	*SPARE*	30		
31	*RECEPTACLE*	20	0.36			31	32				20	*SPARE*	32		
33	*RECEPTACLE*	20		0.72		33	34				20	*SPARE*	34		
35	*SPARE*	20				35	36				20	*SPARE*	36		
37	*SPARE*	20				37	38				20	*SPARE*	38		
39	*SPARE*	20				39	40				20	*SPARE*	40		
41	*SPARE*	20				41	42				20	*SPARE*	42		
	Subtotals (kVA):		4.84	4.04	3.80			4.00	4.00	3.20		Subtotals (kVA)			
	Total Loads:		Phase A:	8.84	kVA			60.00	%			Demand Factor			
			Phase B:	8.04	kVA			14.33	kVA			Demand Load			
			Phase C:	7.00	kVA			17.91	kVA			Load x 1.25			
	Total Connected Load:			23.88	kVA			49.77	A			AMP			

Panelboard LR-3D1 Circuit Calculations					
Circuit 30					
Mark	Quantity	W/Luminaire	Total W	PF	Total VA
T-1	96	6.0	576.00	0.99	581.82
		Totals:	576.00	0.99	581.82

Panelboard					
Tag		HL-3D	HLE-3D	LR-3D1	LCP-1
Voltage System		480Y/277 V	480Y/277 V	208Y/120 V	480Y/277 V
Calculated Design Load (kW)		147.64	169.01	46.94	83.55
Calculated Power Factor		0.807	0.801	0.833	0.81
Calculated Design Load (kVA)		182.94	210.88	56.32	102.58
Calculated Design Load (A)		220.14	253.76	156.44*	123.44
Feeder					
Feeder Protection Size		125 A	150 A	110 A	70 A
Number of Sets		1	1	1	1
Wire Size					
	Phase	(3) 4/0	(3) 250 kcmil	(3) 3/0	(3) #1
	Neutral	(1) 4/0	(1) 250 kcmil	(2) 3/0	(1) #1
	Ground	#6	#6	#6	#8
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.3718	0.4598	0.3117	0.1901
	Total – All Phases	1.1154	1.3788	0.9351	0.5703
	Neutral	0.3718	0.4598	0.6234	0.1901
	Ground	0.0726	0.0726	0.0726	0.0437
	Total – All Wires	1.5598	1.911	1.6311	0.8041
Minimum Conduit Area (Sq. in.) (Above x 2.5)		4.0513	4.9293	4.1395	4.1395
Conduit Size (NEC Chapter 9, Table 4)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Conduit Size (NEC Table C.1)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Feeder Length		207 ft.	25 ft.	140 ft.	140 ft.
Final Voltage Drop (V)		4.80	0.60	1.70	1.70
Final Voltage Drop (%)		1.00%	0.12%	1.4%	1.4%
Feeder Re-sizing		Not Needed	Not Needed	Not Needed	Not Needed

Redesign

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: LR-3D1		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	110						
120/208, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225						
10,000MIN A.I.C. SYM			In MCC	.		Feed Through:	X	Ground Bus	X						
Neutral: 200%		Number of Poles:		42		TVSS:		Isolated Ground Bus	X						
CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT		
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.		
1	*P.C. RECEPTACLE*	20	0.80			1	2	0.80			20	*P.C. RECEPTACLE*	2		
3	*RECEPTACLE*	20		1.08		3	4		0.80		20	*P.C. RECEPTACLE*	4		
5	*P.C. RECEPTACLE*	20			0.80	5	6			0.80	20	*P.C. RECEPTACLE*	6		
7	*RECEPTACLE*	20	1.08			7	8	0.80			20	*P.C. RECEPTACLE*	8		
9	*P.C. RECEPTACLE*	20		0.80		9	10		0.80		20	*P.C. RECEPTACLE*	10		
11	*RECEPTACLE*	20			0.54	11	12			0.80	20	*P.C. RECEPTACLE*	12		
13	*P.C. RECEPTACLE*	20	0.80			13	14	0.80			20	*P.C. RECEPTACLE*	14		
15	*SPARE*	20		1.50		15	16		0.80		20	*P.C. RECEPTACLE*	16		
17	*P.C. RECEPTACLE*	20			1.16	17	18			0.80	20	*P.C. RECEPTACLE*	18		
19	*RECEPTACLE*	20	1.08			19	20	0.80			20	*P.C. RECEPTACLE*	20		
21	*P.C. RECEPTACLE*	20		0.72		21	22		0.80		20	*CLEANING RECEPTACLE*	22		
23	*P.C. RECEPTACLE*	20			0.90	23	24			0.80	20	*CLEANING RECEPTACLE*	24		
25	*P.C. RECEPTACLE*	20	0.72			25	26	0.80			20	*CLEANING RECEPTACLE*	26		
27	*RECEPTACLE*	20		0.72		27	28		0.80		20	*CLEANING RECEPTACLE*	28		
29	*P.C. RECEPTACLE*	20			0.40	29	30			0.72	20	*STUDY AREA TASK LIGHTING*	30		
31	*RECEPTACLE*	20	0.36			31	32	1.50			20	*SPARE*	32		
33	*RECEPTACLE*	20		0.72		33	34		1.50		20	*SPARE*	34		
35	*SPARE*	20			1.50	35	36			1.50	20	*SPARE*	36		
37	*SPARE*	20	1.50			37	38	1.50			20	*SPARE*	38		
39	*SPARE*	20		1.50		39	40		1.50		20	*SPARE*	40		
41	*SPARE*	20			1.50	41	42			1.50	20	*SPARE*	42		
	Subtotals (kVA):		6.34	7.04	6.80			7.00	7.00	6.92		Subtotals (kVA)			
	Total Loads:		Phase A:	13.34	kVA			72.74	%			Demand Factor (worksheet)			
			Phase B:	14.04	kVA			29.90	kVA			Demand Load			
			Phase C:	13.72	kVA			37.37	kVA			Load x 1.25			
	Total Connected Load:			41.10	kVA			103.85	A			AMP			

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: LCP-1

Existing

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: LCP-1		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	.
277/480, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225
14,000MIN A.I.C. SYM			In MCC	.		Feed Through:	.	Ground Bus	.
Neutral: 100%		Number of Poles:		42		TVSS:	.	Isolated Ground Bus	.

CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.
1	*ZONE 1 LS LOBBY LTG	20	0.42					0.72			20	ZONE 18 SITE LIGHTING*	2
3	SPARE	20							0.24		20	ZONE 19 SITE LIGHTING*	4
5	*ZONE 3 EXTERIOR LTG	20			1.40					0.24	20	ZONE 20 SITE LIGHTING*	6
7	*ZONE 4 LS LOBBY LTG	20	0.31					0.36			20	ZONE 21 SITE LIGHTING*	8
9	*ZONE 5 LS LOBBY LTG	20		0.56					0.70		20	ZONE 22 SITE LIGHTING	10
11	*ZONE 6 EXTERIOR LTG	20			1.25						20	SPARE	12
13	*ZONE 7 ML LOBBY LTG	20	0.84					0.38			20	ZONE 24 SITE LIGHTING*	14
15	*ZONE 8 ML LOBBY LTG	20		0.56							20	SPARE	16
17	*ZONE 9 EXTERIOR LTG	20			1.40					0.40	20	ZONE 26 SITE LIGHTING*	18
19	SPARE	20						0.05			20	ZONE 27 SITE LIGHTING*	20
21	*ZONE 11 EXTERIOR LTG	20		1.25					0.40		20	ZONE 28 SITE LIGHTING*	22
23	*ZONE 12 ML LOBBY LTG	20			0.31					0.27	20	ZONE 29 EXTERIOR LTG*	24
25	*ZONE 13 EXTERIOR LTG	20	0.63					0.27			20	ZONE 30 EXTERIOR LTG*	26
27	*ZONE 14 EXTERIOR LTG	20		0.84					0.23		20	ZONE 31 EXTERIOR LTG*	28
29	*ZONE 15 SITE LIGHTING	20			1.70					0.20	20	ZONE 32 EXTERIOR LTG*	30
31	*ZONE 16 SITE LIGHTING	20	1.40					0.23			20	ZONE 33 EXTERIOR LTG*	32
33	*ZONE 17 SITE LILGHTING	20		1.60					0.27		20	ZONE 34 EXTERIOR LTG*	34
35	*ZONE 35 ML LOBBY LTG	20			0.46					0.42	20	ZONE 36 LS LOBBY LTG	36
37	SPARE	20									20	SPARE	38
39	SPARE	20									20	SPARE	40
41	SPARE	20									20	SPARE	42
	Subtotals (kVA):		3.60	4.81	6.52			2.01	1.84	1.53		Subtotals (kVA)	
	Total Loads:		Phase A:		5.61 kVA				80.00 %			Demand Factor	
			Phase B:		6.65 kVA				16.25 kVA			Demand Load	
			Phase C:		8.05 kVA				20.31 kVA			Load x 1.25	
	Total Connected Load:				20.31 kVA				24.46 A			AMP	

REMARKS: * - DENOTES REMOTE CONTROL BREAKER

Panelboard LR-3D1 Circuit Calculations

Mark	Quantity	V/Luminaire	Total W	PF	Total VA
Circuit 5 - Zone 3 Exterior					
UL-1	19	85.0	1615.00	0.90	1794.44
UL-2	2	85	170.00	0.9	188.89
Totals:			**1615.00**	**0.90**	**1794.44**
Circuit 11 - Zone 6 Exterior					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
XWM-1	20	48.0	960.00	0.90	1066.67
Totals:			**960.00**	**0.90**	**1066.67**
Circuit 17 - Zone 9 Exterior					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
FL-1	8	272.0	2176.00	0.90	2417.78
Totals:			**2176.00**	**0.90**	**2417.78**
Circuit 18 - Zone 26 Site					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
XPO-1	4	118.0	472.00	0.90	524.44
Totals:			**472.00**	**0.90**	**524.44**
Circuit 21 - Zone 11 Exterior					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
XWM-1	20	48.0	960.00	0.90	1066.67
Totals:			**960.00**	**0.90**	**1066.67**
Circuit 25 - Zone 13 Exterior					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
XAM-1	12	48.0	576.00	0.90	640.00
Totals:			**576.00**	**0.90**	**640.00**
Circuit 27 - Zone 14 Exterior					
Mark	Quantity	V/Luminaire	Total W	PF	Total VA
XAM-1	9	48.0	432.00	0.90	480.00
Totals:			**432.00**	**0.90**	**480.00**

Panelboard

Tag		HL-3D	HLE-3D	LR-3D1	LCP-1
Voltage System		480Y/277 V	480Y/277 V	208Y/120 V	480Y/277 V
Calculated Design Load (kW)		147.64	169.01	46.94	83.55
Calculated Power Factor		0.807	0.801	0.833	0.81
Calculated Design Load (kVA)		182.94	210.88	56.32	102.58
Calculated Design Load (A)		220.14	253.76	156.44*	123.44
Feeder					
Feeder Protection Size		125 A	150 A	110 A	70 A
Number of Sets		1	1	1	1
Wire Size					
	Phase	(3) 4/0	(3) 250 kcmil	(3) 3/0	(3) #1
	Neutral	(1) 4/0	(1) 250 kcmil	(2) 3/0	(1) #1
	Ground	#6	#6	#6	#8
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.3718	0.4598	0.3117	0.1901
	Total – All Phases	1.1154	1.3788	0.9351	0.5703
	Neutral	0.3718	0.4598	0.6234	0.1901
	Ground	0.0726	0.0726	0.0726	0.0437
	Total – All Wires	1.5598	1.911	1.6311	0.8041
Minimum Conduit Area (Sq. in.) (Above x 2.5)		4.0513	4.9293	4.1395	4.1395
Conduit Size (NEC Chapter 9, Table 4)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Conduit Size (NEC Table C.1)		2.50" EMT	2.50" EMT	2.50" EMT	2.50" EMT
Feeder Length		207 ft.	25 ft.	140 ft.	140 ft.
Final Voltage Drop (V)		4.80	0.60	1.70	1.70
Final Voltage Drop (%)		1.00%	0.12%	1.4%	1.4%
Feeder Re-sizing		Not Needed	Not Needed	Not Needed	Not Needed

Redesign

BRANCH CIRCUIT PANELBOARD SCHEDULE

Panel Name: LCP-1		Mounting:	Surface:	X		Main Lugs Only:	.	Amp Main CB	.
277/480, 3 Phase, 4 Wire			Flush:	.		Shunt Trip Main:	.	Amp Bus	225
14,000MIN A.I.C. SYM			In MCC	.		Feed Through:	.	Ground Bus	.
Neutral: 100%		Number of Poles:		42		TVSS:	.	Isolated Ground Bus	.

CKT	Load	TRIP	KVA/Phase			Poles	Poles	KVA/Phase			TRIP	Load	CKT
No.		(Amp)	A	B	C			A	B	C	(Amp)		No.
1	*ZONE 1 LS LOBBY LTG	20	0.42			1	2	0.72			20	ZONE 18 SITE LIGHTING*	2
3	SPARE	20		3.50		3	4		3.50		20	SPARE	4
5	*ZONE 3 COURTYARD UPLT	20			1.79	5	6			0.24	20	ZONE 20 SITE LIGHTING*	6
7	*ZONE 4 LS LOBBY LTG	20	0.31			7	8	3.50			20	SPARE	8
9	*ZONE 5 LS LOBBY LTG	20		0.56		9	10		0.70		20	ZONE 22 SITE LIGHTING	10
11	*ZONE 6 EXTERIOR LTG	20			1.07	11	12			3.50	20	SPARE	12
13	*ZONE 7 ML LOBBY LTG	20	0.84			13	14	3.50			20	SPARE	14
15	*ZONE 8 ML LOBBY LTG	20		0.56		15	16		3.50		20	SPARE	16
17	*ZONE 9 LIGHT WELL FLOOD	20			2.42	17	18			0.52	20	ZONE 26 COURTYARD SITE*	18
19	SPARE	20	3.50			19	20	0.05			20	ZONE 27 SITE LIGHTING*	20
21	*ZONE 11 EXTERIOR LTG	20		1.07		21	22		0.40		20	ZONE 28 SITE LIGHTING*	22
23	*ZONE 12 ML LOBBY LTG	20			0.31	23	24			0.27	20	ZONE 29 EXTERIOR LTG*	24
25	*ZONE 13 EXTERIOR LTG	20	0.64			25	26	0.27			20	ZONE 30 EXTERIOR LTG*	26
27	*ZONE 14 EXTERIOR LTG	20		0.48		27	28		0.23		20	ZONE 31 EXTERIOR LTG*	28
29	*ZONE 15 SITE LIGHTING	20			1.70	29	30			0.20	20	ZONE 32 EXTERIOR LTG*	30
31	*ZONE 16 SITE LIGHTING	20	1.40			31	32	0.23			20	ZONE 33 EXTERIOR LTG*	32
33	*ZONE 17 SITE LILGHTING	20		1.60		33	34		0.27		20	ZONE 34 EXTERIOR LTG*	34
35	*ZONE 35 ML LOBBY LTG	20			0.46	35	36			0.42	20	ZONE 36 LS LOBBY LTG	36
37	SPARE	20	3.50			37	38	3.50			20	SPARE	38
39	SPARE	20		3.50		39	40		3.50		20	SPARE	40
41	SPARE	20			3.50	41	42			3.50	20	SPARE	42
	Subtotals (kVA):		10.61	11.27	11.25			11.77	12.10	8.65		Subtotals (kVA)	
	Total Loads:		Phase A:		22.38 kVA				66.24%	%		Demand Factor	
			Phase B:		23.37 kVA				43.49 kVA			Demand Load	
			Phase C:		19.90 kVA				54.36 kVA			Load x 1.25	
	Total Connected Load:				65.65 kVA				65.46 A			AMP	

KGB Maser Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: EDPS-M41

Existing

DISTRIBUTION PANEL SCHEDULE

Panel Name: EDPS-M41
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X; Flush: .; In MCC: .

Main Lugs Only: . Amp Main CB 800
Shunt Trip Main: . Amp Bus 800
Feed Through: . 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*ACF-1*	253.90	211.00	100	600A	450A	3	*460G*
2	*ACF-3*	253.90	211.00	100	600A	450A	3	*460G*
3	*ACF-5*	253.90	211.00	100	600A	450A	3	*460G (STAND-BY)*
4	*HMS-0B - HMS-3B*	23.80	20.00		225A	225A	3	*300G*
5	*RO-2*	11.00	9.00	7.5	100A	40A	3	*40G*
6	*PRE-TREATMENT*	7.60	6.32	5	100A	30A	3	*30G*
7	*CONTROL PANEL*	20.00	16.00		100A	30A	3	*30NG*
8	*SPACE*							
9	*EFN-24*	65.00		50	100A	70A	3	*115G (STAND-BY)*
10	*EFN-26*	72.20	60.00	75	225A	150A	3	*150G (STAND-BY)*
11	*SPARE*				100A	100A	3	
12	*SPARE*				225A	225A	3	
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

Switchboard					
Tag		EDPS-M41	EDPS-M42	MDP-M41	MDP-M42
Voltage System		480Y/277V	480Y/277V	480Y/277V	480Y/277V
Calculated Design Load (kW)		700.87	796.10	614.29	904.46
Calculated Power Factor		0.80	0.80	0.80	0.80
Calculated Design Load (kVA)		876.08	955.12	767.86	1130.58
Calculated Design Load (A)		1054.25	1197.50	924.03	1360.50
Feeder					
Feeder Protection Size		1200A	1600A*	1000A	1600A
Number of Sets		3	4	3**	4***
Wire Size					
	Phase	500 kcmil	350 kcmil	350 kcmil	500 kcmil
	Neutral	500 kcmil	350 kcmil	350 kcmil	500 kcmil
	Ground	3/0	4/0	2/0	4/0
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.7901	0.5958	0.5958	0.7901
	Total – All Phases	2.3703	1.7874	1.7874	2.3703
	Neutral	0.7901	0.5958	0.5958	0.7901
	Ground	0.3117	0.3718	0.2624	0.3718
	Total – All Wires	3.4721	2.7550	2.6456	3.5322
Minimum Conduit Area (Sq. in.) (Above x 2.5)		8.6803	6.8875	6.6140	8.8305
Conduit Size (NEC Chapter 9, Table 4)		3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Conduit Size (NEC Table C.1)		3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Feeder Length		300 ft.	150 ft.	750 ft.	750 ft.
Final Voltage Drop (V)		2.7	1.7	8.5	6.6
Final Voltage Drop (%)		0.97%	0.61%	3.07%	2.38%
Feeder Re-sizing		Not Needed	Not Needed	500 kcmil**	See Below

*Main circuit protection is too close to the next breaker size to be considered free from accidental trip
**Feeder size change to 4 sets of (3) 500 kcmil + (1) 500 kcmil neutral to yield 4.5V (1.62%) drop
***Voltage drop calculation yields adding an extra set with the same 500 kcmil cables

Redesign

DISTRIBUTION PANEL SCHEDULE

Panel Name: EDPS-M41
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X; Flush: .; In MCC: .

Main Lugs Only: . Amp Main CB 1200
Shunt Trip Main: . Amp Bus 1200
Feed Through: . 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*AHU-INT-LS1*	192.00	159.55	75	400A	250A	3	*(3) 4/0 phase conductors, (1) #4 ground in 2"C*
2	*AHU-INT-LS2*	192.00	159.55	75	400A	250A	3	*(3) 4/0 phase conductors, (1) #4 ground in 2"C*
3	*SPACE*							
4	*HMS-0B - HMS-3B*	23.80	20.00		225A	225A	3	*300G*
5	*RO-2*	11.00	9.00	7.5	100A	40A	3	*40G*
6	*PRE-TREATMENT*	7.60	6.32	5	100A	30A	3	*30G*
7	*CONTROL PANEL*	20.00	16.00		100A	30A	3	*30NG*
8	*SPACE*							
9	*EFN-24*	65.00	54.02	50	100A	70A	3	*115G (STAND-BY)*
10	*EFN-26*	72.20	60.00	75	225A	150A	3	*150G (STAND-BY)*
11	*SPARE*	80.00	66.48		100A	100A	3	
12	*SPARE*	180.00	149.58		225A	225A	3	
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: EDPS-M42

Existing

DISTRIBUTION PANEL SCHEDULE

Panel Name: EDPS-M42
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X | Flush: . | In MCC: .

Main Lugs Only: . | Amp Main CB 800
Shunt Trip Main: . | Amp Bus 800
Feed Through: . | 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*ACF-2*	253.90	211.00	100	400A	380A	3	*400G*
2	*ACF-4*	253.90	211.00	100	400A	380A	3	*400G*
3	*ACF-9*	52.00	30.00	40	100A	100A	3	*115G (STAND-BY)*
4	*ACF-10*	52.00	30.00	40	100A	100A	3	*115G*
5	*ACF-11*	34.00	28.00	25	100A	70A	3	*85G*
6	*HMS-0D - HMS-3D*	16.00	13.30		225A	225A	3	*300NG*
7	*ACF-12*	156.00	94.00	125	225A	225A	3	*230G*
8	*VACUUM PUMP (VCP-1)*	104.00		3(40)	200A	200A	3	*200G - (2 ACTIVE, 1 STAND-BY)*
9	*SPARE*				100A	30A	3	
10	*SPARE*				100A	30A	3	
11								
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

Switchboard				
Tag	EDPS-M41	EDPS-M42	MDP-M41	MDP-M42
Voltage System	480Y/277V	480Y/277V	480Y/277V	480Y/277V
Calculated Design Load (kW)	700.87	796.10	614.29	904.46
Calculated Power Factor	0.80	0.80	0.80	0.80
Calculated Design Load (kVA)	876.08	955.12	767.86	1130.58
Calculated Design Load (A)	1054.25	1197.50	924.03	1360.50
Feeder				
Feeder Protection Size	1200A	1600A*	1000A	1600A
Number of Sets	3	4	3**	4***
Wire Size				
Phase	500 kcmil	350 kcmil	350 kcmil	500 kcmil
Neutral	500 kcmil	350 kcmil	350 kcmil	500 kcmil
Ground	3/0	4/0	2/0	4/0
Wire Area (Sq. in.) (Table above)				
Each Phase	0.7901	0.5958	0.5958	0.7901
Total – All Phases	2.3703	1.7874	1.7874	2.3703
Neutral	0.7901	0.5958	0.5958	0.7901
Ground	0.3117	0.3718	0.2624	0.3718
Total – All Wires	3.4721	2.7550	2.6456	3.5322
Minimum Conduit Area (Sq. in.) (Above x 2.5)	8.6803	6.8875	6.6140	8.8305
Conduit Size (NEC Chapter 9, Table 4)	3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Conduit Size (NEC Table C.1)	3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Feeder Length	300 ft.	150 ft.	750 ft.	750 ft.
Final Voltage Drop (V)	2.7	1.7	8.5	6.6
Final Voltage Drop (%)	0.97%	0.61%	3.07%	2.38%
Feeder Re-sizing	Not Needed	Not Needed	500 kcmil**	See Below

*Main circuit protection is too close to the next breaker size to be considered free from accidental trip
**Feeder size change to 4 sets of (3) 500 kcmil + (1) 500 kcmil neutral to yield 4.5V (1.62%) drop
***Voltage drop calculation yields adding an extra set with the same 500 kcmil cables

Redesign

DISTRIBUTION PANEL SCHEDULE

Panel Name: EDPS-M42
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X | Flush: . | In MCC: .

Main Lugs Only: . | Amp Main CB 1600
Shunt Trip Main: . | Amp Bus 2500
Feed Through: . | 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*AHU-INT-MS1*	192.00	159.55	75	400A	250A	3	*(3) 4/0 phase conductors, (1) #4 ground in 2"C*
2	*AHU-INT-MS2*	192.00	159.55	75	400A	250A	3	*(3) 4/0 phase conductors, (1) #4 ground in 2"C*
3	*ACF-9*	52.00	30.00	40	100A	100A	3	*115G (STAND-BY)*
4	*ACF-10*	52.00	30.00	40	100A	100A	3	*115G*
5	*ACF-11*	34.00	28.00	25	100A	70A	3	*85G*
6	*HMS-0D - HMS-3D*	16.00	13.30		225A	225A	3	*300NG*
7	*ACF-12*	156.00	94.00	125	225A	225A	3	*230G*
8	*VACUUM PUMP (VCP-1)*	104.00	86.42	3(40)	200A	200A	3	*200G - (2 ACTIVE, 1 STAND-BY)*
9	*SPARE*	80.00	66.48		100A	30A	3	
10	*SPARE*	80.00	66.48		100A	30A	3	
11								
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: MDP-M41

Existing

DISTRIBUTION PANEL SCHEDULE

Panel Name: MDP-M41	Mounting:	Surface:	X	Main Lugs Only:	.	Amp Main CB	1000
277/480, 3 Phase, 4 Wire		Flush:	.	Shunt Trip Main:	.	Amp Bus	1000
65,000MIN A.I.C. SYM		In MCC	.	Feed Through:	.	100% NEUTRAL	

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	LOAD (CONN) KVA	LOAD (CONN) HP	BREAKER FRAME (AMPS)	BREAKER TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*ACF-7*	77.00	63.00	60	225A	110A	3	*115G*
2	*RTF-1*	40.00	33.00	30	100A	80A	3	*85G*
3	*GWP-12*	34.00	28.00	25	100A	70A	3	*85G (STAND-BY)*
4	*RTF-3*	27.00	21.49	20	100A	60A	3	*60G*
5	*HM-3B - HM-0B*	57.44	47.70		225A	225A	3	*255G*
6	*HL-3B - HL-0B*	166.74	138.00		400A	400A	3	*400NG*
7	*HM-4A*	26.19	21.75		400A	400A	3	*380G*
8	*HL-M4*	9.15	7.60		100A	100A	3	*115NG*
9	*LR-4C VIA 30 KVA XFMR 'TRE-LR-4C'*	18.70	15.50		100A	50A	3	*50G*
10	*SPARE*				225A	225A	3	
11	*SPARE*				225A	225A	3	
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

Switchboard				
Tag	EDPS-M41	EDPS-M42	MDP-M41	MDP-M42
Voltage System	480Y/277V	480Y/277V	480Y/277V	480Y/277V
Calculated Design Load (kW)	700.87	796.10	614.29	904.46
Calculated Power Factor	0.80	0.80	0.80	0.80
Calculated Design Load (kVA)	876.08	955.12	767.86	1130.58
Calculated Design Load (A)	1054.25	1197.50	924.03	1360.50
Feeder				
Feeder Protection Size	1200A	1600A*	1000A	1600A
Number of Sets	3	4	3**	4***
Wire Size				
Phase	500 kcmil	350 kcmil	350 kcmil	500 kcmil
Neutral	500 kcmil	350 kcmil	350 kcmil	500 kcmil
Ground	3/0	4/0	2/0	4/0
Wire Area (Sq. in.) (Table above)				
Each Phase	0.7901	0.5958	0.5958	0.7901
Total – All Phases	2.3703	1.7874	1.7874	2.3703
Neutral	0.7901	0.5958	0.5958	0.7901
Ground	0.3117	0.3718	0.2624	0.3718
Total – All Wires	3.4721	2.7550	2.6456	3.5322
Minimum Conduit Area (Sq. in.) (Above x 2.5)	8.6803	6.8875	6.6140	8.8305
Conduit Size (NEC Chapter 9, Table 4)	3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Conduit Size (NEC Table C.1)	3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Feeder Length	300 ft.	150 ft.	750 ft.	750 ft.
Final Voltage Drop (V)	2.7	1.7	8.5	6.6
Final Voltage Drop (%)	0.97%	0.61%	3.07%	2.38%
Feeder Re-sizing	Not Needed	Not Needed	500 kcmil**	See Below

*Main circuit protection is too close to the next breaker size to be considered free from accidental trip
**Feeder size change to 4 sets of (3) 500 kcmil + (1) 500 kcmil neutral to yield 4.5V (1.62%) drop
***Voltage drop calculation yields adding an extra set with the same 500 kcmil cables

Redesign

DISTRIBUTION PANEL SCHEDULE

Panel Name: MDP-M41	Mounting:	Surface:	X	Main Lugs Only:	.	Amp Main CB	1000
277/480, 3 Phase, 4 Wire		Flush:	.	Shunt Trip Main:	.	Amp Bus	1200
65,000MIN A.I.C. SYM		In MCC	.	Feed Through:	.	100% NEUTRAL	

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	LOAD (CONN) KVA	LOAD (CONN) HP	BREAKER FRAME (AMPS)	BREAKER TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*SPACE*							
2	*RTF-1*	40.00	33.00	30	100A	80A	3	*85G*
3	*GWP-12*	34.00	28.00	25	100A	70A	3	*85G (STAND-BY)*
4	*RTF-3*	27.00	21.49	20	100A	60A	3	*60G*
5	*HM-3B - HM-0B*	57.44	47.70		225A	225A	3	*255G*
6	*HL-3B - HL-0B*	166.74	138.00		400A	400A	3	*400NG*
7	*HM-4A*	26.19	21.75		400A	400A	3	*380G*
8	*HL-M4*	9.15	7.60		100A	100A	3	*115NG*
9	*LR-4C VIA 30 KVA XFMR 'TRE-LR-4C'*	18.70	15.50		100A	50A	3	*50G*
10	*SPARE*	180.00	149.58		225A	225A	3	
11	*SPARE*	180.00	149.58		225A	225A	3	
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

Electrical Panelboard Designs: MDP-M42

Existing

DISTRIBUTION PANEL SCHEDULE

Panel Name: MDP-M42
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X | Flush: . | In MCC: .

Main Lugs Only: . | Amp Main CB: 1000
Shunt Trip Main: . | Amp Bus: 1000
Feed Through: . | 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*ACF-6*	77.00	64.00	60	225A	110A	3	*115G*
2	*ACF-8*	77.00	64.00	60	225A	110A	3	*115G*
3	*ACF-12*	96.00	80.00	75	225A	125A	3	*130G*
4	*HM-3D - HM-0D*	159.84	132.73	7.5	400A	400A	3	*400G*
5	*HL-3D - HL-0D*	113.63	94.36	7.5	225.00	225A	3	*255NG*
6	*HM-4B*	37.93	31.50	7.5	400A	400A	3	*380G*
7								
8	*SPARE*				225A	225A	3	
9	*SPARE*				225A	225A	3	
10	*GWP-11*	34.00	28.00	25	100A	70A	3	*85G*
11	*RTF-2*	27.00	21.49	20	100A	60A	3	*60G*
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

Switchboard					
Tag		EDPS-M41	EDPS-M42	MDP-M41	MDP-M42
Voltage System		480Y/277V	480Y/277V	480Y/277V	480Y/277V
Calculated Design Load (kW)		700.87	796.10	614.29	904.46
Calculated Power Factor		0.80	0.80	0.80	0.80
Calculated Design Load (kVA)		876.08	955.12	767.86	1130.58
Calculated Design Load (A)		1054.25	1197.50	924.03	1360.50
Feeder					
Feeder Protection Size		1200A	1600A*	1000A	1600A
Number of Sets		3	4	3**	4***
Wire Size					
	Phase	500 kcmil	350 kcmil	350 kcmil	500 kcmil
	Neutral	500 kcmil	350 kcmil	350 kcmil	500 kcmil
	Ground	3/0	4/0	2/0	4/0
Wire Area (Sq. in.) (Table above)					
	Each Phase	0.7901	0.5958	0.5958	0.7901
	Total – All Phases	2.3703	1.7874	1.7874	2.3703
	Neutral	0.7901	0.5958	0.5958	0.7901
	Ground	0.3117	0.3718	0.2624	0.3718
	Total – All Wires	3.4721	2.7550	2.6456	3.5322
Minimum Conduit Area (Sq. in.) (Above x 2.5)		8.6803	6.8875	6.6140	8.8305
Conduit Size (NEC Chapter 9, Table 4)		3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Conduit Size (NEC Table C.1)		3.0" EMT	3.0" EMT	3.0" EMT	3.0" EMT
Feeder Length		300 ft.	150 ft.	750 ft.	750 ft.
Final Voltage Drop (V)		2.7	1.7	8.5	6.6
Final Voltage Drop (%)		0.97%	0.61%	3.07%	2.38%
Feeder Re-sizing		Not Needed	Not Needed	500 kcmil**	See Below

*Main circuit protection is too close to the next breaker size to be considered free from accidental trip
**Feeder size change to 4 sets of (3) 500 kcmil + (1) 500 kcmil neutral to yield 4.5V (1.62%) drop
***Voltage drop calculation yields adding an extra set with the same 500 kcmil cables

Redesign

DISTRIBUTION PANEL SCHEDULE

Panel Name: MDP-M42
277/480, 3 Phase, 4 Wire
65,000MIN A.I.C. SYM

Mounting: Surface: X | Flush: . | In MCC: .

Main Lugs Only: . | Amp Main CB: 1600
Shunt Trip Main: . | Amp Bus: 2500
Feed Through: . | 100% NEUTRAL

CKT NO.	EQUIPMENT	LOAD (CONN) AMPS	KVA	HP	BREAKER FRAME (AMPS)	TRIP (AMPS)	Poles	WIRE SIZE / REMARKS
1	*AHU-EXT-1*	130.00	108.03	50	225A	175A	3	*(3) 1/0 phase conductors, (1) #6 ground in 1.5"C*
2	*AHU-EXT-2*	130.00	108.03	50	225A	175A	3	*(3) 1/0 phase conductors, (1) #6 ground in 1.5"C*
3	*ACF-12*	96.00	80.00	75	225A	125A	3	*130G*
4	*HM-3D - HM-0D*	159.84	132.73	7.5	400A	400A	3	*400G*
5	*HL-3D - HL-0D*	113.63	94.36	7.5	225.00	225A	3	*255NG*
6	*HM-4B*	37.93	31.50	7.5	400A	400A	3	*380G*
7								
8	*SPARE*	180.00	149.58		225A	225A	3	
9	*SPARE*	180.00	149.58		225A	225A	3	
10	*GWP-11*	34.00	28.00	25	100A	70A	3	*85G*
11	*RTF-2*	27.00	21.49	20	100A	60A	3	*60G*
12								
13								
14								
15								
16								
17								
18								

PROVIDE INTEGRAL TVSS UNIT

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

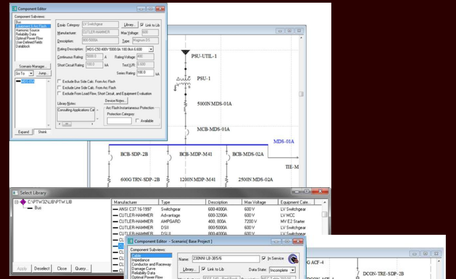
Depth Topic 1: SKM Analysis Summary

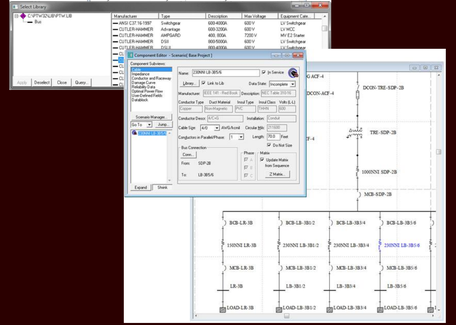
Equipment

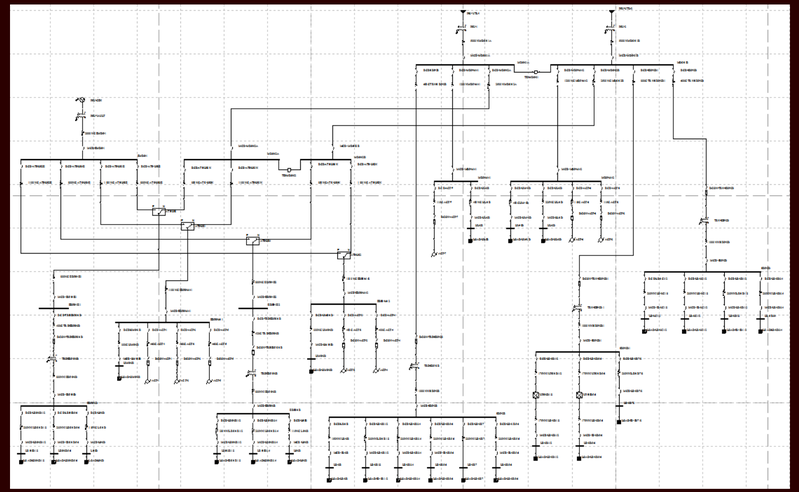
SKM Model Equipment Schedule

Lvl	Name	Location	Floor/plan	Voltage	RATING	Series Rating
Switchgear	MDS-01A	W-P003	*E2.08-P*	480/277V	5,000A	100 kAIC
	MDS-01B	W-P003	*E2.08-P*	480/277V	5,000A	100 kAIC
	MDS-02A	N-P051	*E2.04D-LP*	480/277V	2,000A	100 kAIC
	MDS-02B	N-P053	*E2.04D-LP*	480/277V	2,000A	100 kAIC
	EMDS-1	N-P052	*E2.04D-LP*	480/277V	2,000A	65 kAIC
Switchboards Level 1	EDPS-1E1	N-P052	*E2.04D-LP*	480/277V	800A	65 kAIC
	EDPS-1E2	N-P052	*E2.04D-LP*	480/277V	800A	65 kAIC
	SDP-2B	W-P245	*E2.28-P*	480/277V	1,000A	65 kAIC
	SDP-2D	N-P258	*E2.28D-P*	480/277V	1,000A	65 kAIC
	SDP-2D1	N-P238	*E2.2E-P*	480/277V	1,000A	65 kAIC
Panelboards Level 2	EDPS-3B	W-P338	*E2.38-P*	208/120V	800A	65 kAIC
	EDPS-3D	N-P347	*E2.38-P*	208/120V	800A	65 kAIC
	EDPS-M41	N-M401	*E2.4C-P*	480/277V	800A	65 kAIC
	EDPS-M42	N-M401	*E2.4C-P*	480/277V	800A	65 kAIC
	MDP-M41	N-M401	*E2.4C-P*	480/277V	1,000A	65 kAIC
	MDP-M42	N-M401	*E2.4C-P*	480/277V	1,000A	65 kAIC
	HL-3B	W-P338	*E2.38-P*	480/277V	200A	14 kAIC Min.
	HMS-3B	W-P338	*E2.38-P*	480/277V	100A	14 kAIC Min.
	LB-3B1/2	W-Q304	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B3/4	W-321	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B5/6	W-337	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B7	W-Q304	*E4.3B*	208/120V	225A/MLO	10 kAIC Min.
	LBS-3B1/2	W-Q304	*E4.3B*	208/120V	225A	10 kAIC Min.
	LBS-3B3/4	W-321	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B	W-P338	*E2.38-P*	208/120V	175A	10 kAIC Min.
	LB-3B5/6	W-337	*E4.3B*	208/120V	225A	10 kAIC Min.
	LS-3B	W-P338	*E2.38-P*	208/120V	100A	10 kAIC Min.
	LB-3C1/2	W-Q307	*E2.3C-P*	208/120V	150A	10 kAIC Min.
	LB-3C1/2	W-Q307	*E2.3C-P*	208/120V	225A	10 kAIC Min.
	HL-3D	N-P347	*E2.3D-P*	480/277V	200A	14 kAIC Min.
	HM-3D	N-P347	*E2.3D-P*	480/277V	100A	14 kAIC Min.
	HMS-3D	N-P347	*E2.3D-P*	480/277V	100A	14 kAIC Min.
	LB-3D1/2	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LB-3D5/6	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LB-3D7/8	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LBS-3D1/2	Q-3D06	*E4.3D*	208/120V	225A	10 kAIC Min.
	LBS-3D5/6	N-361	*E4.3D*	208/120V	225A	10 kAIC Min.
	LR-3D1/2	N-P346	*E2.3D-P*	208/120V	225A	10 kAIC Min.
	LR-3D3/4	N-P346	*E2.3D-P*	208/120V	225A	10 kAIC Min.
	LS-3D	N-P347	*E2.3D-P*	208/120V	100A	10 kAIC Min.

Lvl	Name	Location	*Enl. Plan*	Rating	Poles/Ph/Voltage	Series Rating
Distribution Equipment Level 1	ATS-HS1	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
Mains	ATS-HS2	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
	ATS-HS3	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
	ATS-HS4	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
Level 2	TRN-SDP-2B	W-P249	*E2.2B-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRN-SDP-2D	N-P258	*E2.2D-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRN-SDP-2D1	N-P238	*E2.2E-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRE-EDPS-3B	W-P338	*E2.38-P*	225 kVA	480Δ - 208Y/120V	N/A
	TRE-EDPS-3D	N-P347	*E2.3D-P*	225 kVA	480Δ - 208Y/120V	N/A
	UPS-3D-1/2	N-361	*E4.3D*	50 kVA	N/A	Unknown
	UPS-3D-5/6	N-361	*E4.3D*	50 kVA	N/A	Unknown
Lvl						
Mech. Equipment Penthouse	ACF-1	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-2	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-3	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-4	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-5	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-6	N-M401	60 hp		110 A MCP, 100 A FS	------
	ACF-7	N-M401	60 hp		110 A MCP, 100 A FS	------
	ACF-8	N-M401	60 hp		110 A MCP, 100 A FS	------

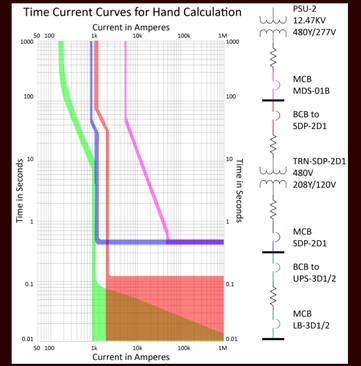


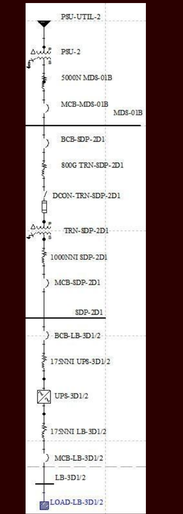




Fault Analysis Summary					
		Available Fault Current			
Bus Name	Voltage	3-Phase	X/R	LINE/GRND	X/R
EDPS-1E1	480	39353.3	3	8391.63	0.2
EDPS-1E2	480	38449.6	2.9	8364.93	0.2
EDPS-3B	208	8147.9	1.6	9238.12	1.6
EDPS-3D	208	9963.3	1.6	10713.51	1.6
EDPS-M41	480	26611.3	2.1	7238.23	0.3
EDPS-M42	480	32169.3	2.4	7817.41	0.3
EMDS-1	480	10039.0	4.9	1621.01	0.1
HL-3B	480	13108.6	1.6	5383.71	0.5
HL-3D	480	11810.3	1.2	4971.80	0.5
HM-3D	480	13304.3	1.6	5406.24	0.5
HMS-3B	480	15707.0	1.4	5858.97	0.4
HMS-3D	480	17537.7	1.4	6259.26	0.4
LB-3B1/2	208	7593.2	1.1	6792.20	1.2
LB-3B3/4	208	7756.9	1.1	6964.21	1.2
LB-3B5/6	208	7756.9	1.1	6964.21	1.2
LB-3B7	208	8104.7	1.2	7334.45	1.2
LB-3C1/2	208	4502.6	0.9	4019.60	1
LB-3D1/2	208	138.7	7.9	134.64	8.1
LB-3D5/6	208	138.7	7.9	134.64	8.1
LB-3D7/8	208	4508.2	0.9	4021.00	1
LBS-3B1/2	208	6467.5	1.2	6633.94	1.2
LBS-3B3/4	208	6467.5	1.2	6633.94	1.2
LBS-3D1/2	208	7560.1	1.2	7361.22	1.2
LBS-3D5/6	208	7560.1	1.2	7361.22	1.2
LR-3B	208	9213.2	1.2	8620.65	1.2
LR-3B5/6	208	7756.9	1.1	6964.21	1.2
LR-3C1/2	208	3773.0	0.8	3288.52	0.9
LR-3D1/2	208	6503.1	1.1	6244.65	1.2
LR-3D3/4	208	6503.1	1.1	6244.65	1.2
LS-3B	208	6746.9	1.1	7098.78	1
LS-3D	208	7936.7	1.1	7928.46	1
MDP-M41	480	18646.1	1.9	6337.24	0.4
MDP-M42	480	19033.2	1.9	6367.69	0.4
MDS-01A	480	57411.7	5.7	9248.60	0.1
MDS-01B	480	57406.8	5.7	9248.52	0.1
MDS-02A	480	44453.2	3.5	8669.88	0.2
MDS-02B	480	44450.1	3.5	8669.80	0.2
SDP-2B	208	10951.5	1.6	10647.34	1.7
SPD-2D	208	8645.7	1.4	9083.76	1.5
SDP-2D1	208	8574.7	1.3	9026.44	1.6

Results





KGB Maser
Management Engineering Consulting

Lighting/Electrical References

Dimming System
Lutron Ecosystem Overview. Lutron Electronics Company. Web. 9 Feb. 2011. <http://www.lutron.com/Products/WholeBuildingSystems/EcoSystem/Pages/Overview.aspx>.

Eaton Distribution Equipment
"Electrical Selector." Eaton Electrical Homepage. Web. 12 Mar. 2011. <http://www.eaton.com/Electrical/index.htm>.

Electrical Code
National Electrical Code: 2008. Quincy, MA: National Fire Protection Association, 2007. Print.

Electrical System Modeling
Afshin, and Johnny. FAQ: Modeling an Uninterruptable Power System (UPS). Manhattan Beach, CA: SKM Systems Analysis, Inc. PDF. <http://www.skm.com/Modeling_a_UPS_in_PTW.pdf>

IES Handbook
Block, Judith, ed. IESNA Lighting Handbook. 9th ed. New York City: Illuminating Engineering Society of North America, 2000. Print.

Luminaire Products
1. Alkco Lighting - <http://www.alkco.com/>
2. LiteControl - <http://litecontrol.com/>
3. Lithonia Lighting - <http://www.lithonia.com/>
4. Kurt Versen Lighting - <http://www.kurtversen.com/>
5. Deco Lighting - <http://www.getdeco.com/>
6. AllScape Lighting - <http://www.allscape.net/new/index.html>
7. Kim Lighting - <http://www.kimlighting.com/>
8. Lightolier - <http://www.lightolier.com/home/home-swf.jsp>
9. Louis Poulsen Lighting - <http://www.louispoulsen.com/en-us.aspx>

Lutron Control Products - <http://www.lutron.com/Pages/Default.aspx>

Osram Sylvania
Osram Sylvania - Product Catalogs Home. Osram Sylvania. Web. <http://www.sylvania.com/ProductCatalogs>.

Philips Advance Transformer
Product Catalog Datasheets. Philips Advance Transformer. Web. <http://www.advance.philips.com/ecatalog/>.

Reflectance Research
1. Benjamin Moore Paint - Color Selection Tools and Resources for Design Professionals. Benjamin Moore Paints. Web. 2 Feb. 2011. <http://www.benjaminmoore.com/bmpsweb/portals/bmps.portal?_nfpb=true&_pageLabel=fa_home>.
2. Resene Paints, Coatings, Wood Stains, Decorating Ideas, Custom Paint, Interior & Exterior Paint. Resene Paints. Web. 2 Feb. 2011. <http://www.resene.co.nz>.
3. J+J/Invision Broadloom and Modular Commercial Carpet. J+J/Invision. Web. 2 Feb. 2011. <http://www.jj-invision.com/products/View_All.aspx>.

Shading System
Motorized Shades - ElectroShades - Bottom Up Shades. MechoShade Systems. Web. 9 Feb. 2011. <http://www.mechoshade.com/motorizedshades/electro_bottomup.cfm>.

SquareD Distribution Equipment
"Schneider Electric Home." Schneider Electric Is the Global Specialist in Energy Management - Schneider Electric United States. Web. 28 Feb. 2011. <http://www.schneider-electric.us/sites/us/en/home.page>.

Wattstopper Wall Box Occupancy
"Product Type - Passive Infrared." Wattstopper. Web. 25 Mar. 2011. <http://wattstopper.com/products/productline_list.html?category=37&type=Commercial>.

KGB Maser
Management Engineering Consulting

Lighting/Electrical Appendices

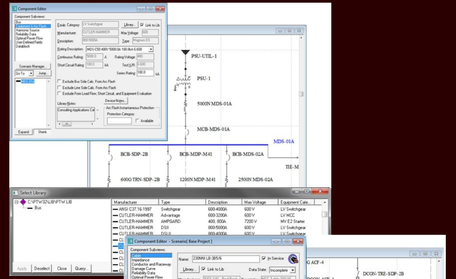
Depth Topic 1: SKM Analysis Summary

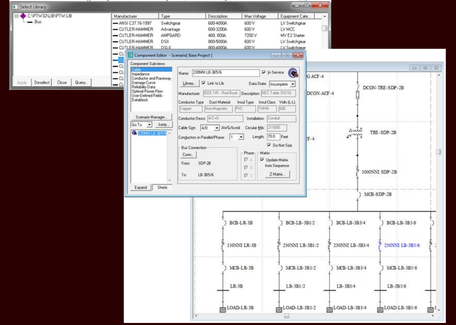
Equipment

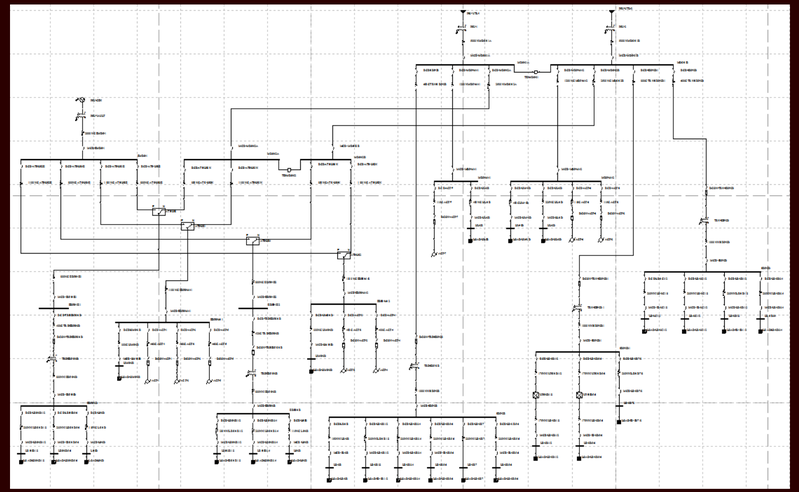
SKM Model Equipment Schedule

Lvl	Name	Location	Floor/plan	Voltage	RATING	Series Rating
Switchgear	MDS-01A	W-P003	*E2.08-P*	480/277V	5,000A	100 kAIC
	MDS-01B	W-P003	*E2.08-P*	480/277V	5,000A	100 kAIC
	MDS-02A	N-P051	*E2.04D-LP*	480/277V	2,000A	100 kAIC
	MDS-02B	N-P053	*E2.04D-LP*	480/277V	2,000A	100 kAIC
	EMDS-1	N-P052	*E2.04D-LP*	480/277V	2,000A	65 kAIC
Switchboards Level 1	EDPS-1E1	N-P052	*E2.04D-LP*	480/277V	800A	65 kAIC
	EDPS-1E2	N-P052	*E2.04D-LP*	480/277V	800A	65 kAIC
	SDP-2B	W-P245	*E2.28-P*	480/277V	1,000A	65 kAIC
	SDP-2D	N-P258	*E2.28D-P*	480/277V	1,000A	65 kAIC
	SDP-2D1	N-P238	*E2.2E-P*	480/277V	1,000A	65 kAIC
Panelboards Level 2	EDPS-3B	W-P338	*E2.38-P*	208/120V	800A	65 kAIC
	EDPS-3D	N-P347	*E2.38-P*	208/120V	800A	65 kAIC
	EDPS-M41	N-M401	*E2.4C-P*	480/277V	800A	65 kAIC
	EDPS-M42	N-M401	*E2.4C-P*	480/277V	800A	65 kAIC
	MDP-M41	N-M401	*E2.4C-P*	480/277V	1,000A	65 kAIC
	MDP-M42	N-M401	*E2.4C-P*	480/277V	1,000A	65 kAIC
	HL-3B	W-P338	*E2.38-P*	480/277V	200A	14 kAIC Min.
	HMS-3B	W-P338	*E2.38-P*	480/277V	100A	14 kAIC Min.
	LB-3B1/2	W-Q304	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B3/4	W-321	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B5/6	W-337	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B7	W-Q304	*E4.3B*	208/120V	225A/MLO	10 kAIC Min.
	LBS-3B1/2	W-Q304	*E4.3B*	208/120V	225A	10 kAIC Min.
	LBS-3B3/4	W-321	*E4.3B*	208/120V	225A	10 kAIC Min.
	LB-3B	W-P338	*E2.38-P*	208/120V	175A	10 kAIC Min.
	LB-3B5/6	W-337	*E4.3B*	208/120V	225A	10 kAIC Min.
	LS-3B	W-P338	*E2.38-P*	208/120V	100A	10 kAIC Min.
	LB-3C1/2	W-Q307	*E2.3C-P*	208/120V	150A	10 kAIC Min.
	LB-3C1/2	W-Q307	*E2.3C-P*	208/120V	225A	10 kAIC Min.
	HL-3D	N-P347	*E2.3D-P*	480/277V	200A	14 kAIC Min.
	HM-3D	N-P347	*E2.3D-P*	480/277V	100A	14 kAIC Min.
	HMS-3D	N-P347	*E2.3D-P*	480/277V	100A	14 kAIC Min.
	LB-3D1/2	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LB-3D5/6	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LB-3D7/8	N-361	*E4.3D*	208/120V	175A	10 kAIC Min.
	LBS-3D1/2	Q-3D06	*E4.3D*	208/120V	225A	10 kAIC Min.
	LBS-3D5/6	N-361	*E4.3D*	208/120V	225A	10 kAIC Min.
	LR-3D1/2	N-P346	*E2.3D-P*	208/120V	225A	10 kAIC Min.
	LR-3D3/4	N-P346	*E2.3D-P*	208/120V	225A	10 kAIC Min.
	LS-3D	N-P347	*E2.3D-P*	208/120V	100A	10 kAIC Min.

Lvl	Name	Location	*Enl. Plan*	Rating	Poles/Ph/Voltage	Series Rating
Distribution Equipment Level 1	ATS-HS1	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
Mains	ATS-HS2	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
	ATS-HS3	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
	ATS-HS4	N-P052	*E2.04D-LP*	800 A	4P, 480V	65 kAIC
Level 2	TRN-SDP-2B	W-P249	*E2.2B-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRN-SDP-2D	N-P258	*E2.2D-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRN-SDP-2D1	N-P238	*E2.2E-P*	300 kVA	480Δ - 208Y/120V	N/A
	TRE-EDPS-3B	W-P338	*E2.38-P*	225 kVA	480Δ - 208Y/120V	N/A
	TRE-EDPS-3D	N-P347	*E2.3D-P*	225 kVA	480Δ - 208Y/120V	N/A
	UPS-3D-1/2	N-361	*E4.3D*	50 kVA	N/A	Unknown
	UPS-3D-5/6	N-361	*E4.3D*	50 kVA	N/A	Unknown
Lvl						
Mech. Equipment Penthouse	ACF-1	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-2	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-3	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-4	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-5	N-M401	100 hp		200 A MCP, 175 A FS	------
	ACF-6	N-M401	60 hp		110 A MCP, 100 A FS	------
	ACF-7	N-M401	60 hp		110 A MCP, 100 A FS	------
	ACF-8	N-M401	60 hp		110 A MCP, 100 A FS	------

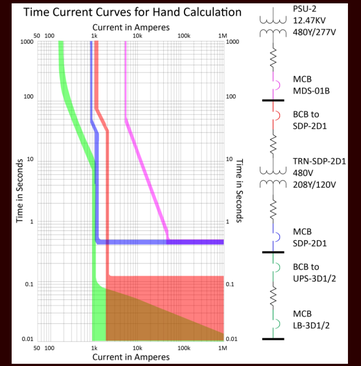


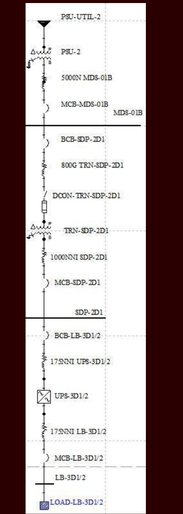




Fault Analysis Summary					
		Available Fault Current			
Bus Name	Voltage	3-Phase	X/R	LINE/GRND	X/R
EDPS-1E1	480	39353.3	3	8391.63	0.2
EDPS-1E2	480	38449.6	2.9	8364.93	0.2
EDPS-3B	208	8147.9	1.6	9238.12	1.6
EDPS-3D	208	9963.3	1.6	10713.51	1.6
EDPS-M41	480	26611.3	2.1	7238.23	0.3
EDPS-M42	480	32169.3	2.4	7817.41	0.3
EMDS-1	480	10039.0	4.9	1621.01	0.1
HL-3B	480	13108.6	1.6	5383.71	0.5
HL-3D	480	11810.3	1.2	4971.80	0.5
HM-3D	480	13304.3	1.6	5406.24	0.5
HMS-3B	480	15707.0	1.4	5858.97	0.4
HMS-3D	480	17537.7	1.4	6259.26	0.4
LB-3B1/2	208	7593.2	1.1	6792.20	1.2
LB-3B3/4	208	7756.9	1.1	6964.21	1.2
LB-3B5/6	208	7756.9	1.1	6964.21	1.2
LB-3B7	208	8104.7	1.2	7334.45	1.2
LB-3C1/2	208	4502.6	0.9	4019.60	1
LB-3D1/2	208	138.7	7.9	134.64	8.1
LB-3D5/6	208	138.7	7.9	134.64	8.1
LB-3D7/8	208	4508.2	0.9	4021.00	1
LBS-3B1/2	208	6467.5	1.2	6633.94	1.2
LBS-3B3/4	208	6467.5	1.2	6633.94	1.2
LBS-3D1/2	208	7560.1	1.2	7361.22	1.2
LBS-3D5/6	208	7560.1	1.2	7361.22	1.2
LR-3B	208	9213.2	1.2	8620.65	1.2
LR-3B5/6	208	7756.9	1.1	6964.21	1.2
LR-3C1/2	208	3773.0	0.8	3288.52	0.9
LR-3D1/2	208	6503.1	1.1	6244.65	1.2
LR-3D3/4	208	6503.1	1.1	6244.65	1.2
LS-3B	208	6746.9	1.1	7098.78	1
LS-3D	208	7936.7	1.1	7928.46	1
MDP-M41	480	18646.1	1.9	6337.24	0.4
MDP-M42	480	19033.2	1.9	6367.69	0.4
MDS-01A	480	57411.7	5.7	9248.60	0.1
MDS-01B	480	57406.8	5.7	9248.52	0.1
MDS-02A	480	44453.2	3.5	8669.88	0.2
MDS-02B	480	44450.1	3.5	8669.80	0.2
SDP-2B	208	10951.5	1.6	10647.34	1.7
SPD-2D	208	8645.7	1.4	9083.76	1.5
SDP-2D1	208	8574.7	1.3	9026.44	1.6

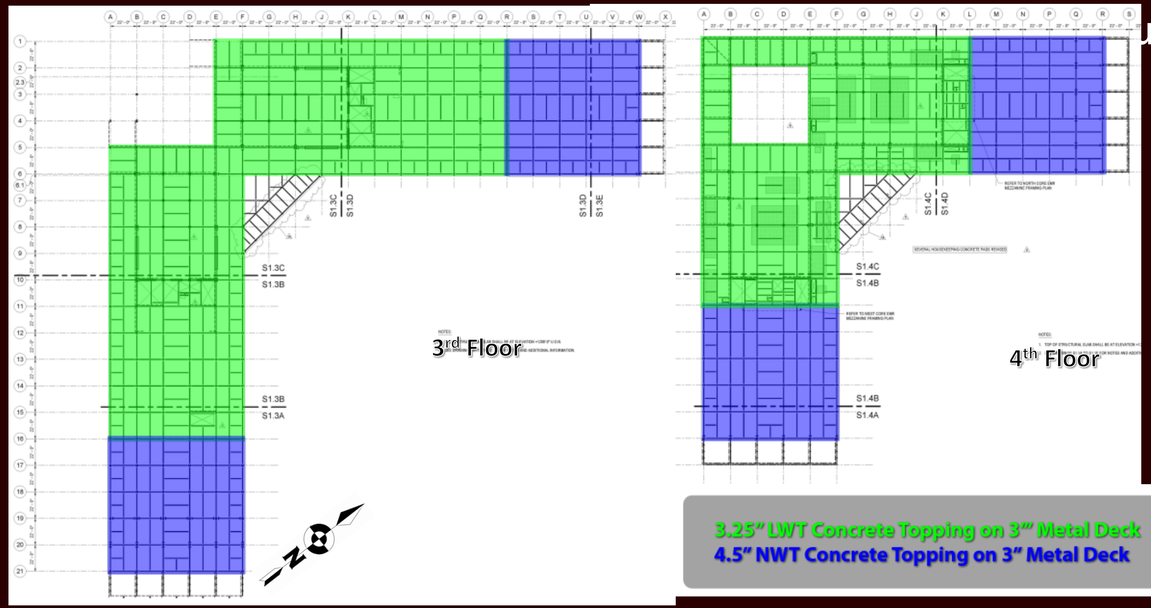
Results

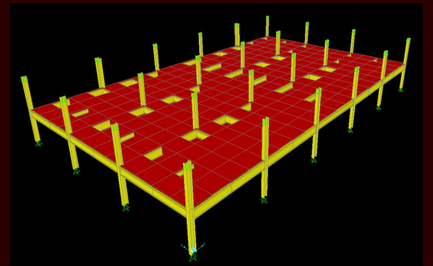


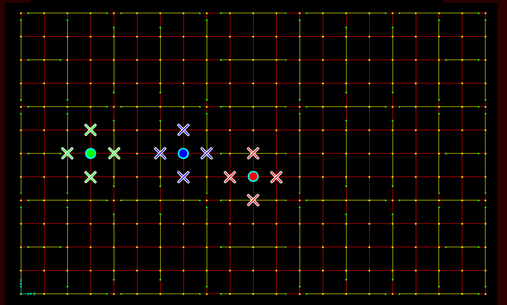


KGB Maser
Management Engineering Consulting

uctural Appendices





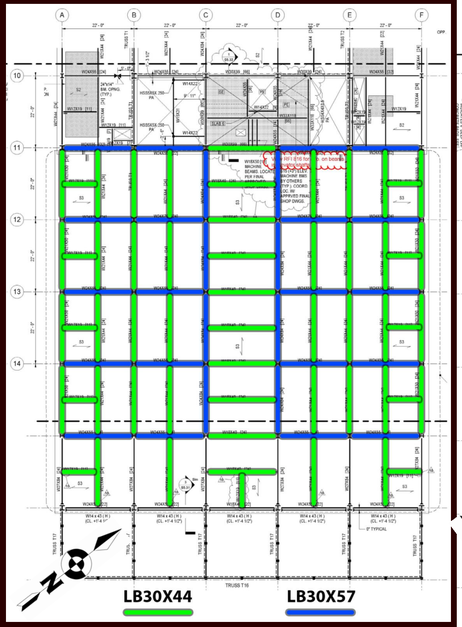


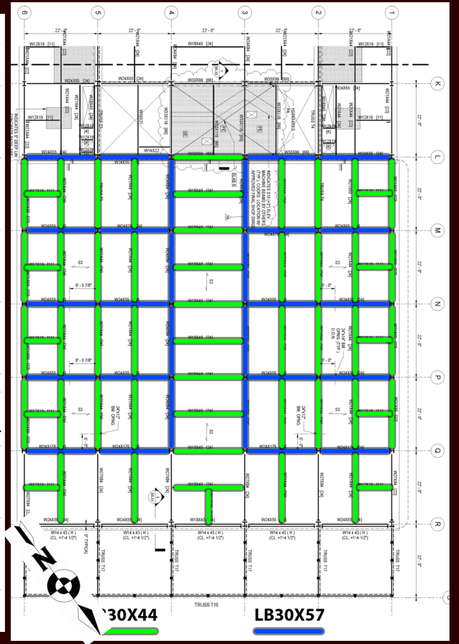
SPAN	Lx	Ly	t	w	Wslab	Wbeams	NODE	Wi	Δ	Wi.Δ^2	P.Δ	Tcalc	T(SAP)	Vel
	ft	ft	in	ksf	kip	kip		kip	in		P=100 k	sec	sec	μ in/sec
SPAN-A	22.0	22.0	3.3	0.049	23.619	4.103	1	0.533	0.0012	0.0000	178.6212	0.0639		3916
							2	0.902	-0.0195	0.0003				
- due to load at A13							3	0.902	-0.0330	0.0010				
							4	0.902	-0.0195	0.0003				
							5	0.533	0.0012	0.0000				
							A1	0.902	0.0551	0.0027				
							A2	1.640	0.0596	0.0058				
							A3	1.640	0.0774	0.0098				
							A4	1.640	0.0596	0.0058				
							A5	0.902	0.0552	0.0027				
							A6	0.902	0.0913	0.0075				
							A7	1.640	0.2216	0.0805				
							A8	1.640	0.2886	0.1366				
							A9	1.640	0.2217	0.0806				
							A10	0.902	0.0914	0.0075				
							A11	0.902	0.0614	0.0034				
							A12	1.640	0.6814	0.7615				
							A13	1.640	1.7862	5.2335				
							A14	1.640	0.6818	0.7624				
							A15	0.902	0.0614	0.0034				
							A16	0.533	0.0052	0.0000				
							A17	0.902	0.0818	0.0060				
							A18	0.902	0.1219	0.0134				
							A19	0.902	0.0826	0.0062				
							A20	0.533	0.0051	0.0000				

SPAN	Lx	Ly	w	Wslab	Wbeams	NODE	Wi	Δ	Wi.Δ^2	P.Δ	Tcalc	T(SAP)	Vel
	ft	ft	ksf	kip	kip		kip	in		P=100 k	sec	sec	μ in/sec
SPAN-A	22.0	22.0	0.049	23.619	4.510	1	0.549	0.0013	0.0000	160.6674	0.0609		3099
						2	0.919	-0.0175	0.0003				
- due to load at A13						3	0.919	-0.0295	0.0008				
						4	0.919	-0.0175	0.0003				
						5	0.549	0.0013	0.0000				
						A1	0.919	0.0470	0.0020				
						A2	1.657	0.0640	0.0068				
						A3	1.657	0.0981	0.0160				
						A4	1.657	0.0640	0.0068				
						A5	0.919	0.0470	0.0020				
						A6	0.919	0.0773	0.0055				
						A7	1.657	0.1908	0.0603				
						A8	1.657	0.2487	0.1025				
						A9	1.657	0.1908	0.0603				
						A10	0.919	0.0774	0.0055				
						A11	0.919	0.0525	0.0025				
						A12	1.657	0.6123	0.6212				
						A13	1.657	1.6067	4.2763				
						A14	1.657	0.6122	0.6209				
						A15	0.919	0.0526	0.0025				
						A16	0.549	0.0050	0.0000				
						A17	0.919	0.0907	0.0076				
						A18	0.919	0.1352	0.0168				
						A19	0.919	0.0905	0.0075				
						A20	0.549	0.0050	0.0000				

KGB Maser
Management Engineering Consulting

Structural Appendices





CELLULAR BEAM INFORMATION		
Job Name	TEST	
Beam Mark #	LB1	
Span	22.000	ft
Spac. Left	11.000	ft
Spac. Right	11.000	ft
Mat. Strength-Fy	50	ksi
Cellular Beam	LB30X57	
Root Beams (T/B)	W21X57	W21X57
d	21.06	21.06
bf	6.555	6.555
tf	0.65	0.65
tw	0.405	0.405

CELLULAR PARAMETERS:		
Min. Hole Diameter	15.99	in
Max. Hole Diameter	27.97	in
STD Hole Diameter Do	20.75	in
STD Hole Spacing S	29.250	in
Web Post Width "e"	8.500	in
S / Do	1.41	
Gross Depth "dg"	30.52	in
dg / Do	1.471	
Cutting Loss	0.910	
dt top	4.887	in
dt bot	4.887	in

CMC Steel Products

LOADING INFORMATION				
Uniform Distributed Loads				
Live Load	0	plf	Pre-comp %	0%
Dead Load	57	plf	Pre-comp %	85%
Concentrated Point Loads				
Load #	Magnitude	Dist from	Percent DL	Percent
(#)	(kips)	Lft. End (ft)	(%)	Pre-Comp.
P1	68.53	11.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION			
Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	3/4"
conc. wt. - wc (pcf)	115	stud ht. (in)	5
conc. above deck - tc (in)	3 1/4	studs per rib	1
rib height - hr (in)	3	composite %	100%
rib width - wr (in)	6	STUD SPACING:	
		29 | 29	

RESULTS		
Failure Mode	Interaction	Status
Bending	0.993	OK
Web Post	0.659	OK
Shear	0.446	OK
Concrete	0.387	OK
Pre-Comp.	0.446	OK
Overall	0.993	OK

DEFLECTION		
Pre-Composite Deflection	0.009	=L/29971
Live Load Deflection	0.195	=L/1357

EXPAND'D. SXN. PROP'S		
Avg. wt.	57.00	plf
Anet	12.03	in^2
Agross	20.43	in^2
Ix net	2459	in^4
Ix gross	2760	in^4
Ix critical	2546	in^4
Min Sx net	161	in^3
Min Sx gross	181	in^3
Min Sx critical	167	in^3
rx min	11.62	in
Iy net	31	in^4
Sy net	9.33	in^3

COMPOSITE SXN. PROP'S		
n	11.758	
beffec.	66.000	in
Actr	18.243	in^2
N.A. ht.	26.901	In Steel
Itr	5554	in^4
Ieffec.	5554	in^3
Sxconc	562.546	in^3
Sxsteel	206.478	in^3

WARNINGS

CONSTRUCTION BRIDGING	
End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging Spacing (ft)	41

Stnd " Do " & " S "

To Help Sheet

Find Lightest Cellular Beam

CELLULAR BEAM INFORMATION		
Job Name	TEST	
Beam Mark #	LB1	
Span	22.000	ft
Spac. Left	11.000	ft
Spac. Right	11.000	ft
Mat. Strength-Fy	50	ksi
Cellular Beam	LB30X44	
Root Beams (T/B)	W21X44	W21X44
d	20.66	20.66
bf	6.5	6.5
tf	0.45	0.45
tw	0.35	0.35

CELLULAR PARAMETERS:		
Min. Hole Diameter	15.69	in
Max. Hole Diameter	27.44	in
STD Hole Diameter Do	20.75	in
STD Hole Spacing S	29.250	in
Web Post Width "e"	8.500	in
S / Do	1.41	
Gross Depth "dg"	30.12	in
dg / Do	1.452	
Cutting Loss	0.910	
dt top	4.687	in
dt bot	4.687	in

CMC Steel Products

LOADING INFORMATION				
Uniform Distributed Loads				
Live Load	1650	plf	Pre-comp %	0%
Dead Load	953	plf	Pre-comp %	85%
Concentrated Point Loads				
Load #	Magnitude	Dist from	Percent DL	Percent
(#)	(kips)	Lft. End (ft)	(%)	Pre-Comp.
P1	0.00	11.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION			
Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	3/4"
conc. wt. - wc (pcf)	115	stud ht. (in)	5
conc. above deck - tc (in)	3 1/4	studs per rib	1
rib height - hr (in)	3	composite %	100%
rib width - wr (in)	6	STUD SPACING:	
		22 | 22	

RESULTS		
Failure Mode	Interaction	Status
Bending	0.402	OK
Web Post	0.507	OK
Shear	0.380	OK
Concrete	0.178	OK
Pre-Comp.	0.380	OK
Overall	0.507	OK

DEFLECTION		
Pre-Composite Deflection	0.099	=L/2675
Live Load Deflection	0.091	=L/2914

EXPAND'D. SXN. PROP'S		
Avg. wt.	44.00	plf
Anet	8.89	in^2
Agross	16.16	in^2
Ix net	1772	in^4
Ix gross	2032	in^4
Ix critical	1847	in^4
Min Sx net	118	in^3
Min Sx gross	135	in^3
Min Sx critical	123	in^3
rx min	11.22	in
Iy net	21	in^4
Sy net	6.35	in^3

COMPOSITE SXN. PROP'S		
n	11.758	
beffec.	66.000	in
Actr	18.243	in^2
N.A. ht.	27.929	In Steel
Itr	4312	in^4
Ieffec.	4312	in^3
Sxconc	510.623	in^3
Sxsteel	154.404	in^3

WARNINGS

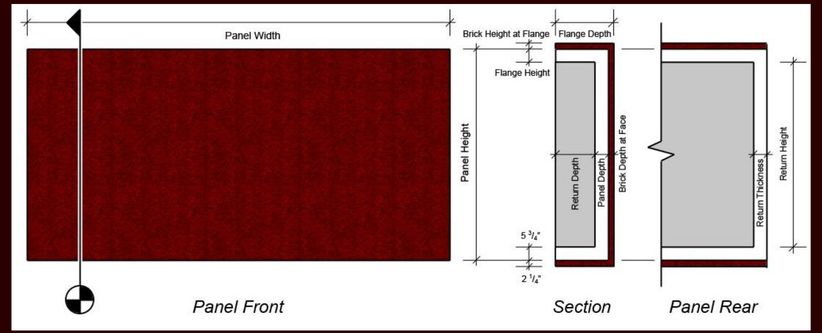
CONSTRUCTION BRIDGING	
End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging Spacing (ft)	38

Stnd " Do " & " S "

To Help Sheet

Find Lightest Cellular Beam

Structural Appendices



	Precast Panel Dimensions		
	Panel Height	141.125	in.
	Panel Depth	5	in.
	Brick Depth at Face	0.75	in.
	Flange Height	10	in.
	Brick Height at Flange	0.5	in.
	Flange Depth	15.75	in.
	Panel Width	263.25	in.
	Return Thickness	14	in.
	Return Depth	10	in.
	Return Height	121.125	in.
	Volume Concrete	157.593	ft.3
	Weight Concrete	23638.96	lb.
	Volume Brick	18.52405	ft.3
	Weight Brick	2222.886	lb.
(factored)	Total	36206.58	lb.
(factored)	Total with Planters	43930.29	lb.

	Wind Force	
(factored)	50.992	psf.

Self Weight Check Upright			
Weight/in.	137.5369	lb./in.	
Inertia of Panel	2032473	in.4	
Moment	1191423	lb.in.	
Stress	41.36329	psi.	OK

Planter Gravity Check Upright			
Weight/in.	166.8767	lb./in.	
Inertia of Panel	2032473	in.4	
Moment	1445581	lb.in.	
Stress	50.18705	psi.	OK

Wind Check On Face			
Weight/in.	4.249333	lb./in.	
Inertia of Strip	125	in.4	
Moment	10578.86	lb.in.	
Stress	211.58	psi.	OK

Wind Check On Flange			
Weight/in.	24.98697	lb./in.	
Inertia of Flange	2812.5	in.4	
Moment	172855.3	lb.in.	
Stress	460.9476	psi.	OK

Self Weight Check Prostrate			
Weight/in.	8.166667	lb./in.	(factored)
Inertia of Strip	125	in.4	
Moment	14730.64	lb.in.	
Stress	294.6128	psi.	OK

Planter Gravity Check Prostate			
Weight/in.	10.79167	lb./in.	(factored)
Inertia of Strip	125	in.4	
Moment	19465.49	lb.in.	
Stress	389.3098	psi.	OK

Cantilever Check on Flange Self Weight			
Weight/in.	15.16667	lb./in.	
Inertia of Flange	1000	in.4	
Moment	758.3333	lb.in.	
Stress	3.791667	psi.	

Cracking Stress		
477.2971	psi	(factored)

KGB Maser
Management Engineering Consulting

Structural Appendices

Corbel Dimensions		
L1=	6	in.
L2=	6	in.
b=	14	in.
h=	18	in.
d=	16.5	in.
a=	5.5	in.
λ=	1	
μ=	1.4	
β=	1	
ϕ=	0.75	
f'c=	5000	psi.
fy=	60000	psi.
Vu=	36.2	k.
Nu=	7.2	k.

Required Steel		
Vu.max=	189	k.
As.req=	0.44	in.2
μe=	3.4	
As.req=	0.32	in.2
As.min=	0.77	in.2
As=	0.77	in.2
Ah=	0.30	in.2
Ldh=	0.00	in.

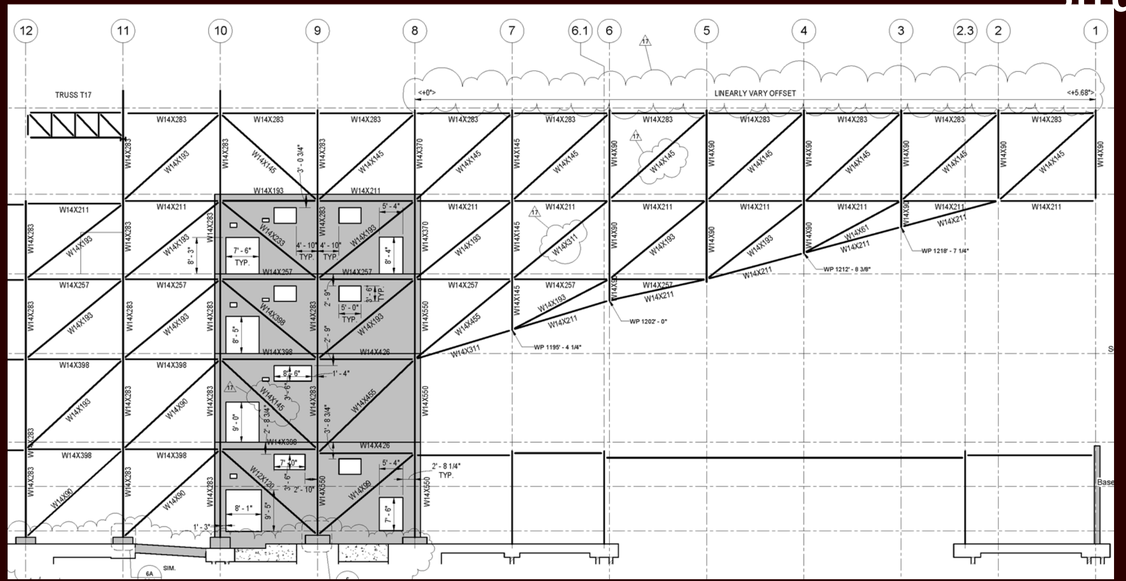
Results			
As.prov=	0.88	in.2	OK
Bar Size=	6		
(#) Bars=	2		
Ah.prov=	0.4	in.2	OK
Bar Size=	4		
(#) Bars=	2		

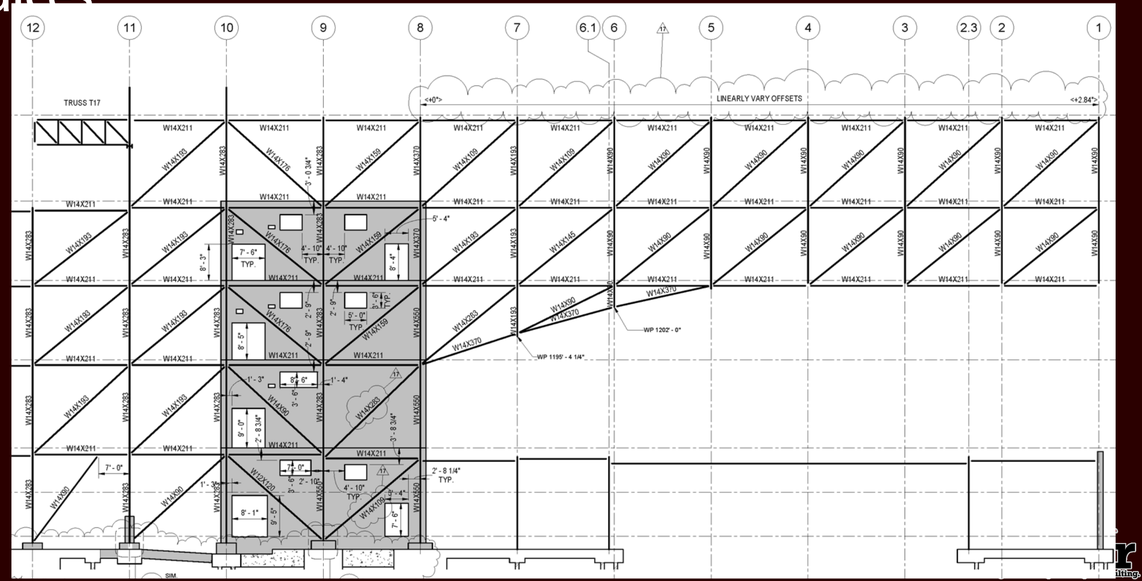
Connection Dimensions		
b=	14	in.
h=	36	in.
d=	35	in.
a=	7	in.
λ=	1	
μ=	1.4	
ϕ=	0.75	
f'c=	5000	psi.
fy=	60000	psi.
Vu=	36.2	k.
Nu=	7.2	k.

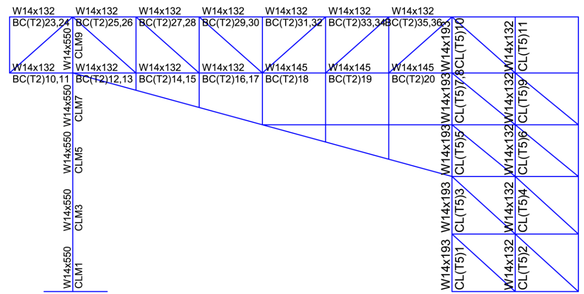
Required Steel			
As.1=	0.33	in.2	
μe=	3.4		
As.2=	0.32	in.2	
As.req=	0.33	in.2	
Ash.req=	0.805	in.2	
An=	0.161	in.2	
Ah.req=	0.083	in.2	
Vc=	69.3	k.	
Av.min=	0.001	in.2	
ϕVn=	61.87	k.	OK
Ld.As=	16.97	in.	

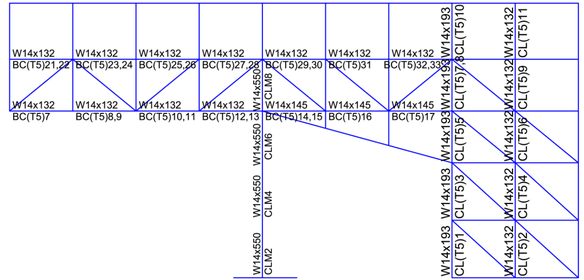
Results			
As.prov=	0.4	in.2	OK
Bar Size=	4		
(#) Bars=	2		
Ash.prov=	0.88	in.2	OK
Bar Size=	6		
(#) Bars=	2		
Av.prov=	0.11	in.2	OK
Bar Size=	3		
(#) Bars=	1		
Ah.prov=	0.11	in.2	OK
Bar Size=	3		
(#) Bars=	1		

Structural Appendices





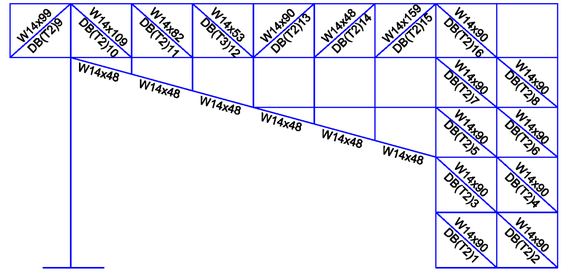


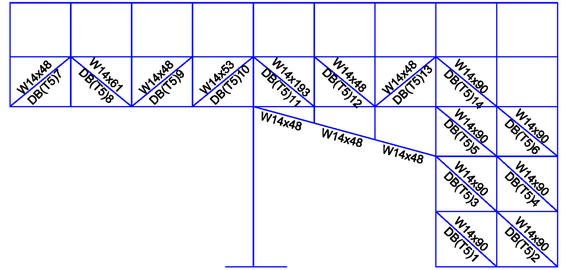


Structural Appendices

TABLE: Element Forces - Frames

Frame	Station	OutputCase	P	V2	V3	M2	M3	Section	Length	Length	Interaction
Text	in	Text	Kip	Kip	Kip	Kip-in	Kip-in		in	ft	
CL(T2)1	0	All Factored Loads	-2566.34	2.013	-0.485	-1.1E-14	-2.3E-13	W14X283	240	20	0.87
CL(T2)1	120	All Factored Loads	-2562.6	2.013	-0.485	58.154	-241.525	W14X283	240	20	0.88
CL(T2)1	240	All Factored Loads	-2558.87	2.013	-0.485	116.307	-483.049	W14X283	240	20	0.90
CL(T2)2	0	All Factored Loads	-763.225	-0.891	0.158	-1.4E-14	-1.1E-13	W14X132	240	20	0.59
CL(T2)2	120	All Factored Loads	-761.641	-0.891	0.158	-18.934	106.876	W14X132	240	20	0.60
CL(T2)2	240	All Factored Loads	-760.057	-0.891	0.158	-37.868	213.751	W14X132	240	20	0.61
CL(T2)3	0	All Factored Loads	-2577.54	-1.544	-0.485	116.307	-35.398	W14X283	240	20	0.89
CL(T2)3	120	All Factored Loads	-2573.8	-1.544	-0.485	174.461	149.839	W14X283	240	20	0.89
CL(T2)3	240	All Factored Loads	-2570.07	-1.544	-0.485	232.615	335.076	W14X283	240	20	0.90
CL(T2)4	0	All Factored Loads	-677.764	-2.592	1.081	155.089	-482.068	W14X132	240	20	0.59
CL(T2)4	120	All Factored Loads	-676.18	-2.592	1.081	25.314	-170.969	W14X132	240	20	0.54
CL(T2)4	240	All Factored Loads	-674.596	-2.592	1.081	-104.46	140.13	W14X132	240	20	0.55
CL(T2)5	0	All Factored Loads	-2460.79	-14.624	29.091	2470.084	-1847.08	w14x311	216	18	0.95
CL(T2)5	108	All Factored Loads	-2457.43	-14.624	29.091	-671.753	-267.677	w14x311	216	18	0.78
CL(T2)5	216	All Factored Loads	-2454.07	-14.624	29.091	-3813.59	311.725	w14x311	216	18	0.98
CL(T2)6	0	All Factored Loads	-565.966	-8.097	7.933	824.811	-605.656	W14X132	216	18	0.61
CL(T2)6	108	All Factored Loads	-564.54	-8.097	7.933	-31.908	268.841	W14X132	216	18	0.44
CL(T2)6	216	All Factored Loads	-563.114	-8.097	7.933	-888.628	1143.338	W14X132	216	18	0.67
CL(T2)7	0	All Factored Loads	-1915.77	36.244	99.693	5802.812	1608.581	w14x311	216	18	1.00
CL(T2)7	60	All Factored Loads	-1913.91	36.244	99.693	821.252	1433.913	w14x311	216	18	0.67
CL(T2)7	120	All Factored Loads	-1912.04	36.244	99.693	-5160.31	-740.755	w14x311	216	18	0.92





Mechanical Appendices

Utility Information from OPP	
Utility	Cost ($)/Unit
Purchased Steam	$9.85/1000 lbm ($0.82/therm)
Purchased Chilled Water	$0.22/ton-hr ($1.83/therm)
Electric Consumption	$0.07517/kWh
Electric On Peak	$1.09/kW
Water (N/A in current model)	$3.32/1000 gallons

ASHRAE Weather Data Used			
ASHRAE Altoona, PA	Summer Design Condition: Cooling 0.4%	Winter Design Condition: Heating 99.6%	Chilled Beam: Dehumidification 0.4%
Outside Air Dry Bulb (°F)	4.7	88.5	-
Mean Coincident Wet Bulb (°F)	-	72.0	77.7
Humidity Ratio (Grains/lb)	-	85.7	118.0
Dew Point (°F)	-	-	70.4

OPP Design Conditions			
Area	Season	Indoor	Outdoor
Comfort Areas	Summer Winter	75°F DB, 50% RH 75°F DB, 50% RH	90°F DB, 74°F WB 0°F DB
Labs	Summer Winter	Lab specific	92°F DB, 74°F WB 0°F DB
Animal Holding	Summer Winter	64-79°F DB[1], 30-70% RH[1]	95°F DB, 75°F WB -10°F DB

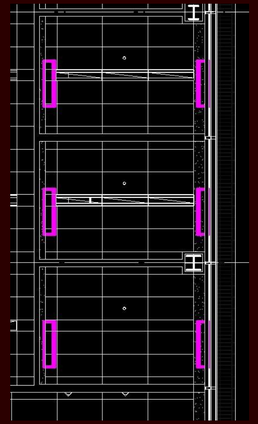
KGB Maser
Management Engineering Consulting

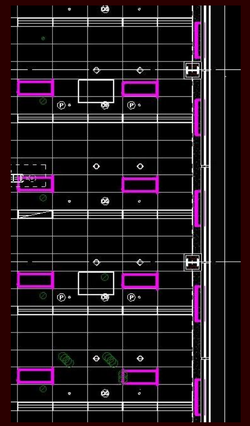
$$3{,}000\ GPM_{BeamLoop} * (62^oF - 58^oF) * 500 = (1{,}500\ GPM_{AHU} * (58^oF - 56^oF) * 500) + (187.5\ GPM_{Campus} * (58^oF - 42^oF) * 500)$$

Mechanical Appendices

Occupant Ventilation Examples: Student/Office Areas				
People	Occupant Latent Load Ventilation Btu/hr	CFM Needed to Offset Latent 50% RH	CFM Needed to Offset Latent 52% RH	CFM Needed to Offset Latent 53% RH
4.8	952	200	140	127
1.1	220	46	32	29
1.8	361	76	53	48

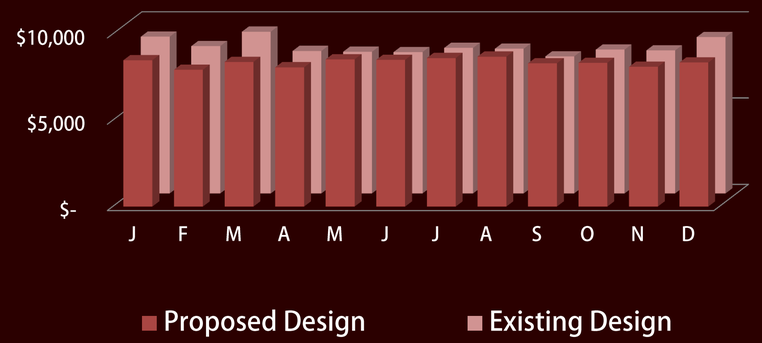
Mechanical Appendices



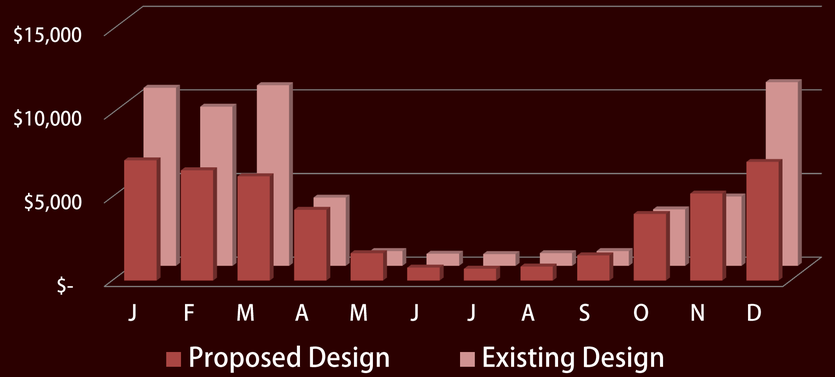


Mechanical Appendices

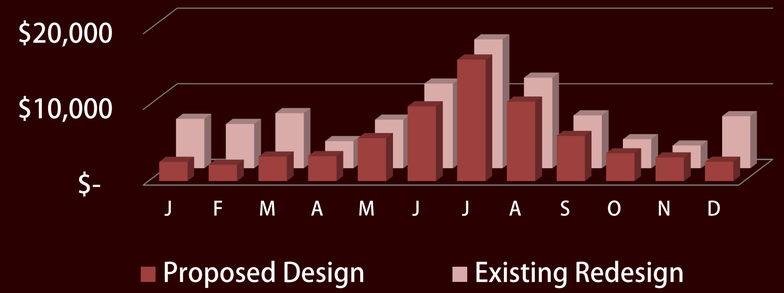
Annual Electricity Costs



Annual Steam Costs

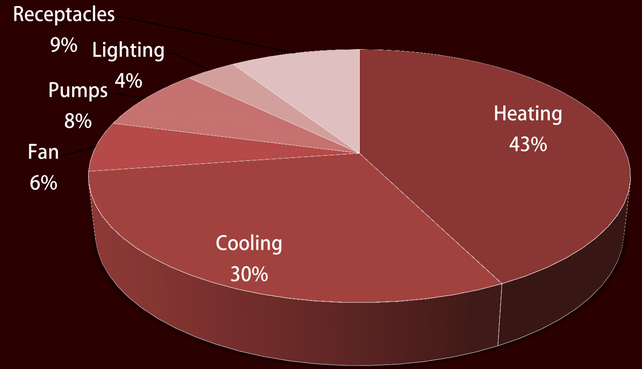


Annual Chilled Water Costs

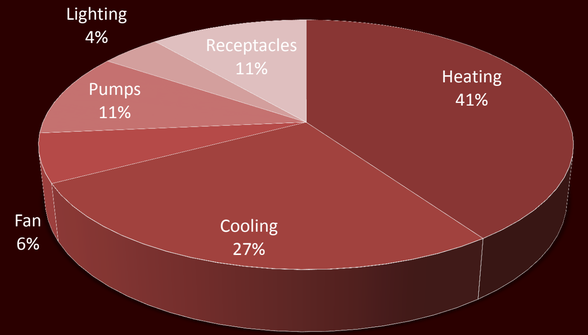


Mechanical Appendices

Existing Design Energy Use Breakdown



Proposed Design Energy Use Breakdown



Mechanical Appendices

Bin Data for Williamsport, PA		
Temperature (°F)	Enthalpy (BTU/lbm)	Hours of Occurrence
-13.0	-3.1	1
-8.0	-1.9	4
-3.0	0.0	10
2.0	1.4	23
7.0	2.6	59
12.0	4.2	107
17.0	5.5	191
22.0	7.2	322
27.0	9.0	528
32.0	10.6	846
37.0	12.6	844
42.0	14.3	689
47.0	16.6	652
52.0	18.7	647
57.0	21.4	707
62.0	24.5	747
67.0	27.1	762
72.0	29.3	630
77.0	30.7	456
82.0	32.3	316
87.0	33.9	151
92.0	35.6	52
97.0	36.5	12

Entering Coil Conditions			
Enthalpy Wheel Only: VAV, 100 fpm		Dual Wheel: Neutral Air+ Chilled Beams, 80 fpm	
Temperature (°F)	Enthalpy (BTU/lbm)	Temperature (°F)	Enthalpy (BTU/lbm)
36.6	14.4	27.7	12.6
38.7	14.9	29.8	13.1
40.9	15.7	32.0	13.9
43.0	16.3	34.1	14.5
45.2	16.8	36.3	15.0
47.3	17.5	38.4	15.7
49.5	18.1	40.6	16.3
51.6	18.8	42.7	17.0
53.8	19.6	44.9	17.8
55.9	20.3	47.0	18.5
58.1	21.1	49.2	19.3
60.2	21.9	51.3	20.1
62.4	22.9	53.5	21.1
64.5	23.7	55.6	21.9
66.7	24.9	57.8	23.1
68.8	26.2	60.8	25.3
71.0	27.4	62.9	26.5
76.0	30.4	65.1	27.4
78.1	31.1	67.2	28.0
80.3	31.7	69.4	28.7
82.4	32.4	71.5	29.4
84.6	33.2	73.7	30.1
86.7	33.5	75.8	30.5

$$\left(\frac{Btu}{hr}\right) = 1.1 * (Bin\ Temperature - 52^{o}F) * CFM * Hours\ of\ Occurence$$

$$\frac{Btu}{hr} = 4.5 * (Bin\ Enthalpy - 21.5) * CFM * Hours\ of\ Occurence$$

$$\frac{Btu}{hr} = 4.5 * (21.5 - Bin\ Enthalpy) * CFM * Hours\ of\ Occurence$$

$$Therms = \frac{\frac{Btu}{hr}}{10{,}000}$$

KGB Maser
Management Engineering Consulting

Mechanical Appendices

Fume Hood Position- Variable Air Volume Factor				
Percent Open	Percent Bin	Hour Occurrence	Percent Occurrence	Bin*% Occurrence
0-10 (Minimum)	0.05	5100	0.58	0.03
11-20	0.15	0.00	0.00	0.00
21-30	0.25	0.00	0.00	0.00
31-40	0.35	0.00	0.00	0.00
41-50	0.45	0.00	0.00	0.00
51-60	0.55	2384	0.27	0.15
61-70	0.65	0.00	0.00	0.00
71-80	0.75	0.00	0.00	0.00
81-90	0.85	0.00	0.00	0.00
91-100	0.95	1276	0.15	0.14
Totals		8760	1.00	0.32

Fume Hood Exhaust Comparison				
Design	Fan Type	CFM	Static Pressure	HP
Existing 100 fpm	(3) Greenheck Vektor MD-33	21,400	5″	50
	(3) Greenheck Vektor MD-33	11,600	5″	25
Proposed 80 fpm	(3) Greenheck Vektor MD-33	17,200	5″	40
	(3) Greenheck Vektor MD-33	9,280	5″	15

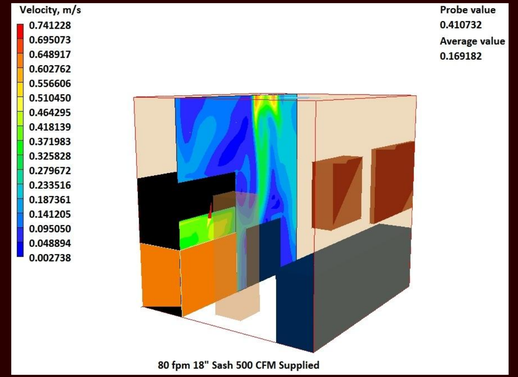
Summary of Fume Hood Makeup Air Costs and Savings		
Metric	100 fpm VAV	80 fpm ACBs
Cooling/Dehumidification	$233,356.06	$122,597.17
Heating	$6,479.29	$13,447.52
Fan	$110,512.71	$81,042.65
Humidification	$17,610.24	$33,343.69
CAV Operation Costs	$367,958.30	$250,431.03
VAV Multiplier for Operation	0.32	0.32
Adjusted Operation Costs	$116,704.95	$79,428.95
Percent Savings		31.94%

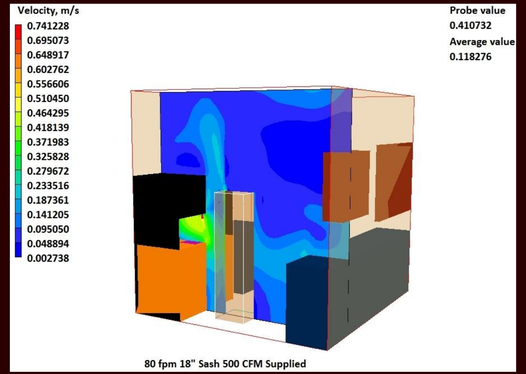
KGB Maser
Management Engineering Consulting

Mechanical Appendices

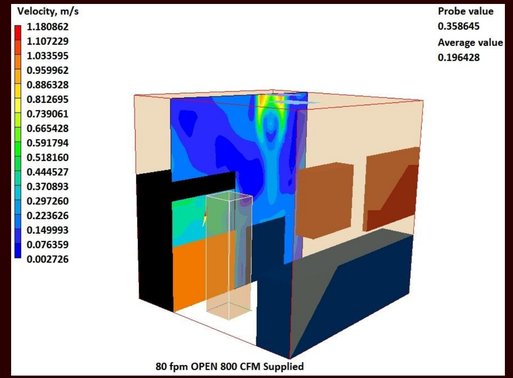
Price Comparison of Fume Hoods						
Fume Hood Size (feet)	Existing Fume Hoods: Labconco Premier Fume Hoods			Proposed Low Flow Fume Hoods: Labconco XStream Fume Hoods		
	Unit Price	Quantity	Total Price	Unit Price	Quantity	Total Price
4	$7,360.00	2	$14,720.00	$7,480.00	2	$14,960.00
5	$8,380.00	14	$117,320.00	$8,650.00	14	$121,100.00
6	$8,920.00	52	$463,840.00	$9,270.00	52	$482,040.00
8	$12,350.00	1	$12,350.00	$13,220.00	1	$13,220.00
		Total	$608,230.00		Total	$631,320.00
Model information on low flow fume hoods can be found in Appendix 4.H						

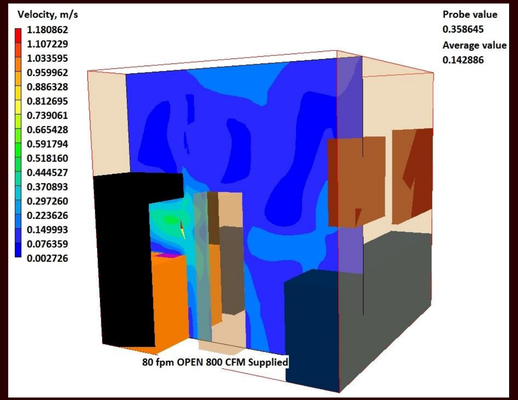
Mechanical Appendices



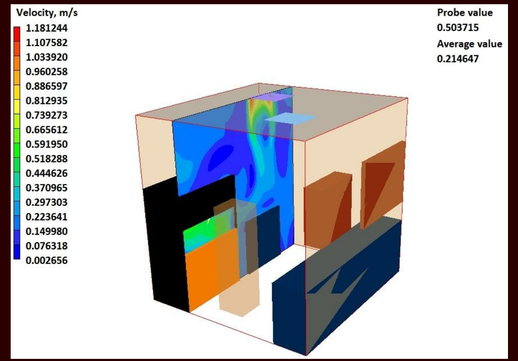


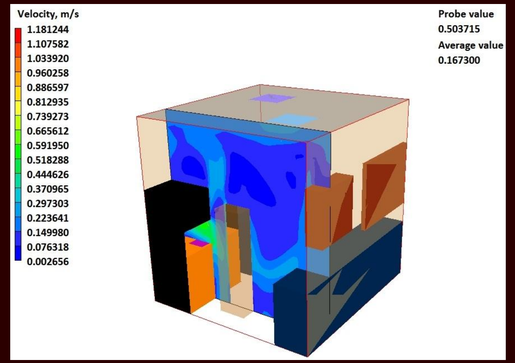
Mechanical Appendices





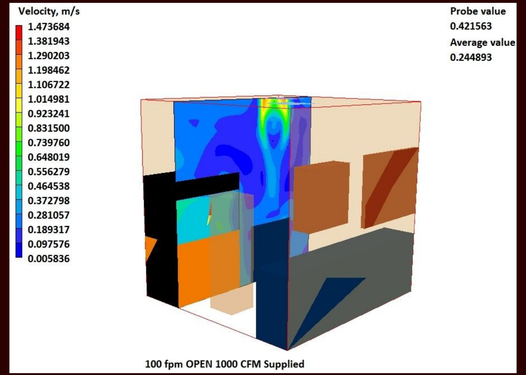
Mechanical Appendices

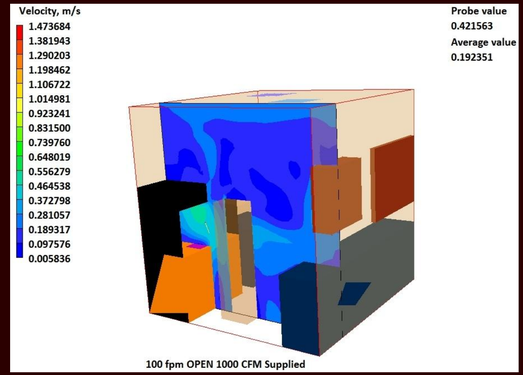




Mechanical Appendices

Model Parameters	
Turbulence Model	KECHEN
Differencing Scheme	Hybrid
Energy Equation	Temperature
Iterations	4,000
Ambient Temperature	25°C
Grid Size	55 x 45 x 42





Mechanical Appendices

CFD File Results: Residuals					
Scenario	Mass Residual	Temperature Residual	KE Residual	EP Residual	Simulation Length (hr:min)
100 fpm, 18″ Sash	1.01%	0.01%	11.6%	0.6%	1:59
80 fpm, 18″ Sash	0.63%	0.009%	12.5%	0.1%	2:05
100 fpm, 30″ Sash	1.60%	0.01%	12.5%	0.9%	2:04
80 fpm, 30″ Sash	1.11%	0.01%	9.8%	0.45%	2:06

CFD Results: Face Velocities and Concentrations					
Scenario	Specified Outlet CFM	Supplied Inlet CFM	Face Velocity	Concentration: Face	Percent Increase
100 fpm, 18″ Sash	675	600	0.5037 m/s	0.11287	-
80 fpm, 18″ Sash	540	600	0.4107 m/s	0.12898	14.2%
100 fpm, 30″ Sash	1125	1000	0.4215 m/s	0.11856	-
80 fpm, 30″ Sash	900	800	0.3586 m/s	0.13994	18.0%

KGB Maser
Management Engineering Consulting

Mechanical Appendices

Detailed Geometries						
Element	Length	Width	Height	Location		
	Δx (m)	Δy (m)	Δz (m)	x (m)	y (m)	z (m)
Room	3.3528	3.218	3.3528	-	-	-
Human	0.5	0.5	1.89	2.48	1.21	0.0
Table	1.0668	0.853	1.0668	0.579997	0.0	0.0
Fume Hood Base	1.4	0.853	1.0668	1.9528	0.0	0.0
Fume Hood Wall1	0.0	0.853	2.0	1.9528	0.0	0.0
Fume Hood Wall2	0.0	0.853	2	3.3528	0.0	0.0
Fume Hood Sash	1.4	0.0	0.48	1.9528	0.853	1.52
Fume Hood Top	1.4	0.853	0.1	1.9528	0.0	2.00
Table (2)	3.3528	0.609759	1.0668	0.0	2.608241	0
Cabinet	0.914630	0.304800	0.914630	2.0	2.9132	1.6
Wallboard	1.544630	0.075	1.15	0.0	3.143	1.429996
General Exhaust	0.609	0.609	0.0	2.0	2.0	3.3528
Ceiling Diffuser	0.15225	0.15225	0.15225	Varies		
Contaminant Inlet	0.335280	0.3048	0.0	2.557516	0.49	1.06685
Fume Hood Outlet	1.4	0.853	0.0	1.952800	0.0	2

KGB Maser
Management Engineering Consulting