University Health System| Charlottesville, VA

Central Bed Tower Expansion

Sarah L. Bell

Professor James Faust | **Dr. Craig Dubler**

Construction Management| 2011-2012

University Health System| Charlottesville, VA

Central Bed Tower Expansion

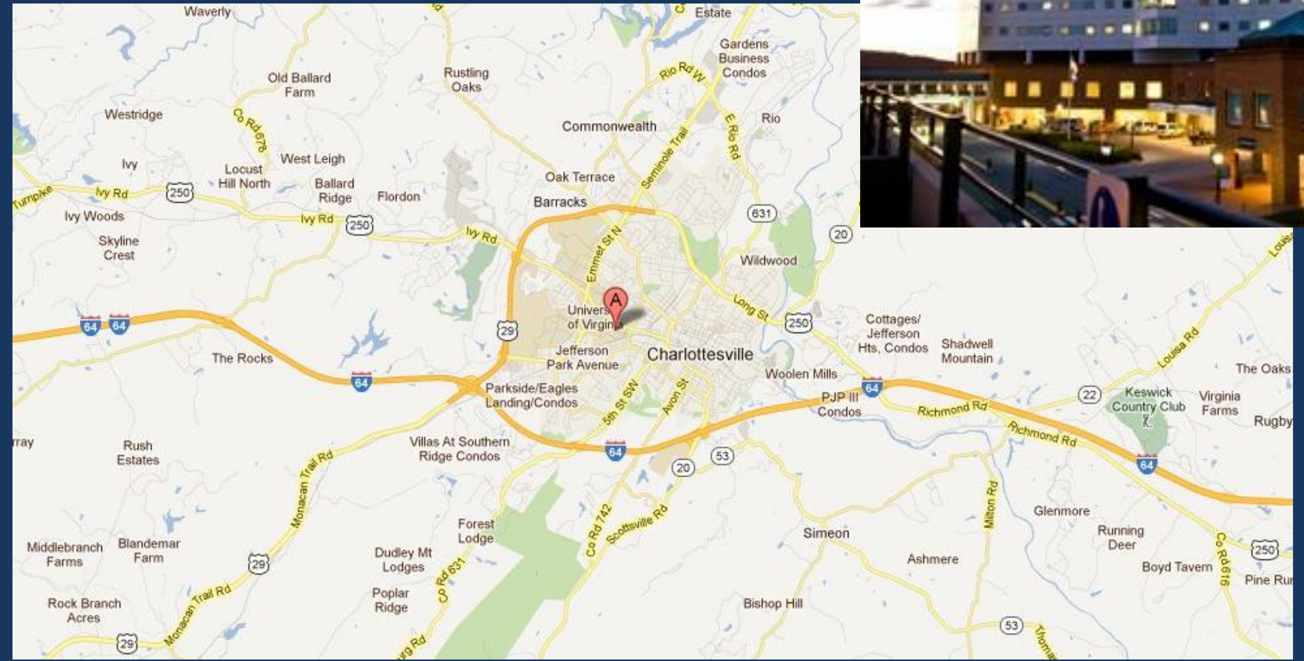
Sarah L. Bell

Senior Thesis Presentation

Construction Management| **2011-2012**

Presentation Outline

- Project Overview
- Prefabricated Acoustical Walls (Breadth)
- BIM Implementation with Phased Scheduling
- Photovoltaic Façade Change (Breadth)
- Prefabricated MEP Systems
- Conclusions and Recommendations



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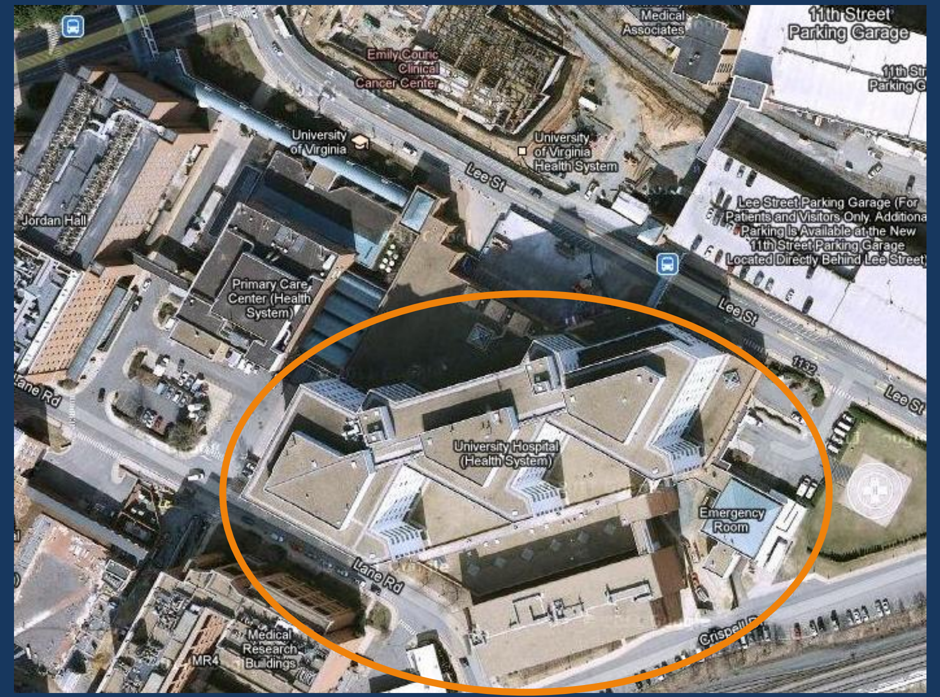
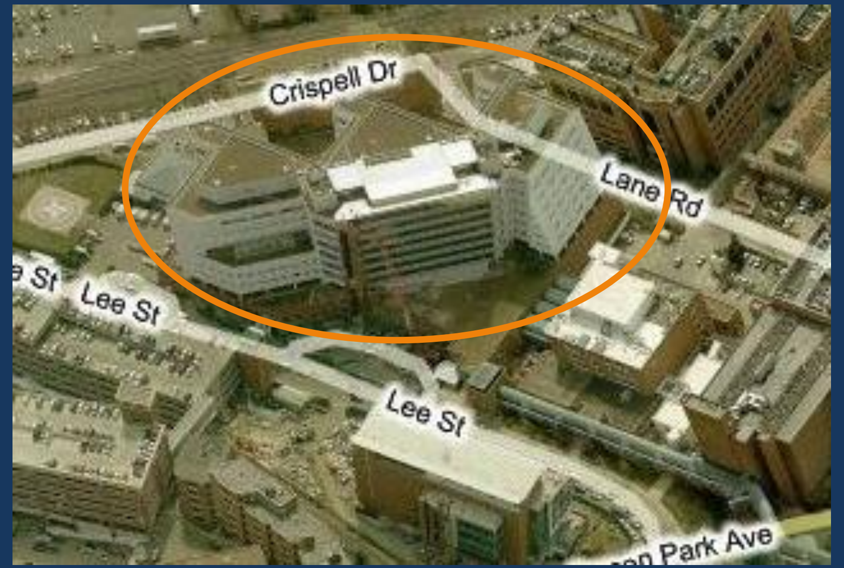
Project Overview

- **Occupants**: University of Virginia Health System
- **Location**: University of Virginia at Charlottesville, VA
- **Function**: Medical Facility Expanding Patient Care Wing
- **Size**: 60,000 ft^2 (New), 70,000 ft^2 (Renovated)
- **Stories**: 6 Occupied Floors , 2nd Floor Mechanical Space
- **Schedule:** August 2008 – December 2011
- **Cost:** $55 Million
- **Delivery Method**: Design Assist CM Agent – Multiple Prime Contract

Project Overview





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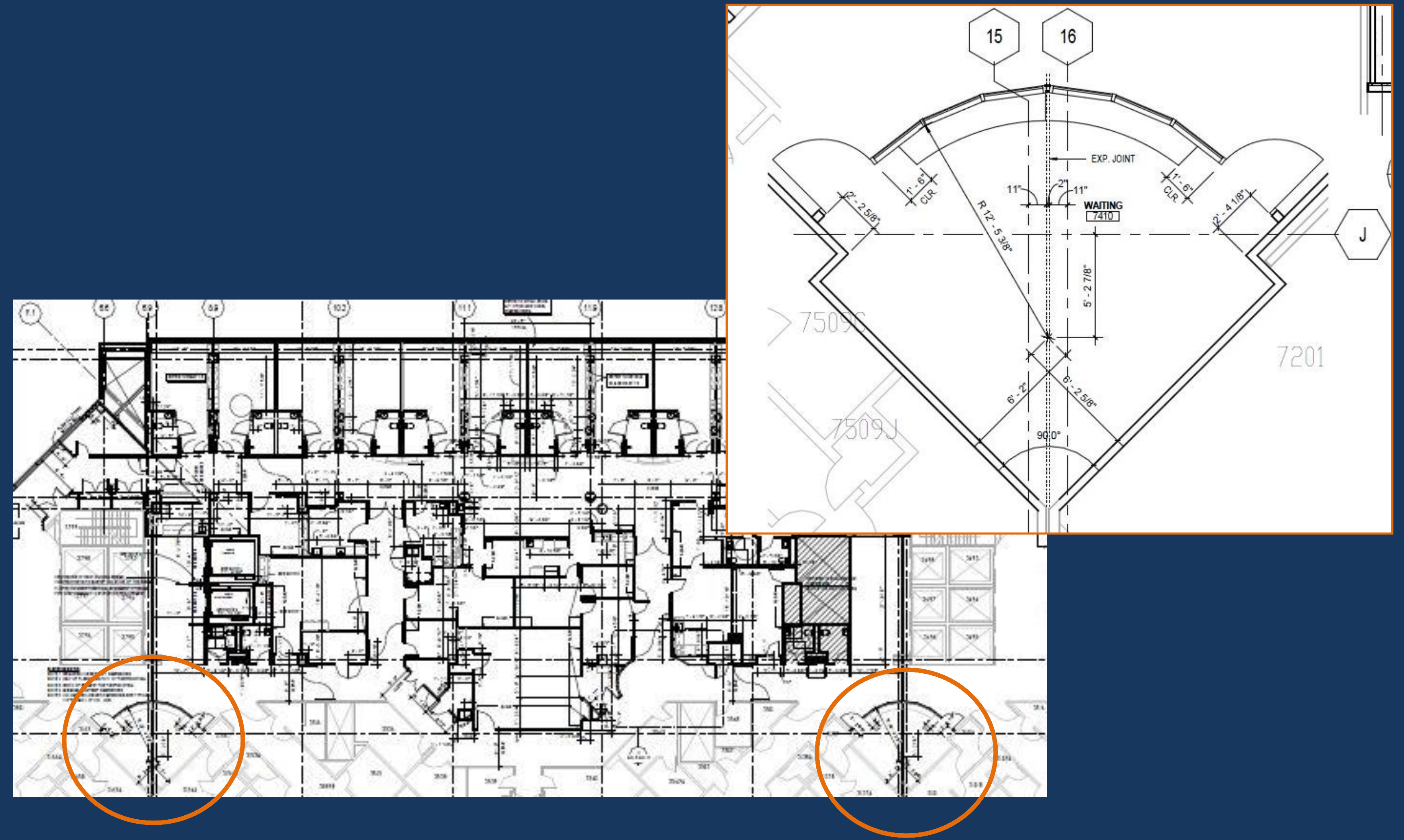
Analysis I –Prefabricated Acoustical Wall

Prefabricated Acoustical Walls

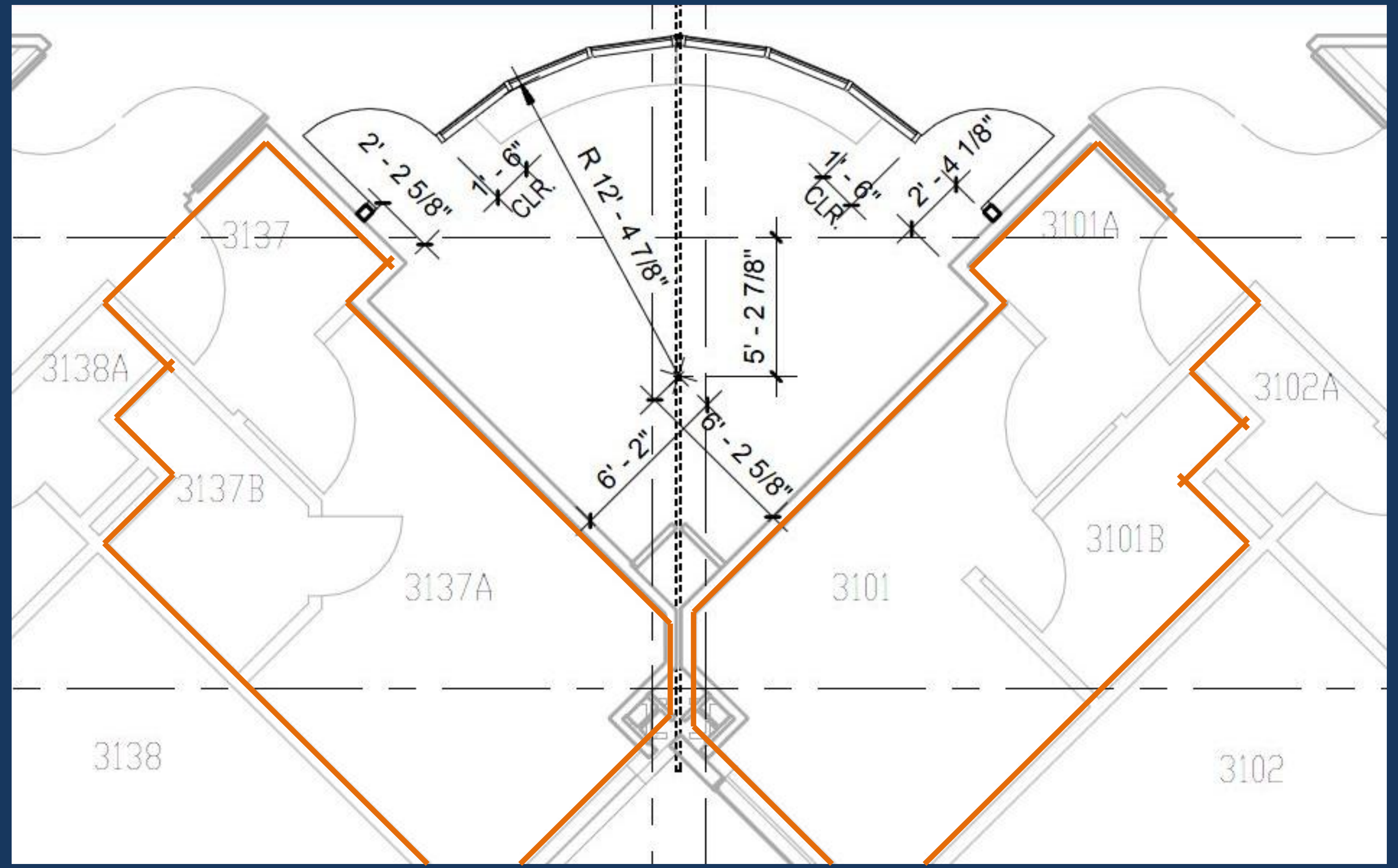


Prefabricated Acoustical Walls

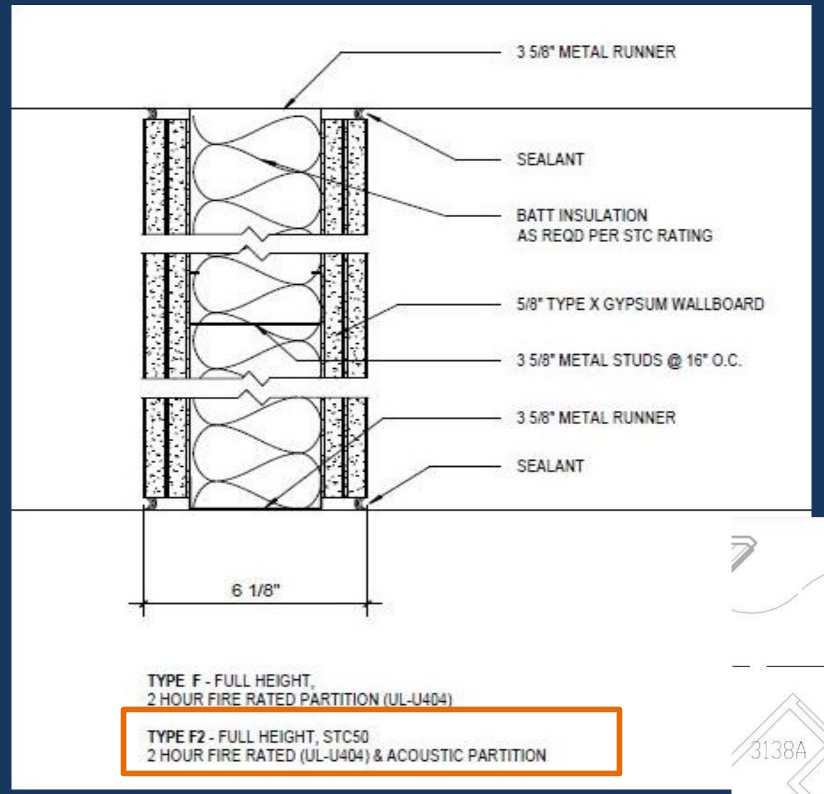
Problem – Renovation areas are subject to time restrictions due to high noise volume, vibrations, and dust control originating from the construction areas

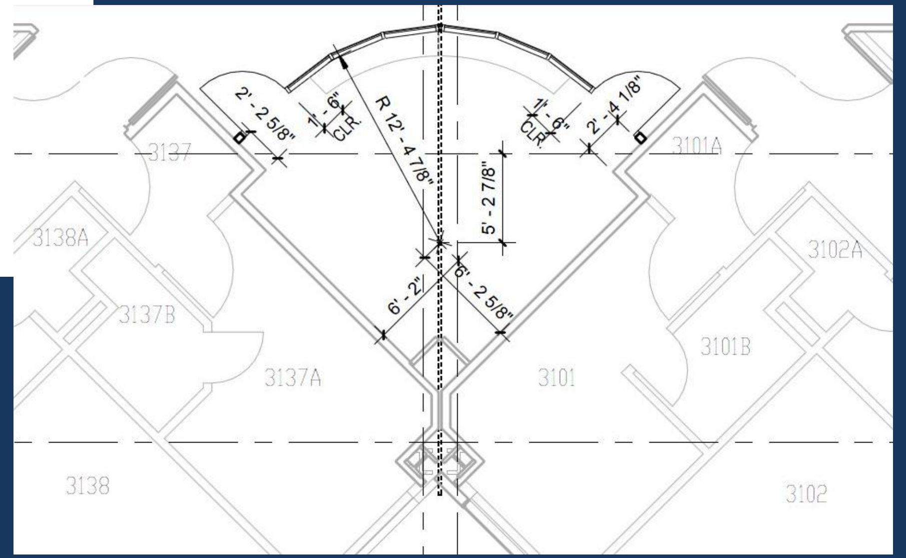
Goal – Increase work productivity and quality via the implementation of prefabricated acoustical walls.

Prefabricated Acoustical Walls



Prefabricated Acoustical Walls





Prefabricated Acoustical Walls

Wall Constructability

- Ensure a completely sealed enclosure
- Noise frequency estimated to be 125 Hz
- Expected noise volume from source around 86 dB
- Normal conversation noise level is around 63 dB
- Want Noise Volume reduced to under 63 dB

Prefabricated Acoustical Walls

$$NR = TL + 10\log(a_2/S)$$

Noise Reduction 125 dB	
Noise Level at Source	86 dB
TL	38 dB
a_2	464.4 Sabins
S	168 ft²
NR	42.4 dB
Noise Transferred	44 dB

Prefabricated Acoustical Walls

Wall Cost Analysis

Cost of Acoustical Walls	
Type	**Cost**
Material	$17,504.45
Lost Revenue	$831,600
Total	$849,104.45

Prefabricated Acoustical Walls

Outcome

- No Solution for vibrations
- Theoretically, acoustical walls were a good idea
- Practically, walls are too heavy and cannot extend to base of the next floor's metal decking
- Time restrictions will remain in place
- There is no cost benefit of using these walls

Prefabricated Acoustical Walls

Schedule Analysis

- Original duration of 50 days/floor
- Adjacent private patient rooms will need to be vacated
- Only one waiting room per floor may be renovated at a time
- No schedule reduction expected

Prefabricated Acoustical Walls

Wall Cost Analysis

Cost of Acoustical Walls	
Type	**Cost**
Material	$17,504.45
Lost Revenue	$831,600
Total	$849,104.45

Prefabricated Acoustical Walls

Recommendation

- Prefabricated Acoustical Walls are not recommended for this project.

Prefabricated Acoustical Walls

Schedule Analysis

- Original duration of 50 days/floor
- Adjacent private patient rooms will need to be vacated
- Only one waiting room per floor may be renovated at a time
- No schedule reduction expected

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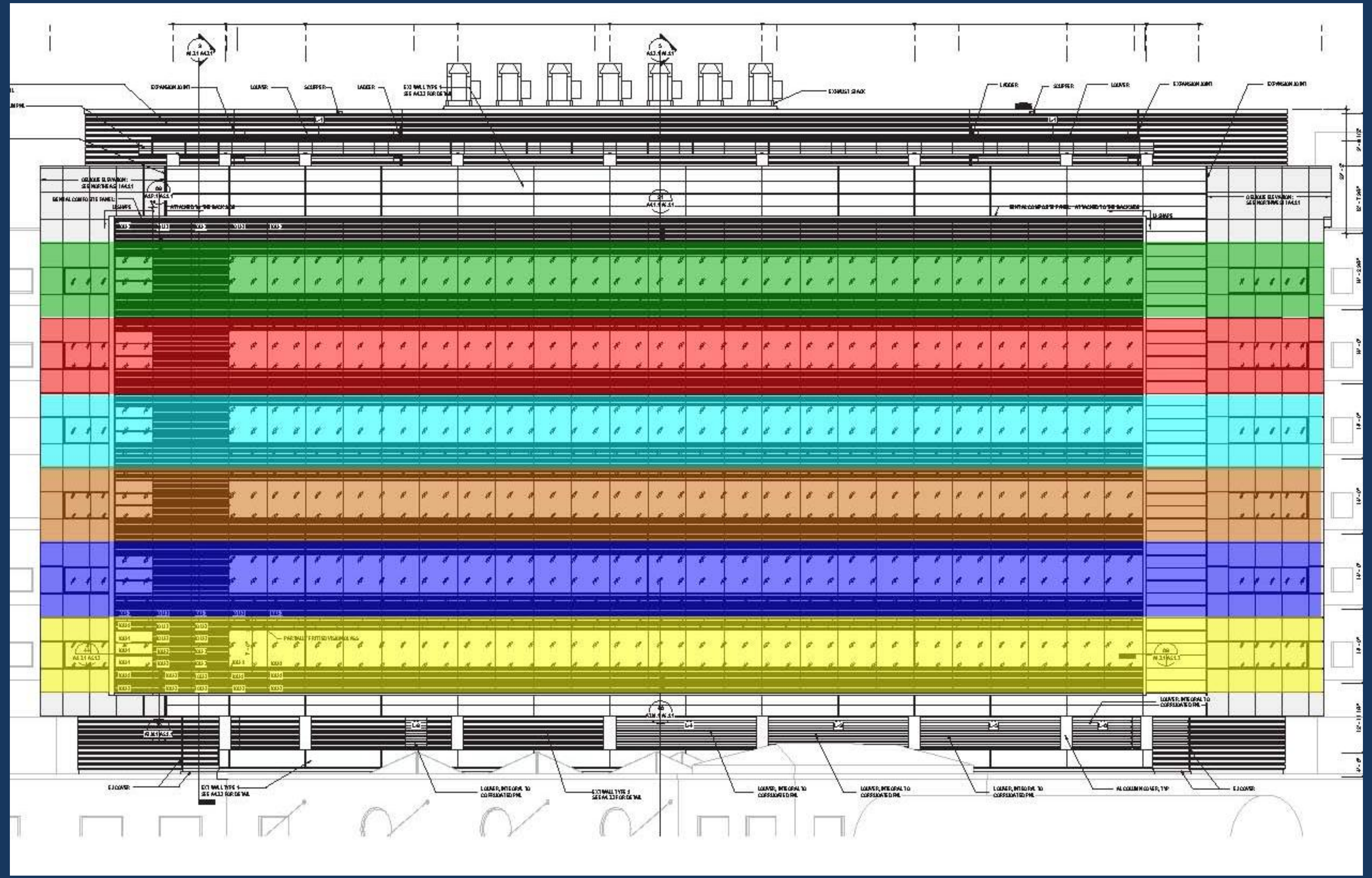
Analysis II –BIM Implementation

BIM Implementation



BIM Implementation

Problem – Project is several months behind schedule and the schedule lacks organization possibly causing delays in construction

Goal – Add quality and possible acceleration to the project by creating a phased schedule that can be linked to a 3D model

BIM Implementation

Phase I – Building Prep

- Owner Vacancy
- Demolition and Steel Strengthening

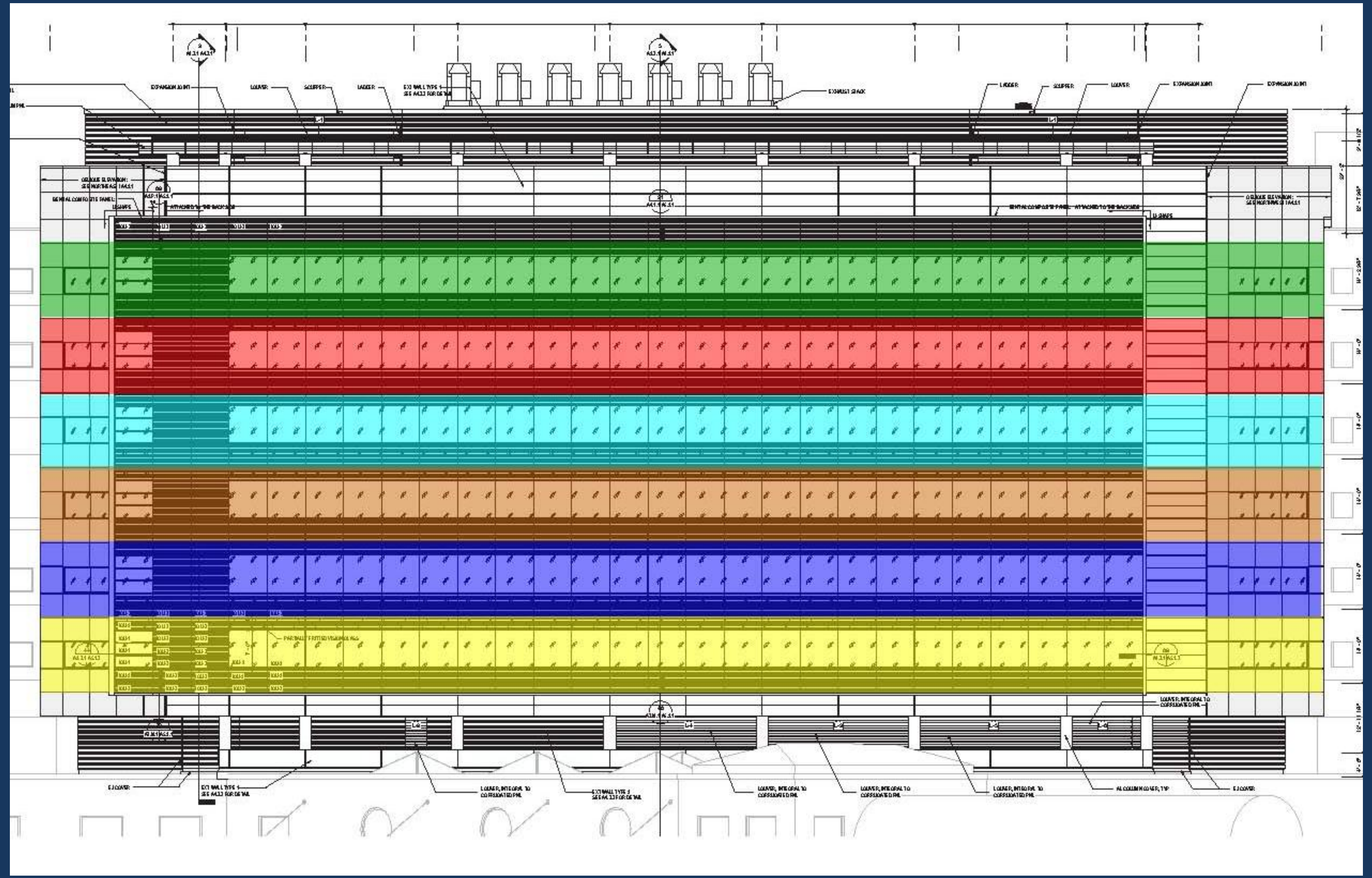
Phase II– Structure

- Superstructure
- Façade

Phase III– Interior

- Rough-In
- Finishes
- Commissioning

BIM Implementation



BIM Implementation

Outcome

- Implementing a Phased Schedule on this project is expected to reduce the duration construction by one month
- Increase in quality of construction experience for hospital staff and patrons
- Detailed interior modeling is impractical
- Use of general phased models would prove beneficial for all parties involved

BIM Implementation

Phase I – Building Prep

- Owner Vacancy
- Demolition and Steel Strengthening

Phase II– Structure

- Superstructure
- Façade

Phase III– Interior

- Rough-In
- Finishes
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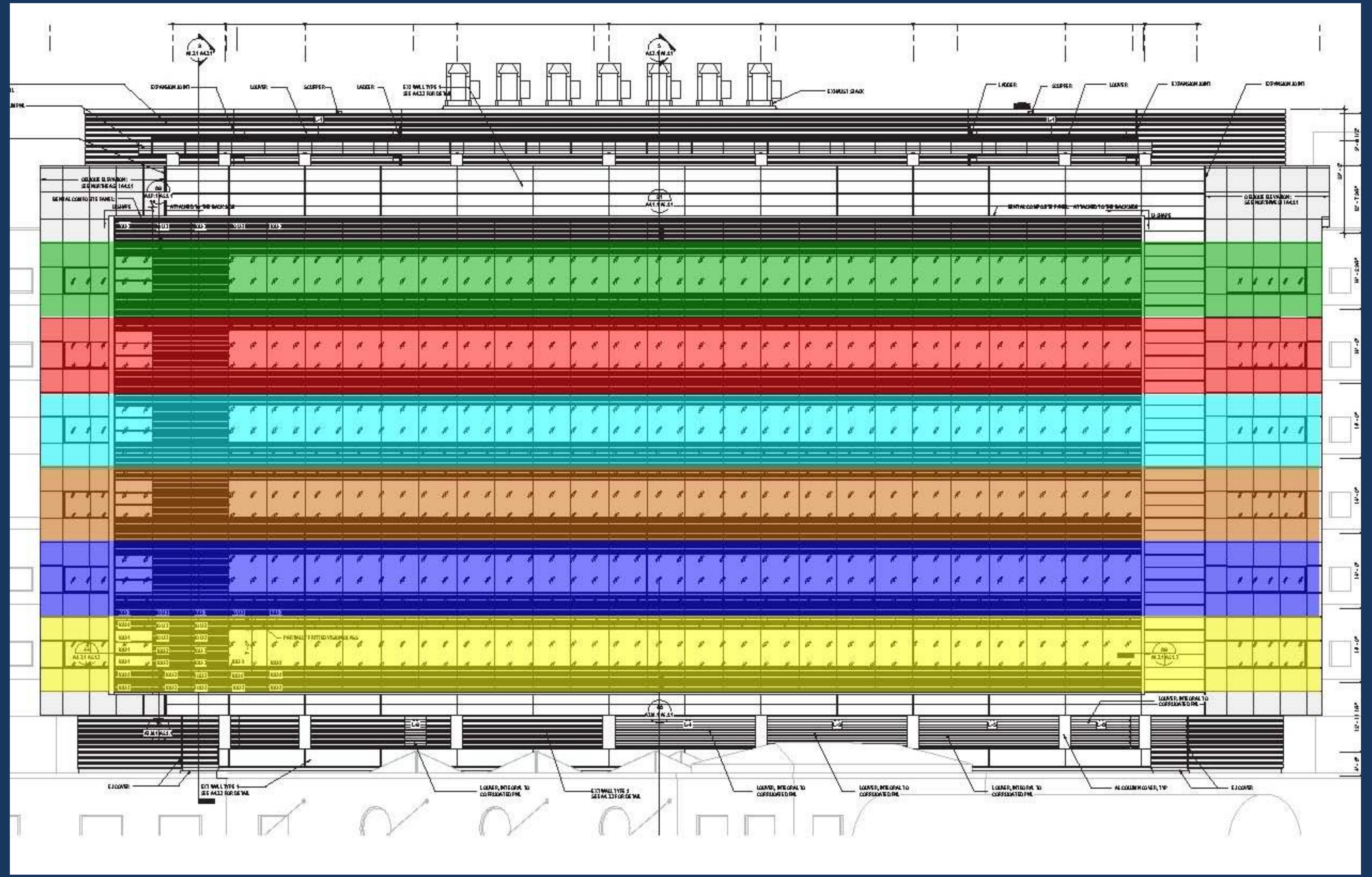
BIM Implementation



BIM Implementation

Recommendation

- Phased Scheduling and Simple 3D Models are recommended for this project.

BIM Implementation

Phase I – Building Prep

- Owner Vacancy
- Demolition and Steel Strengthening

Phase II– Structure

- Superstructure
- Façade

Phase III– Interior

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- Finishes
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Analysis III –Photovoltaic Façade Change

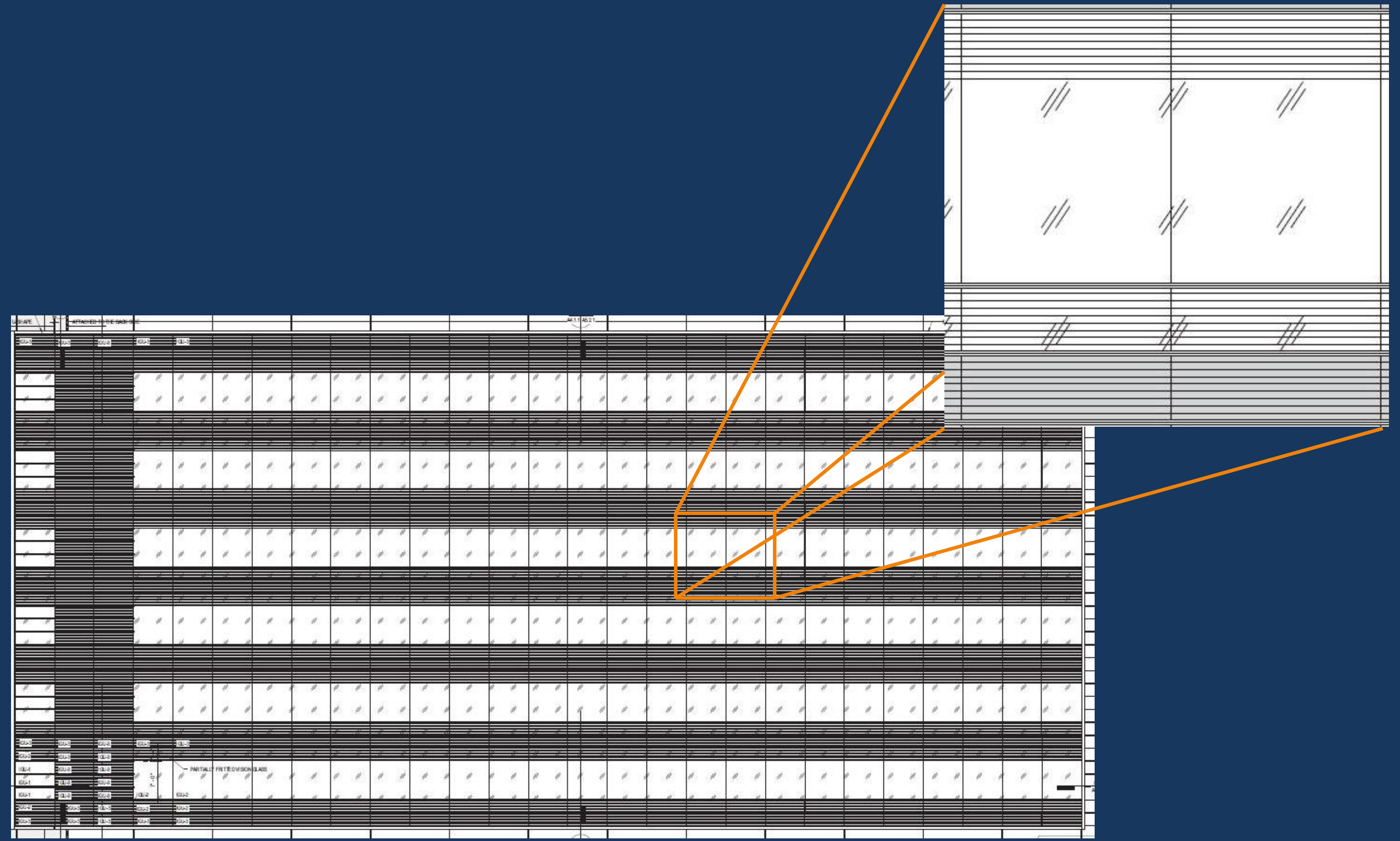
Photovoltaic Façade Change

Photovoltaic Façade Change

Problem – 17,500 ft^2 glass façade offers little privacy for room occupants and has the potential to take on sustainable aspect

Goal – Value engineer the glass façade to include photovoltaic panels ,potentially reducing the hospital's electrical load

Photovoltaic Façade Change



Photovoltaic Façade Change

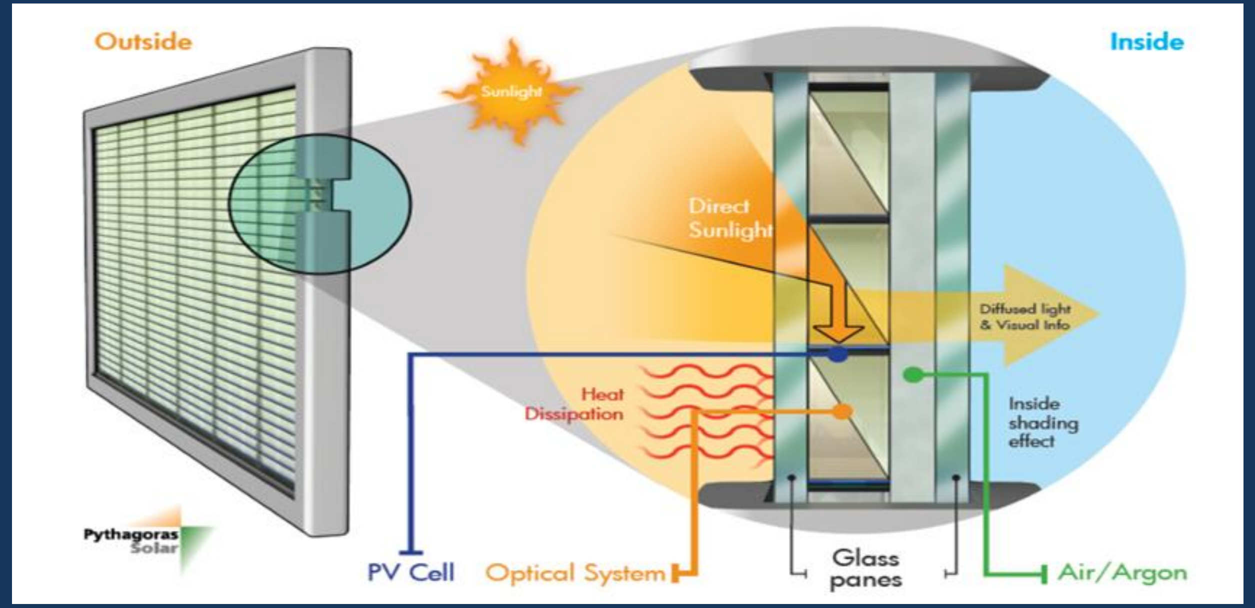
PVGU Design Parameters	
Location	Charlottesville, VA
Latitude	38.03°N
Longitude	78.48°W
Elevation	594' (181m)
Façade Orientation	NNW
Total Area of Glass Facade	17,955 ft²
Area Covered by PVGU	10,080 ft²
Tilt Angle	90°
Sun Hours/Day	
High	4.5
Low	3.37
Average	4.13

Photovoltaic Façade Change

Outcome

- Location and Azimuth is not ideal for this system
- System does not produce enough energy to sustain the expected loads
- Payback period is much greater than system lifespan

Photovoltaic Façade Change



System Summary	
System Size	112.4 kW
AC Energy	41,381 kWh
Energy Value	$3,310.48
Cost of System	$75/ft²
Payback Period	>> 25 years

Photovoltaic Façade Change

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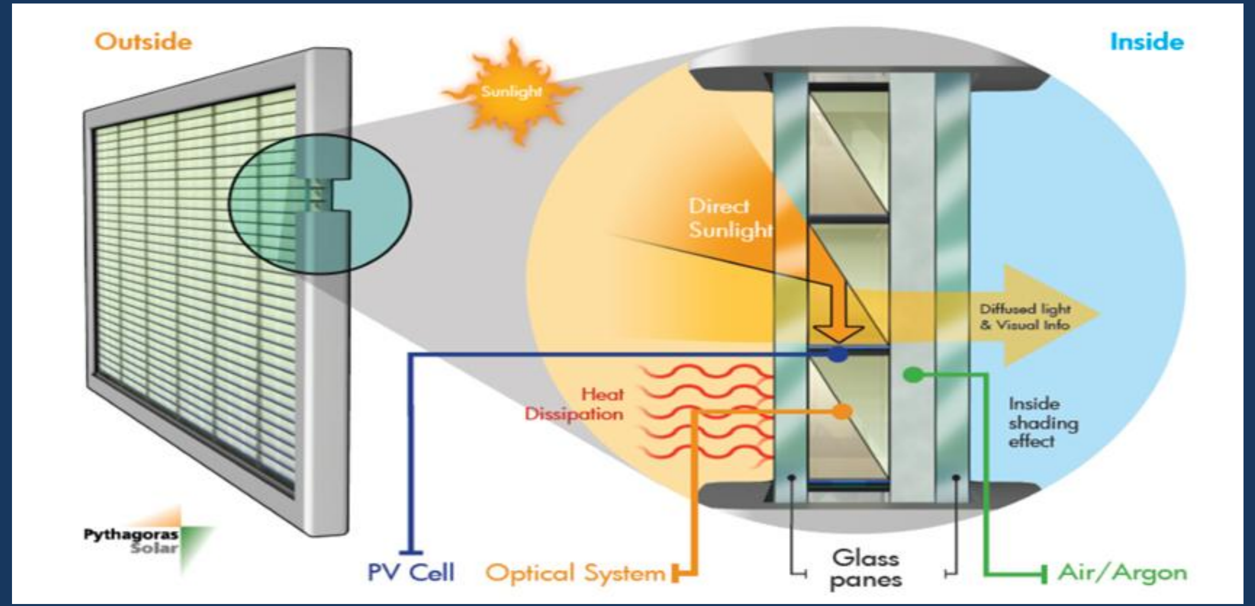
Tilt Angle	90°
Sun Hours/Day	
High	4.5
Low	3.37
Average	4.13

Photovoltaic Façade Change

Recommendation

- Photovoltaic Glass Panels are not recommended for use on this project.

Photovoltaic Façade Change



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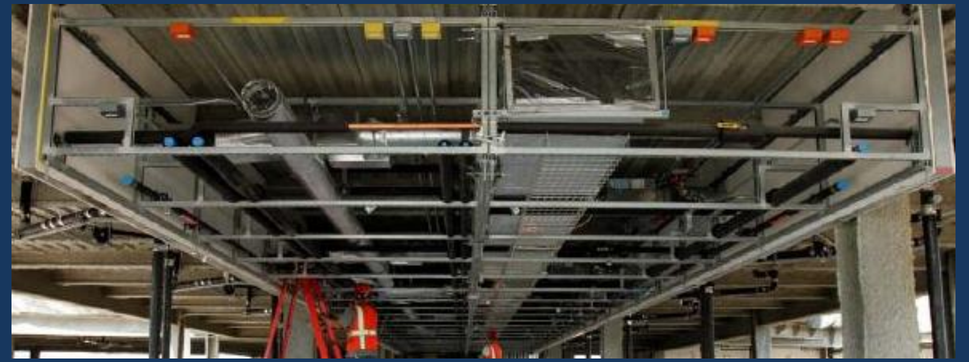
Analysis IV –Prefabricated MEP Systems

Prefabricated MEP Systems



Prefabricated MEP Systems

Problem - Project is several months behind schedule due to continuous delays and restricted work hours

Goal - Reduce the construction schedule through the use of prefabricated MEP Systems

Prefabricated MEP Systems

Benefits of Prefabricated Systems

- Safety
- Quality Control
- Waste Reduction
- Cost Savings
- Schedule Reduction

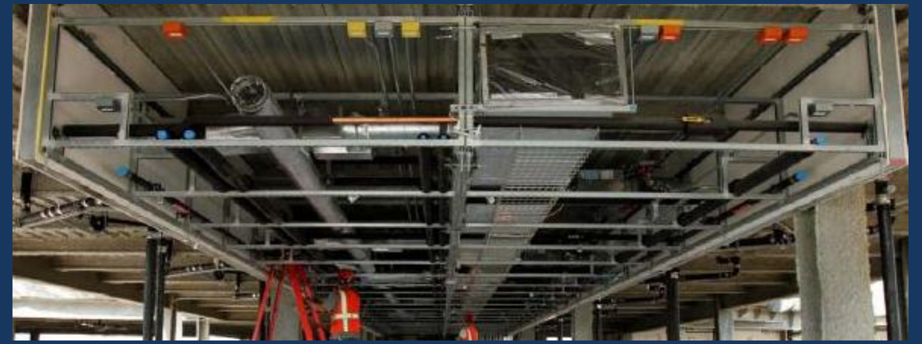
Challenges Facing Prefabricated Systems

- Project Labor Agreement
- Interfering Trade Packages

Prefabricated MEP Systems

(2) Types of Prefabricated Systems to be Used:

Type I – Modular MEP Racks



Prefabricated MEP Systems

"You will save anywhere between 75% to 85% of the critical path labor hours by utilizing prefabricated MEP modules opposed to using the traditional method."

-MEP Solutions

Estimated 50% time saved by separate prefabricated utilities

Prefabricated MEP Systems

(2) Types of Prefabricated Systems to be Used:

Type II – Separate Utilities

Prefabricated MEP Systems

Schedule Reduction

- Estimated Time Savings is around 65% of original duration

Summary of Schedule Reduction per Floor		
	Original Duration (days)	**Modified Duration (days)**
Electrical Rough-In	80 x .65	28
Mechanical Rough-In	74 x .65	26
Plumbing Rough-In	64 x .65	23

Prefabricated MEP Systems

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-MEP Solutions

Estimated 50% time saved by separate prefabricated utilities

Prefabricated MEP Systems

Cost Savings

Summary of Labor Cost Savings		
	Traditional Method	**Prefabrication Method**
Electrical Rough-In	$1,608,455.10	$562,959.28
Mechanical Rough-In	$1,445,818.96	$507,990.45
Plumbing Rough-In	$935,720.31	$336,274.49
In-Shop Labor	N/A	$815,511.87
Crane Operator	N/A	$25,634.67
Total	$3,989,994.36	$2,248,370.75
Cost Savings		44%

Prefabricated MEP Systems

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Prefabricated MEP Systems

Outcome

- Prefabricated MEP results in significant schedule savings
- Labor costs can be reduced by around 44% across all applicable trades
- Increased safety and quality control can be expected

Prefabricated MEP Systems

Cost Savings

Summary of Labor Cost Savings		
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Prefabricated MEP Systems

Recommendation

- This method is recommended for use on this project

Prefabricated MEP Systems

Cost Savings

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Conclusions and Recommendations

- Analysis #1 – Because the schedule was not reduced an no money was saved, prefabricated acoustical walls are not recommended
- Analysis #2 – Due to the time savings and increased quality for hospital patrons, phased scheduling and 3D modeling is recommended
- Analysis #3 – Because the PVGU system does not repay their cost within 25 years, this system is not recommended
- Analysis #4 – Due to schedule and cost savings along with increased safety, the prefabricated MEP method is recommended for use in this project

University Health System| Charlottesville, VA

Central Bed Tower Expansion

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Construction Management| 2011-2012

Acknowledgements

Dr. Craig Dubler

Professor James Faust

Professor Moses Ling

Penn State AE Faculty

HBE Project Team

My Friends and Family

Acknowledgements

University of Virginia Health System

Gilbane Russell Trust + Teamwork = Solutions

SmithGroup architecture engineering interiors planning

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Construction Management| 2011-2012

Questions

Appendices

Absorption Coefficient of Adjacent Room

Type	No. of Type	Size	Total Size (ft²)	α (decimal percent)	a (sabins)
Wall	2	16'x14'	448	.55	246.4
	2	10'x14'	280		154
Ceiling	1	10'x16'	160	.38	60.8
Floor	1	10'x16'	160	.02	3.2
Total	464.4 sabins				

R.S. Means Wall Assembly Cost

Item	Quantity	Material($)	Installation($)	Sub-Total ($)	Total($)
Metal Stud	1	.67	1.01	1.68	1.68
5/8" GWB	4	.31	.53	.84	3.36
3-1/2" Fiberglass Insulation	1	.59	.39	.98	.98
Taping & Finishing	2	.10	1.06	1.16	2.32
Total Cost	$8.34 x (93.4/100) x .836 = $6.51			$6.51/ft²	

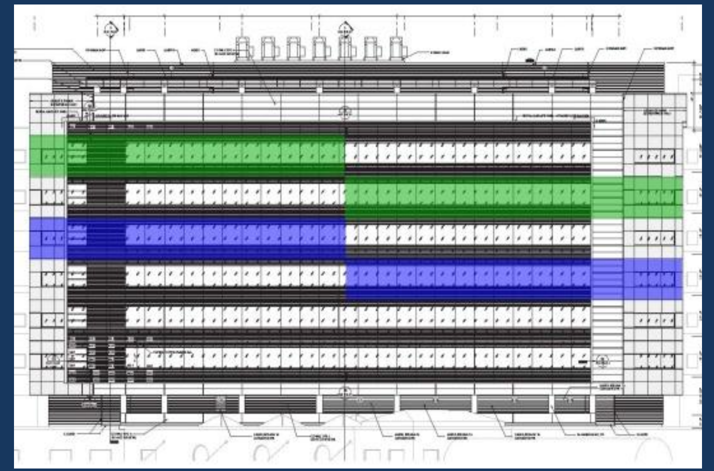
Appendices

Color Key

Renovation in Progress

Enclosures Erected

Complete



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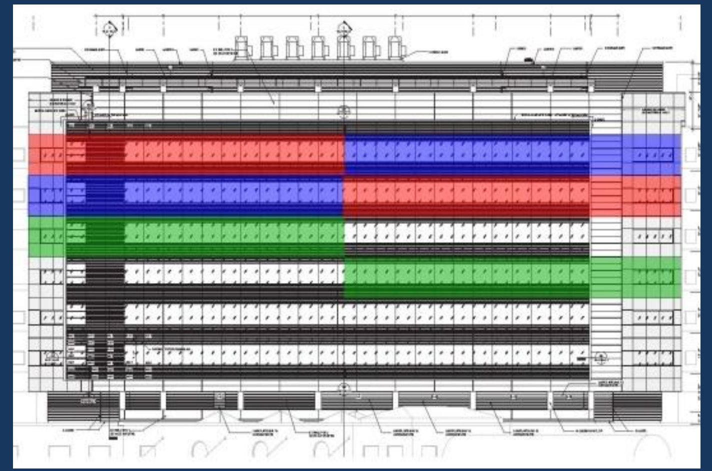

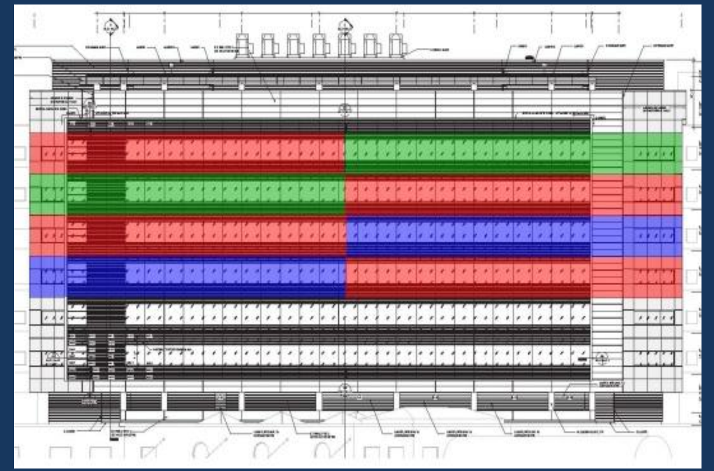

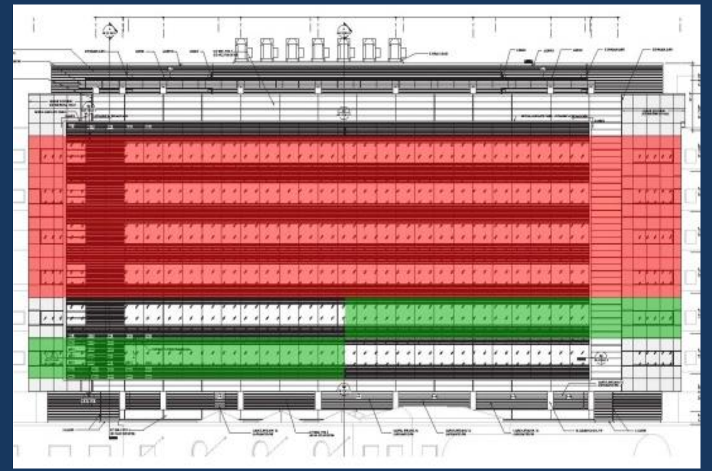

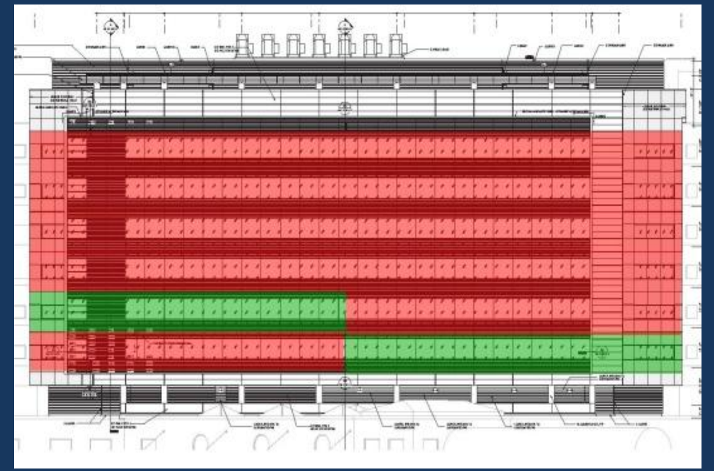

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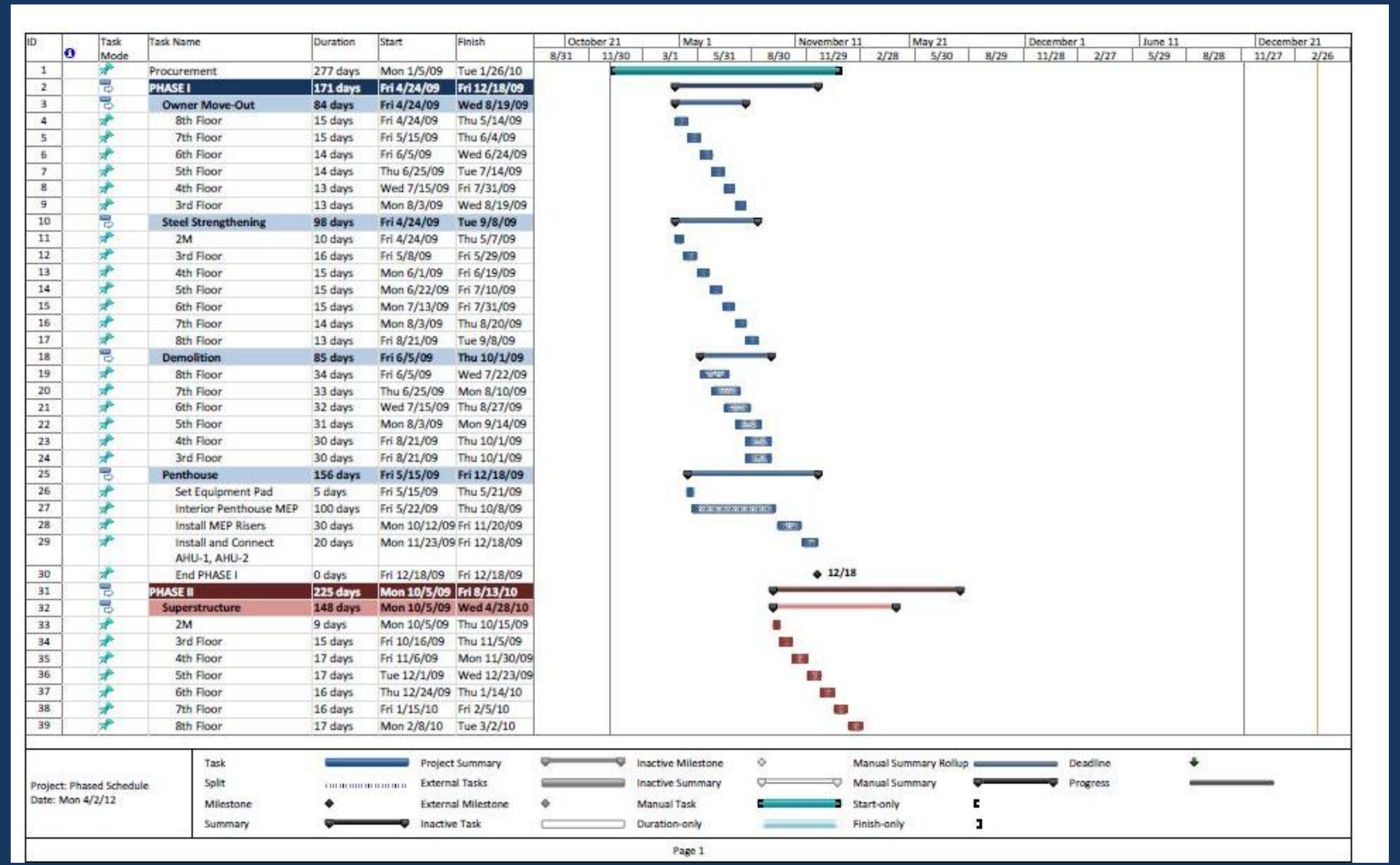
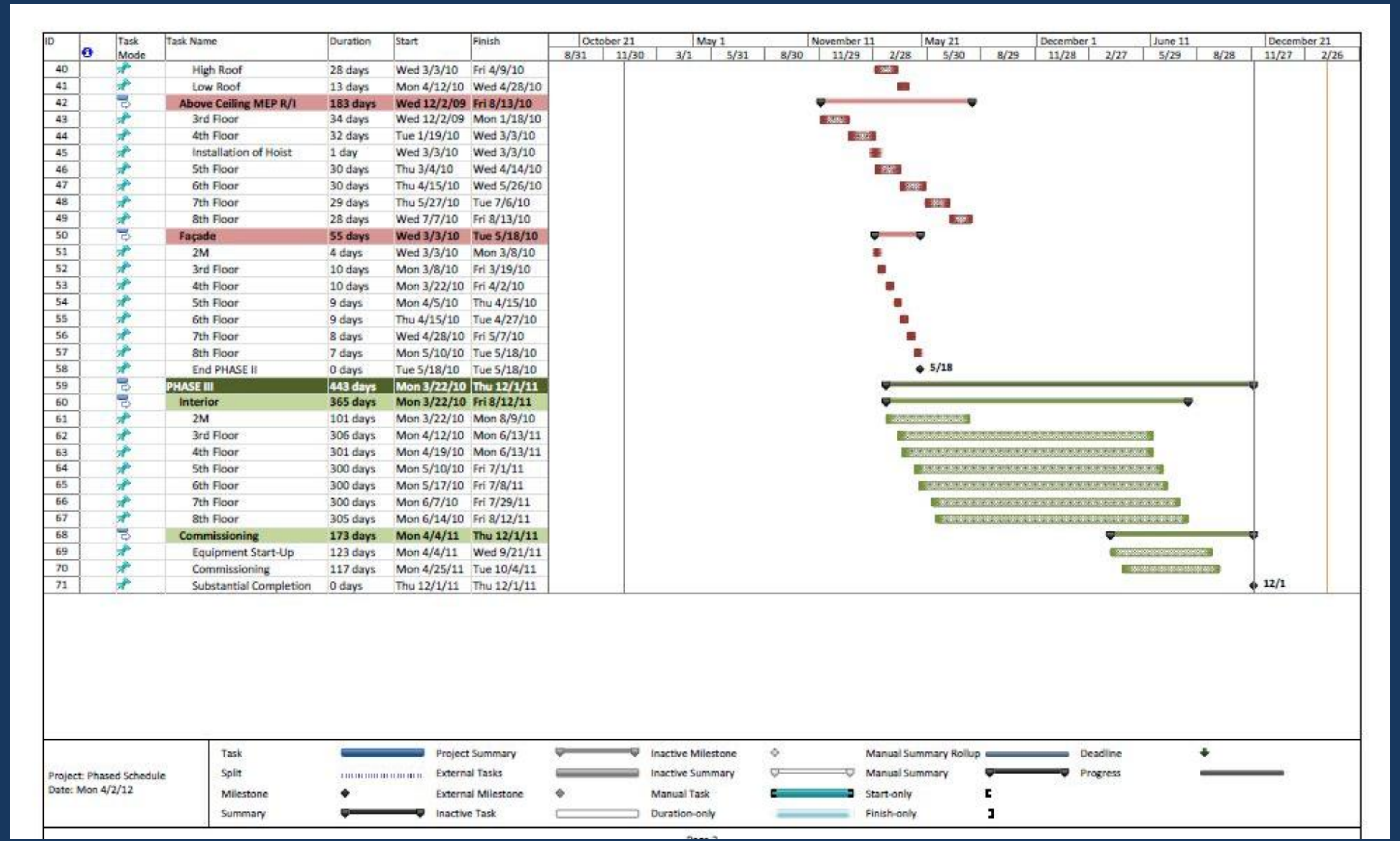


ID	Task Mode	Task Name	Duration	Start	Finish
1		Procurement	277 days	Mon 1/5/09	Tue 1/26/10
2		**PHASE I**	**171 days**	**Fri 4/24/09**	**Fri 12/18/09**
3		**Owner Move-Out**	**84 days**	**Fri 4/24/09**	**Wed 8/19/09**
4		8th Floor	15 days	Fri 4/24/09	Thu 5/14/09
5		7th Floor	15 days	Fri 5/15/09	Thu 6/4/09
6		6th Floor	14 days	Fri 6/5/09	Wed 6/24/09
7		5th Floor	14 days	Thu 6/25/09	Tue 7/14/09
8		4th Floor	13 days	Wed 7/15/09	Fri 7/31/09
9		3rd Floor	13 days	Mon 8/3/09	Wed 8/19/09
10		**Steel Strengthening**	**98 days**	**Fri 4/24/09**	**Tue 9/8/09**
11		2M	10 days	Fri 4/24/09	Thu 5/7/09
12		3rd Floor	16 days	Fri 5/8/09	Fri 5/29/09
13		4th Floor	15 days	Mon 6/1/09	Fri 6/19/09
14		5th Floor	15 days	Mon 6/22/09	Fri 7/10/09
15		6th Floor	15 days	Mon 7/13/09	Fri 7/31/09
16		7th Floor	14 days	Mon 8/3/09	Thu 8/20/09
17		8th Floor	13 days	Fri 8/21/09	Tue 9/8/09
18		**Demolition**	**85 days**	**Fri 6/5/09**	**Thu 10/1/09**
19		8th Floor	34 days	Fri 6/5/09	Wed 7/22/09
20		7th Floor	33 days	Thu 6/25/09	Mon 8/10/09
21		6th Floor	32 days	Wed 7/15/09	Thu 8/27/09
22		5th Floor	31 days	Mon 8/3/09	Mon 9/14/09
23		4th Floor	30 days	Fri 8/21/09	Thu 10/1/09
24		3rd Floor	30 days	Fri 8/21/09	Thu 10/1/09
25		**Penthouse**	**156 days**	**Fri 5/15/09**	**Fri 12/18/09**
26		Set Equipment Pad	5 days	Fri 5/15/09	Thu 5/21/09
27		Interior Penthouse MEP	100 days	Fri 5/22/09	Thu 10/8/09
28		Install MEP Risers	30 days	Mon 10/12/09	Fri 11/20/09
29		Install and Connect AHU-1, AHU-2	20 days	Mon 11/23/09	Fri 12/18/09
30		End PHASE I	0 days	Fri 12/18/09	Fri 12/18/09
31		**PHASE II**	**225 days**	**Mon 10/5/09**	**Fri 8/13/10**
32		**Superstructure**	**148 days**	**Mon 10/5/09**	**Wed 4/28/10**
33		2M	9 days	Mon 10/5/09	Thu 10/15/09
34		3rd Floor	15 days	Fri 10/16/09	Thu 11/5/09
35		4th Floor	17 days	Fri 11/6/09	Mon 11/30/09
36		5th Floor	17 days	Tue 12/1/09	Wed 12/23/09
37		6th Floor	16 days	Thu 12/24/09	Thu 1/14/10
38		7th Floor	16 days	Fri 1/15/10	Fri 2/5/10
39		8th Floor	17 days	Mon 2/8/10	Tue 3/2/10

Project: Phased Schedule
Date: Mon 4/2/12

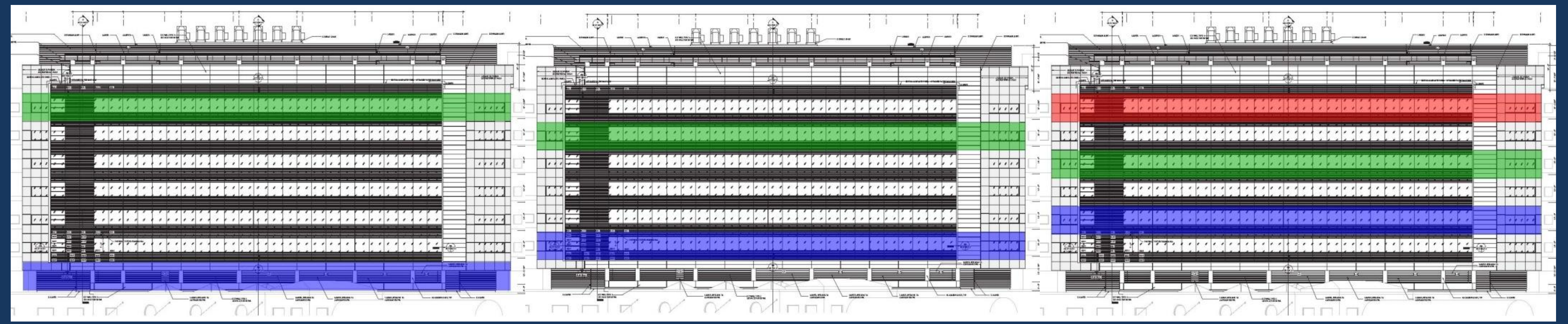
Page 1

Appendices



ID	Task Mode	Task Name	Duration	Start	Finish
40		High Roof	28 days	Wed 3/3/10	Fri 4/9/10
41		Low Roof	13 days	Mon 4/12/10	Wed 4/28/10
42		**Above Ceiling MEP R/I**	**183 days**	**Wed 12/2/09**	**Fri 8/13/10**
43		3rd Floor	34 days	Wed 12/2/09	Mon 1/18/10
44		4th Floor	32 days	Tue 1/19/10	Wed 3/3/10
45		Installation of Hoist	1 day	Wed 3/3/10	Wed 3/3/10
46		5th Floor	30 days	Thu 3/4/10	Wed 4/14/10
47		6th Floor	30 days	Thu 4/15/10	Wed 5/26/10
48		7th Floor	29 days	Thu 5/27/10	Tue 7/6/10
49		8th Floor	28 days	Wed 7/7/10	Fri 8/13/10
50		**Façade**	**55 days**	**Wed 3/3/10**	**Tue 5/18/10**
51		2M	4 days	Wed 3/3/10	Mon 3/8/10
52		3rd Floor	10 days	Mon 3/8/10	Fri 3/19/10
53		4th Floor	10 days	Mon 3/22/10	Fri 4/2/10
54		5th Floor	9 days	Mon 4/5/10	Thu 4/15/10
55		6th Floor	9 days	Thu 4/15/10	Tue 4/27/10
56		7th Floor	8 days	Wed 4/28/10	Fri 5/7/10
57		8th Floor	7 days	Mon 5/10/10	Tue 5/18/10
58		End PHASE II	0 days	Tue 5/18/10	Tue 5/18/10
59		**PHASE III**	**443 days**	**Mon 3/22/10**	**Thu 12/1/11**
60		**Interior**	**365 days**	**Mon 3/22/10**	**Fri 8/12/11**
61		2M	101 days	Mon 3/22/10	Mon 8/9/10
62		3rd Floor	306 days	Mon 4/12/10	Mon 6/13/11
63		4th Floor	301 days	Mon 4/19/10	Mon 6/13/11
64		5th Floor	300 days	Mon 5/10/10	Fri 7/1/11
65		6th Floor	300 days	Mon 5/17/10	Fri 7/8/11
66		7th Floor	300 days	Mon 6/7/10	Fri 7/29/11
67		8th Floor	305 days	Mon 6/14/10	Fri 8/12/11
68		**Commissioning**	**173 days**	**Mon 4/4/11**	**Thu 12/1/11**
69		Equipment Start-Up	123 days	Mon 4/4/11	Wed 9/21/11
70		Commissioning	117 days	Mon 4/25/11	Tue 10/4/11
71		Substantial Completion	0 days	Thu 12/1/11	Thu 12/1/11

Project: Phased Schedule
Date: Mon 4/2/12



Appendices

Single Patient Room				
Light Type	**Description**	**No. of Lamps**	**Wattage**	**Total Watts**
UBM-2	Fluorescent Wallwasher with Recessed Aperture	2	26	52
UBM-3A	Metal Halide Adjustable Accent Luminaire	2	20	40
UBM-4.1A	Linear Fluorescent Surface Mounted	1	24	24
UBM-6A	Compact Fluorescent Shower Light	2	32	64
UBM-6B	Pendent LED Fixture with Mono Point Canopy	2	3	6
UBM-9	Fluorescent Wall Sconce	1	17	17
UBM-12A	Linear Fluorescent Parabolic Downlight	1	54	54
UBM-14A	Surface Mounted Linear Color Changing Uplight	1	54	54
UBM-15A	Fluorescent Staggered Strip - Surface Mounted	3	54	162
UBM-16	Linear Fluorescent Strip - Surface Mounted in Cove	1	39	39
UBM-18	LED Recessed Wall Luminaire for Wet Location	2	3	6
UBM-20	Direct/Indirect Linear Fluorescent Luminaire	2	54	108
UBM-22	Staggered Lamps Continuous Rows Fixture		54	0
UBM-23	Wall Mounted Plug-In With Gooseneck Arm Multi Direction Task Luminaire	1	3	3
Total W/h for one patient room				**629**

Appendices

PVGU Sizing Calculations (Full Lighting Load)		
Sun Hours/Day	4.13	Determined from Wholesale Solar's Solar Mapping Chart
Total Wh/Day	2743.2 kW	114.27 kW/h lighting load multiplied by 24 hours
Watts per Hour of Sunlight	664.21 kW	2743.2 kW/day divided by 4.13 Sun Hours/Day
Actual Produced Power	195.13 W/h	11.15 W/ft² (taken from tech specs) multiplied by 17.5 ft²
# of Panels Required	3504	664.21 kW divided by 195.13 W
Total kW Panels can Produce	464.19 kW	(195. 13 W/h)x(576 panels)x(4.13 hours) divided by 1000
% of Required Power that can be Supplied	17%	464.19 kW ÷ 2743.2 kW

PVGU Sizing (Patient Room Lighting Load)		
Sun Hours/Day	4.13	Determined from Wholesale Solar's Solar Mapping Chart
Total Wh/Day	1087 kW	45.29 kW/h lighting load multiplied by 24 hours
Watts per Hour of Sunlight	263.17 kW	1087 kW/day divided by 4.13 Sun Hours/Day
Actual Produced Power	195.13 W/h	11.15 W/ft² (taken from tech specs) multiplied by 17.5 ft²
# of Panels Required	1348.7	263.17 kW divided by 195.13 W/h
Total kW Panels can Produce	464.19 kW	(195. 13 W/h)x(576 panels)x(4.13 hours) divided by 1000
% of Required Power that can be Supplied	42.7%	464.19 kW ÷ 1087 kW

Appendices

PVGU Design Parameters	
Location	Charlottesville, VA
Latitude	38.03°N
Longitude	78.48°W
Elevation	594' (181m)
Façade Orientation	NNW
Total Area of Glass Facade	17,955 ft²
Area Covered by PVGU	10,080 ft²
Tilt Angle	90°
Sun Hours/Day	
High	4.5
Low	3.37
Average	4.13

COST:

Fronius 7.5-1 → $3,305/Inverter

Total of 14 Inverters for both systems

$3,305 x 14 = $46,270

Total Cost = $46,270